Natural Resource Based Green Supply Chain Management

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To my parents

Liu Muren and Shi Yazhou

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Acronym

SCM = Supply Chain Management

GSCM = Green Supply Chain Management

RBV = Resource Based View

NRBV = Natural Resource Based View

NRB-GSCM = Natural Resource Based – Green Supply Chain Management

Inter-OEPs = Inter – Organisational Environmental Practices

Intra-OEPs = Intra – Organisational Environmental Practices

DfE = Design for Environment

EPB = Environmental Protection Bureaus

SEM = Structural Equation Modeling

EFA = Exploratory Factor Analysis

CFA = Confirmatory Factor Analysis

Cmin = Chi square

DF = Degree of Freedom

CFI = Comparative Fit Index

GFI = Goodness of Fit Index

RMSEA = Root Mean Square Error of Approximation

AVE = Average Variance Extracted

Executive Summary

Increasing specialisation of supply chain functions in business systems requires firm management of natural environmental issues beyond their organisational boundaries. The aim of this research is to conceptualise and empirically verify a structural model of natural resource based green supply chain management (GSCM), and its relationship, with an indication of cause and effect, to relevant GSCM internal mechanisms, antecedent and performance outcomes.

This research designed advanced methodological processes to understand the NRB-GSCM model. First, the methodology captures the background of GSCM and identifies its gaps and establishes research aims and objectives. Second, the methodology involves a comprehensive up to date literature review, which was conducted to identify earlier measurement scales in natural resource based GSCM research. Third, the reliability and validity of the NRB-GSCM model are confirmed through the adoption of advanced statistical analytical processes including data screening, exploratory factor analysis, confirmatory factor analysis and structural equation modelling.

Findings of this research have established a natural resource based green supply chain management model and empirically verified among a representative sample of Chinese aluminum fabrication manufacturers. Intra-organisational and inter-organisational environmental practices were found to have a significant positive influence on environmental, operational and economic performances. Findings also demonstrate that firms can leverage their existing environmental capabilities toward their supply chains and can increase the influence on performance outcomes.

Implication of this research shows that the NRB-GSCM model incorporates a firm's strategic resources and can furnish managers with validated measurement scales to evaluate their strengths and weaknesses in their GSCM implementation and determine how firms can successfully implement GSCM to promote sustainable industrial development.

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Chapter 1 Introduction and Overview

1.1 Introduction

In Our Common Future (1987:P47) the World Commission on Sustainable Development (WCED), defined the term sustainable development '*as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs'*. Similarly, a sustainable enterprise is one that contributes to sustainable development by simultaneously delivering economic, social and environmental benefits – the so-called triple bottom line (Elkington, 1994). The economic development in China has seen some dramatic improvements during the beginning of the 21st Century. China's steady annual GDP growth rate has brought wealth and prosperity to the nation, but at the expense of the Chinese natural environment and society (Peters et al., 2007). As a developing country with a strong reliance on labour and pollution intensive industries, China has to balance its economic, social and environmental performances (Peters et al., 2007). In response to concerns over the integration of economics, environment and society, Green Supply Chain Management (GSCM) has been developed, which takes environmental and social elements into consideration when managing the supply chain. GSCM aims to maximise overall environmental and social profit by adopting a life cycle approach through product design, material selection, manufacturing, and sales and recovery, and therefore helps the firm to realise its sustainable development and improvement.

Over the last decade or so, the GSCM literature has grown considerably. Theory and empirical research to date has explored the implementation and effects of such practices as eco-design, cleaner production, environmental purchasing, and green/reverse logistics, on selected performance outcomes, using economic, operational and environmental measures. However, this work is still arguably preliminary and questions still remain. For example, there are still GSCM practices that have not been explored in terms of the effects on performance outcomes. In addition, organisational theory, particularly the natural resource based view and

institutional theory, has remained relatively unexplored, both theoretically and empirically, and offers potentially important insights on how firms successfully configure, coordinate and adopt energy efficient and low carbon technologies throughout their supply chains to promote sustainable development. The few studies that have explored organisational theory and its impact on GSCM have focused on only a few independent/moderating variables and have raised more questions than answers.

1.2 Green Supply Chain Management

1.2.1 Development of GSCM

The emergence of SCM and then GSCM, is associated with the considerable expansion of supply chains into international locations that has occurred during the last three decades, especially in the automobile, consumer electronics and textile industries (Ballou et al., 2000). This growth in globalisation and the additional management it brings has captured the attention of senior level management in numerous organisations (Coyle and Bardi, 2002). Efficient supply chain configuration is associated with the rise of Japanese manufacturing power and their concept of 'Keiretsu' business systems in the 1980s. Concepts such as total cost of ownership, product life cycle analysis and long term collaborative relationships with suppliers began to be used in a growing number of organisations (Womack et al., 1990, Coyle and Bardi, 2002, Cousins and Lamming, 2008). Gradually, SCM gained popularity during the 1990s and continues to be a focal point for helping organisations differentiate from their competitors and gain additional competitive advantage in the global market place, through co-ordination with the suppliers upstream, and with customers downstream (Coyle and Bardi, 2002). To a further extent, this supplier-customer co-ordination could stretch from the primary materials sourcing to manufacturing to distribution to retailers and to the final customer of the end product and services (Levi and Kaminsky, 1999).

Traditionally, the 'Keiretsu' systems were found to be mostly locally based customer and supplier relationships (Womack et al., 1990). This however is shifting towards more geographically dispersed systems, with firms sourcing a portion of their assembly and manufacturing work across continental boundaries.

Chinese manufacturing plays a critical role in the global supply chain and is another reason for the chosen research context. China's competitiveness is often associated with a relatively lower cost for manufacturing labour intensive products; a willingness to leap into productivity increases within a short period of time; extensive experience in manufacturing for the global supply chain as well as in international trade; and a first mover advantage for large scale infrastructure improvement among other developing countries that encourage easier and lower cost for transportation (Economist, Apr 21st 2012). Consequently, asset specificity and the cost for switching to other suppliers enable many Chinese manufacturing firms to suffer less from demand fluctuation. Most of the Chinese manufacturing capacity also is in the form of clusters with close geographical proximity, which brings down the cost for component sourcing and increases the ability to mobilise migrant labour within a short period of time. For example, China's coastal city Shenzhen demonstrated a good showcase as it was transformed from a poor fishing village in less than thirty years into one of China's richest cities. Its population is now around 12million, including about 6 million migrant workers (Economist, Apr 21st 2012).

However, despite the above-mentioned manufacturing competitive advantage, the lack of research and innovation in relation to product and process design and environmental protection development are fatal weaknesses to the survival of many Chinese manufacturers when facing future competition. Foreign manufacturing firms are more likely than Chinese companies to introduce new and innovative products (Economist, Apr 21st 2012). The U.S manufacturing sector consists of 11% of GDP, but it is account for 68% of domestic spending on R&D. As manufacturing goes digital, many manufacturing jobs are most likely to move from the labour intensive type to the more knowledge intensive type, by deploying automated assembly lines with enhanced flexibility with the manufacturing jobs done with machines rather than people. As the trend continues many 'job-light' manufacturing jobs are created, bringing in a whole range of jobs such as designers, IT specialists, accountants, logistics experts, and marketing staff, all feeding into the manufacturing supply

chain which will bring benefits to the larger economy (ibid). Many Chinese manufacturers severely lack such capability. America's manufacturing output in dollar terms is similar to China's, but it achieves this with only 10% of the workforce deployed by China (ibid).

There is a lack of capability and resources which are the main constraints for environmental protection efforts in China (Christmann and Taylor, 2001). Chinese manufacturers lack the investment for research and innovation for developing environmental technologies. This, combined with the absence of domestic environmental protection industries, means that environmental technologies must be imported (ibid). It is clear that as SCM in manufacturing goes digital, it will encourage a paradigm shift from low cost manufacturing to SCM capability development. For example, instead of focusing more on controllable intra-functional management within organisational boundaries, a drive towards inter-organisational coordination beyond the immediate function is anticipated. Although difficult, it offers under-explored opportunities (Ballou et al., 2000). Through exploring opportunities in supply chain management, Chinese manufacturers need to have a clearer vision for the manufacturing of the future, leveraging their existing capabilities and developing skills that enable them make better quality products, with more efficient and environmentally friendly production.

A number of authors attempt to define supply chain management. Ellram (1991) refers to a supply chain as a network of firms interacting to deliver products or services to the end customer, linking flows from raw material supply to final delivery. Christopher (1992) suggests that a supply chain is a network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer. Saunders (1994) argues that the supply chain is the total chain of exchange from original source of raw material, through the various firms involved in extracting and processing raw materials, manufacturing, assembling, distributing and retailing to the ultimate end customers. Handfield and Nichols (2002b) argue that SCM is an integrated management system of supply chain organisations and activities through cooperative organisational relationships, business processes, and high levels of information sharing systems that provide member organisations a sustainable competitive advantage.

In addition, firms that successfully implement their SCM can yield the following benefits:

- Increased recognition of the supply chain's contribution to the firm's strategy and the impacts on the firm's financial returns, whilst helping to increase their market share with a consequent improvement in shareholder value (Ballou et al., 2000).
- Firms can also strive for kaizen, or continuous improvement in internal processes. Using concepts such as lean manufacturing and lean supply, firms attempt to eliminate costs by innovating to improve efficiency and reduce waste with their own enterprises and across their entire business system (Cousins and Lamming, 2008, Handfield and Nichols, 2002a).
- SCM enables management to focus on the overall profitability of the supply chain, increasing revenues by having just-in-time (JIT) scheduling, vendor managed inventory and decreased spending through lean manufacturing techniques for more efficient material, financial and information flows (Levi and Kaminsky, 1999).
- SCM encourages a shift from low-cost manufacturing to more value creation with links in R&D and distributions.

Following the above discussion, it is clear that SCM encompasses all organisational activities associated with the flow and transformation of goods from raw materials to the end-user, as well as the associated information flows (Coyle and Bardi, 2002). Material and information flows in the supply chain are often considered as linear processes (ibid) and also detached from the natural world in the wider sense. In contrast, this research views the industrial world as a part of the natural system, providing an opportunity in understanding the value of modelling the industrial system as an eco-system to achieve sustainable performance (Lowe and Moran, 1997).

1.2.2 Definition of Green Supply Chain Management

GSCM has emerged as an important organisational philosophy to achieve corporate economic profit whilst also improving the environmental and social performance of the organisation and their partners (Van Hoek, 2002). For example, many multi-national companies (MNC) that operate in less developed countries face challenges concerning their supply chains. For example, campaigners against harsh working conditions and environmental deterioration are increasing; and, unions from the MNC home country can also be negative towards competition from low-wage countries and will likely pounce on any hint of scandal in the supply chain operation (Economist, Mar 31st 2012). Klassen and Angell (1998) note forces that drive firms to adopt GSCM practices can include:

1. The decline of natural resources and associated price increases on raw materials are causing procurement problems for manufacturing organisations (ibid).
2. Customers and regulatory bodies are demanding environmentally friendly practice and competitors are gaining advantage from environmental technological investment (ibid).
3. Shareholders are including environmentally friendly practice in their investment portfolio considerations (ibid).

According to Zhu and Sarkis (2008:P262) the scope of GSCM practices range from "*green purchasing to integrated life-cycle management of supply chains flowing from supplier, through to manufacturer, customer, and closing the loop with reverse logistics*".

Sarkis (2003) suggests the 'closed looped' system philosophy of 'eco-system' thinking is not explicitly included in the common supply chain definition. The author suggests integration of green values into a fully cyclical supply chain is needed to contribute to mainstream operations management literature. To understand green supply chain strategy holistically, it is important to clarify some earlier definitions on corporate environmentalism, which range from reactive monitoring of environmental impacts to a more proactive approach in adopting pollution prevention technologies, encouraging recycling, reuse, reclamation, remanufacturing and reverse logistics

(Sarkis, 2003). By taking the environmental management approach into a supply chain perspective, Messelbeck and Whaley (1999) suggest that the supply chain network not only consists of suppliers, distributors, and consumers, but that the transportation between the supplier and the consumer, along with the environmental effects of research and development, production, storage, and the waste stream must be considered.

A number of research papers have theorised about the factors that facilitate effective environmental management of suppliers. They view SCM as a purchasing function with involvement in environmental activities that include reduction, recycling, reuse and substitution of materials and suggest innovations in SCM and industrial purchasing may be considered in the context of the environment (Narasimhan and Carter, 1998, Green and Morton, 1998). Similarly, Handfield and Sroufe (2005:P7) defined GSCM as "*a formal system that integrates strategic, functional and operational procedures and processes for training, summarizing and reporting environmental information to stakeholders of the firm*". A green purchasing strategy can be applied to a series of lower-level tactical and operational decisions. This process primarily focuses on supplier performance, audit, design, waste minimisation, training, reporting to top management and goal setting (Handfield and Sroufe, 2005).

Some definitions of GSCM (Table 1) require firms to address environmental impacts from their intra-organisational products and operations, in addition to inter-organisational environmental initiatives, and to take a more holistic view rather than a single perspective. Zsidisin and Siferd (2001) criticised the shortcoming of this argument in two respects: first, the definition is solely based on the purchasing perspective and second, there is insufficient explanation to capture the holistic and synergistic impact that inter-organisational practice has on the natural environment. Zsidisin and Siferd (2001:P69) redefined the term so that "*green supply chain management is the set of supply chain management policies held, actions taken and relationships formed in response to concerns related to the natural environment with regard to the design, acquisition, production, distribution, use, reuse and disposal of the firms goods and services*."

This research builds on earlier definitions of GSCM, summarised in Table 1suggests that firms need to address environmental impacts from a more holistic view rather than a single perspective, and that environmental issues would need to be incorporated into a firm's intra-organisational products and operations, as well as their inter-organisational environmental initiatives.

Table 1 GSCM Definitions

Source	Year	Page	Definition
Lee and Klassen	(2008)	575	"GSCM can be defined as a buying organisation's plans and activities that integrate environmental issues into supply chain management in order to improve the environmental performance of suppliers and customers"
Carter and Roger	(2008)	368	"SSCM 'as the strategic, transparent integration and achievement of an organisation's social, environmental, and economic goals in the systemic coordination of key inter-organisational business processes for improving the long-term economic performance of the individual company and its supply chains"
Seuring and Müller	(2008)	1700	"Sustainable SCM is the management of material, information and capital flows as well as cooperation among companies along the supply chain while integrating goals from all three dimensions of sustainable development, i.e., economic, environmental and social, which are derived from customer and stakeholder requirements. In sustainable supply chains, environmental and social criteria need to be fulfilled by the members to remain within the supply chain, while it is expected that competitiveness would be maintained through meeting customer needs and related economic criteria."
Srivastava	(2007)	54-55	"Integrating environment thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life."
Lutz Preuss (Sarkis Book)	(2006)	206	"Greener supply chain management should address three interrelated task areas, upstream, internal and downstream of the organisation. Upstream of the organisation, supply chain managers can address the environment in the supplier selection and evaluation criteria and in the specifications for components; they might be involved in green joint design activities with suppliers or product life-cycle analyses. Within the organisation, supply chain management might be involved in initiatives like design for environment, the establishment of an environmental management system or the handling of products. Downstream of the organisation supply chain management is often charged with the responsibility for disposal and the sale of excess stock, including opportunities for recovery and recycling of materials."
Zsidisin and Siferd	(2001)	69	''Environmental purchasing for an individual firm is the set of supply chain policies held, actions taken, and relationships formed in response to concerns associated with the natural environment. These concerns relate to the acquisition of raw materials, including supplier selection, evaluation and development; Suppliers' operations; in-bound distribution; packaging; recycling; reuse; resource reduction; and final disposal of the firm's products."

1.3 GSCM Theoretical Perspectives

Earlier GSCM work has largely focused on two different theoretical perspectives; namely, transaction cost economics (TCE) and the RBV; the latter extending to the NRBV. This research critically evaluates both streams of literature and argues the rationale for choosing the NRBV.

1.3.1 GSCM from Transaction Cost Economics Theory

Earlier works of TCE, can be traced back to the understanding of the 'Nature of the Firm' by Coase (1937). The author criticised neo-classical economic assumptions, suggesting there are costs involved when using market coordinating mechanisms and the main reason for establishing a firm is to reduce the cost of using price mechanisms (ibid). Williamson (1996) proposed behaviour and other transaction dimensions in explaining the governance structure of the firm. First, the behaviour dimension describes bounded rationality (which assumes limited capacity to resolve complex issues in the real world) and opportunism (which describes self-interests seeking practice such as cheating and passing false information). Second, the transaction dimensions include: 1) The frequency with which they recur (the higher the frequencies of exchange, the more likely the firm is to integrate); 2) The degree and type of uncertainty to which they are subject (uncertainties of future market states include ex ante cost and ex post costs); and, 3) Conditions of asset specificity (the degree to which an asset can be redeployed to alternative uses and by alternative users without the sacrifice of productive value).

Transaction cost economic theory suggests that the degree of asset specificity determines how much resources firms are willing to commit to their inter-organisational relationships. Thus the level of environmentally friendly practice is often determined by the degree of resource commitment between two contractual parties (Vachon, 2007; Jiang, 2009). Vachon (2007) incorporates GSCM using TCE theory. Two types of GSCM practices were identified: (1) environmental monitoring and, (2) environmental collaboration. Environmental monitoring uses market- and

arm's-length transactions, and focuses on control and evaluation to ensure members of the supply chain are in compliance with regulatory requirements. Thus to minimise risks for non-compliances, this externalisation orientated approach does not necessarily commit firms to significant resources outside the firm. Another approach refers to environmental collaboration, which is internalisation oriented, and requires firms to commit resources with other organisations and jointly provide solutions to environmental issues (ibid). According to Vachon (2007) manufacturers with a high degree of logistical integration are associated with incomplete contracts and more mature relationships. This reduces the need for control and monitoring activities, which will consequently reduce the need for environmental monitoring activities. In contrast, logistical integration demonstrated with shared understanding of goals and extensive information exchange, would increase the level of environmental collaboration activities. Similarly, technological supply chain integration, with strategic knowledge flow between organisations, is a form of asset specific investment, and would increase environmental collaboration and decrease the need for environmental monitoring and control. In addition, their research found that a reduced supply chain base would increase the level of environmental collaboration.

Similarly, Jiang's (2009) research, which also applied asset specificity, found peer to peer governance linked with supplier commitment to compliance with environmental and social initiatives. The research found that the complexity of products as well as the duration of contracts, are both positively and significantly related to peer to peer (asset specific) governance and that this encourages the supplier's commitment. In contrast, the research also found that buyer-supplier governance might not necessarily encourage suppliers to commit on green purchasing, due to the buyers having no asset specific investment to lose and the suppliers lack of reward, for example a longer-term contract. A lack of asset specific investment on a green purchasing programme would only encourage suppliers to do just enough for not being caught (ibid).

1.3.2 Resource Based View (RBV)

1.3.2.1 Characteristics of RBV

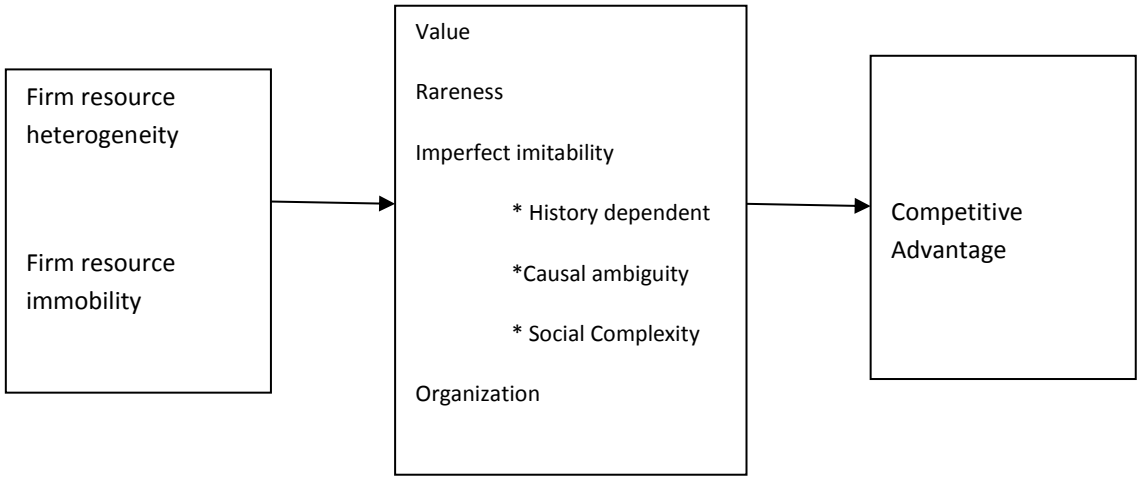
RBV explicitly focuses on the productive resources and capabilities of firms and explores the possibility that the choice of governance cannot be separated from analysing how the tangible and intangible resources, controlled by firms in an exchange, create value in that exchange (Barney, 2007). First, it must sometimes be the case that a firm does not possess all the resources and capabilities it needs to be competitively successful. Second, it must be difficult or costly for a firm to create that resource or capability on its own. Finally, it must be difficult for a firm without a resource or capability that it needs to be successful to gain access to that resource or capability by acquiring a firm that already has it (ibid).

From the RBV perspective, it is important to recognise that it is a firm's bundle of resources rather than a product deployment of those resources that determines a firm's competitive position (Wernerfelt, 1984). If the strategic factor market is perfectly competitive, even if firms implementing strategies that create an imperfectly competitive product market, those strategies are not a source of economic rents (Barney, 1986). In contrast, one firm's expectations on strategic factors are different from another. This heterogeneous nature of a firm's expectations makes it possible for certain firms to obtain above normal returns from acquiring strategic resources to implement a product market strategy. The fundamental assumptions of the RBV theory (see Figure 1) relates to a firm's resource heterogeneity and immobility. Barney (1986, 1991) argues that firms could not expect to obtain sustained competitive advantage when strategic resources, such as human, organisational, and financial resources, are evenly distributed across competing firms and that they are highly transferable.

Instead, the RBV theory focuses on the importance of organisational resources that are valuable, rare, inimitable and non-substitutable (Barney, 1991). The inimitability of a firm's strategic resources provides the firm with a protective mechanism from competitors acquiring similar resources. This is because such resources can be causally ambiguous, as they have developed over time through repeated learning and

experience, as well as socially complex, through highly coordinated activities involving large numbers of people and teams, i.e., few individuals would have sufficient knowledge about the overall phenomenon (Barney, 1991). By extending environmental values as a firm's causally ambiguous and socially complex resources can create competitive advantage.

Figure 1 Conceptual Linkage of Heterogeneity & Immobility, Resources and Sustained Competitive Advantage



Source: Adapted from Barney (2007) Resource Based Theory

1.3.2.2 Critics of RBV

Despite the importance of RBV in explaining a firm's strategic behaviours, research from the TCE perspective criticises the RBV theory arguing that it has: 1) an absence of a behaviour dimension such as opportunism; 2) a narrow view at its analytical core; and, 3) a lack of explanation on competitive activity and market power (Lewin and Phelan 2000; Priem and Butler 2001; Foss and Knudsen 2001).

First, the absence of opportunism concerns the predictive power of RBV and it is not clear what limits the size of the firm (Williamson, 1999). Without opportunism actors could meet under the same roof and enjoy the same learning benefits as anticipated in the firm according to Foss (1996). Chi (1994) argues that the absence

of transaction costs in RBV means that it is not possible to frame corporate strategy issues such as the choice of distribution channels, and the relations to suppliers in terms of comparative contracting.

Second, Foss (2002) contends that the resource based strategy at its analytical core is the process of creating, capturing, and protecting value and is conceptualised narrowly. Value creation by means of product innovation/differentiation, advertising, improving contractual arrangements and internal organisation (Machovec, 1995) and other ways of reducing inefficiencies cannot be represented (Foss, 2002). Foss (2002) interpreted that in the RBV core model, value creation is represented through the stochastic draw of a technology that is more cost efficient than those controlled by competitors. Value protection is then represented through a barrier to imitation that may protect the relevant rent stream in equilibrium, and capture is correspondingly represented in terms of imitative competition. Protecting rent through barriers on new entry cannot be represented, because the price-taking assumption means that market-power is absent (Foss, 2002).

Lastly, Makowski and Ostroy (2001) argue that the RBV is constrained by a narrow explanation of competitive activities, as they are at best limited to protecting costly-to-imitate, rent-yielding resources. Product differentiation, price discrimination, technological competition, and all the signalling tactics described in the industrial organisation literature are, at best, hard to squeeze into the straitjacket of competitive equilibrium (Ibid). In addition, the RBV lacks an explanation of market power. Foss (2002) argues that the RBV's explanation of market power is excluded, since firms have no bargaining power in the product market. Foss explained competitive advantage cannot be a matter of 'market power' in the sense of Porter's (1980) view of raising price above cost through restricting supply. Thus, there can be no profits from market power, only scarcity rents.

1.3.3 Natural Resource Based View (NRBV)

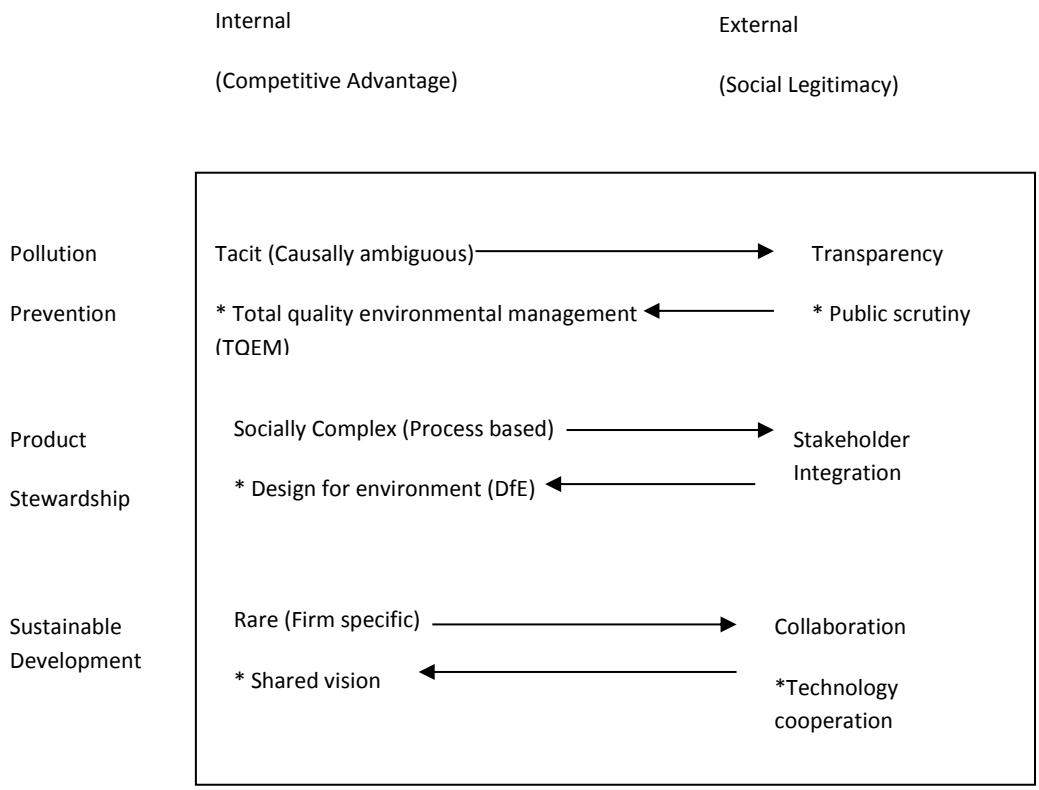
Hart (1995) took a different perspective from Barney (1991) and argued that a purely 'internally based' competitive approach may prove inadequate because of the issue of external relations. In contrast, the author recognises the challenges imposed from both natural and social environments, and suggested it is likely that strategy and competitive advantage are rooted in a firm's capabilities in facilitating environmentally responsible activity (ibid).

The earlier attempts to link environmental values with performance was conceptually proposed by Hart (1995) where NRBV consists of three interconnected strategies (

Figure **2**): 1) pollution prevention which is seen as a causally ambiguous routine that can create a firm's unique cost reductions as its competitive advantage; 2) product stewardship which enables a firm to minimise economic and social costs of the product; and because product stewardship programmes involve strong engagement with external stakeholders, firms can establish socially complex networks to pre-empt competition; and, 3) a shared vision for sustainable development by minimising its environmental impact and demonstrating strong engagement with external stakeholders which should open up future opportunities and gains from a stabilised capability growth for long term competitiveness. This research follows specifically on from Hart's (1995) NRBV framework examining causally ambiguous and socially complex resource on a firm's performance outcomes.

However, although Hart (1995) logically discussed the linkage between corporate environmental strategy and RBV in terms of its inimitability and rareness, the argument lacked empirical support prompting further research with empirical orientation. Sharma and Vredenburg (1998) carried out the first attempt to empirically investigate the NRBV framework, based on a case study of the Canadian oil and gas industry. They identified environmentally responsible practices as a higher order environmental proactive construct involving the following dimensions (Table **2**):

Figure 2 Hart 1995 NRBV Framework



Source: Adapted Hart (1995) Sustained Competitive Advantage

Table 2 Sharma and Vredenburg (1998) Environmental Strategy Measures

Sharma and Vredenburg (1998) Environmental Strategy Measures	Over all Construct Reliability: Cronbach's coefficient alpha: 0.84
Modified business practices to reduce impact on animal species and natural habitats	0.85
Voluntary actions for environmental restoration	0.83
Reduced wastes and emissions from operations	0.81
Reduced purchases of non renewable materials, chemicals, and components	0.84
Reduced the use of traditional fuels, by substitution of, and research	0.83
Reduced energy use	0.82
Reduce the environmental impact of its products	0.97
Reduce the risk of environmental accidents, spills, and releases	0.82
Established partnerships to reduce environmental impact	0.80
Undertakes the actions for environmental audit, public disclosure, employee training and community	0.84

Source: adapted from Sharma and Vredenburg (1998)

Sharma and Vredenburg (1998) found environmentally responsible practices associated with organisational capability, which represents a higher order factor consisting of stakeholder integration, continuous higher order learning and continuous innovation. Although Sharma and Vredenburg's (1998) research found a direct link between organisational capabilities and organisational benefit (such as increased efficiency, productivity, process innovation and knowledge of management operations), they found no direct link between environmentally responsible practices and organisational benefit.

Klassen and Whybark (1999), by identifying the above lack of direct empirical link between proactive environmental practice and performance measures, argue that pollution prevention relies on tacit knowledge and is connected to operational improvement. Their research investigated two types of independent variables of environmental technology: pollution prevention technologies and pollution control technologies. They found that firms that geared towards pollution control (end of pipe solutions) were more likely to incur negative impacts on their manufacturing performance whereas firms that implemented pollution prevention technologies improved their manufacturing performance in terms of cost, speed, quality and flexibility (ibid). In line with Hart's (1995) NRBV proposition, managers can therefore apply pollution prevention strategies to improve their manufacturing performance.

Pollution prevention, by reducing the amount of waste generated from products and processes, demonstrate a firm's proactive attitude toward the environment, that can be later transformed into environmental leadership (Buysse and Verbeke, 2003), which, according to Klassen and Whybark (1999), not only improves the firm's manufacturing performance but can also improves the firm's relationships with government where firms can then take advantage of the cooperative relationship with government in negotiation for future environmental regulations. For example, Buysse and Verbeke's (2003) empirical study, based on sample of 197 Belgium firms, found that environmental strategies based on the level of the firm's environmental proactiveness, involved several simultaneous improvements including shifts from pollution control (end of pipe solution) to pollution prevention and to a higher level of environmental leadership strategies (sustainable strategies). At one level, preventative environmental strategies are strongly linked with regulatory

pressures. As companies shift toward higher-level environmental leadership, the presence of regulatory compliance diminishes. This is because firms taking an environmental leadership view the development of green competencies as a source of competitive advantage rather than as a response to regulatory pressures. Consequently, a firm's relationship with government is more likely to be cooperative rather than based on command and control (Buysse and Verbeke, 2003).

Other research on GSCM attempts to link GSCM with corporate strategy. Instead of studying the link to performance measures, Berchicci et al. (2012) study the interaction of environmental capabilities with corporate strategy. Their research found that a firm with superior environmental capabilities is more likely to acquire physically proximate facilities with inferior environmental capabilities and vice versa. This is due to firms with inferior environmental capabilities are more likely to be associated with weak stock performance, thus they became the target for firms with superior environmental capabilities. Vice versa, firm's with inferior environmental capabilities are likely to acquire firms with stronger environmental performance, because they see that such an acquisition will give them a pathway to access greater environmental capabilities (ibid).

1.3.4 Rational for choosing Natural Resource Based View (NRBV)

Although earlier research applied TCE to identify GSCM from internalisation and externalisation frameworks, Vachon (2007) and Jiang (2009) applied asset specificity to supplier commitment on green purchasing. But the above mentioned research ignores organisational resources and capabilities in making internalisation decisions (Barney, 2007). In addition, the theoretical basis on TCE can focus too narrowly on cost minimisation, and not on value maximisation (Zajac and Olsen, 1993). TCE theory takes the productive capability of firms in an exchange as given and only focuses on how gains from trade in an exchange are to be allocated among those firms (Barney, 2007).

This research recognises that TCE addresses low cost optimisation but is more of a short-term view, and neglects potential gains through collaborative quality and skills

improvement with supply chain partners. There is also an overreliance on the bargaining power among supply chain members, thus constraining the potentials for collaborative capability development of GSCM practices among supply chain members. Consequently, supply chain transformations towards lean manufacturing with a focus on cost effectiveness can pressurise the material-planning department to seek cost reductions (Womack et al., 1990). As a result, a firm's leverage in sourcing strategies is through economies of scale and imposed bargaining powers that maybe useful in the short term to secure 'quick wins' but in the long run the firm's supply chain may be vulnerable. Thus, an overreliance on minimising supply chain transaction costs, in turn, neglects potential gains from capability development.

In response to the RBV's ignorance of opportunism and its narrow view at its analytical core, Conner (1991) suggests that under certain circumstances firms have advantage over market relationships in the joint activity of creating and redeploying specific capital. Further, the advantage of firms in the creation-redeployment combination need not stem from an opportunism-control advantage. Instead, it is argued that the firm has advantage over a collection of market transactions in those situations where redeployment inside the firm is more efficient and more productive because of the opportunity to benefit from asset interdependencies within the firm (Conner, 1991). Following this notion, it is possible that firms benefit from interdependencies among its supply chain members. Based on the above discussion, NRBV theory provides a useful framework in explaining a firm's GSCM as resources/capabilities that would lead to performance improvement.

Building on the GSCM concept, with its particular focus on the environmental dimension of business supply chains, the next section of this research recognises the research gaps in the area of GSCM.

1.4 Research Gaps

Although there are a number of research studies that have identified various dimensions of GSCM (Table 5) and attempted to link NRBV theory with GSCM to explain a firm's competitive position and performance improvement, there are still questions that remain.

Research Gap 1 – Issues on empirical verification of GSCM measurement scales: earlier research in the field has been preoccupied with discussions of what constitutes GSCM and the identification of practices. The majority of empirical research conducted thus far has been primarily case-based and aimed at identifying factors that underpin successful GSCM. Although Zhu and Sarkis (2006) conducted empirical research of GSCM practice and performance in China, their study was limited due to a number of reasons. 1. The study only considered economic and environmental performance and neglected operational issues. 2. The research used convenient sampling and a student population to represent actual practice in the Chinese manufacturing sector. 3, The investigation was restricted to the Dalian economic region and fails to represent the overall manufacturing sector in China. In practice, companies typically make considerable investment in GSCM practices. This makes it particularly important to achieve better performance in order to justify the investment. However, publications are very limited on an effective measurement of GSCM in the existing literature.

Research Gap 2 – Issues on establishing measurements of natural resource attributes of GSCM practices: There is a lack of consensus to clearly define the nature of GSCM practices, partially due to the fact that GSCM is a new area of study, the theory is under developed, and the research is still unclear both as to how specific types of GSCM practices generate tacit (causally ambiguous) and collaborative (socially complex) resources, and to how causally ambiguous resources interact with socially complex resources from a GSCM perspective.

Research Gap 3 – Issues on the understanding of internal mechanisms of GSCM practices: Firm's environmental responsibilities can be associated with a divergence of 'saying' and 'doing'. Many scholars refer this phenomenon as 'green washing', as firms can market themselves as being environmentally proactive by establishing

environmental management procedures and policies, and essentially, since most of their manufacturing activities are outsourced to sub-contractors, the knowledge intensive (highly value added activities) would appear to have less impact on the environment. Although, firms can pass environmental auditing and increase their marketing activities to promote their environmental responsibilities, eventually those superficial improvements would cause more damage when the firm's real environmental damages are exposed. On the other side of coin, while proactive environmental management with firms adopting pollution prevention technologies and implementing EMS can generate significant performance improvement, such effort may only represent their environmental responsibilities within the organisational boundary rather than full responsibility throughout their supply chains. With increasingly strategic management trends towards focusing on core competencies, global sourcing and SCM practices, firms can benefit more financial profitability by delegating low value tasks outside. Consequently, the traditional internalised view on a firm's environmental responsibility may prove to be inadequate. For example, Apple's financial performance and profitability is under threat as there is now increasing pressure on their supply chain labour practices and environmental toxicities from product manufacturing. By outsourcing their production overseas or to other subcontractors, the focal company may not directly be causing environmental impact from manufacturing the physical product; however, their financial profitability is largely dependent on those supply chain partners. With increasing institutional pressures, purely externalising the environmental responsibility outside of the focal firm can be inadequate; any mismanagement of the environmental issues among supply chain partners would have a direct financial consequence and risk a loss of trust from their customers.

Research Gap 4 – Issues on the empirical understanding of the antecedents, mediating factors and consequences of GSCM practice: GSCM research has a lack of in-depth understanding of the impact on performance. At the theoretical level, it is argued that performance improvement of a company can be achieved through deploying GSCM practices (Zhu and Sarkis, 2004a, Klassen and Vachon, 2003). It is also suggested that GSCM impacts on performance through organisational unique resources/capabilities and institutional pressures (Hart, 1995, Darnall, 2006a, Zhu and Sarkis, 2007). The focus of this research is to both identify the antecedents, in

particular the institutional effects on a firm's adoption of GSCM practices, and to examine the direct and mediating effects of GSCM on appropriate performance measures. In addition, the literature has mainly identified GSCM practices from case studies of firms that have achieved successful implementation. The problem with these case studies is that researchers subjectively select companies that have implemented successful GSCM practices – leading, in turn, to problems of establishing both causality and generalisability. Taking the first problem, as the sampling of successful GSCM practices does not vary on the dependent variable, it is not possible to establish causal relationships between practice and performance. It is therefore necessary to include firms that are not practicing GSCM and also firms that fail to gain performance outcomes from their GSCM practice. With the second problem, normative conclusions drawn from these case studies may not be generalisable, thus it is necessary to go beyond small sample groups (Christmann, 2000).

1.5 Aims and Objectives

The aim of this research was to develop and test a generic model of the institutional effect and performance outcomes associated with GSCM, on a sample of Chinese aluminium fabrication firms.

The GSCM practices explored in this research incorporate practices associated with eco-design, green purchasing, internal environmental management and green logistics. The objectives of the main aim are to firstly conceptualise a GSCM measurement model involving institutional effects, GSCM practices and performance outcomes. Secondly, measurement constructs of a NRB-GSCM, based on Intra organisational environmental practices (Intra-OEPs) and Inter organisational environmental practices (Inter-OEPs), GSCM antecedents involving regulatory, market and competitive measures, and environmental, operational and economic performance, measures will be proposed and empirically verified. Finally, the research will empirically test causal relationships of GSCM in a structural model to determine how firms in China can successfully implement GSCM to promote sustainable development.

This study contributes to the literature with the empirical examination of the construct of institutional effects, GSCM practices and performance. This can furnish managers with validated measurement scales to evaluate their strengths and weaknesses in their GSCM implementation. The aims of this research were broken down into the following objectives:

Objective 1: The development of a measurement model (Chapter 2) of GSCM Content, Antecedents and Consequences (addressing research gap 1)

The identification and critical evaluation of GSCM measurement instrument

1. The development of a comprehensive measurement instrument of NRB-GSCM, including: 1) Intra-OEPs; 2) green purchasing; 3) DfE; 4) green logistics; and 5) the identification and critical evaluation of Inter-OEPs as higher order constructs.
2. The development of a comprehensive measurement instrument of the 3 institutional effects, including regulatory-, customer and competitive effects.
3. The development of a comprehensive measurement instrument of 3 performance outcomes, including environmental-, operational-, and economic outcomes.

Objective 2: The development of a conceptual model (Chapter 3) of institutional effects on GSCM practices (addressing research gap 4)

The identification and critical evaluation of institutional effects on GSCM practices:

4. The development of a conceptual model (tier 2) of the effects on, and role of institutional effects on NRB-GSCM.

Objective 3: The development of a conceptual model (Chapter 3) of NRB-GSCM interactive effects (addressing research gap 2 and 3)

5. The development of a conceptual model of the effect on, and role of Intra-OEPs on Inter-OEPs (as higher/second order construct) as well as on all the individual aspects (as lower/first order constructs) of Inter-OEPs.

Objective 4: The development of a conceptual model (Chapter 3) of NRB-GSCM and the relation to performance outcomes (addressing research gap 4)

6. The development of a conceptual model of the effects on, and role of NRB-GSCM on performance outcomes.

Objective 5: The establishment of mediation relationships (tier 4) of NRB-GSCM and Performance Outcomes (addressing research gap 4)

7. The development of a conceptual model of the mediating effect of NRB-GSCM independently and interactively on performance measures;

Objective 6: The establishment of structural model on institutional effect, GSCM practice and performance outcomes (addressing research gap 4)

8. The empirical test of the structural model.

The aim in the first phase of the research, through a critical review of the literature, was to develop a conceptual model of GSCM in a four-tier model involving: 1) institutional effects on NRB-GSCM; 2) an NRB-GSCM interactive effect; 3) the effect of NRB-GSCM on performance outcomes; and, 4) NRB-GSCM and performance mediating effects. From this, causal relationships, in the form of hypotheses, were formulated. Appropriate research methodologies and data analysis techniques are critically evaluated in terms of their capabilities of firstly ensuring validity and reliability of the measurement instrument, and then secondly comprehensively testing the causal relationships – the hypotheses – generated by the conceptual model.

The second phase developed a measurement instrument designed to gather appropriate data to test the hypotheses. This involved an in-depth literature review on earlier empirical studies in this research domain to ensure the questionnaire design adequately measures current institutional effects, GSCM practices and performance. Given the usual difficulties in securing industrial participation, established contacts will be exploited. For this and other reasons highlighted in the methodology chapter, the aluminium fabrication industry in China was selected as the research context. Firstly, the recent, rapid economic expansion, increasing environmental impact and changing social dynamics in China also figured strongly

in the selection, not to mention the environmental burden, and changing nature and challenges facing the aluminium fabrication industry there. Secondly, focusing on the aluminium fabrication industry supported a more in-depth understanding of GSCM implementation. Thirdly, the author had existing contacts with key personnel in the industry that can help to increase the response rate.

This was followed by an empirical test of causal relationships to determine how firms in the Chinese aluminium fabrication industry can successfully implement GSCM to promote sustainable development. A large-scale quantitative survey was employed enabling an advanced statistical analysis using structural equation modelling techniques to confirm/refute causal relationships. To achieve representativeness of the aluminium fabrication industry in China, companies with revenue over 20million RMB and who employ more than 100 people were approached as there were approximately only 391 organisations which accounted for over 60 percent of the entire industry. In focusing on this sector and country, one foreseen limitation was a lack of generalisability to other sectors and countries/regions. A final reflection of how this limitation can be minimised and addressed in future research is given (Table **3**).

Table 3 Links between the research gaps and the objectives

Gap & Objectives	Gap 1 Measurement	Gap 2 NRB-GSCM attribute	Gap 3 GSCM internal mechanisms	Gap 4 Antecedents, Mediating and Performance relationships
Objective 1	Chapter 2	Chapter 2		
Objective 2		Chapter 3		Chapter 3
Objective 3			Chapter 2,3	
Objective 4				Chapter 3,4, 5
Objective 5				Chapter 3,4, 5
Objective 6				Chapter 4,5

1.6 Thesis Structure

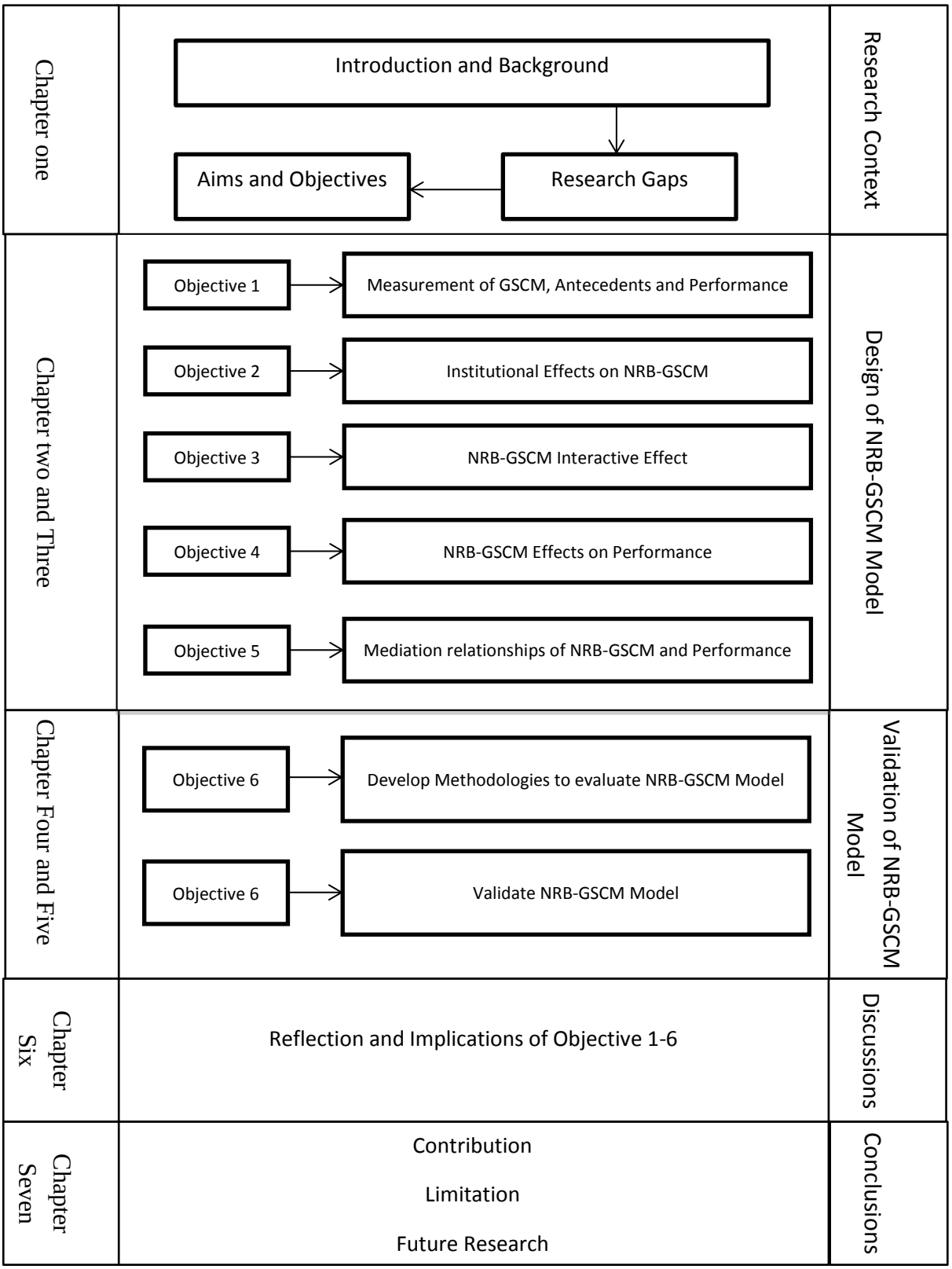
This section briefly illustrates the research process through which a better understanding of GSCM drivers, practices and performance were achieved.

The research followed a logical development of quantitative research methodology and involves five main stages (Table **4**):

1. Literature review (Chapter 2): Firstly, the literature relating to concepts of GSCM was critically reviewed and the components of the overall GSCM construct were identified. Secondly, a critical review of the literature relating to the conceptualisation and operationalisation of institutional effect, GSCM practices and performance was conducted.
2. Research hypotheses development and model generation (Chapter 3): based on theories and existing empirical research findings: The relationships between institutional effects, GSCM practices and performance are elaborated on. Research hypotheses are developed logically and the research model is generated.
3. Research design and methodology (Chapter 4): Discussions are entered into to determine and justify the most appropriate research design and methodology chosen for this research. Sampling procedure, data collection, the design of the survey instrument, questionnaire administration, and validity and reliability of the research design is discussed at the theoretical level.
4. Data analysis (Chapter 5): The most appropriate data analysis techniques of the measurement models are evaluated, particularly a) structural equation modelling (SEM); b) convergent validity of measurement models using confirmatory factor analysis; c) discriminate validity test using Pearson correlation; and, d) reliability tests of each construct using Cronbach's Alpha.
5. Discussions, findings, conclusions and recommendations (Chapter 6, 7): The discussion will be based on the findings from the data analysis and its significance in the context of extant literature. The conclusions will summarise the academic contribution and practical contribution of this empirical study of institutional effects, GSCM practices and performance.

The limitations of the research and recommendations for future research will then be developed and reflected on.

Table 4 Thesis Structure Flow Chart



1.7 Summary

This chapter has outlined the research background, given an introduction to the development of GSCM from the earlier supply chain management (SCM) literature and practices. The major characteristics of GSCM are then critically discussed. The theoretical base of GSCM is critically discussed from the transaction cost economic perspective and resource based view (RBV) and the more recent natural resource based view (NRBV). The rationales for adopting the NRBV theory is justified which provides a foundation for the study of GSCM with its performance relationships. A number of research gaps applying natural resource based green supply chain management (NRB-GSCM) were then identified. Consequently, this process established the aims and objectives. The research process is then proposed to achieve the research objectives. The remaining chapters will move on to the core themes in this research – an in-depth literature review to understand the measurement of GSCM content, GSCM antecedents and GSCM consequences.

Chapter 2 Literature Review

2.1 Introduction

This chapter reviews the literature on the concept and measurement of GSCM, institutional antecedents and performance (Figure 3). With the aim to answer Research Objective 1: The development of a measurement model of GSCM Content, Antecedents and Consequences

The identification and critical evaluation of a GSCM measurement instrument includes:

1. The development of a comprehensive measurement instrument of NRB-GSCM, including: 1) Intra-OEPs; 2) green purchasing; 3) DfE; 4) green logistics; and 5) the identification and critical evaluation of Inter-OEPs as higher order constructs.
2. The development of a comprehensive measurement instrument of the 3 institutional effects, including regulatory-, customer and competitive effects.
3. The development of a comprehensive measurement instrument of 3 performance outcomes, including environmental-, operational-, and economic outcomes.

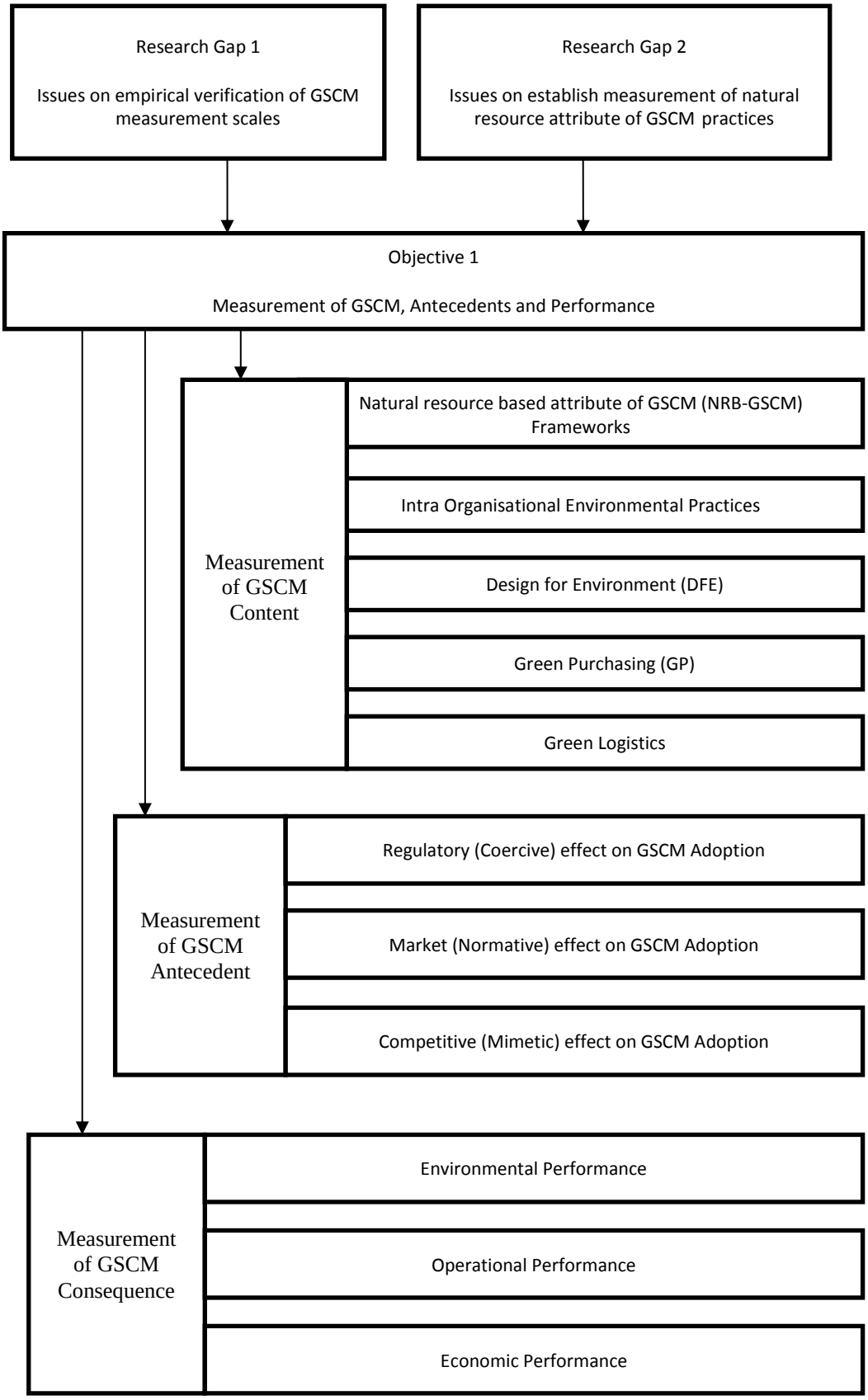
This chapter first clarifies dimensions of GSCM through providing a sample of GSCM conceptual definitions. A review of the literature on natural resource based GSCM then identifies intra-organisational environmental practices (intra-OEPs) that represent causally ambiguous resources and that inter-organisational practices (inter-OEPs) represent socially complex resources. This is followed by a discussion of various dimensions of GSCM including four constructs which are critically evaluated: 1) Intra-OEPs; 2) DfE; 3) green purchasing; and, 4) green logistics.

The second section of this chapter moves on to the theme of institutional theory, which explains the antecedents leading to a firm's adoption of GSCM. First, the main characteristics of institutional theory are discussed, and then elaborated on with

three main constructs identified, namely the: 1) coercive; 2) normative; and, 3) mimetic.

The third section of this chapter reviews the literature on performance outcomes. In this section, an argument is developed proposing that traditional performance measures purely focusing on economic performance are insufficient. This leads to the need to incorporate other intangible measures such as operational and environmental measures. Secondly, it becomes evident that the link between GSCM from a NRBV perspective, and performance measures, requires empirical validation. Finally, three performance dimensions – environmental, operational and, economic – are defined with suggested measurement items.

Figure 3 Flow Chart Literature Review



2.2 NRB-GSCM Framework

The NRB-GSCM framework, that this research proposes, has taken a more holistic approach in defining conceptual dimensions to GSCM, rather than focusing on a single practice such as green purchasing (Carter and Jennings, 2004, Green and Morton, 1996), or green logistics (Murphy and Poist, 2003). By taking GSCM to a higher conceptual level, brings together several specific GSCM components or constructs, including eco-design, green purchasing, internal environmental management, and investment recovery (Zhu and Sarkis, 2004b, Zhu et al., 2008, Zhu et al., 2007a, Zhu et al., 2005). Rao and Holt (2005) recognise green purchasing and internal environmental management as important parts of GSCM, but in addition include downstream activities such as reverse logistics. However, earlier research in characterising GSCM practice components has not recognised the importance of GSCM in terms of its natural resource based attributes, for example, in how a particular type of GSCM practice demonstrates causally ambiguous, socially complex attributes that would further lead to competitive advantage.

An attempt to address this was made by a number of authors taking a NRBV perspective who stressed the importance of environmental factors in terms of a firm's internal capabilities when wanting to achieve fully sustainable competitive advantage (Ebinger et al., 2006, Hart, 1995, Klassen and Whybark, 1999, Bowen et al., 2001, Zhu and Sarkis, 2006, Menguc and Ozanne, 2005, Vachon and Klassen, 2007)

To address these problems, this thesis proposes an alternative conceptualisation through a synthesis of previous work on NRBV (Table 5) (Hart, 1995, Vachon and Klassen, 2007, Klassen and Whybark, 1999, Menguc and Ozanne, 2005) and GSCM (Zhu and Sarkis, 2004a, Rao, 2002). By adopting this more comprehensive framework, GSCM can now be categorised in terms of two broad NRBV constructs: intra-organisational environmental practices (intra-OEPs), which involve the causally ambiguous resources, and inter-organisational environmental practices (inter-OEPs), representing the socially complex resources (Figure 4).

2.2.1 Intra-organisational environmental practices (causally ambiguous resources)

Organisations that adopt a pollution prevention strategy take a proactive stance towards environmental issues. As Hart (1995) pointed out, pollution prevention strategies are knowledge intensive, based on experiences, and developed over time through continuous learning and repeated practices. Thus, pollution prevention, through learning and experience, generate causally ambiguous resources that are unique to the firm. Within this new framework, causally ambiguous resources can be represented by a firm's intra-OEPs, such as the firm's in-house production processes. An integrated preventative environmental strategy, concerning processes, products and services, can increase their eco-efficiency and reduce waste into the natural environment (Tsoulfas and Pappis, 2006).

This new framework therefore holds that intra-OEPs are essentially management routines that develop over time within a firm, and are the unique causally ambiguous resources.

2.2.2 Inter-organisational environmental practices (socially complex resources)

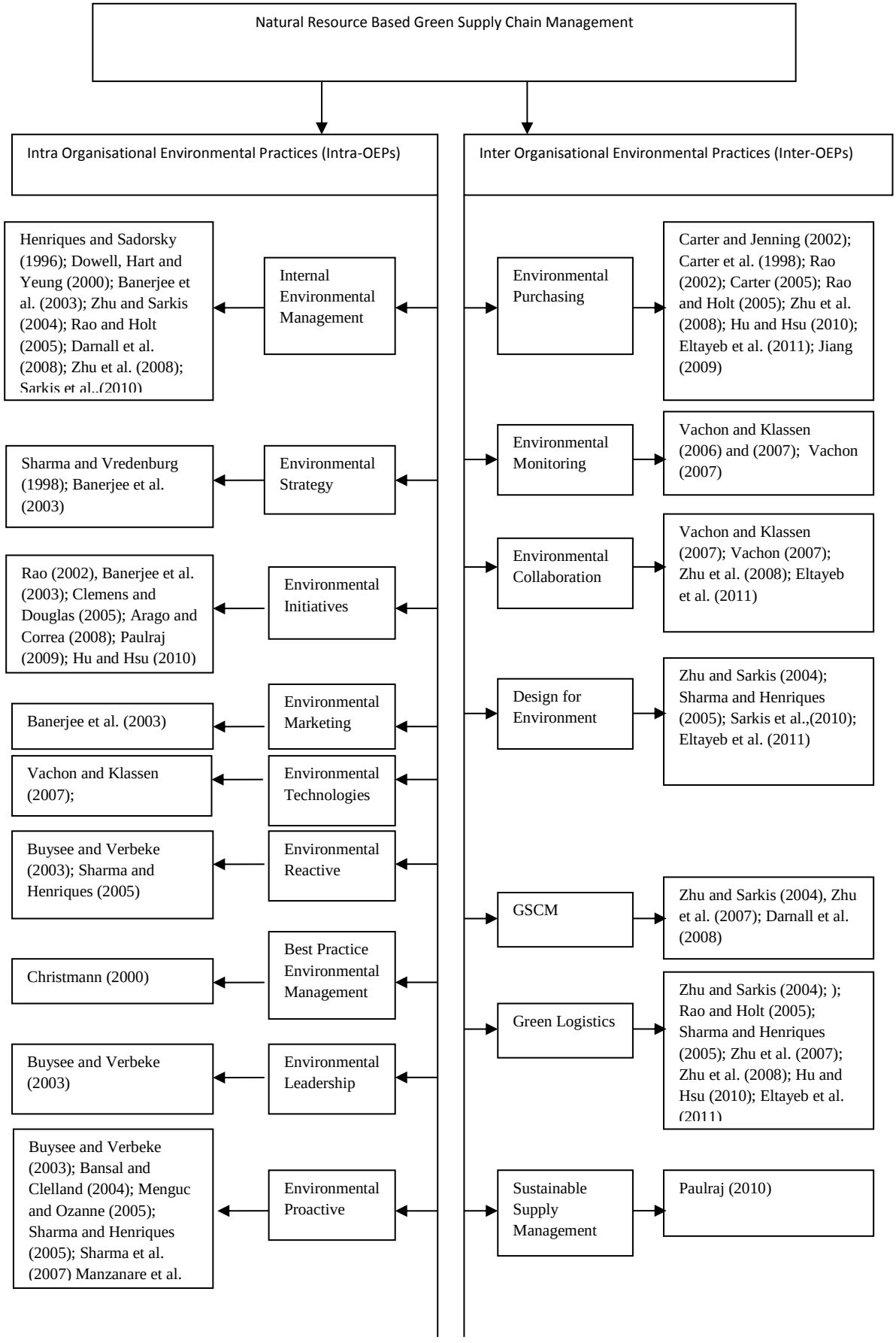
This NRB-GSCM framework proposes that a firm developing inter-OEPs would need to adopt green purchasing, DfE, and green distribution practices which generate socially complex resources through environmental collaboration that in turn would involve trust, commitment and joint goal setting among multiple supply chain members (Vachon, 2007). This is consistent with Hart's (1995) proposition that product stewardship enables a firm to minimise the economic and social costs of a product and because product stewardship programmes involve strong engagement with external stakeholders, the firm can establish socially complex networks to pre-empt competition.

Table 5 GSCM Dimensions

Source	Year	GSCM Dimensions			
Henriques and Sadorsky	(1996)	Internal Environmental Management			
Carter, Ellram and Ready	(1998)	Environmental Purchasing			
Sharma and Vredenburg	(1998)	Environmental Strategy			
Christmann	(2000)	Best Practice Environmental Management			
Dowell, Hart and Yeung	(2000)	Internal Environmental Management			
Carter and Jenning	(2002)	Purchasing social responsibility			
Rao	(2002)	Environmental Initiatives	SCEM		
Sharma and Henriques	(2005)	Pollution Control	Eco-Efficiency	Re-circulation	Eco Design & Ecosystem Stewardship & Business Redifinition
Banerjee, Iyer and Kashyap	(2003)	Internal Environmental Orientation	External environmental orientation	Environmental corporate strategy	Environmental Marketing Strategy
Buysse and Verbeke	(2003)	Reactive Strategy	Pollution Prevention	Environmental Leadership	
Bansal and Clelland	(2004)	Corporate Environmental Legitimacy	Disclosure of environmental liabilities	Expression of environmental commitment	
Zhu and Sarkis	(2004b)	Eco-Design	Internal EMS	Investment Recovery	External EMS
Bansal	(2005)	Environmental Integrity			
Carter	(2005)	Purchasing social responsibility			
Clemens and Douglas	(2006)	Environmental Initiatives			
Menguc and Ozanne	(2005)	**Natural Environmental Orientation Include 3 secondary dimensions:**	Entrepreneurship	Environmental Commitment	CSR
Sharma, Correa and Manzanares	(2007)	Proactive environmental strategy			
Vachon	(2007)	Environmental Monitoring	Environmental Collaboration		

Source	Year	GSCM Dimensions continued			
Vachon and Klassen	(2007)	Environmental Monitoring	Environmental Collaboration		
Zhu, Sarkis, Cordeiro and Lai	(2007b)	Eco-Design	External GSCM Practices	Investment Recovery	
Correa, Torres, Sharma and Garca	(2008)	Environmental Influential Practices			
Darnall, Jolly and Handfield	(2008)	GSCM	EMS		
Manzanare, Correa and Sharma	(2008)	Proactive Environmental Strategy			
Zhu, Sarkis and Lai	(2008)	Eco-Design	Green Purchasing	Internal Environmental Management System	Investment Recovery & Environmental Cooperation with customers
Paulraj	(2009)	Green Practices	Corporate environmental Strategy		
Rao and Holt	(2005)	Green Purchasing	Internal Environmental Management Systems	Green Logistics	
Paulraj	(2011)	Environpreurship	Sustainable Supply Management		
Sarkis, Torre and Diaz	(2010)	Eco-Design	Source reductions	EMS	
Jiang	(2009)	Supplier Codes of Conduct			
Hofer et al.,	(2012)	Environmental Management			
Eltayeb, Zailani and Ramayah	(2011)	Green Purchasing	Reverse Logistics	Environmental collaboration	Eco Design

Figure 4 GSCM Dimensions based on Intra OEPS and Inter OEPS Literature Tree



2.3 Intra Organisational Environment Practice (Intra-OEPs)

2.3.1 The characteristics of Intra-OEPs

Intra-OEPs are a part of a firm's overall GSCM strategy (Rao and Holt, 2005, Zhu et al., 2005) which takes a 'cradle to grave' approach, through taking account of all energy, material consumption, emission and waste related to a specific product and its processes of production. Typical types of intra-OEPs involve:

1. Environmental management systems (EMS) that consist of internal policies, assessments, plans and implementation actions affecting the organisation and its related natural environment (Coglianese and Nash, 2001).
2. Cleaner production, by involving the continuous application of an integrated preventative environmental strategy in processes, products and services to increase the firm's eco-efficiency and to reduce waste into the natural environment (Tsoulfas and Pappis, 2006). Sarkis (2003) suggests that cleaner production practices include the capability to use environmentally friendly materials, and coherent integration and design processes for waste prevention.

In contrast to complying with government environmental regulations, intra-OEPs, such as cleaner production and EMS, are pro-active environmental practices that take account of all energy, material consumption, emission and waste related to an organisation's 'in-house' processes, and specifically focus on environmental practices that arise from within an organisation (Darnall and Edwards, 2006).

Intra-OEPs also represent pro-active environmental practices with the focus on pollution prevention rather than pollution control (Hart, 1995). Following this argument, a number of authors propose one of two generic types of environmental orientation open to organisations: the proactive and/or the reactive approach (Hart, 1995, Klassen and Angell, 1998, Klassen and Whybark, 1999, Handfield et al., 2002).

Proactive policies are maximisation-oriented and set about to reduce costs through waste reduction in a variety of programmes designed to benefit both the environment

and the firm's profit (Klassen and Angell, 1998). The central theme for implementing an EMS is to demonstrate proactiveness on environmental issues that go beyond merely compliance with regulations.

In contrast, reactive approaches refer to policies aimed at meeting the minimum set of actions required to comply with government regulations or customer requirements on environmental concerns (Klassen and Angell, 1998). For example, maintaining the minimal regulatory standard for pollution levels for the purpose of avoiding sanctions, where failure to comply can result in increased costs (fines) and increased intervention in day-to-day operations (Melnyk et al., 2003). Klassen and Whybark's (1999) research found that reactive firms, adopting 'end of pipe' solutions, will likely reduce a firm's overall environmental performance.

2.3.2 The conceptualisation of Intra-OEPs

Earlier research attempting to conceptualise Intra-OEPs cover a wide range of organisational characteristics and strategic foci, and often involves the integration of multi-disciplinary studies from environmental management to business strategy, all of which has created ambiguity in the attempt to conceptualise a measurement. For example, EMS is commonly used to measure a firm's internal environmental practice, but due to different EMS implementation requirements among various organisations, it is difficult to definitively characterise the core practices which comprise every EMS (Darnall et al., 2008). Other research attempts to measure Intra-OEPS (typically by taking samples from multinational companies (MNCs)) through a focus on environmental strategy dimensions, which include: Internal global environmental performance standards, global operational environmental policy standardisation and global environmental communication standardisation (Christmann, 2004). A firm's environmental decisions by adopting environmental 'best practice' include: use of pollution prevention technologies; innovation of proprietary pollution prevention technologies and early timing of environmental initiatives (Christmann, 2000); a firm's natural environmental orientations (Menguc and Ozanne, 2005); internal environmental management (Paulraj, 2009; Rao and

Holt, 2005); and, environmental technology implementations (Vachon and Klassen, 200). Table 6 categorises those earlier empirical measures of a firm's Intra-OEPs.

Table 6 Earlier Research Measures of Intra-OEps

Source **Year**	**Measures of Intra-OEPs**
Darnall, Jolly and Handfield 2008	**EMS Practice** 1. Adopt written environmental policy 2. Implement environmental training for employees 3. Carry out environmental auditing programme 4. Utilise environmental performance indicators and goals 5. Adopt environmental criteria to evaluate employees performance 6. Relied on external audit
Darnall, Henriques and Sadorsky 2008; 2010	**Proactive environmental strategy (α=0.83)** 1. Had a written environmental policy 2. Benchmarked environmental performance 3. Used environmental accounting 4. Had a public environmental report 5. Had environmental performance indicators 6. Carried out external environmental audit 7. Carried out internal environmental audit 8. Had environmental training 9. Used environmental criteria in evaluation of employees
Paulraj 2009	**Internal Environmental Practice** 1. We support the inventory recovery (sale) of excess inventories/ materials 2. We emphasise the use of reusable and returnable packaging for our products 3. We constantly strive to use lesser resources in getting the tasks done 4. We have well-documented waste reduction methodologies in place. 5. We eliminate physical waste from our operations.
	Environmental Commitment 1. We have a formal written plan for dealing with environmental issues 2. We have formal documents describing our environmental issues. 3. We have manuals detailing environmental procedures 4. We have employee training programs on environmental procedures
	Entrepreneurship 1. Our organisation has a cultural emphasis on innovation and R&D in environmentally friendly products 2. Our organisation has a high rate of environmental friendly product introductions 3. We have a bold, innovative, environmentally friendly product development approach 4. Our organisation has a proactive posture to the environmental market **5.** Our organisation is one of the first to introduce new environmentally friendly technologies and product
	CSR 1. Our organisation corrects conditions that endanger the environment. 2. Our organisation disposes of physical waste 53ulfilm environmentally safe methods **3.** Our organisation eliminates the use of products that cause environmental damage
Menguc and Ozanne 2005	NEO (higher order construct on NRBV) 1. CSR (as Hart 1995 pollution prevention) (α=0.81) 2. Entrepreneurship (as Hart 1995 product stewardship) (α=0.88) 3. Environmental commitment (as Hart 1995 sustainable development) (α=0.93)

	Measures of Intra-OEPs Continued
	CSR (as Hart 1995 pollution prevention) 1. Corrects conditions caused that endangers the environment 2. Sustainably uses renewable natural resources (water, soil, forests) 3. Eliminates physical waste from the operations 4. Reduces physical waste through recycling 5. Disposes of physical waste through environmentally safe methods 6. Eliminates the use of products that cause environmental damage 7. Inform customers of the environmental impact of the product marketed
	Entrepreneurship (as Hart 1995 product stewardship) 1. Has a cultural emphasis on innovation and R&D in environmentally friendly products 2. Has a high rate of environmentally friendly product introductions 3. Has a bold, innovative, environmentally friendly product development approach 4. Has a proactive posture to the environmental market 5. Has a strong inclination of high risk, high potential return products in the field of environmentally friendly products. 6. Is first to introduce new environmentally friendly technologies and products
	Environmental commitment (as Hart 1995 sustainable development) 1. Committees dedicated to dealing with environmental issues 2. Formal plan for dealing with environmental issues 3. Formal documents describing an environmental plan 4. Manuals detailing environmental procedures 5. Employee training programs on environmental procedures 6. Environmental information in external communications
Christmann and Taylor 2001	1. Likelihood of ISO 14000 adoption
Christmann 2000	Use of pollution prevention technologies (α= .70) 1. Implementation of new cleaner processes 2. Modification of existing processes 3. In process recycling/ recovery
	Innovation of proprietary pollution prevention technologies (α= .78) 1. We address environmental issue mainly with technologies developed within the company 2. To address environmental issue we mainly developed new process technologies and/ or process changes. 3. To address environmental issue we mainly developed new or improved products
	Early Timing 1. We were one of the first firms in this industry in the U.S. to address environmental issue. 2. We were one of the first firms in this industry worldwide to address environmental issues.
Christmann 2004	Level of internal global environmental standards (α= .80) 1. Relative to our competitors with similar standards our internal standards are tougher 2. Our internal standards are set at the level of environmental regulations in coutry with the toughest regulations in which we are operating.
	Global operational environmental policy standardisation (α= .87) 1. Standardise pollution abatement technologies 2. Standardise environmental control and auditing procedures 3. Standardise management incentives for environmental performance.
	Global environmental communication standardisation (α= .84) 1. Standardise environmental message in advertising 2. Standardise environmental message in communication to public

	Measures of Intra-OEPs Continued
Benerjee, Iyer and Kashyap 2003	Internal Environmental Orientation 1. Environmental issues are not very relevant to the major function of our firm. (R, D) 2. At our firm, we make a concerted effort to make every employee understand the importance of environmental preservation. 3. We try to promote environmental preservation as major goal across all departments. (D) 4. Our firm has a clear policy statement urging environmental awareness in every area of operations. 5. Environmental preservation is high priority activity in our firm. 6. Preserving the environment is a central corporate value in our firm.
	Environmental Corporate Strategy 1. Our firm has integrated environmental issues into our strategic planning process 2. In our firm, quality includes reducing the environmental impact of products and processes. 3. At our firm we make every effort to link environmental objectives with our other corporate goals. 4. Our firm is engaged in developing products and processes that minimise environmental impact. (D) 5. Environmental protection is the driving force behind our firm's strategies. (D) 6. Environmental issues are always considered when we develop new product 7. Our firm develops products and processes that minimise environmental impact. (D)
Rao and Holt 2005	Internal Environmental Management 1. Environmentally-friendly raw materials 2. Substitution of environmentally questionable materials 3. Taking environmental criteria into consideration 4. Environmental design considerations 5. Optimisation of process to reduce solid waste and emissions 6. Use of cleaner technology processes to make savings in energy, water, and waste 7. Internal recycling of materials within the production phase 8. Incorporating environmental total quality management principles such as worker empowerment
Vachon and Klassen 2007	Environmental pollution prevention technology 1. Product adaptation-introducing a new product or modifying an existing product's design leading to an increased use of recycled materials or material substitution. Material reduction products are also included here. 2. Process adaptation, changing the material acquisition, production system or delivery process or process adaptation needed for material substitution. Energy conservation technologies are also included in this category.
	Pollution Control Technology 1. Remediation projects-cleaning up crises or past practices such as cleaning up an environmental spill, remove soil contaminated by chemicals or environmental fines 2. Pollution control technologies-installing equipment at the end of a process, air emission collection or effluent pipes
	Management Systems 1. Management systems-the way the business is managed or people work such as environmental training for employees to minimise spills, environmental audit programs, or operating procedures and practices that reduce environmental impact.
Shharma and Henriques (2005)	Eco-Efficiency 1. Fuel efficiency 2. Energy Efficiency
	Pollution Control 1. Detoxification 2. Synthetic reduction
Correa, Torres, Sharma, Morales 2008	Innovative preventive practices Factor 1 (α= .75) 1. Use of natural environmental argument in marketing 2. Periodic environmental audit 3. Programme of residue recycling 4. Environmental seminar for executives 5. Environmental training of employees 6. Environmental manuals

	Measures of Intra-OEPs Continued
	Innovative preventive practices Factor 2 (α= .73) 1. Sponsorship of environmental event 2. Environmental aspects in administrative work 3. Purchasing environmental requirement 4. Use of environmental certification 5. Insurance cover environmental risks 6. Control emission and discharges
	Eco-Efficient practices Factor 1 (α= .72) 1. Switch off light and machine which are not necessary 2. Close water taps when not in use 3. Avoid wasting chemical product 4. Avoid high level of noise
	Eco-Efficient practices Factor 2 (α= .61) 1. Systematically separate dangerous waste 2. Systematically separate different kind of waste 3. Participate in selling in waste market 4. Recycle box and packaging
Zhu and Sarkis (2004) Zhu, Sarkis, Lai (2007)	Internal environmental management (α= 0.9413) 1. Commitment of GSCM from senior managers 2. Support for GSCM from mid-level managers 3. Cross-functional cooperation for environmental improvements 4. Total quality environmental management 5. Environmental compliance and auditing programs 6. ISO 14001 certification 7. Environmental management systems exist

From earlier measurement studies of a firm's Intra-OEPs, this research recognises that a firm's internal environmental management system has played an important role in establishing the Intra-OEP conceptual construct. Thus, it is necessary to discuss the internal environmental management system's characteristics and conceptual definitions. The ISO 14001 (2004) specifies six distinct phases to guide firms in the implementation of an EMS: 1) Environmental policy; 2) Planning; 3) Implementation; 4) Checking; 5) Management review; and, 6) Continual improvement. From a process-based perspective, Darnall and Edwards (2006) suggest it is important to recognise the following stages for EMS adoption (Table 7):

Table 7 EMS Stage

1	Securing an organisation wide pledge for responsible environmental management.	For example: environmental policy setting with commitment for pollution prevention and compliance with regulations.
2	Evaluation and goal setting	For example: an action plan that translates policies into specific objectives.
3	Creating a management structure	For example: employee environmental training sessions to ensure organisation wide awareness of EMS practices.
4.	Monitoring and corrective action	For example: monitor and correct discrepancies by documenting and periodically audit routine operations.
5.	EMS management review	For example: Critical assessment of internal audit, progress report, non-compliance action and develop EMS status report for further improvement to be made.

Source: adapted from Darnall and Edwards (2006)

ISO 14001 (2004:2) defined an EMS as "*part of an organisation's management system used to develop and implement its environmental policy and manage its environmental aspects.*" (ISO, 2004).

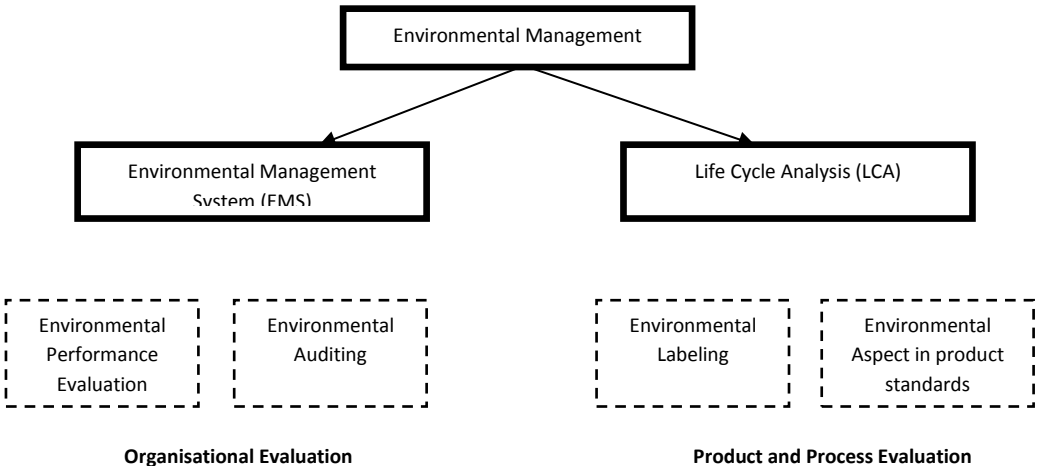
Another definition was proposed by Melynk et al. (2003:332):

"*EMS involves the formal system and database which integrates procedures and processes for the training of personnel, monitoring, summarizing, and reporting of specialized environmental performance information to internal and external stakeholders of the firm. The documentation of this "environmental" information is primarily internally focused on design, pollution control and waste minimization, training, reporting to top management, and the setting of goals. The use of this information for external stakeholders is primarily found in annual reports, focuses on the outputs of the firm, and is used to enhance firm image*".

As shown in (Figure 5) environmental management standards involve a number of tools and sub-standards that support corporate environmental management. These standards can be distinguished into two general categories: 1) organisational evaluation: an EMS provides the framework for the management system with support from performance and auditing standards to ensure successful implementation; and, 2) product and process evaluation: life cycle analysis with

support of environmental labelling and environmental attribute in product standard (Melnyk et al., 2003, Tibor and Feldman, 1996)

Figure 5 Environmental Management Structure



Source: Adapted from Tibor and Feldman, (1996)

An EMS implementation needs to incorporate a 'Life Cycle Analysis' (LCA) philosophy which is defined as the "*compilation and evaluation of the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle*" ISO 14040 (2006:2).

Similarly, Bowen and Cousins (2001) identified three types of cleaner production strategies that focus on waste prevention rather than pollution control:

1. Process strategy including conserving raw materials and eliminating toxic raw materials and reducing toxicity of all emission and wastes.
2. Product strategy involving the reduction of the negative impacts along the life cycle of a product.
3. Service strategy involving the incorporation of environmental concerns into the design and delivery of services.

Hagelaar and Vorst's (2001) analysis of LCA with regard to GSCM, also suggests three types of LCA:

1. Compliance oriented LCA: this concerns complying with rules and regulations with the help of end of pipe technologies.

2. Process oriented LCA: this focuses on controlling the environmental impact caused by production processes by means of integration of production systems and compliance with regulations.
3. Market oriented LCA: this focuses on innovating product design to reduce environmental burdens of the product, in order to achieve competitive advantage.

According to Hicks and Dietmar (2007) the procedures for implementing cleaner production in China, often involves an internal audit team to evaluate the company's current production process and environmental performance. The team then establishes goals for the cleaner production audit, prepares balances of materials, energy and water flows, and develops measures for the reduction of pollution and consumption. After implementing the measures and evaluating the results, the company prepares an audit report that is forwarded to the local government. In return, manufacturers may take advantage of certain support such as subsidies and claiming expenses as an operational cost.

2.3.3 The significance of Intra-OEPs

Based on the continuous improvement concept associated with total quality management and the implementation of voluntary standards, such as the ISO 14001 standard on EMS, firms can reduce the amount of effluent by systematically designing the manufacturing process for prevention through better housekeeping (Handfield and Sroufe, 2005). EMS can provide a systematic approach for firms to implement responsible environmental practices within their organisational structures (Hillary, 2000).

Despite the fact that organisations adopt EMS with aims to reduce their environmental impact, the level of effectiveness for their EMS implementation can be inconsistent (Darnall and Edwards, 2006). Thus, to minimise this inconsistency, ISO 14001 provides guidance for EMS adoption with external third party verification establishing external legitimacy that reduces the inconsistency for its recognition (Bansal and Hunter, 2003). In contrast, organisations adopting a non-

certified EMS have more flexibility in terms of the ways the EMS is integrated within their organisation. Also, it avoids the cost for the EMS certification process (Darnall and Edwards, 2006). However, evidence shows that a certified EMS may have a greater impact on performance than those firms that don't certify their EMS (Melnyk et al., 2003).

According to Melnyk et al. (2003) there are three types of EMS an organisation can implement in pursuit of sustainability: 1) an informal system; 2) a formal system that does not meet the ISO 14001 standard; and, 3) a formal system that meets the ISO 14001 standard. Their results show that the possession of a formal EMS goes beyond pollution abatement and leads to positive impacts on many dimensions of operational performance. Also a certified EMS compared with a non-certified EMS shows greater coverage in terms of environmental practice implemented as well as greater impact on operational performance (ibid).

Klassen and Angell (1998), conducting an international comparison between U.S manufacturing firms and German manufacturing firms, found that German firms are more likely to adopt proactive/ ambition driven environmental management than U.S manufacturing firms. Their research also found manufacturing flexibility related to U.S firms adopting proactive environmental management; in contrast, this relationship was insignificant in German manufacturing firms (ibid).

Rao's (2002) research, based on Southeast-Asian firms, found that a firm's environmental initiatives, such as optimising production processes and implementing cleaner technologies, can enhance the firm's environmental performance (reduction of waste, emissions and improved compliances). In addition, their research found that intra-organisational environmental initiatives to be associated with helping suppliers to become environmentally responsible.

2.3.4 The measures of Intra-OEPs

This research therefore proposes that a firm's Intra-OEPs consists of manufacturing process and policy based measurement items. Table 8 shows the measures for intra-OEPs and their sources to be used in this research.

Table 8 Adopted Intra-OEP measures

Measurement Items	Earlier Contributions
We optimise processes to reduce solid waste and emissions	(Rao, 2002)
We use cleaner technology processes to make savings in energy, water, and waste	(Rao, 2002)
We use internal recycling of materials within the production phase	(Rao, 2002)
We have a clear policy statement urging environmental awareness in every area of operations.	(Banerjee et al., 2003)
We make a concerted effort to make every employee understand the importance of environmental preservation.	(Banerjee et al., 2003)

2.4 Design for Environment (DfE)

2.4.1 The characteristics of DfE

In 1997, the United Nations Environmental Programme proposed the DfE concept which considers environmental aspects at all stages of the product development process and strives for products that make the lowest environmental impact throughout the product life cycle. A number of authors suggest that the product design phase plays the most critical role in determining a product's environmental impacts (Johansson and Lindhqvist, 2005, Hagelaar and Van der Vorst, 2001). Sarkis (1998) states that the goal of DfE is to consider the complete product life cycle when designing environmental aspects into a product or process. Sarkis (1998) identified the difference between a number of design principles, that include design for recycling, design for reuse, and design for remanufacturing. Similarly, Hart (1995) argues that DfE practices can help a firm realise economic benefits through socially complex networks, for example through the involvement of complex supply chain members to encourage DfE, which can pre-empt competition.

Eltayeb et al. (2011) suggest that DfE is an important part of a GSCM initiative, because the design stage defines the function of the product, process and service, as well as the raw materials, the suppliers and the process chemicals selected. These in turn determine the energy that will be consumed to create them and waste which will

be generated (ibid). Eltayeb et al., (2011) found DfE to have a significant positive effect on environmental, economic, and cost reductions as well as other intangible outcomes. Sarkis et al., (2010) argue that DfE encompasses many activities from design for product disassembly, recycling and reuse, resource efficiency and reduction of hazardous materials covering the entire product life cycle, and requires socially complex interactions among other supply chain members. This knowledge and the competencies developed is a capability that can provide firms with significant competitive advantage. Sarkis et al., (2010) point out that DfE requires a different mindset and a focus on new and innovative practices. Developing these soft skills are more likely to be achieved through appropriate environmental training programmes.

2.4.2 The conceptualisation of DfE

Earlier research which attempts to conceptualise design for environment (DfE) mainly focuses on the environmental attribute of products, for example, Fiksel (1996) proposed that DfE should cover the following design principles: 1) Design for recovery and reuse; 2) Design for disassembly; 3) Design for waste minimisation; 4) Design for material conservation; and, 5) Design for accident prevention. They suggest the goal of DfE needs to enable the design team to create eco-efficient products without compromising their cost, quality, and schedule constraints. Sharma and Henriques (2005) suggest that a DfE measure includes two items: 1) designing the product for easy disassembly or reuse, and, 2) product life cycle analysis.

According to Johansson (2002), DfE corresponds to the actions taken during product development that aim at minimising a product's environmental impact during its whole life cycle – from acquiring materials, to manufacturing, use, and ultimately to its final disposal – without compromising other essential product criteria such as performance and cost. DfE requires socially complex interactions among other supply chain members, with the knowledge and competencies developed being a capability that can provide the firm with significant competitive advantage. Sarkis et al., (2010) argues that DfE encompasses many activities from: 1) use of LCA for product design; 2) use of easy-to-break joints between components to facilitate

disassembly; 3) identification of materials to facilitate disassembly; and, 4) use of standardised components to facilitate their reuse. Table 9 summarises earlier empirical measures of a firm's DfE.

Table 9 Earlier Research Measures of DfE

Source **Year**	**Measures of DfE**
Eltayeb, Zailani and Ramayah 2011	1. Design for reduction or elimination of environmentally hazardous materials such as lead, mercury, chromium and cadmium 2. Design for reuse is a design that facilitates reuse of a product or part of it with or without minimal treatment of the used product 3. Design for recycling, is a design that facilitates disassembly of the waste product, separation of parts according to material, and reprocessing of the material 4. Design for remanufacturing, is a design that facilitates repair, rework, and refurbishment activities aiming at returning the product to the new or better than new condition 5. Design for resource efficiency, including reduction of materials and energy consumption of a product during use, in addition to promoting the use of renewable resources and energy
Sarkis et al., (2010)	1. Use of LCA for product design 2. Use of easy to break joints between components to facilitate disassembly 3. Clear identification of materials to facilitate disassembly 4. Use of standardised components to facilitate their reuse.
Shharma and Henriques (2005)	1. Designing product for easy disassemble or reuse 2. Product life cycle analysis
Zhu and Sarkis (2004) Zhu, Sarkis and Lai (2007)	DfE (α= 0.8586) 1. Design of products for reduced consumption of material/energy 2. Design of products for reuse, recycle, recovery of material, component parts 3. Design of products to avoid or reduce use of hazardous of products and/or their manufacturing process

2.4.3 The significance of DfE

Esty and Winston (2009) suggest that benefits of DfE include: helping customers lower their footprint and related costs-benefits that can justify price premiums, drive increased market share, and strengthen customer loyalty. For example, Toyota through eco-design gained access to a new market for energy efficient and environmental friendly cars. Also Sun Microsystems launched a 'green server' on a chip that reduces power consumption and cooling requirements (Ibid). Desimone and Popoff (2000) suggest that DfE, by incorporating eco-efficiency, pursues the following goals:

- Reduce material intensity. Batteries offer an example: In the 1990s, batteries became smaller and longer lasting. Technology helps on this front.
- Reduce energy intensity, manufacturers can use less energy by insulating equipment, reusing wasted heat and more closely monitoring processes.
- Reduce toxic dispersion. The British firm ICI Auto colour met this goal by developing aqua based car paint, which reduced solvent dispersion and could be dried at lower temperatures than traditional paint.
- Recycle. Hewlett-Packard's Hardware Recycling Organisation collects parts that are no longer useful. It then recycles circuit boards and cables to recover precious metals, and reuses plastic to make new products. Automaker Saturn collects damaged parts and reuses them in new cars.
- Use renewable resources.
- Make products last longer. A longer-lived product is replaced less often and therefore leads to less environmental damage. Durability has pitfalls. More durable products cost more to produce, and consumers who don't understand the products' advantages might shun the items for cheaper competitors.

Products incorporating DfE can stick to a restricted set of raw materials to avoid waste and environmental toxicity (Unruh, 2010). For example, when 3M executives discovered that a chemical that had been ubiquitous in some of their products for the past 50 years had been found in trace amounts in humans across the world and in polar bears, they acted decisively. Though the findings did not demonstrate any adverse effects, 3M stopped making those products (ibid). According to Unruh (2010), although over the past 30 years only 9 out of 32,559 new industrial chemicals have been restricted by the U.S EPA, the results of the widespread deployment of a multitude of chemical compounds the effects on human health and the environment are unknown. Thus companies can apply DfE practices to avoid unknown risks by eliminating potentially harmful materials within their product.

The DfE initiative needs to provide a value proposition to customers in order to be successful (Esty and Winston 2009). For example, DuPont in the 1990s were trying to 'close the loop' in their polyester business. They invented a new technique for recycling polyester. In theory, recycling old products from customers would lead to added value and a lowering of their costs. But unlike other industries that involve

toxic dyes and solvents, polyester disposal was not a big problem for customers. The recycled polyester actually costs more than virgin polyester, thus the project failed due to lack of value proposition to customers (ibid).

2.4.4 The measures of DfE

This research therefore proposes that a firm's DfE needs to incorporate the participation of suppliers and customers in environmentally friendly design, and the execution of the entire product life cycle system. Table 10 shows the measures for DfE and their sources to be used in this research.

Table 10 Adopted DfE measures

Measurement Items	Earlier Contributions
Participates in the design of products for disassembly	(Eltayeb et al., 2011)
Participates in the design of products for recycling or reuse	(Eltayeb et al., 2011)
Participates in the design of product for resource efficiency, including reduction of materials and energy consumption	(Eltayeb et al., 2011)
Participates in the design of product for reduction to avoid use of hazardous materials	(Eltayeb et al., 2011)

2.5 Green Purchasing

2.5.1 The characteristics of green purchasing

Green purchasing involves an organisation assessing the environmental performance of their suppliers, which requires the suppliers to undertake measures that ensure environmental quality in their operational systems (Handfield et al., 2002). This research argues that the practice of green purchasing is a socially complex resource,

as establishing a consensus among supply chain members would involve multiple teams and organisations, requiring firms to continuously synchronise their operations and communications to ensure a reliable, environmentally collaborative supply chain. In addition, it is necessary to have frequent communication, assistance, and transference of information between the firm and its suppliers as well as good cross-functional relations with top management and environmental experts, in terms of formalising both the lines of communication and the protocols for interaction among the various functions (Bowen et al., 2001, Sroufe, 2006)

Development of purchasing decisions with environmental considerations began at the end of the twentieth century, influenced from globally recognised definitions on sustainable development and the emergence of international standards on sound environmental practices such as the early BS7570 and then ISO 14000 series (Cousins and Lamming, 2008). The pressure movement of greening the supply chain in the past has targeted well-known brands. Nike, for example, received bad press for deploying child labour in the early 1990s. Immediately after the incidence Nike established a code of conduct for suppliers, and now works in partnership with the Fair Labour Association to challenge industry norms.

2.5.2 The conceptualisation of green purchasing

Given the increased attention on greening supply chains, there is still a lack of academic contribution as to how purchasing functions can integrate environmental initiatives in a firm's strategic decision making (Sroufe, 2006).

Earlier research, which attempts to conceptualise green purchasing, mainly focuses on the process attribute of green purchasing. For example, the use green purchasing as a tool for supplier selection, evaluation and the requirement to conform to the buyer firm's environmental policy (Paulraj, 2010;2009; Darnall et al., 2008; Eltayeb et al., 2011). Others suggest that green purchasing can be more collaborative, such as, guiding, informing and providing resources to help suppliers in their environmental improvement (Paulraj, 2010; 09; Vachon and Klassen, 2003; 2008;

Rao and Holt, 2005). Table 11 summarises earlier empirical measures on a firm's green purchasing practices.

Table 11 Earlier Research Measures of Green Purchasing

Source/Year	Measures of Green Purchasing
Paulraj 2010	Supplier Selection 1. Extent to which the firm selects their potential suppliers based on their environmental competence and environmental performance
	Environmental Collaboration 1. Cooperate with their suppliers to develop environmental strategies 2. Provide suppliers with materials, equipment, specifications, as well as services to support their environmental goals
	Supplier Evaluation 1. Extent to which firms regularly monitor suppliers' internal operations 2. Extent to which firms regularly monitor suppliers' environmental friendly goods 3. Extent to which firms regularly monitor suppliers' environmental friendly goods
Darnall, Jolly and Handfield 2008	GSCM (this research recognize their measures are most GP measures) 1. Access environmental performance of suppliers 2. Require suppliers to establish environmental practices 3. Track the cost of waste throughout the supply chains 4. Inform buyers of the ways to reduce their environmental impacts
Paulraj 2009	Supplier Selection 3. We select suppliers based on their environmental competence 4. Suppliers are selected based on their ability to support our environmental objectives 5. We select suppliers based on their environmental performance 6. We select suppliers based on their ability to develop environmentally friendly goods
	External Environmental Practices 1. We cooperate with our suppliers to achieve environmental objectives 2. We encourage our suppliers to develop new source reduction strategies 3. We cooperate with our suppliers to improve their waste reduction initiatives
	Supplier Evaluation 1. We conduct regular environmental audits into our suppliers' internal operations 2. We periodically evaluate our suppliers' environmental friendly practices 3. We make site visits to suppliers' premises to help them improve their eco-performance
Eltayeb, Zailani and Ramayah 2011	Green Purchasing 1. Product content requirements 2. Product content restrictions 3. Product content labelling or disclosure 4. Supplier questionnaire 5. Supplier environmental management systems 6. Supplier certification 7. Supplier compliance auditing
	Supplier Environmental Collaboration 1. Supplier education 2. Supplier support 3. Joint ventures
Carter 2005	Diversity 1. Purchases from minority/women-owned business enterprise (MWBE) suppliers 2. Has a formal MWBE supplier purchase program

	Measures of Green Purchasing Continued
	Environment 1. Uses a life-cycle analysis to evaluate the environmental friendliness of products and packaging 2. Participates in the design of products for disassembly 3. Asks suppliers to commit to waste reduction goals 4. Participates in the design of products for recycling or reuse 5. Reduces packaging material
	Human right 1. Visits suppliers' plants to ensure that they are not using sweatshop labor 2. Ensures that suppliers comply with child labor laws 3. Asks suppliers to pay a ''living wage'' greater than a country's or region's minimum wage
	Safety 1. Ensures that suppliers' locations are operated in a safe manner 2. Ensures the safe, incoming movement of product to our facilities
Rao and Holt 2005	Green Purchasing 1. Holding awareness seminars for suppliers and contractors; 2. Guiding suppliers to set up their own environmental programs; 3. Bringing together suppliers in the same industry to share their know-how and problems; 4. Informing suppliers about the benefits of cleaner production and technologies; 5. Urging/pressuring suppliers to take environmental actions; and 6. Choice of suppliers by environmental criteria.
Vachon and Klassen 2003; 2008; (Vachon, 2007)	Environmental Cooperation with Suppliers (α=0.96) 1. Achieving environmental goals collectively 2. Developing a mutual understanding of responsibilities regarding environmental performance 3. Working together to reduce environmental impact of our activities 4. Conducting joint planning to anticipate and resolve environmental related problems 5. Making joint decisions about ways to reduce overall environmental impact of our products
(Vachon, 2007)	Environmental Monitoring with Suppliers (α=0.88) 1. Including environmental considerations in selection criteria for suppliers 2. Providing suppliers with written environmental requirements 3. Sending environmental questionnaires to suppliers in order to monitor their compliance 4. Requiring that suppliers have an implemented environmental system 5. Asking suppliers to commit to waste reduction goals
Carter, Ellram and Ready 1998	Green Purchasing 1. Purchases recycled packaging 2. Purchases packaging that is of lighter weight 3. Uses a life-cycle analysis to evaluate the environmental friendliness of products 4. and packaging 5. Participates in the design of products for disassembly 6. Asks suppliers to commit to waste reduction goals 7. Participates in the design of products for recycling or reuse
Hamner (2006)	1. Product content requirements: buyers specify that purchased products must have desirable green attributes such as recycled or reusable items. 2. Product content restrictions: buyers specify that purchased products must not contain environmentally undesirable attributes such as lead, CFCs or plastic foam in packaging materials. 3. Product content labelling or disclosure: buyers require disclosure of the environmental or safety attributes of purchased product content. Such disclosure can be done using green seals and indicators of relative environmental impact such as scientific certification system offered by various commercial organizations. 4. Supplier questionnaires: buyers send questionnaires to suppliers asking them to provide information about their environmental aspects, activities and/or management systems. 5. Supplier environmental management systems: buyers require suppliers to develop and maintain an environmental management system (EMS). However the buyer does not require supplier to certify the system. 6. Supplier certification: buyers require suppliers to have an EMS that is certified as fully compliant with one of the recognized international standards such as the British Standard 7750 (BS7750), ISO 14001 from the International Organization for Standardization(ISO), and the European Union Eco-Management andAudit Scheme (EMAS). 7. Supplier compliance auditing: buyers audit suppliers to determine their level of compliance with environmental requirements.

	Measures of Green Purchasing Continued
Zhu, Sarkis and Lai (2007)	Green Purchasing (α=0.87) 1. Providing design specification to suppliers that include environmental requirements for purchased item 2. Cooperation with suppliers for environmental objectives 3. Environmental audit for suppliers' internal management 4. Suppliers' ISO14000 certification 5. Second-tier supplier environmentally friendly practice evaluation
Zhu and Sarkis (2004)	External GSCM practices (α = 0.9246) 1. Providing design specification to suppliers that include environmental requirements for purchased item 2. Cooperation with suppliers for environmental objectives 3. Environmental audit for suppliers' internal management 4. Suppliers' ISO14000 certification 5. Second-tier supplier environmentally friendly practice evaluation 6. Cooperation with customer for eco-design 7. Cooperation with customers for cleaner production 8. Cooperation with customers for green packaging

Sroufe (2006:20) defines green purchasing as "*environmental plans for firm's long-term material, component or system requirement, suggesting that the purchasing function may help to evaluate the amount of waste flowing into business systems*". Their research suggests that green purchasing helps firms to focus on long term competitiveness rather than short-term goals, where green purchasing can help to identify, quantify, assess and manage the flow of environmental waste through the system with the goal of reducing waste and maximising environmental efficiency.

Following this notion, a firm's environmental impacts can be classified as direct and indirect. Direct impacts are from the environmental waste generated from first tier suppliers whereas indirect impacts relate to environmental waste generated from second tier suppliers and beyond. Handfield (2002) suggests this distinction is important, because companies that adopt green purchasing practices generally evaluate environmental impacts of the first tier supplier, but often do not control environmental impact beyond that. Table 12 summarises a number of earlier definitions on green purchasing.

Table 12 Green Purchasing Definitions

Source	Year	Page	Definition
Sroufe	(2006)	20	"environmental plans for firm's long-term material, component or system requirement.' suggesting that the purchasing function may help to evaluate the amount of waste flowing into business systems."
Ruseel	(Russel, 1998)	9	"Integration of environmental considerations into purchasing policies, programme and actions."
Cater and Carter	(1998)	660	"Purchasing function's involvement in supply chain management activities in order to facilitate recycling, reuse and resource reduction."
Paulraj	(2011)	20	"Sustainable supply management is proposed as a relational capability, and following past research is defined to simultaneously consider the entire process — selection, environmental collaboration and evaluation— of a supply function. It is also considered to favourably mediate the relationship between strategic antecedents and sustainability."
Mulder	(1998)	123	''The practice of public authorities or private companies taking supplier environmental product and process performance into account when purchasing products and service.''

2.5.3 The significance of green purchasing

A number of researchers have theorised about the factors that affect the environmental practice of suppliers. First, firms that change purchasing from a clerical function toward a more strategic focus are likely to develop more effective GSCM practices (Carr and Pearson, 2002). Second, companies that maintain collaborative relationships with suppliers can form trust and a strong commitment to assist more effective GSCM implementation (Mark P. Sharfman, 2007). Jiang (2009) studied the form of governance through buyer-supplier (command based) relationships and peer-peer (cooperation based) relationships, with compliance to a green purchasing code of conduct, among Chinese textile and apparel export suppliers. Their research found the cooperation based relationship had strong evidence for supplier commitment to green purchasing. In contrast, command based buyer-supplier relationships were insignificant to supplier commitment to green purchasing. Vachon (2007) proposes two separate dimensions in measuring inter-organisational relationships between buyer firms and suppliers. The first is environmental monitoring and refers to a supplier compliance based approach, which requires a minimal involvement on the supplier organisation's operation. The second approach refers to environmental collaborations, which requires organisations to invest specific resources in cooperative activities that address environmental issues

in the supply chain. Their research found that environmental collaborations with suppliers that focus less on immediate performance results positively associated with a firm's investment intention towards pollution prevention technologies. On the other hand, environmental monitoring activities with suppliers were found to have no direct impact on either environmental pollution prevention, or pollution control technology investment.

2.5.4 The measures of green purchasing

Building on earlier studies, this research recognises that the focal firm's environmental evaluation, selection and auditing activities of their supply base have played an important role in establishing green purchasing as a conceptual construct. Table 13 shows the measures for green purchasing and their sources to be used in this research.

Table 13 Adopted green purchasing measures

Measurement Items	**Earlier Contributions**
We select potential suppliers based on their environmental competence and environmental performance	(Paulraj, 2009, Vachon, 2007)
Suppliers are selected based on their ability to support our environmental objectives	(Paulraj, 2009)
We ask if suppliers have an implemented environmental system	(Vachon, 2007)
We periodically evaluate our suppliers' environmental friendly practices	(Paulraj, 2009)
We conduct regular environmental audits into our suppliers' internal operations.	(Paulraj, 2009)

2.6 Green Logistics

2.6.1 The characteristics of Green Logistics

Green distribution typically refers to the greening of forward distribution which is closely tied to the requirements of the customer, whereas reverse logistics requires highly complex information exchange among supply chain members in taking back

products from consumers at the end of the product's life. Green distribution, taken as a whole, therefore requires that a large number of supply chain members co-ordinate and integrate environmental management into their distribution functions of transportation mode, packaging, labelling and reverse logistics.

Sarkis (2003) suggests that reverse logistics has an environmental focus primarily on the return of recyclable or reusable products and materials into the forward supply chain. The use of environmental packaging for preventing products getting damaged can have a significant impact on the amount of solid waste going to landfill and its adverse impact on the environment. A number of packaging directives within the EU and other Asian countries have put forward legislative measures to promote recycling and reuse of product packaging (Rao, 2002). In addition to environmental packaging, companies can also carry out more environmentally friendly distribution practices by, for example, considering alternative fuel sources and using navigation systems to reduce distances travelled and their overall environmental impact (Kam et al., 2003).

From the forward logistic flow to the opposite logistic flow of materials, products and information, the customers become the first link in the reverse distribution channel. This role change can add more complexity to the green logistics system. Outsourcing reverse logistics to Third Party Logistic (3PL) providers or Third Party Reverse Logistic (3PRL) providers to carry out reverse collection, inspection and sorting of returned products, and waste collection from customers, has the benefit of less fuel consumption, less packaging and the opportunity to consolidate volumes in a reverse network (Sarkis et al., 2004).

The reverse logistics system is fundamentally different to the forward logistics system. Typically the ability to forecast return volumes changes from 'many to one' rather than 'one to many', the product quality is not uniform, and the costs are also less visible (Tibben-Lembke and Rogers, 2002). In addition, and according to Horvath et al., (2005) reverse logistics is likely to incur higher costs due to the asset value of a returned product being significantly lower than the original cost of the item. Thus the timing of returns can have implications on the liquidity for retailers. Similarly, Min et al., (2006) note that returns often have higher inventory holding

costs than the outbound inventory, thus ways to minimise time and cost of the returned product is a critical function of reverse logistics.

Kopicki et al. (1993) suggest two types of reverse logistics systems. The first system refers to open loop systems, where products are transferred to other parties willing and able to reuse the materials or products, and do not necessarily return to the original producers. The second system refers to a closed loop system, where materials are returned and reused by the originator before reselling. Bernon et al's. (2011) research in the retail industry, suggests that the critical success factors of reverse logistics involve: 1) operational performance; 2) organisational integration; and, 3) management reporting and control. They suggest that in the retail industry, liberal return policies can add complexity to reverse logistic operations. For example, a product that is fit for resale can be wrongly coded as 'faulty'; also the collection process of faulty products can be more costly than asking the customer to keep the product (ibid).

2.6.2 The conceptualisation of Green Logistics

Earlier research on conceptualising green logistics has mainly focused on 'closing the supply chain loop' (Kopicki, et al., 1993), reverse logistics (Eltayeb et al., 2011; Bernon et al., 2011, Sarkis, 2003) and environmentally friendly product distribution systems (Sarkis, 2004). Table 14 summarises earlier empirical measures of a firm's green logistics practices.

Table 14 Earlier research Measures of Green Logistics

Source Year	Measures of Green Logistics
Rao and Holt 2005	Green Logistics 1. Environment-friendly waste management; 2. Environmental improvement of packaging; 3. Taking back packaging; 4. Eco-labelling; 5. Recovery of company's end-of-life products; 6. Providing consumers with information on environmental friendly products and/or production methods; and 7. Use of environmentally-friendly transportation
Eltayeb, Zailani and Ramayah 2011	Reverse Logistics 1. Reuse, is the process of collecting used products from the field, and distributing or selling them used. The ultimate value of the product is reduced, without additional processing. 2. Remanufacturing, is the process of collecting a used product from the field, assessing its condition, and replacing defective or obsolete parts with new or refurbished parts. The identity and functionality of the original product is retained. 3. Recycling, is the process of collecting used products, disassembling them, separating them into material categories, and processing them into recycled products, components, and/or materials. The identity and functionality of the original materials is lost.
Shharma and Henriques (2005)	1. Durable Design 2. De-packaging 3. Internal recycling
Zhu and Sarkis (2004)	Investment recovery ($\alpha = 0.8501$) 1. Investment recovery (sale) of excess inventories/materials 2. Sale of scrap and used materials 3. Sale of excess capital equipment

Green logistics is a key element with regard to the increasingly stringent regulatory pressures across Europe on the end of life products and product take back schemes. Some manufacturers have engaged in product recovery to reduce production costs, enhance environmental performance and pre-empt legislation. Eltayeb et al. (2011:498) define reverse logistics as "*focus[ing] primarily on the return or take-back products and materials from the point of consumption to the forward supply chain for the purpose of recycling, reuse, remanufacture, repair, refurbishing, or safe disposal of the products and materials.*"

2.6.3 The significance of Green Logistics

Earlier research of green logistics practices is mostly anecdotal and focuses mainly on the 'best practice' of large organisations. For example, Esty and Winston (2009)

suggest that many companies have found ways to lower value chain costs by cutting the environmental and financial expenses of product distribution. Esty and Winston (2009) suggest a number of best practices were found to be valuable examples for other companies to follow:

- Dell has upped its average truckload from 18,000 to 22,000 pounds and worked with UPS to optimise delivery strategies (ibid).
- 3M developed innovative systems to install adjustable decks in trucks. Placing pallets on two levels allowed just one 3M facility to reduce the number of daily truckloads by 40 percent and save $110,000 per year (ibid).
- IKEA's 'flat packaging' has allowed IKEA to pack its trucks and trains much tighter, in some product categories the company has achieved a 50 percent increase in fill rate, which helped the company to save up to 15 percent on fuel per item (ibid).

Unruh (2010) suggests that towards the end of the product life cycle and the recycling of materials into new products, the traditional 'value chain' needs to be reconceived into a 'value cycle' and a design for profitable recycling. Using recycled aluminium, steel, paper, glass and, in many cases, plastic is cheaper than buying original materials (ibid). Their research identified two types of recycling at the 'components level' with 'shallow loop' recycling and at the materials level with deep loop recycling.

- Shallow-loop recycling is for example refurbishing or reusing product parts (such as toner cartridges). For example, Fuji Xerox implemented a program to recover and reuse its equipment components, drastically reducing the costs of importing new parts. The firm also designed a tracking system to monitor product wear and allow clients to make precise predictions about product life cycle. By weight, less than 0.5% of Xerox products end up in landfills (ibid).
- Deep-loop recycling requires using waste materials that break down easily. Steelcase remade its Think office chair using only eight materials, which were all biodegradable. The 100% recyclable chair is designed to 'come apart with simple hand tools'. This redesign also reduces assembly time (ibid).

Eltayeb et al. (2011) found reverse logistics to have a significant impact on cost reductions, and suggest that the adoption of reverse logistics among their sample of Malaysian firms is reflected directly in the reduction of the cost of materials and packaging because the firms use recycled or reused materials instead of virgin ones. Their research found no direct relationship between reverse logistics and economic performance, which is due to the high cost associated with product recovery and recycling which makes returned products and components economically uncompetitive to the use of new materials.

According to Sheu and Chou (2005), current reverse logistics integration has a number of problems. First, integration on reverse logistics is rooted in conflicting goals among supply chain members. Second, a comprehensive optimisation model is lacking that helps coordinate different conditions and requirements on supply chain members' logistical demands. Finally, the willingness of customers to return products and government regulations on extended producer responsibility also influence the reverse logistic operation (Sheu and Chou, 2005).

Operations concerned with distribution are closely tied to the requirement of the customer. Although the lean manufacturing concept and associated just in time (JIT) scheduling can provide more efficient distribution and a reduced warehousing need, the reliance on frequent transportation can have a negative impact on the natural environment (Zhu and Sarkis, 2004a). Thus, a balance needs to be reached among supply chain members to achieve optimised distribution without harming the environment. Pohlen and Farris (1992) studied the reverse logistics of plastics. A number of stages were identified, namely: collection, separation, densification, transitional processing, delivery and integration. However, due to the different characteristics of organisations, industries and product types, the requirements may vary among organisations (Pohlen and Farris, 1992).

2.6.4 The measures of Green Logistics

Building on from earlier measurement research relating to a firm's green logistics practices, this research recognises that the focal firm's reverse logistics collection

networks, asset recovery from secondary markets, and environmental friendly forward distribution systems on the supply chain have played an important role to establish green logistics as a conceptual construct. Table 15 shows the measures for green logistics and their sources to be used in this research.

Table 15 Adopted green logistics measures

Measurement Items	**Earlier Contributions**
We engage and establish collection networks for reuse, recycling and remanufactured products from other organisations	Developed
We have a regular supply base in the secondary market	Developed
We provide consumers with information on environmentally friendly products and/or production methods	(Rao and Holt, 2005)
We use more environmentally friendly transportation methods	(Rao and Holt, 2005)

2.7 The Antecedents of NRB-GSCM

2.7.1 Introduction

The antecedents for implementing GSCM practices are categorised based on two broad categories see (Figure 6): 1) external (institutional theory) and, 2) internal (firm resource/capabilities).

The first stream of research refers to institutional theory, which emphasises the role of social and cultural pressures imposed on organisations that influence their management structures. This stems from legitimacy theory in that firms are influenced by stakeholders such as government, customers and industrial competitors. The emphasis of the institutional perspective is on the importance of obtaining legitimacy for the purpose of demonstrating social worthiness. The second stream of research focuses on the leveraging of the firm's resource base and capabilities to implement GSCM practices, such as leveraging top management commitment and implementing JIT and quality management practices to encourage adoption of GSCM practices. This stream of research focuses on the internal

perspective of the firm's resource base, where causally ambiguous and socially complex resources create tacit knowledge and organisational routines that can lead to the successful implementation of GSCM practices.

Some research views both institutional and RBV perspectives to be complementary in understanding the influence on a firm's environmental behaviour. For example, Menguc et al. (2010) see institutional theory as explaining the external influences moderating the effect of internally driven perspectives of the resource based view, to capture the extent of the firm's environmental behaviour. Their research found that regulatory pressure positively moderates the effects of entrepreneurial orientations on proactive environmental strategy. They suggest that firms build proactive environmental strategies based on entrepreneurial orientation and is effective when the intensity of government regulation elevates. Sarkis et al. (2010) suggest that environmental training generates knowledge and learning capabilities that can have a positive moderation effect between stakeholder pressures and the adoption of environmentally responsible practices.

Jiang (2009) adopts the transaction cost economics (TCE) perspective to understand the transaction dimensions and corresponding governance structure, as well as the relation to compliance for supplier codes of conduct between multi-national firms and textiles suppliers based in China. The research adopted an antecedent-mediation-consequence structural model to verify the governance structure based on: 1) a peer-to-peer governance structure and, 2) a buyer-to-supplier governance structure. The results show that increased asset specific investment and longer term contract duration can encourage greater commitment between buyer and supplier to form a peer-to-peer governance structure that would enable suppliers to comply with supplier codes of conduct. In contrast, price pressures led to buyer-supplier based relationships that are not associated with compliance to supplier codes of conduct.

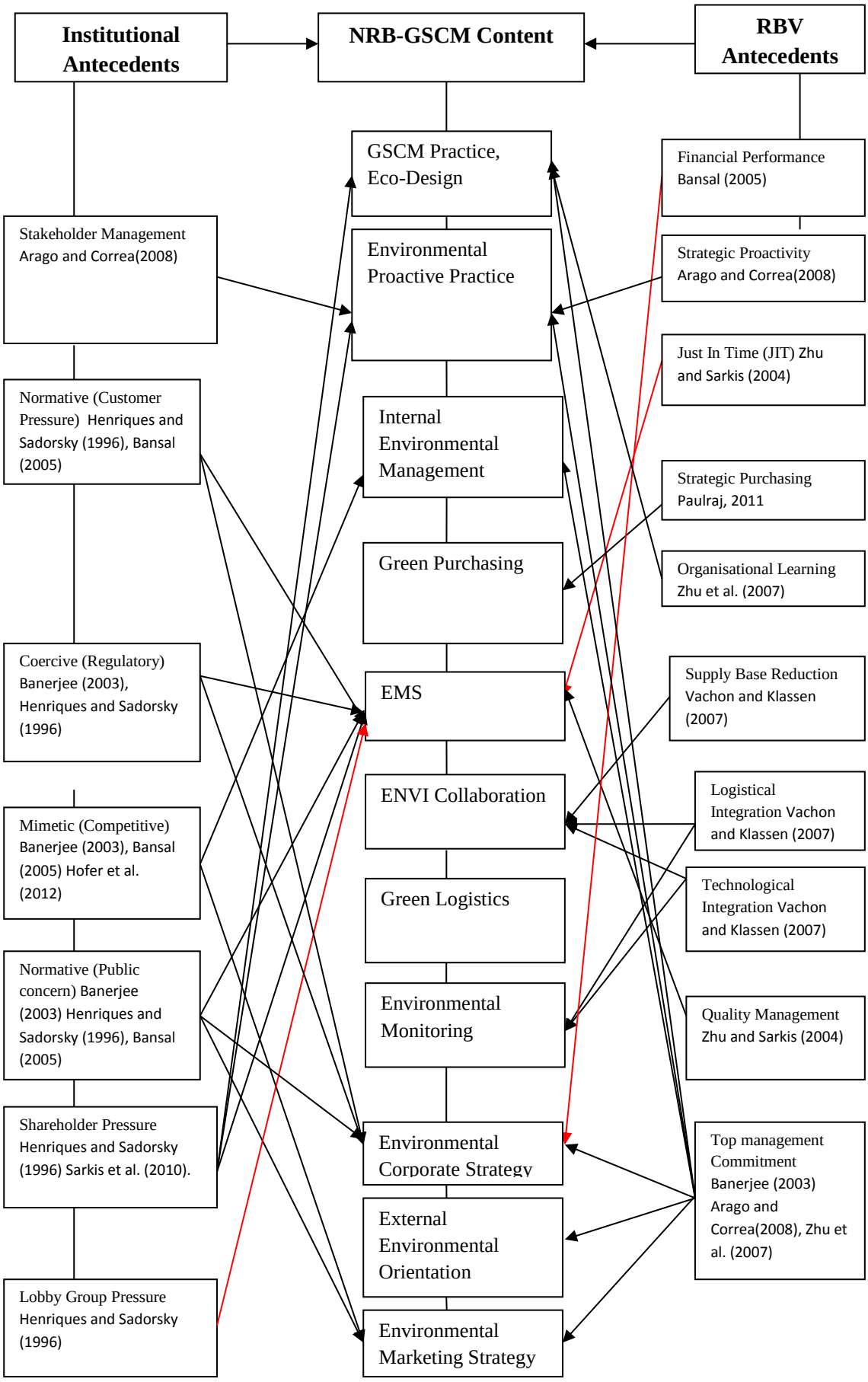
First, this research acknowledges the earlier research in measuring the antecedents of GSCM (Table 16) and the importance of both the theoretical perspectives in motivating firms to adopt comprehensive GSCM practices, but as it is beyond the scope of this thesis, only a brief introduction on RBV antecedents will be given. The second part of this section focuses on the institutional theory perspective that the

adoption of GSCM practices may increase a firm's legitimacy to operate by external actors (Zhu and Sarkis, 2007)

Table 16 GSCM Antecedents Dimensions

Source	Year	**GSCM Antecedents Dimensions**		
Vachon and Klassen	(2007)	Logistic Integration	Technology Integration	
Henriques and Sadorsky	(1996)	Internal GSCM Driver	Environmental Pressure Source	
Christmann	(2000)	Internal GSCM Driver		
Sarkis, Torre and Diaz	(2010)	Stakeholder Pressures	Training	
Zhu, Sarkis, Cordeiro and Lai	(2007b)	Management Support	Organisational Learning	
Zhu and Sarkis	(2004b)	JIT	Quality Management	
Aragon-Correa	(2008)	Shared Vision	Stakeholder Management	Strategic Proactive
Clemens and Douglas	(2006)	External GSCM Driver	Internal GSCM Driver	
Hofer et al.,	2012	Competitive pressure	Size, profitability, market leadership	
Menguc et al.,	(2010)	Government	Customers	Entrepreneurial Orientation
Zhu, Sarkis, Cordeiro and Lai	(2007b)	Management Support	Organisational Learning	
Banerjee, Iyer and Kashyap	(2004b)(2003)	Regulatory Force	Public Concern	Competitive Advantage
Christmann	(2004)	Government Pressures	Customer pressures	Industry Pressures
Darnall, Henriques and Sadorsky	(2008)	Regulatory pressure	Social pressures	Market Pressure
Sharma and Henriques	(2005)	Economic stakeholder	social and ecological stakeholder, Environmental group	Regulator
Zhu, Sarkis, Cordeiro and Lai	(2007)	Regulatory	Customer	Supplier
Sarkis, Torre and Diaz	(2010)	External Stakeholder Pressure	Cost Pressure	Industry Level
Bansal	2005	International experience & Capital management capability	Organisational Slack & Large Firms	Mimetic & Media Attention & Fines
Henriques and Sadorsky	1996	Customer Pressure	Shareholder Pressure & Lobby group pressure	Regulatory Pressure & Community Pressure &
Hofer et al	2012	Rival EMS Activity		

Figure 6 Natural Resource Based GSCM, RBV and Institutional Antecedents Literature Tree



2.7.2 Resource Based GSCM Antecedents

GSCM research to date has treated a firm's resource bundle as the motivation for adopting GSCM practices. This type of RBV and environmental strategy research focuses on general management practices, such as quality management and strategic purchasing, as the firm's valuable, inimitable resources to mediate the effect of environmental practices and performance measures. For example, Zhu and Sarkis (2007) suggest that Chinese organisations with experience in TQM and ISO 9000 could leverage their accumulated system based knowledge to implement effective GSCM. Bowen and Cousins (2001) uses RBV theory to argue that a firm's internal resources are perceived as a predictor of green purchasing behaviour. They go on to suggest that focusing on the development and deployment of a firm's internal resources, rather than a focus on external pressures, better explains the implementation of GSCM practices. Similarly, Darnall et al. (2008) compares resource based antecedents against external oriented institutional antecedents and found that firms can complement their internal knowledge based capabilities, such as quality management, employee commitment, environmental research and development, and export orientation, and are more likely to adopt a more comprehensive EMS than firms motivated by institutional pressures. Vachon and Klassen (2007) examine the impact of environmental collaborative activity, and suggest logistical integration, technological integration and supply reduction lead to environmental collaborations with suppliers. Internal management capabilities are an important attribute for implementing advanced environmental practices, while in the absence of those internal capabilities implementing advanced environmental practices will be more costly (Darnall and Edwards, 2006). Though it is possible to adopt an EMS without the presence of complementary resources, as an alternative, some organisations receive benefits from external assistance, such as government subsidies and consultancies, but this consequently results in more capital expenditures for adoption (ibid).

Finally, organisational management practices and capabilities can generate intangible resources for learning that motivate firms to implement GSCM. It is a complimentary resource to GSCM practices and eventually improves on a firm's performance. Empirical evidence shows that environmental capabilities are more

likely to be associated with higher profit in the presence of complimentary resources (Christmann, 2000). Chan (2005), in an investigation into whether foreign enterprise investments in China benefited from practice of the tenets of the NRBV, proposes a positive influence from a firm's specific resources on the adoption of environmental strategies through the mediating effect of organisational capabilities. Their finding shows the same adoption will eventually lead to favourable corporate environmental and financial performance.

2.7.3 Institutional Antecedents

DiMaggio and Powell (1983) stressed the importance of coercive, normative and mimetic pressures and how these pressures lead to organisational homogeneity. This stream of research is also known as New Institutional Sociology (NIS). The main emphasis is that organisations not only compete for resources, but are also influenced by institutional legitimacy. The three mechanisms of coercive, normative and mimetic isomorphism cause organisations to become alike.

Relating to decisions in adopting GSCM practices, previous research indicates that institutional pressures from regulators, the market and competitors may play a particularly important role in encouraging firms to adopt similar GSCM practices. DiMaggio and Powell (1983) argue that environmental action in a certain industry is an institutional process subject to competitive and institutional effects. Their research suggested that the institutional process occurs through coercive, mimetic, and normative mechanisms, and structural isomorphism is the consequence that organisations produce similar practices and structures that share a common organisational field (ibid).

Many scholars from an institutional perspective argue that a company can gain social legitimacy through 'stakeholder' engagement. Scott (1992) suggests organisations need to conform to the external environment, particularly with multinational companies operating in different countries with multi-cultural and multi-institutional environments.

Hoffman (2001) criticised comments made by conventional profit seeking arguments, i.e., that any investment in improving environmental performance would contribute to increased cost, that pursuing environmental goals was antithetical to sound business strategy and a violation of fiduciary of managers to shareholders. In contrast, Hoffman (2001) suggested that managers now consider environmental protection in cultural terms which merge with institutionally legitimate business concerns. The institutional definition of environmental protection has moved out of the realm of socially responsible management or regulatory compliance and has entered the realm of strategic business management (ibid). Henriques and Sadorsky (1999) indicate that when dealing with environmental issues, although environmental regulation was an important instigator, other factors such as customer pressure, shareholder pressure and community pressure also played a significant role in determining whether firms have an environmental plan.

The level of resource inter-dependence between the stakeholder and the firm is critical for understanding how stakeholders influence the firm's environmental strategies. Frooman (1999) categorises stakeholder influence into usage and withholding, and direct and indirect strategies. He presented four scenarios of resource interdependence. First, the focal firm and stakeholders have high resource interdependence: stakeholders are likely to directly influence the firm's usage of resources so that their objectives are accommodated. Second, stakeholders control the critical resources of the firms, but not the resource dependence of the firm: they can withhold resources from the focal firm, unless they adopt certain practices. Third, when both the stakeholders and the focal firm have no resource interdependence, stakeholders are likely to use indirect strategies to influence other stakeholders to withhold the firm's resources. Lastly, when the stakeholders' resources depend on the firm, but the firm has no dependence on the stakeholder, it is unlikely that the stakeholder can influence the firm's practices.

Sharma and Henriques (2005) conducted an empirical study on the effects of two types of stakeholder influences, namely, withholding and usage influence on corporate sustainable practices. Based on a sample of Canadian forestry industry companies, their results show a number of significant findings in terms of stakeholder influence on sustainable practices: 1) customer demand for information on product sustainability had a positive impact on recirculation of sustainable

practices; 2) Firms that undertake DfE practices are positively associated to withholding strategies, such as director's liability, environmental protests, and environmental groups lobbying provincial governments; and, 3) usage strategies also positively influence DfE adaptations, such as customer demand for product certification and employee information via taskforce recommendations.

Applying institutional theory, Zhu et al., (2007a) argue the level of GSCM implementation is different across different industrial sectors. Industrial sectors with a higher level of GSCM implementation are associated with better performance outcomes. Their research found that the electrical/electronic industry has relatively higher levels of GSCM implementation and achieves better performance outcomes than automobile, power generation and chemical industries in China.

According to Sarkis et al. (2010), the externalities of environmental issues can cause stakeholders to increase pressure on companies to reduce negative environmental impact and increase positive ones. They found that institutional effects have a positive influence on all three types of environmental practices: 1) environmental product design; 2) reduction of material usage, and, 3) managerial aspects. They also suggest that training programmes develop intangible knowledge capacities and have positive mediating effects between institutional pressures on adopting environmental practices.

Similarly, Darnall and Edwards (2006) argue that organisations having the same ownership structure are expected to develop similar capabilities that reduce the cost for EMS adoption. Their research, which applied institutional theory, found aggregate ownership structure related to EMS adoption cost. Based on the survey data of organisations documenting their EMS adoption cost over 3 years, they showed that public owned organisations had greater access to complementary capabilities reducing the cost for EMS adoption. In contrast, private and government owned organisations incurred higher costs for EMS adoption (ibid). To elaborate further, three types of institutional pressures that may have an influence on a firm's practice are now discussed in turn: 1) coercive; 2) normative; and, 3) mimetic pressures.

2.7.4 Regulatory (Coercive)

2.7.4.1 The characteristics of regulatory effect

Conformity through coercive pressures occurs through the influence exerted by government (Zhu et al., 2007b). Firms need to comply with environmental regulations from their home country as well as their export countries. Companies that do not comply to those regulatory requirements, can face penalties and, in the worst cases, cease to operate. In addition, failure to meet regulatory demands also leaves firms vulnerable to a bad public image and customer relations, which can consequently affect the firm's performance.

Darnall et al. (2008) suggest that by utilising proactive environmental practices, firms are more able to form collaborative partnerships with government and explore more non-regulatory ways in which government can encourage greater environmental improvement. This partnership with government also builds trust (Hoffman, 2001), and also facilitating the adoption of voluntary environmental actions such as ISO 14001. This sends positive signals to government that the firm is proactive on environmental issues, and thus helps government to cut environmental monitoring costs, and instead, give more incentives to create effective non-regulatory environmental support. A good reputation with regulators may also provide firms with greater political influence when negotiating the terms for forthcoming regulations with government officials (Darnall et al., 2008).

Earlier research on measures of regulatory effects on a firm's GSCM practices has mainly focused on both the regulatory forces that influence the firm's environmental strategy (Banerjee et al., 2003), and the governmental environmental pressures on the firm's environmental performance (Christmann, 2004). Table 17 summarises earlier research measures of regulatory effects on firms GSCM practices.

Table 17 Earlier Research Measures of Regulatory Effect

Source Year	Measures of Regulatory Effect
Banerjee, Iyer and Kashyap 2003	Regulatory Forces 1. Regulation by government agencies has greatly influenced our firm's environmental strategy. 2. Environmental legislation can affect the continued growth of our firm 3. Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment. 4. Tougher environmental legislation is required so that only firms that are environmentally responsible will survive and grow. (D)
Christmann, 2004	Government Pressures (α= .80) 1. In ten years, environmental regulations affecting this industry will be more similar across countries than today. 2. Next ten years, global environmental standards will gain importance for this industry 3. Next ten years, regional environmental standard will gain importance in this industry
Darnall, Henriques and Sadorsky; 2008	Regulatory pressure 1. How important the influence of public authorities was on the environmental practice of their facility 2. Number of regulatory inspections received over the last three years

Although environmental regulations are still designed, implemented and enforced at the national level, international governmental environmental cooperation through multilateral environmental treaties has increased (Christmann, 2004). Companies that have operations in different countries and face international regulatory pressures can be expected to design global environmental policies that focus on performance outcomes. For example, by setting high global environmental performance for all their operations assures they are consistent with international environmental treaties and national level environmental regulations. Christmann (2004) found empirical evidence showing international environmental regulations are significantly related to MNCs minimum global environmental performance standards.

According to Esty and Winston (2009) companies that are already beyond compliance are interested in stricter laws, where the imposed costs on the less prepared competitors could keep them out of a market space. A number of best practices by leading international firms are identified (Esty and Winston, 2009) for example:

- Electrolux in 1999 announced a partnership with Toshiba to develop energy-saving technology to prepare for the expected introduction of stricter global environmental regulations (ibid).

- Nokia has anticipated its business for laws like the regulation on hazardous substances and, in particular, take-back laws (ibid).
- BP also anticipated stricter environmental regulations and discovered more than $2 billion in efficiency savings by internally trading greenhouse gas emissions between business units; the experience also helped it shape the UK emission trading system, and then the European Union's (ibid).
- DuPont gained market share when the Montreal Protocol phased out production of ozone-depleting chlorofluorocarbons (CFCs). With $500 million in CFC-based revenues. DuPont initially fought the phase out until it realised that it would make even more money in the CFC-substitute market (ibid).

A number of research studies show evidence that environmental regulations in developed countries have been effective in mitigating environmental issues. For example, the Toxic Release Inventory (TRI) in the United States and the enactment of regulations such as the U.S. Superfund Amendments and Reauthorisation Act, 1986 (SARA) for the clean-up of wastes and emissions (Sharma and Henriques, 2005). According to Sharma and Henriques (2005) almost all industrialised countries now regulate toxic wastes and emissions. Pollution control is a standard practice that corporations must undertake to remain within the law. Usually regulations define the technologies and processes to be used by firms, the concentration of chemicals that can be discharged, and the treatment and disposal of these wastes through recovery systems.

Martin and Kemper (2012) found that through regulatory pressure, German consumers are obliged to recycle electronics and batteries, and retailers and producers are required to take them back. In addition, to conserve non-renewable energy resources, the German government adopted Renewable Energy Act in 2000 to promote investment in solar energy. According to Martin and Kemper (2012) the problem for large-scale solar energy projects required that the producers demand high prices for the power they generated. Consequently, the German government required grid operators to purchase solar at five times the cost of conventional power and simulated a very high price for fossil fuel used to generate power (ibid). This policy helped investors to justify the high capital cost of investing in solar power

technology. In addition, German companies received production leverage from selling turnkey photovoltaic production facilities to Chinese manufacturers. Eventually the cost per installed watt for solar energy dropped from about $11 to about $3. This price stability offered by the government allowed investors to rely on reasonable returns on investment in solar technology and to fund the innovation in solar panel technology and production scale that has pushed the costs of solar below the cost of fossil fuel (ibid). The German solar power sector has achieved a scale and technological maturity that no longer require price protection. Similarly, China aims to raise the level of renewable energy to 15% of its total energy mix by 2015, up from 9% in 2010 (renewable includes hydropower). In order to achieve this target, the regulators amended the Renewable Energy Law in December 2009, that require electricity-grid companies to buy all power generated by renewable energy producers (EIU, 2012). Klassen and Angell (1998) elaborate on characteristics of environmental regulations in the U.S and Germany which are summarised in Table 18.

Research into the coercive pressures on a firm's performance measures has shown mixed results of successes and failures. Successfully applied environmental regulation would positively affect the firm's environmental practice and performance improvement, while, failed regulatory guidance can waste a firm's resources on wrong environmental initiatives, consequently reducing a firm's performance. For example, in the U.S, the Energy Policy Act of 2005 mandates the blending of renewable fuels into gasoline and precipitated a major investment in ethanol production capacity. This policy had a negative effect on the firm's performance because an unexpected drop in the international oil price reduced the profitability of ethanol producing firms. As the failure of the policy becomes evident, the government signalled that it may reverse back, but that would mean writing off the previous investment in ethanol production (Martin and Kemper, 2012).

Table 18 Environmental Regulatory Characteristics between U.S and Germany

U.S	Description	Germany	Description
Performance-based standards	Set ambient quality levels, with regulators extrapolating the limits from the ambient level e.g., Clean Air Act.	**Principle of Precautionary Action**	Emphasises the use of best available technologies for the environment
Technology-based standards	Control specific discharges based on technological feasibility e.g., Clean Water Act.	**Polluter Pays Principle**	Demands that the cost of environmental burdens be borne by those who create them
Criminal provisions	Holding corporate directors and operating managers criminally responsible for environmental spills or other mismanagement.	**Principle of Cooperation**	Involvement of all social groups in defining and implementing objectives and measures
Free market transactions	Buy-back by the U.S. power generation industry of old, polluting cars from consumers instead of installing expensive new air pollution equipment at their plants, thereby achieving the same pollutant reductions at lower overall cost.	**Principle of Anticipatory Protection**	Anticipating and preventing the development of future environmental problems
Dissemination of information	Government publication of plant-level toxic pollutant emissions U.S. Toxic Release Inventory, thus increasing public pressure on firms to improve their environmental practices.		

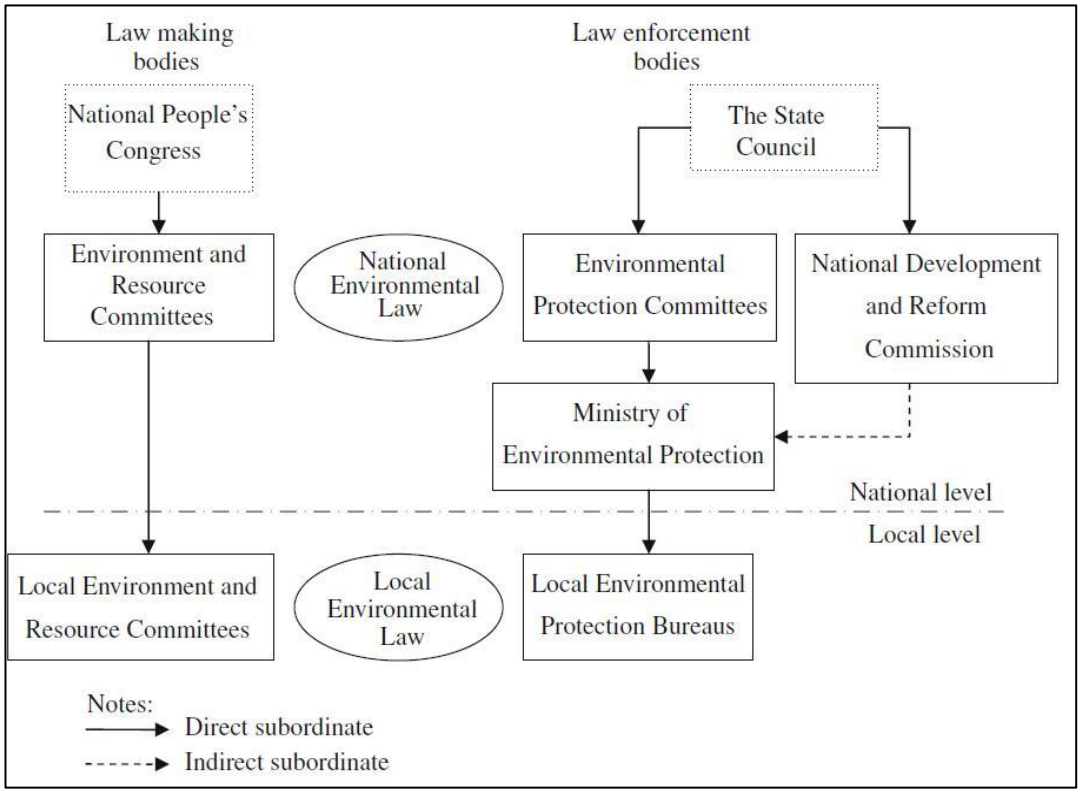
Source: Adapted from Klassen and Angell (1998)

According to Chang and Wang (2010) the overall environmental protection framework in China consists of the following four components:

1. Environmental planning: Known as the Five Year Plan (FYP) where the environmental authorities prepare the FYP to address environmental issues; subsequently, provincial and local government embody the goals set in national plan into their own environmental FYP at the sub-national level.
2. Environmental legislation: Laws concerning environmental protection in China
3. Policy instrument and measures: This includes three major pollution control policies in China: 1) Three Synchronisations Policy; 2) Environmental Impact Assessment; and, 3) Pollution charge.

4. Institutional setting in China ‘s environmental governance systems (see Figure 7).

Figure 7 Environmental governance structure in China



Source: adapted from Chang and Wang (2010)

From Figure 7 above, the main structures to regulate China’s environmental protection system include: 1) Environment and Resource Committees of the People’s Congress; 2) Environmental Protection Committees of government; and, 3) Ministry of Environmental Protection (MEP). The MEP is responsible for environmental governance in the country, which includes formation and implementation of national policies, legislation and regulation related to water and air quality, solid waste governance, nature protection, and nuclear safety (Chang and Wang, 2010).

The following environmental laws in China are designed to specifically regulate the firm’s pollution activities:

The anti-pollution law requires that total emissions have control measures such as the Total Emission Control (TEC) Zones, where all polluters are required to comply with the prescribed standards. Furthermore, the establishment of a national emission

fee system on the basis of categories and quantities of atmospheric pollutants and of a reporting system covering all relevant data. New and expanding sulphur dioxide-emitting power plants as well as large and medium-sized enterprises that do not meet prescribed standards for pollution discharge have to install desulphursing and dust removal equipment. Existing enterprises must adopt control measures by a timetable to be determined by the State Council (Beyer, 2006).

The water pollution prevention and control law provides a unified basin or region-wide planning approach that directly links to the responsibility of the MEP. The law requires all units that discharge pollutants directly or indirectly into water bodies to register with the local environmental protection bureaus (EPB) and supply information regarding the quality and quantity of pollutants discharged and the available treatment facilities (Beyer, 2006).

Solid waste pollution prevention and control law requires industrial units producing solid waste to register with local EPB to furnish data of its waste output, flow direction, storage, treatment and other relevant information. In case of non-compliance, pollution discharge fees can be imposed by the EPB. In terms of unwanted waste imports into China, the law addresses the issues of solid waste import and inter-provincial transfer and a ban on solid waste that cannot be utilised as raw material (Beyer, 2006).

The environmental impact assessment (EIA) law requires a report on the environmental effects of a project. EIA law requires submission of new environmental-impact reports if the investor makes important changes to the original construction plans. They specify punishments for non-observance, including fines of up to Rmb200,000 or orders to halt construction (EIU, 2012).

The cleaner production promotion law defines the scope of clean production, including labelling and the sale of toxic construction and decoration materials (EIU, 2012). It outlines the roles and responsibilities of relevant government departments, specifies the obligations of enterprises, and details incentives and liabilities (Hicks and Dietmar, 2007).

A number of authors (Wang, 2006, Hicks and Dietmar, 2007) argue that the green trade barrier is becoming a major obstacle to the export of China's products.

Countries can impose environmental protection to limit the import of foreign goods. Selective green barriers as non-tariff trade measures can be misused in the name of environmentalism including green tariffs, green technology standards, environmental labelling, green packaging, and green subsidy, which if improperly used can deteriorate international trade (Lawrence, 2011). The green trade barrier will weaken the competitiveness of China's products and even cause them to lose market share (Wang, 2006). For example, the European Union has banned the sale of 320 agricultural chemicals since December 31 2003, affecting the export of pesticides and many agricultural products to which those pesticides are applied (ibid). In response to green barriers, the Chinese government and firms has been aggressively working toward building an internationally recognised national certification scheme; the China Forest Certification Council (CFCC) with more than 3 million hectares of forests CFCC-certified. China becomes one of the most active supporting countries in PEFC (Program for the Endorsement of Forest Certification) in the Chain of Custody (CoC) certification, which tracks PEFC certified materials through the production process (Lawrence, 2011).

2.7.4.2 The measures of regulatory effect

Synthesising earlier measurement research relating to the regulatory effects on a firm's GSCM behaviour, this research recognises that a firm's perception on environmental regulations, and the level of environmental regulations affecting the firm's perceived growth plays an important role in measuring the firm's perceived regulatory effects on GSCM behaviour. Table 19 shows the measures for regulatory effect and their sources to be used in this research.

Table 19 Adopted regulatory effect measures

Measurement Items	**Earlier Contributions**
Regulation by government agencies has greatly influenced our firm's environmental strategy.	(Banerjee et al., 2003)
Environmental legislation can affect the continued growth of our firm	(Banerjee et al., 2003)
Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment.	(Banerjee et al., 2003)
Tougher environmental legislation is required so that only firms that are environmentally responsible will survive and grow.	(Banerjee et al., 2003)
Our industry is faced with strict environmental regulation	(Banerjee et al., 2003)

2.7.5 Market Effect (Normative)

2.7.5.1 The characteristics of market effect

As public concern about environmental degradation rises, customers are increasingly considering environmental factors in their purchasing decisions (Christmann, 2004). Widespread environmental information that is freely available to the public, in addition to government regulatory pressure, social movements, such as labour unions, trade associations, environmental and community groups, can mobilize public sentiment, alter accepted norms and change people's perception about a firm's environmental issues (Darnall et al., 2008). Media stories of catastrophic environmental disasters, such as the BP deep-water horizon oil spill in 2010, and the Fukushima Daiichi nuclear disaster in 2011, have heightened public awareness of the firm's environmental performance. In some cases, if manufacturers do not feel pressure from the market, they may be reluctant to implement innovative environmental practices (Zhu and Sarkis, 2007).

The green consumerism movement, beginning in the late 1980s and early 1990s, has resulted in some sustainable goods and services moving out of the margins and into mainstream markets, particularly in the food sector (Wapner, 1996). Hill (1997) argues that in the manufacturing industry, environmental pressures move along from

the customer end of the supply chain to the organisations in question and from them to their suppliers, and thus, apart from a rare monopolistic situation, customers almost always hold the balance of power. Consequently, many consumer products have started to go mainstream, such as eco-designed automobiles and sustainable housing (Weizsacker et al., 1997).

Earlier research on the measures of market effect on a firm's GSCM practices has mainly focused on public concerns of a firm's environmental issues (Banerjee et al., 2003), and domestic and international customer pressures on a firm's environmental performance (Christmann and Taylor, 2001; Christmann, 2004). Darnall et al. (2008) measure market effect based on two different dimensions. The first refers to the market pressure from the supply chain customers. The second dimension refers to the pressure from social groups. Table 20 summarises earlier research measures of the market effect on a firm's GSCM practices.

Table 20 Earlier Research Measures of Market Effect

Source **Year**	**Measures of Market Effect**
Banerjee, Iyer and Kashyap 2003	Public Concern 1. Our customers feel that environmental protection is a critically important issue facing the world today 2. The North American Public is very concerned about environmental destruction 3. Our customers are increasingly demanding environmentally friendly products and services 4. The public is more worried about the economy than about environmental protection. (R, D) 5. Our customers expect our firm to be environmentally friendly. (D)
Christmann and Taylor (2001)	1. Export to Developed Countries (Percentage of total sales sold to developed regions 2. Multinational Customers
Christmann, 2004	Customer pressures 1. Environmental strategies that we implement in one country affect considerably our environmental reputation with customers in other countries
Darnall, Henriques and Sadorsky; 2008	Social pressures (α= .75) 1. Influence of labour unions on environmental practices 2. Influence of trade association on environmental practices 3. Influence of environmental groups on environmental practices 4. Influence of community groups on environmental practices Market pressures (α=0.63) 1. Influence of household consumers on environmental practices 2. Influence of commercial buyers on environmental practices 3. Influence of suppliers on environmental practices

According to Christmann (2004), an MNC's environmental strategy is affected by the environmentally conscious consumer. An environmental incidence from one of the MNC's subsidiaries in one country can affect their reputation and operation performance in other countries. For example, The Brent Spar incident, where the British Shell subsidiary disposed of the oil platform Brent Spar by sinking it in the Atlantic Ocean in 1995, triggered widespread environmental protest and negative environmental press. This incident illustrates mismanagement of an MNC's subsidiaries environmental decision-making process can be costly for subsidiaries in other countries and consequently to the entire MNC (ibid). A firm's reputation for environmental responsibility is based on the information about the firm's environmental conduct that the customer can obtain (ibid). Christmann (2004) suggests that MNCs can influence public perception about their environmental conduct by standardising their environmental message. Similarly, Banerjee et al. (2003) suggest that market demand can influence corporate environmentalism in two ways: First, firms may present a green image to indicate their responsiveness to public concern, and second, firms could develop an environmental strategy to target green consumers.

Zhu and Sarkis' (2004b) study on large organisations in China, has shown no significant relationship with quality management and environmental management. This is due to most large organisations being state owned. Furthermore, with a largely domestic driven market, they also have less pressure from stakeholders. In contrast, medium sized enterprises, many having pressure for environmental responsibility from their joint venture partners, have a significant relationship with environmental management implementation (ibid). Thus, a lack of market pressure may result in organisations having weaker environmental performance and losing additional customers, which in turn influences economic performance.

Christmann and Taylor (2001), based on the environmental behaviour of large multi-national companies, argue that globalisation encourages the convergence of environmentalism across firms in developed and developing countries in a number of ways. First, large multinational firms with experience of tougher environmental regulations from developed countries are likely to transfer their advanced practices and technologies to local subsidiaries in developing countries. Consequently, a multinational firm's subsidiaries in developing countries might exert pressure on

domestic suppliers to improve their environmental performance. For instance, Schell (2011) argues that Chinese companies are under pressure from MNCs that wish to ensure a 'green' supply chain. Wal-Mart has some 20,000 Chinese suppliers, or 'partners', that reportedly provide Wal-Mart with about 70% of the nearly $420 billion worth of goods that it sells globally each year. China has become so crucial to Wal-Mart's supply chain that in 2002, Wal-Mart moved its global sourcing headquarters across the border from Hong Kong to Shenzhen, in southern China (Schell, 2011). With some 30,000 Chinese factories making things for Wal-Mart, the company's future was tied to China in the most fundamental way (ibid).

Market pressure can drive a firm with a desire to appear environmentally responsible. For example, a number of leading global firms are carefully crafting and directing social pressure by adopting voluntary environmental responsibility certification and recognition for improvement in energy efficiency and waste management. For instance, Coca-Cola felt sufficient pressure regarding its use of clean water to establish water-stewardship goals, which is a commitment to watershed protection projects and to increasing supplies of clean drinking water. McDonald's demonstrated its commitment to conserving global fish stocks by sourcing their fish from sustainable fisheries and gained certification from the Marine Stewardship Council (Martin and Kemper, 2012).

2.7.5.2 The measures of Market effect

Building on earlier measurement research relating to the market effect on a firm's GSCM behaviour, this research recognises that customer expectations, trust, public concern and media exposures, play important roles in measuring the firm's perceived market effect on GSCM behaviour. Table 21 shows the measures for market effect and their sources to be used in this research.

Table 21 Adopted market effect measures

Measurement Items	**Earlier Contributions**
Greening the supply chain can improve trust from our customers	Developed
The public is very concerned about environmental destruction	(Banerjee et al., 2003)
Media exposures for pollution activities is strong in our industry	Developed
Our customers expect our firm to be environmentally friendly.	(Banerjee et al., 2003)

2.7.6 Competitive (Mimetic)

2.7.6.1 The characteristics of competitive effect

Mimetic pressure is also known as the benchmarking strategy; that is, to follow best practice of successful competitors. According to DiMaggio and Powell (1983), uncertainty is the main driving force behind a firm's imitation activity. The benefit is that the level of uncertainty can be reduced in an organisational environment by imitating the structure and activities of similar firms. Shenkar (2010) suggests that the copycat strategy, where profitable imitation can save costs, simplify logistics and add efficiency. As the speed of innovation increases, firms need to exercise mimetic activities as a business tactic. For example, Apple and Wal-Mart both borrowed characteristics from their respective imitative models and combine with their own field of expertise to create competitive advantage (Shenkar, 2010).

Mimetic successful practices can also create second mover advantage and acquire market share. For instance, in the 1990s, a number of private and governmental organisations attempted to mimic efficient supply chain configuration from Japanese manufacturing techniques such as total cost of ownership, product life cycle analysis and long term collaborative relationships with suppliers and their concept of 'Keiretsu' alliances based business systems.

According to Shenkar (2010), the globalisation of trade motivates firms to realise higher economic benefit by pushing strategy, such as Value Chain Modularisation

(VCM). Through the acquisition of modular pieces of the value chain, firms can create products by assembling other companies' modules (ibid). Vizio for example uses an assembly-only strategy, where the firm exploits opportunities to reduce costs on R&D and patent protection and enables the firm to focus on sales to create more than 12% of the flat-panel TV market in the US (ibid).

Environmental issues are associated with considerable uncertainties because of the complexity of environmental problems. Industry associations play an important role in setting industry norms for environmental protection (Christmann, 2004). Consequently, firms can imitate their competitor's environmental action to assure that their responses meet the norms required to maintain legitimacy.

Earlier research on measures of competitive effects on a firm's GSCM practices has mainly focused on the firm's motivation to capture market share, the cost advantage in the competitive market (Banerjee et al., 2003), and imitation of their competitor's environmental behaviour to achieve legitimacy within industry norms (Christmann, 2004). Table 22 summarises earlier research on measures of the competitive effect on a firm's GSCM practices.

Table 22 Earlier Research Measures of Competitive Effect

Source **Year**	**Measures of Competitive Effect**
Banerjee, Iyer and Kashyap 2003	Competitive Advantage 1. Being environmentally conscious can lead to substantial cost advantages for our firm. 2. Our firm has realized significant cost savings by experimenting with ways to improve the environmental quality of our products and processes. 3. By regularly investing in research and development on cleaner products and processes, our firm can be a leader in the market. 4. Our firm can enter lucrative new markets by adopting environmental strategies. 5. Our firm can increase market share by making our current products more environmentally friendly. 6. Reducing the environmental impact of our firm's activities will lead to a quality improvement in our products and processes.
Christmann, 2004	Industry Pressures (α= .77) 1. Industry initiatives/associations advocate the implementation of worldwide environmental standards by firms. 2. Our major competitors set worldwide environmental standards for their operations and products 3. Our major competitors implement environmental strategies on a worldwide basis.

According to Christmann (2004), industry associations setting up environmental initiatives are doing so to protect the collective reputation of their respective sector. This increases the international and national voluntary environmental initiatives that are not directly mandated by government regulations. Since industry environmental codes of conduct address mainly operational aspects of environmental policies and do not specify performance target, their research found empirical evidence that in the absence of a specific outcome measure, industry pressures for environmental policy standardisation are positively associated with the company's global standardisation of operational environmental policies.

Through imitation, firms can capitalise on the success of their peers and will likely mimic the most visible and well defined activities (Bansal, 2005). Similarly, Cai et al. (2008) argue that the adoption of GSCM requires relatively high investment and is associated with uncertain economic and political pay-offs. Second movers can imitate the success of the pioneers, particularly the visible and well defined successful activities of others (Cai et al., 2008). Globalisation has created an opportunity for Chinese firms to converge best business practices from successful international firms (Christmann and Taylor, 2001). Hofer et al. (2012) applied the Schumpeterian economic perspective to examine competitive determinants of a firm's environmental management activities. Their research found the focal firm's environmental activities influenced by the rival firm's environmental activities. Because environmental management activities may satisfy stakeholder expectations, which can then help firms seize market opportunities and market leaders would implement greater environmental management activities compared to their rival firm's past environmental activity. In addition, their research found firm size and market leadership both to positively mediate their rival's past environmental activity with focal firm's environmental management activity, given the fact that larger firms and market leaders are more likely to have resource and organisational slacks to implement environmental management practices.

2.7.6.2 The measures of Competitive effect

Synthesising earlier measurement research relating to the competitive effect on a firm's GSCM behaviour, this research recognises that a firm's perceived competitive benefit, such as market leadership, market entry, cost leadership and influence on market shares, plays an important role in measuring the firm's perceived competitive effects on GSCM behaviour. Table 23 shows the measures for competitive effect and their sources to be used in this research.

Table 23 Adopted competitive effect measures

Measurement Items	Earlier Contributions
By regularly investing in research and development on cleaner products and processes, our firm can be a leader in the market.	(Banerjee et al., 2003)
Being environmentally conscious can lead to substantial cost advantages for our firm	(Banerjee et al., 2003)
Our firm can enter lucrative new markets by adopting environmental strategies.	(Banerjee et al., 2003)
Our firm can increase market share by making our current products more environmentally friendly.	(Banerjee et al., 2003)

2.8 Performance

2.8.1 Introduction

Owing to the increasing competitive pressure from globalisation of manufacturing activities and markets, organisations have to reorient their strategies, operations, processes and procedures to remain competitive (Lo and Fryxell, 2003). However, to achieve such competitive standing, the organisation must be able to make some kind of performance measurement as a prerequisite for its improvement. Slack et al. (2003:640) define performance measurement as ''*the process of quantifying action, where management means the process of quantification and the performance of the operation is assumed to derive from actions taken by its management*". In contrast, a

measurement of GSCM performance is relatively new in this multi-disciplinary research area, and promises to give an opportunity for enterprises to assess their performance after implementing a GSCM strategy. GSCM performance evaluation cannot just be based on its financial aspect. Business intangibles including environmental aspects need to be integrated at a strategic level (Kaplan and Norton, 2001). In order to assess the effects on operations, there is a clear need to measure environmental performance. James (1994) suggests that it requires an extension of existing measurement and reporting activities to encompass all the three elements of sustainable development – the economic, environmental and social elements, as well as the interactions between them. This requires a set of sustainability indicators that are comparable, complete and credible (Ranganathan, 1999). Organisations are faced with a range of possible approaches for the development of indicators to measure environmental performance and the approach that they may take is dependent on a number of factors such as the amount of resources that the decision maker would be willing to dedicate. According to Kaplan and Norton (1996) the traditional financial based performance measurement fails to measure all the critical factors affecting business success. A number of earlier studies, all proposing sustainability-based performance evaluation (Sarkis, 2003, Figge, 2002) and sustainable supply chain based decision support systems such as the supply chain environmental analysis tool (SCEnAT) have focused extensively on the environmental impact on operational performance as well as the importance of considering environmental aspects into corporate strategic decision making (Koh et al., 2012).

Research relating to environmental and economic performance has been fragmented. Earlier research, based on traditional economic theory, commonly focus on the effects on 'externality', which is categorised as either positive or negative externality. In relation to environmental issues, negative externality, for example, is the environmental cost incurred to the local community, because they involuntarily receive pollutants from industrial practices. In contrast, a positive externality is the benefit to an industrial firm of discharging pollutant to the environment without any cost. Solutions to externality issues from the TCE perspective is a clearly defined property right which makes the polluter pay for the cost incurred. As such, the continuation of the TCE perspective, by treating environmental issues as costs, results in firms believing that any environmental improvement made by a

manufacturing firm transfers the cost previously incurred by society back to the firm, consequently, manufacturing performance worsens.

In contrast, Klassen and Whybark's (1999) research focused on the operational level in manufacturing, taking preventative environmental technologies as the firm's strategic resources. They found that high environmental performance will bring profit to the firm. Considering the moderating effect of industrial growth, higher industrial growth can bring better environmental performance and more profit.

Earlier empirical studies based on NRBV, link environmental performance to economic performance, suggesting that pollution prevention as a proactive environmental approach has a positive relation to economic performance (Russo and Fouts, 1997, Klassen and Whybark, 1999). Russo and Fouts (1997) suggest that environmental performance and economic performance are positively linked and that industry growth moderates the relationships, with the financial returns to environmental performance higher in high-growth industries.

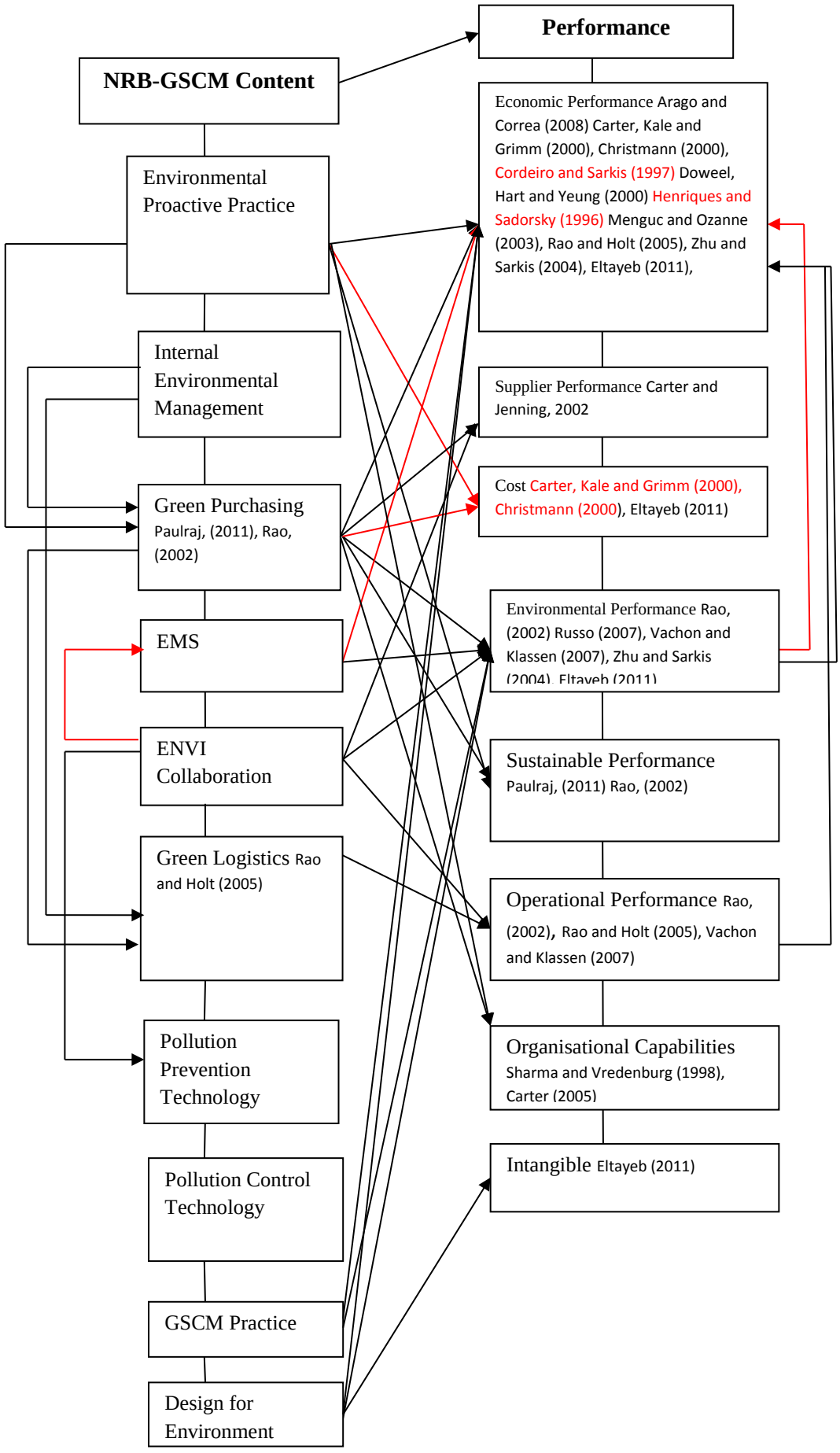
However, Chan (2005) investigated a sample of foreign direct investment (FDI) firms in China, and suggests that the adoption of environmental strategy will eventually lead to favourable corporate environmental and financial performance. In contrast to the proposed hypothetical model, their research found no significant relationships of environmental performance with economic performance. Chan (2005) argues that this is due to foreign enterprise investment in China which leads to part of their output being sold to overseas markets. As such, it may inferred that the insignificant relationship that was found is due to the overseas consumers being relatively unaware of the various green initiatives taken by the foreign enterprise investment. In addition, China's environmental regulation and infrastructure development are potential limiting factors as well as the confusion due to the involvement of various actors (ibid).

Based on the earlier literature on GSCM performance dimensions (Table 24) and empirical relationships with GSCM measures (Figure 8) this research proposes to use environmental, operational and financial measures to explore the impacts from GSCM practices.

Table 24 GSCM Performance Dimensions

Source	Year	GSCM Performance Dimensions		
Rao and Holt	(2005)	Economic	Competitiveness	
Sarkis and Cordeiro	(1997)	Economic	Environmental	
Vachon	(2007)	Economic		
Vachon and Klassen	(2007)	Operational		
Sharma and Vredenburg	(1998)	Organisational Capabilities	Organisational Benefit	
Rao	(2002)	Environmental	Competitiveness	Economics
Menguc and Ozanne	(2005)	Economic		
Henriques and Sadorsky	(1996)	Economics		
Dowell, Hart and Yeung	(2000)	Economic		
Christmann	(2000)	Cost Advantage		
Zhu, Sarkis and Lai	(2008)	Economic	Operational	Environmental
Zhu and Sarkis	(2004b)	Economic	Environmental	
Aragon- Correa et al.,	(2008)	Economics		
Bansal	(2005)	Economic Prosperity	Social Equity	

Figure 8 Natural Resource Based GSCM and Performance Literature Tree



2.8.2 Environmental Performance

2.8.2.1 The characteristics of environmental performance

Environmental performance is a concern of managers due to reasons ranging from regulations, contractual compliance, public perception, and competitive advantage (Theyel, 2001). Beamon (1999) argues that traditional supply chain performance measures are inadequate considering the extension of environmental values into supply chain objectives. Environmental performance measures such as waste, energy use and resource use need to be incorporated. Frosch (1994) argues that an inter-firm linkage facilitated by proximity could lead to improvement in environmental performance. Geffen and Rothernberg (2000) suggest that relations with suppliers aid the adoption and development of innovative environmental technologies, and such an interactive exercise may lead to improvements in environmental performance. Rao (2002) proposed measures for environmental performance including: 1) reduction of solid/liquid waste; 2) reduction of emissions; and, 3) improvement of compliance. The research found that increased environmental initiatives and supply chain environmental management practices helped firms to improve their environmental performance, despite the fact that no direct relationship between environmental performance and economic performance was found. The research found environmental improvement helped firms to increase competitiveness, with competitiveness consequently leading to economic improvement.

Although the above research argues for GSCM practices with environmental performance measures, the earlier studies are mostly hypothetical and lack empirical findings to support GSCM's causal relationships with environmental performance improvement. Synthesising earlier work, this research suggests that environmental performance includes a reduction in the following: air emissions, solid waste disposal, wastewater discharge and production and use of hazardous materials. Table 25 summarises earlier research contributions in environmental performance measures.

Table 25 Earlier research Measures of Environmental Performance

Source **Year**	**Measures of Environmental Performance**
(Sarkis and Cordeiro, 1997)	1. Fugitive non-point air emissions 2. Stack or point air emissions 3. Discharges to receiving streams and water bodies 4. Underground injection on-site. 5. Releases to land on-site. 6. Discharges to publicly owned treatment works 7. Other off-site transfers 8. On-site and off-site energy recovery 9. On-site and off-site recycling 10. On-site or off-site treatment 11. Non-Production releases
(Vachon and Klassen, 2007)	Environment (α=0.79) 1. Solid waste disposal 2. Air emission 3. Water emission
(Beamon, 1999)	Resource Use Product Recovery 1. Remanufacturing 2. Reuse 3. Recycling 4. Waste emission and exposure hazard
(Zhu and Sarkis, 2004b)	Environmental Performance (α=0.94) 1. Reduction of air emission 2. Reduction of waste water 3. Reduction of solid wastes 4. Decrease of consumption for hazardous/harmful/toxic materials 5. Decrease of frequency for environmental accidents 6. Improve a enterprise's environmental situation
(Eltayeb et al., 2011)	1. Compliance to environmental standards 2. Reductions in air emissions 3. Resource consumption 4. Consumption of hazardous materials
(Paulraj, 2011)	1. Reduction in air emission 2. Reduction in waste (water and/or solid) 3. Decrease in consumption of hazardous/harmful/toxic materials 4. Decrease in frequency for environmental accidents 5. Increase in energy saved due to conservation and efficiency improvements
(Rao, 2002)	1. Reduction of solid/ liquid waste 2. Reduction of emissions 3. Improvement of compliance

2.8.2.2 The measures of Environmental Performance

Fu et al. (2007) argue that environmental deterioration, which resulted in approximately 51,000 disputes in 2005, has been considered one of the important causes of social unrest in Chinese society. Zhu and Sarkis (2004b) argue that GSCM practice can be a costly investment and the pressures to perform environmentally are also great. However, the above effort does not guarantee improved environmental performance. Thus, the understanding of the relationship between GSCM practices and environmental performance is necessary, especially for firms in countries that need to balance a growing economy and environmental protection such as China. Their research found that win-win relationships between GSCM practices and environmental performance do exist among Chinese manufactures (ibid)

Air emissions, such as the greenhouse gas (GHG) emissions, mainly consist of carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydro and per fluorocarbons (HFCs, PFCs) and sulphur hexafluoride (SF6) from manufacturing process reactions, distribution and treatment processes (Verfaillie and Bidwell, 2000). Approximately 8 billion tons per year of carbon in the form of carbon dioxide are emitted globally through the burning of fossil fuels for transportation, heat and electricity worldwide. This is about 5 billion tons more than the absorptive capacity of the biosphere (Senge, 2008). Verfaillie (2000) suggests that the climate change issue related to increasing concentrations of greenhouse gases is a global concern. Thus reduction on GHG emission levels may represent the effects of GSCM implementation. Due to China's reliance on coal for its energy needs, almost two-third of China's cities does not meet the standards set out by the World Health Organisation for acceptable levels of total suspended particulates and sulphur dioxide (Smil, 1998). China's coal reserve is estimated to contribute to 70% of suspended particulate emission, 90% of sulphur dioxide, 67% of NOx and 70% of CO2 emissions. According to Fu et al. (2007), the major air pollutants are particulate matter (PM), SO2, and nitrogen oxides (NOx). Currently, more than 40% of China's cities are suffering from high levels of suspended particles. Acid rain resulting from air pollution is prevalent in southern China. Acid rain leads to acidifi-cation of surface waters and soils, which can cause ecosystem dysfunction, including loss of fish populations and forest dieback. In 2005, approximately 38% of Chinese

cities and counties had annual average pH values <5.6. This indicates that they were likely affected by acid rain (ibid).

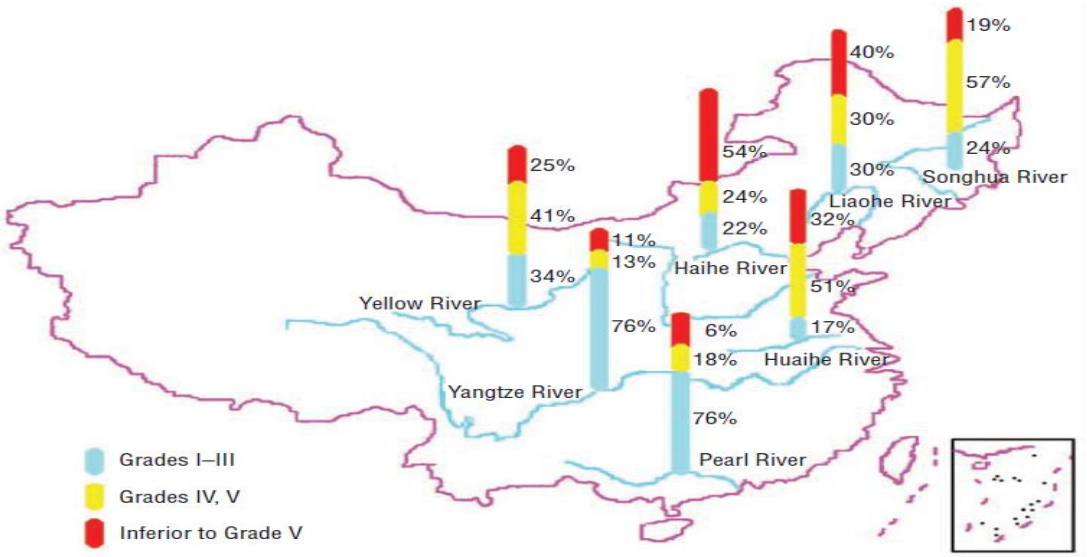
It is necessary for companies to ensure that the generation of hazardous wastes is reduced and also that adequate disposal facilitates are available. Exposure to chemicals like dioxin, a by-product of production processes such as paper making, or heavy metals such as lead and mercury can create severe public health risks (Esty and Winston, 2009). The European Union REACH directive mandates that manufacturers must prove the safety of every new and old chemical. Chemicals used from insecticides to detergents to plastics, may change hormone levels in animals and people, and thus can damage biological processes such as reproduction, growth and immune function. A GSCM strategy requires companies to adopt environmentally friendly purchasing, including taking into consideration the purchasing of materials that consist of less environmentally harmful elements, the use of fewer materials and more renewable and recyclable resources. In 2011, China's state Council approved a five-year blueprint to tackle heavy-metal pollution as part of the 12th Five-Year Plan, which has set an emission-reduction target for five heavy metals — lead, mercury, chromium, cadmium and arsenic — by 15% from 2007 levels (AMM, 2012). According to the American Metal Market (AMM) (2012), from 2009 to 2011 over 1,000 enterprises have been closed down for illegal discharge of toxic heavy metals. Still, in January 2012, two companies, Jinchengjiang Hongquan Lithopone Material Co and Guangxi Jinhe Mining Co, were caught in a severe cadmium spill in the Longjiang River in Guangxi region. It threatened the drinking water supply for 1.5 million people (AMM, 2012).

Water is a critical input to agriculture and many industrial processes. Globally, industries are facing constraints from water accessibility. With a rising population, intensified urbanisation and rapidly growing economies, water scarcity and pollution have become major issues to business (Esty and Winston, 2009). According to the European Union Water Framework Directive the industrial wastewater discharge is classified as point source pollutions. Companies that use too much water or degrade water quality will face political attack, public backlash, intensified regulation and even legal action (Esty and Winston, 2009). Green supply chain companies are expected to monitor their pollution discharge, implement wastewater treatment facilities to reduce the volume of toxic materials discharged into the surrounding

water, and ensure the legal compliances on wastewater quality. Thus further cost reductions may be incurred.

China is plagued by two paradoxical water crises, since northern China suffers from regular drought whereas floods threaten the south (Beyer, 2006). The available per capita volume of water is ~2200 m3, only 25% of the world average, about 44% of the population lives in the north but has access to only ~15% of the water resources (Fu et al., 2007). The water shortage will be exacerbated by serious pollution. More than 60% of China's large lakes are eutrophic, and the water quality has declined in over 50% of its rivers (ibid). Water of Grades I–III is suitable for drinking, Grade IV is for industrial and recreational use, and Grade V is for agricultural use (Fu et al., 2007). The water quality at more than 50% of the monitored sections in five of China's seven largest rivers (the Liaohe, Songhua, Haihe, Huaihe, and Yellow rivers) is considered Grade IV or worse in a five-class grading system, indicating heavy pollution (ibid) (Figure 9). More than 75 percent of the water flowing through China's urban areas is unsuitable for drinking or fishing, and about 80 percent of China's sewage effluent flows directly into waterways without any prior treatment, about 30 percent of the nation's rivers are polluted (ibid). Sixty million people have difficulties in getting access to water for their daily needs and almost three times that number drink contaminated water every day (ibid).

Figure 9 Water quality map China



Source: adapted from (Fu et al., 2007).

According to Li (2009), China's water productivity is $3.6 per cu m, and is lower than the average of $ 4.8 per cu m in middle-income countries, and $ 35.8 per cu m in high-income countries. Water use in the agricultural sector accounts for 65 percent of the country's total. But only 45 percent are actually consumed on crops, due to extensive waste in irrigation systems. The industrial sector takes up 24 percent of the total water consumption in the country. The recycling rate is only 40 percent, compared to 75-85 percent in developed countries (ibid).

According to Sun (2007), increasing land-to-sea pollutants has also led to further deterioration of offshore water quality, based on more than 500 pollution outlets monitored by the State Ocean Administration of China (SOA). About 77 percent of the outlets were discharging more pollutants than permitted, so that every day 9,230 tons of land-sourced pollutants were pumped into offshore seawater. The pollutants were mostly chemical oxygen demands (COD), suspended matter, phosphate, ammonia and nitrogen. Improper distribution of pollution outlets is another problem with only 11 percent of waste being discharged in designated areas while about 42 percent went into sea fishery farms. Others went into harbour areas and natural marine reserves (ibid).

During the operational processes, such as packaging, production and distribution, certain waste materials may be generated which require disposal. Around the world, more than 90 percent of computers, TVs, video and audio equipment and many other consumer electronics finish their life cycle in landfill. According to Senge (2008), packaging waste, mostly cardboard and diverse plastic containers and wrappings, has grown 400 percent in the past twenty years. Only very few plastics are recycled. Over 90 percent of plastics worldwide end up in landfill. By adopting a GSCM strategy, the volume of solid waste can be reduced through conducting environmentally friendly purchasing and cleaner production, and developing environmentally friendly packaging. According to Verfaillie (2000), waste is certainly an issue of growing global concern, and organisations will need to specify the definition and measurement method used to track and report their waste amounts. Specific indicators may include type of waste, e.g. hazardous/non-hazardous, or its final destination e.g. landfill, recycling or incineration.

Recycling has become a global industry in China. Even though it produces more waste than it can process, it is the largest importer of the world's waste materials. China imports as much as a third of Britain's recyclables and the entire US West coast's waste paper market (Manthey, 2012). Zhang Yin, China's and the world's richest woman, made a fortune buying up waste paper and shipping it to China to be made into packaging (ibid).

China is also the world's main destination for high-tech waste or 'e-waste' – computers, cell phones and other electronic products are shipped to China where they are taken apart and recycled (Manthey, 2012). According to Moxley (2011), despite improvements to treatment facilities in recent years, China still lacks large numbers of high-tech recycling facilities and relies instead on environmentally damaging methods of disposal. Some e-waste is burned and large amounts of hazardous material are abandoned without treatment (ibid). Improper handling of e-waste can impact human health and the environment. Heavy metals, including lead, tin and barium, can contaminate underground and surface water, and electrical wires are sometimes burnt in open air in order to get to the copper inside, spreading carcinogens into the air. For example, Guiyu town in southern China's Guangdong province, is home to the world's highest recorded levels of dioxin – environmental pollutants that threaten human health – which are released into the air by burning plastics and circuit boards to extract metals (bid).

This research based on earlier contributions on measuring environmental performance identified the following environmental performance measures shown in Table 26.

Table 26 Adopted environmental performance measures

Measurement Items	Earlier Contributions
Reduced Air emissions	(Sarkis and Cordeiro, 1997, Vachon and Klassen, 2007, Zhu and Sarkis, 2004b, Paulraj, 2011, Rao, 2002, Eltayeb et al., 2011)
Reduced waste water discharges to receiving water bodies	(Sarkis and Cordeiro, 1997, Vachon and Klassen, 2007, Zhu and Sarkis, 2004b, Paulraj, 2011, Rao, 2002)
Reduced disposal of hazardous materials	(Zhu and Sarkis, 2004b, Beamon, 1999, Paulraj, 2011, Eltayeb et al., 2011)
Reduced solid waste disposal	(Vachon and Klassen, 2007, Zhu and Sarkis, 2004b, Paulraj, 2011, Rao, 2002)

2.8.3 Operational Performance

2.8.3.1 The characteristics of operational performance

GSCM may have significant impacts on corporate operational performance (Kitazawa and Sarkis, 2000), and is represented at the levels of the product, process and collaboration among supply chain companies. Kaplan and Norton (1996) describe the operational performance as an internal business process in its balanced scorecard framework, where the internal business process identifies the critical processes in which the organisation must excel in, in order to fulfil the value proposition to the customer's will and further lead to improvement in financial performance. In contrast, NRB-GSCM is distinct from the internal business process approach by addressing both intra- and inter-organisational environmental impacts on operations. The operational performance measures selected in this study have been identified and include quality, efficiency and flexibility measures that arguably have the most influential impact on an organisation's operational performance.

2.8.3.2 The measures of Operational Performance

Operational measures such as quality can be enhanced through leveraging knowledge and operational routines between the ISO 140001 and ISO 9000 certification systems (King and Lenox, 2001). This argument is also supported by Rao (2002), i.e., that environmental initiatives and supply chain environmental management can enhance operational measures. It is important to note that in the original research, Rao (2002) argued that product quality, increased efficiency, productivity, and cost savings formed a competitiveness construct. This research acknowledges the difference in labelling for this construct. After examining the content of the measure it is consistent with the operational measures used in this study. Table 27 summarises earlier research measures of operational performance.

Table 27 Earlier Research Measures of Operational Performance

Source/ Year	Measures of Operational Performance
(Vachon and Klassen, 2007)	Cost (α=0.79) 1. Production costs 2. Total product costs 3. Labour productivity
	Quality (α=0.79) 1. Conformance to design 2. Product durability 3. Perceived overall product quality 4. Promptness in solving customer complaints
	Flexibility (α=0.85) 1. Order fulfilment speed 2. Manufacturing throughput time 3. Meeting delivery due date
	Delivery (α=0.76) 1. Ability to change delivery date 2. Ability to change output volume 3. Ability to change product mix
(Eltayeb et al., 2011)	1. Decrease in product, material, packaging costs
Zhu, Sarkis and Lai (2007)	Operational Performance (α=0.93) 1. Increase amount of goods delivered on time 2. Decrease inventory levels 3. Increase scrap rate 4. Promote product's quality 5. Increase product line 6. Improved capacity utilization

Improvements on production efficiencies can be made through Eco-efficiency improvements. According to WBCSD's definition (Verfaillie, 2000: 8) "*Eco-efficiency is achieved by the delivery of competitively-priced goods and services that satisfy the human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with earth's estimated carrying capacity.*"

On the operational flexibility dimension, GSCM practices may complement lean operations or Just-In-Time management, to move towards the elimination of all waste in order to develop an operation that is faster, more dependable, produces higher quality products and services and above all, operates at low cost (Lamming et al., 2004). Klassen (2001) suggests that JIT and lean production strategies could be a benefit for pollution prevention.

Vachon and Klassen (2006, 2007) note that environmental collaboration between suppliers and customers leads to improved manufacturing performance, such as improved quality, delivery and flexibility.

In terms of organisational benefits, Sharma and Vredenburg (1998) suggest that environmentally responsible practice is associated with the emergence of organisational capabilities which would lead to a number of organisational benefits that include operational measures such as increased efficiency, productivity, process innovation and knowledge of management operations. Their research concludes that environmentally responsible practice does not appear to have a negative impact on corporate competitiveness (ibid).

Following a number of established operational performance measures, this research identified following operational performance measures shown in Table 28

Table 28 Adopted operational performance measures

Measurement Items	Earlier Contributions
Perceived overall product quality	(Vachon and Klassen, 2007, Rao and Holt, 2005, Rao, 2002)
Promptness in solving customer complaints	(Vachon and Klassen, 2007)
Meeting delivery due date	(Vachon and Klassen, 2007)
Ability to change output volume	(Vachon and Klassen, 2007)
Ability to change product mix	(Vachon and Klassen, 2007)

2.8.4 Economic Performance

2.8.4.1 The characteristics of economic performance

Research on the relationship between economic performance measures and an organisation's environmentally friendly behaviour has been inconclusive (Wagner et al., 2001) with findings of positive, negative and even U-shaped associations. In terms of the positive findings, research has found that an organisation's environmental improvement can be transformed into economic benefit such as increased market share, sales, return on assets and rewards from financial markets.

Figge (2002) proposes a sustainable value added framework, which argues that improvement on a sustainable internal process such as the efficient use of energy, water and materials, has a positive impact on the corporate economic performance in terms of Return on Capital Employed (ROCE). Rao (2002) notes that the positive relationship between environmental performance and economic performance is mediated by an organisation's environmental competitive differentiation. Sharma and Vredenburg (1998) propose that higher performance measures in terms of organisational benefits include economic cost reduction measures, such as material cost, process/production cost and cost for regulatory compliances. Their study shows no direct link between environmentally responsible practices to organisational benefits, but these relationships can be positively mediated by the emergence of

organisational capabilities (ibid). Table 29 summarises earlier research measures of economic performances.

Table 29 Earlier Research Measures of Economic Performance

Source Year	**Measures of Economic Performance**
Porter and van der Linde 1995 (p126)	1. Materials savings resulting from more complete processing, substitution, reuse, or recycling of production inputs 2. Better utilisation of by-products in producing more products 3. Elimination or reduction of cost of activities involved in discharges or waste handling, transportation and disposal 4. Lower energy consumption during production process and during product use 5. Lower packaging cost 6. Lower product cost (for instance, from material substitution 7. Conversion of waste into valuable forms
Mollenkopf and Closs 2005	1. Create additional revenue 2. Reduce operating costs 3. Minimize the opportunity costs of writing off defective or out of date products.
(Rao and Holt, 2005)	1. New market opportunities; 2. Product price increase; 3. Profit margin; 4. Sales; and 5. Market share.
Carter 2005	1. Production costs have been reduced 2. Lowered the costs of purchased materials 3. Labour costs have decreased 4. Total costs have been reduced
Sarkis and Cordeiro 2001	1. Return on Sales
Menguc and Ozanne (2005)	1. Sales growth 2. Profit after tax 3. Market Shares
(Eltayeb, Zailani et al. 2011)	1. Increase in profitability 2. Increase in productivity 3. Increase in sales 4. Cost reductions
Arago et al., 2008	1. Return on investment 2. Earnings growth
Carter et al., 2000	1. Net incomes 2. Cost of goods sold
Christmann 2000	Cost advantage (α= .79) 1. We incur lower compliance costs with regulations of environmental issue in the U.S. than our domestic competitors. 2. Overall, our strategy addressing this issue improves our cost position relative to domestic competitors. 3. Overall, our strategy addressing this issue improves our cost position relative to foreign competitors.
(Sarkis and Cordeiro, 1997)	1. 1 year earnings per share forecast 2. 5 year earnings per share forecast
Henriques and Sadorsky (1996)	1. Sales to assets ratio (high ratio indicate that firm is working close to capacity making it more susceptible to introduce environmental plan)

	Measures of Economic Performance Continued
Zhu and Sarkis (2004) Zhu, Sarkis and Lai (2007)	Positive Economics Performance Measures (α=0.9) 1. Decrease cost for materials purchasing 2. Decrease cost for energy consumption 3. Decrease of fees for waste treatment 4. Decrease fees for waste discharge 5. Decrease fines for environmental accidents
	Negative Economics Performance Measures (α=0.87) 1. Increase of investment 2. Increase of operational cost 3. Increase of training cost 4. Increase cost for purchasing environmental friendly materials
Dowell et al., 2000	1. Tobin's q (firm market value per dollar of replacement costs of tangible assets.
Paulraj (2011)	1. Decrease in cost of materials purchased 2. Decrease in cost of energy consumption 3. Decrease in fee for waste discharge 4. Improvement in return on investment 5. Improvement in earnings per share
Correa, Torres, Sharma, Morales 2008	1. Return on investment 2. Earnings growth
Darnall, Henriques and Sadorsky; 2008	Business Performance (α=0.61) 1. Profit: Whether facility profits had changed over the past three years 2. Growth: How facility's value of shipment changed in the last three years

Jacobs et al. (2010), by identifying the types of corporate environmental initiatives published, suggest, that while the majority of environmental initiatives are value neutral, environmental initiatives such as environmental philanthropy and ISO 14001 certification are viewed positively by the market via the revenue gains from enhanced reputation. In contrast to the voluntary emissions reductions, despite its benefit in terms of mitigating future regulatory risks and reputation, the market reacted negatively, due to the concerns of the cost of the project and the uncertainty of the impact on revenues (ibid). Rao's (2002) research found no direct positive relationship between environmental performance and economic performance, but suggests environmental performance can mediate a firm's competitiveness and economic performance. Eltaeyb et al. (2011), based on a sample of EMS certified supply chain initiatives in a Malaysian industry, suggest that Eco-Design and reverse logistics supply chain environmental practices are significantly associated with firms cost reduction performance. Also, Eco-Design is significantly associated with overall economic performance such as productivity, profitability, revenue and market shares.

Some researchers also argue that the relationship between corporate economic performance and environmental practices has been contradictory, in that organisations that invest in pollution prevention have shown negative financial performance and can destroy shareholder value (Wagner et al., 2001, Sarkis and Cordeiro, 2001, Sarkis and Cordeiro, 1997). However, they also point out the limitations on managerial reward/remuneration systems, based purely on short term financial results rather than long term sustained growth in addressing both tangible and intangible issues, restrict a firm's behaviour in adopting GSCM practices.

Arguably, these inconsistent results may be due to different measurement data and the theoretical approaches applied (Wagner et al., 2001). To address this, a number of higher level economic performance measures may be adopted, such as return on capital employed (ROCE), market share, and profit margins, that would reflect directly on the organisation's bottom line.

Sarkis & Zhu (2004a) also had a mixed bag of findings with reductions in the cost for materials purchasing and energy usage, reduced fees for waste treatment and fines for environmental accidents, whilst, on the other hand, increases in operational, training and purchasing costs. In contrast, Eltayeb et al. (2011) suggest that cost reduction is an operational measure rather than an economic performance measure. Their research, based on factor analysis results, show productivity, profitability, revenue and market shares are reflected in the firm's overall economic performance, while a decrease in production, material, and packaging costs are related to cost reduction measures that are focused on the operational level.

Menguc and Ozanne (2005) adopted three measures on economic performance: 1) sales growth; 2) profit after tax, and, 3) market shares. They argues these performance measures reflect both market performance (market shares) and financial performance (sales growth and profit after tax)

2.8.4.2 The measures of economic performance

Earlier research uses economic performance measures with inconsistent result. Thus, this research attempts to contribute to more empirical evidence on the relationships

between GSCM and economic performance. The following economic performance measures (Table 30) were included in this study: 1) production costs reduction; 2) new market opportunities; 3) market share; 4) product price increase; and, 5) sales increase.

Table 30 Adopted economic performance measures

Measurement Items	Earlier Contributions
Production costs reduction	(Rao and Holt, 2005, Carter, 2005, Mollenkopf et al., 2005, Carter and Jennings, 2000, Christmann, 2000, Eltayeb et al., 2011, Rao, 2002, Paulraj, 2011)
New market opportunities	(Rao, 2002, Rao and Holt, 2005)
Market share	(Rao, 2002, Rao and Holt, 2005, Menguc and Ozanne, 2005)
Product price increase	(Rao, 2002, Rao and Holt, 2005, Eltayeb et al., 2011)
Sales increase	(Rao, 2002, Rao and Holt, 2005, Eltayeb et al., 2011, Menguc and Ozanne, 2005)

2.9 Summary

This chapter began with a critical literature discussion on conceptualising the measurement scales of GSCM through the natural resource based view. NRB-GSCM constructs are then identified in terms of intra-organisational environmental practices (Intra-OEPs) and represent a firm's causally ambiguous resources and that inter-organisational environmental practices (Inter-OEPs), as a higher order construct, represent a firm's socially complex resources. Inter-OEPs demonstrate environmental collaborations between organisations on GSCM. The measurement of the higher order Inter-OEPs construct were based on established first order constructs and include: 1. Design for Environment (DfE). 2. Green Purchasing (GP). 3. Green Logistics (GL).

Second, this chapter identified GSCM antecedents through the lens of institutional theory based on regulatory (coercive), customer (normative) and competitive

(Mimetic) constructs. The established measurement for each above institutional construct was critically discussed. This chapter also acknowledged the fact that the institutional perspective was externally driven based on social, regulatory and market factors. An alternative theory, based on strategic management, and in particular, the resource based view (RBV), was more internally focused. However, due to the time scale to conduct this research, the RBV theory link to the adaptation of GSCM was suggested for future research. Finally, GSCM performance measurement scales were discussed based on the review of literature on established performance measurement. This research recognised the importance for a balanced environmental, economic and operational performance for a firm to sustain their competitive advantage.

This chapter particularly focused on research gap 1 and research gap 2 and was critically discussed in terms of existing literature on established measurement scales of GSCM content, antecedents and consequence.

Chapter 3 NRB-GSCM Causal Model

3.1 Introduction

This chapter, based on reviews of the literature on measurement of GSCM, establishes a natural resource based green supply chain model. This chapter aims to answer the following research objectives:

Objective 2: The development of a conceptual model of institutional effects on GSCM practices (addressing research gap 4)

This is achieved by the identification and critical evaluation of institutional effects on GSCM practices:

1. The development of a conceptual model (tier 2) of the effects on, and role of institutional effects on NRB-GSCM.

Objective 3: The development of a conceptual model of NRB-GSCM interactive effects (addressing research gaps 2 and 3)

This is achieved by:

2. The development of a conceptual model of the effect on, and role of Intra-OEPs on Inter-OEPs (as higher/second order construct) as well as on all the individual aspects (as lower/first order constructs) of Inter-OEPs.

Objective 4: The development of a conceptual model of NRB-GSCM and the relation to performance outcomes (addressing research gap 4)

This is achieved by:

3. The development of a conceptual model of the effects on, and role of NRB-GSCM on performance outcomes.

Objective 5: The establishment of mediation relationships (tier 4) of NRB-GSCM and Performance Outcomes (addressing research gap 4)

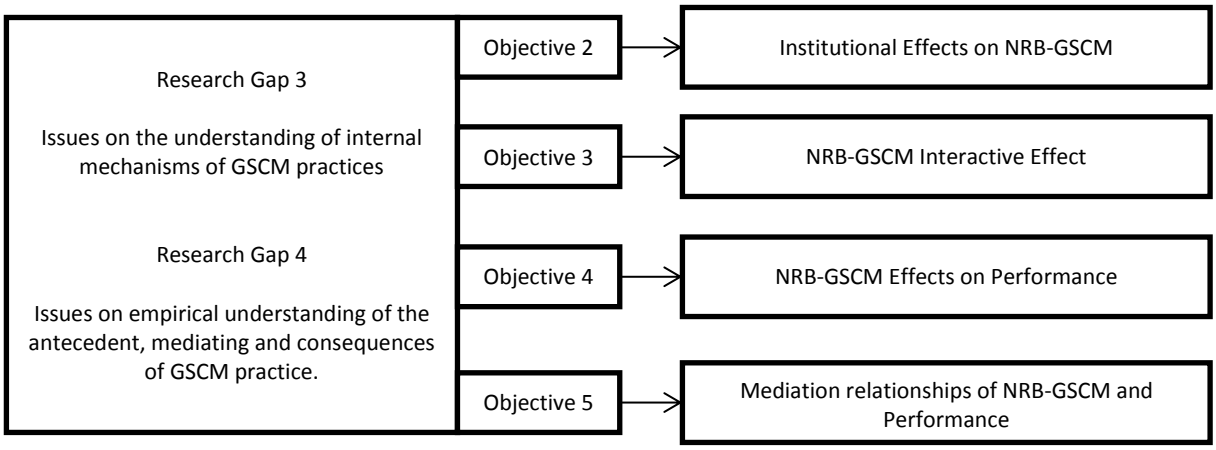
This is achieved by:

4. The development of a conceptual model of the mediating effect of NRB-GSCM independently and interactively on performance measures;

As discussed in chapter 2, the GSCM approach integrates environmental management literatures with the supply chain management concept, by bringing together environmental values into the firm's supply chains. Few theories and empirical research studies to date have explored the implementation and effects of such practices as eco-design, cleaner production, environmental purchasing, and green/reverse logistics, on selected performance outcomes, using economic, operational and environmental measures (Zhu and Sarkis, 2004a, Klassen and Vachon, 2003). However, this work is still arguably preliminary and questions still remain. For example, there are still GSCM practices that have not been explored in terms of the effects on performance outcomes and further yet, there is little investigation into the effects and role on performance measures, both independently and interactively. In addition, organisational theory, particularly RBV, NRBV and Institutional Theory, has remained relatively unexplored, both theoretically and empirically, and offers potentially important insights on how firms successfully implement a GSCM approach throughout their supply chain to promote sustainable production and consumption. The few studies that have explored organisational theory and its impact on GSCM practices have focused on only a few independent/moderating variables and have raised more questions than answers.

The relationships among institutional impacts and GSCM practices cannot be fully appreciated through direct association only. Instead, it is the complex interactions between these aspects that lead to better understanding of their impact on organisational performance. As elaborated in Chapter 2, this research systematically reviews literature on GSCM performance, GSCM practices and Institutional impacts on GSCM, based on the previously identified operational construct, the interactive relationships among those measurement models are explored (see Figure 10).

Figure 10 Flow Chart Theory Building



3.2 Institutional Effects on NRB-GSCM

3.2.1 Theoretical links of institutional theory with NRB-GSCM

Research drawing on institutional theory has shown that a firm's motivation to undertake GSCM practices is affected by pressures from regulators and the market (Arora and Cason, 1995). Henriques and Sadorsky (1999) indicate that when dealing with environmental issues, although environmental regulation was an important instigator, other factors such as customer pressure, shareholder pressure and community pressure also played a significant role in determining whether firms have an environmental plan. The external drivers on firms to adopt GSCM have been identified in this study, based on an institutional perspective that includes regulatory, market and competitive pressures (DiMaggio and Powell, 1983; Arora and Cason, 1995; Suchman, 1995; Henriques and Sadorsky, 1999; Scott, 2008).

Institutional theory asserts that firms adopt GSCM initiatives in order to gain legitimacy or acceptance within society. Thus, the adoption of GSCM practices may increase a firm's legitimacy to operate by external actors (Zhu and Sarkis, 2007).

Involvement of environmental voluntary agreement can have a mixture of firms that have sustentative environmental improvement and those that took symbolic actions.

Delmas et al. (2010) argue that early adopter and late adopter of voluntary climate change agreements face different pressures from their institutional environment, therefore, adopting the same practices but for different reasons. Delmas et al. (2010) suggest that sustentative improvement for corporations on voluntary climate change agreements are likely to be earlier joiners. In contrast, late joiners are more likely to adopt symbolic cooperation. Their study shows that early joiners of voluntary climate change agreements were subject to a higher level of political pressure at the state level and dependent on local and federal regulatory agencies than late joiners. Also early adopters are better connected to the trade associations and more visible. Although their research found early entrants reduce their emissions more than nonparticipants, no significant differences were found between EMS participants and nonparticipants in the reduction of emissions (ibid).

Institutional perspectives suggests that a firm's decision to adopt GSCM practices is in response to market and regulatory pressures. But through an institutional lens alone, it cannot explain the effectiveness of GSCM among its adopters, for example, it is difficult to distinguish between narrative storytelling with actual performance improvement. According to Banerjee et al. (2003), environmental market campaigns can reflect a firm's orientation and commitment to the environment, but merely emphasising orientation without concern for strategic implementation might lead to a charge of 'green washing'. In response, researchers have argued that a firm's response to external pressures is influenced by their access to resources and the capabilities that have developed over time (Oliver, 1997; Barney, 1991). For example, firms may develop their GSCM in response to institutional pressure, but their specific actions may differ, and some firms would outperform others based on their ability to leverage their tangible and intangible resources. The heterogeneity and immobility are likely due to firms unique set of resources (Barney, 1991). Thus, the main criticisms on institutional theory to explain GSCM regarding its decoupling from superficial GSCM practice to actual GSCM practices will be complemented by proposing an integration of institutional theory with a natural resource based view as the theoretical lens of this research to determine the motivations for adopting GSCM practices. This research recognises the effect from institutional theory as an external driver on a firm's GSCM implementation, but suggests that NRB-GSCM has a role in transforming institutional conformity into actual performance improvement.

A combined theoretical approach may reduce the biases by addressing two important questions: 1) why organisations adopt GSCM practices; and, 2) how GSCM outcomes are different among GSCM adopters. In addition to the theoretical contribution in integrating institutional theories and NRBV, this model also provides a consideration of practical implications, i.e., to inform managers why to adopt GSCM and how can they can improve performance outcomes.

This research adopts an incremental view to explain the processes when firms adopt GSCM practices. Firstly, institutional theory has shown that a firm's motivation to undertake GSCM practices begins with pressures from regulators and the market (Arora and Cason, 1995). Secondly, with increasing institutional pressure, the firm develops strong intra-organisational environmental capabilities which are causally ambiguous. Thirdly, such intra-organisational environmental capabilities can lead to inter-organisational environmental practices, which are socially complex in nature. Consequently, this transforms the firm from having homogeneously conforming and converging resources, into heterogeneously inimitable resources which can direct firm towards competitive advantage (Christmann, 2000; Hart, 1995; Russo and Fouts, 1997).

3.2.2 Regulatory effect on NRB-GSCM

Environmental regulation, through fines, penalties and exposure for non-compliance, can affect a firm's growth and survival (Banerjee et al., 2003). Increasing concerns for global and domestic environmental pollution motivates both developed and developing countries around the world to impose stricter environmental regulations. According to earlier empirical research, a firm's environmental behaviour, particularly in energy and pollution intensive industries, is significantly related to government coercive pressures (Banerjee et al., 2003).

Jennings and Zandbergen (1995) argue that because of coercive forces, through regulation and regulatory enforcement, firms within an industry have implemented similar practices. There are also heterogeneous influences of coercive pressures exerted upon different industries, which has led to organisational variations in

environmental strategies (Levy and Rothenberg, 2002). Jennings and Zandbergen (1995) apply institutional theory as an approach to ecologically sustainable organisations, and suggest that because of coercive forces, regulatory enforcement is the main driving force for business sustainability. The authors also claim that firms that share the same organisational field are influenced in a similar way by institutional forces.

On the other hand, regulatory pressures, exerted upon different industries or firms exporting to different countries, leads to heterogeneous influences of coercive pressures which has led to organisational variation in environmental strategies (Levy and Rothenberg, 2002). Because environmental regulation and associated compliance costs vary from industry to industry, often the smokestack industries are exposed to higher environmental risks and liabilities than other industries (Hoffman, 1999). Similarly, Banerjee et al.'s (2003) research based on a multi-industry sample of North American firms, found that the effects of environmental regulatory forces on environmental strategy are greater in high environmental impact industries.

Min and Galle (1997) identified that in the U.S both state and federal environmental regulations are two key factors affecting a buying firm's green purchasing practices. In Europe the EU Integrated Product Policies (IPP) drive green consumerism through setting guidelines and regulatory requirements in pushing businesses to produce environmentally friendly products and facilitate coordination with consumer groups.

With decreasing resources and increasing environmental problems, both central and local governments in China have established many environmental regulations, whereas, the main polluters and resource consumers have experienced higher regulatory pressures. In addition, regulatory pressure requires Chinese companies exporting products and selling to their foreign customers to comply with export market regulations. For example, the European Union WEEE directive requires Chinese manufacturers to take back used products or pay a premium when they export electrical and electronic equipment into the EU. This policy has created substantial pressure on Chinese manufacturers, since nearly one quarter of its exported electronic appliances are sold to the EU (Zhu et al., 2008). Other countries,

such as Japan and USA have also put forward different environmental requirements for fabric and dyes of clothes imported from China (ibid).

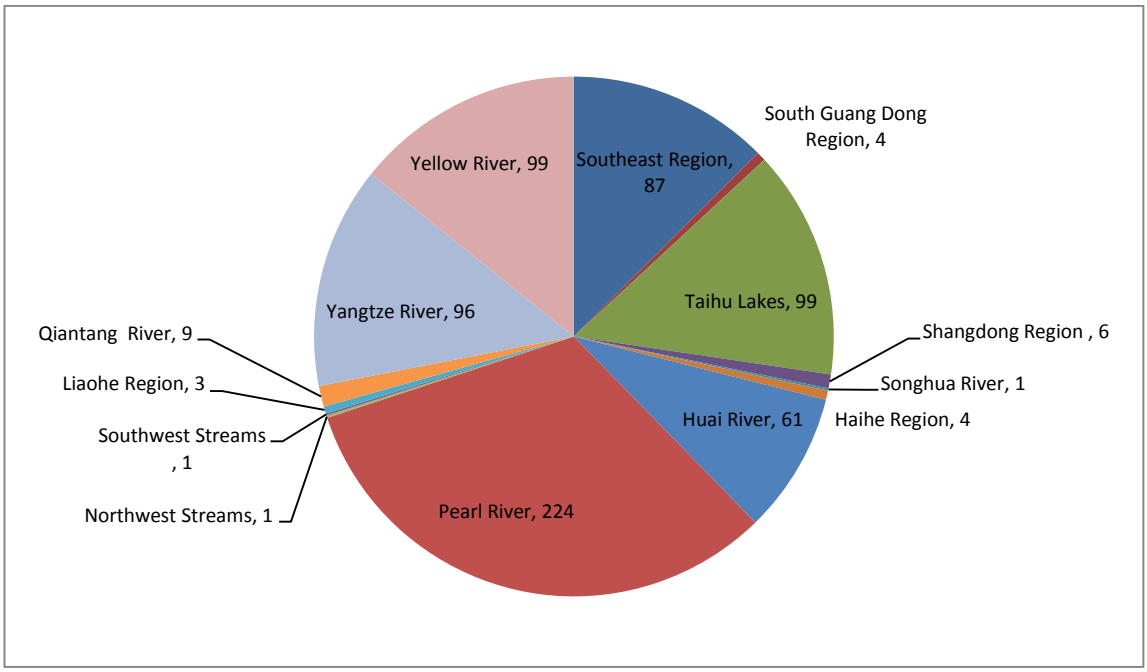
Facing the demand of modernising Chinese manufacturing industry to compete in the global playing field, the Chinese government has changed over from resource subsidies to levying taxes for some resources such as coal and natural gas (Zhu and Cote, 2004), whilst at the same time developing more comprehensive environmental regulations. In 2007 the Chinese Ministry of Environmental Protection (MEP) issued a notice that strengthened environmental supervision of export industries. The notice requires authorities to suspend export licences and to refuse export-quota applications by companies found to be violating environmental regulations (EIU, 2012). Multinational companies are also facing scrutiny from strengthened environmental regulation in China, for example, in 2007 former SEPA (now MEP) launched a "post-check-up" of 130 multinational companies that had been found to be breaking environmental law during 2004-2007. The follow-up inspection of the 130 enterprises showed that all had ceased the activities initially found to have been in breach of environmental regulations, but three were found guilty of new infringements of environmental rules (EIU, 2012).

Environmental regulatory efforts on the Chinese aluminium industry has been increasing, particularly for improving transparency for providing information for environmental violations to the public domain, for example, information are increasingly became available to public relating to firm’s pollution activities on freshwater resources in China (see Figure 11).

Analysing pollution cases published by the Institute of Public and Environmental Affairs, the following types of environmental violations in the aluminium industry were identified:

- Release pollution exceed environmental standards.
- Violation of Environmental Impact Assessment and Three Synchronisation Policy.
- Direct pollution without any treatment, treatment facilities not in use.
- Illegal transfer of pollution to another site.

Figure 11 Aluminium production related environmental violations across 14 fresh water reserves in China



The Chinese government in recent years has been increasing its effort towards implementing new environmental regulatory measures and provides the resources necessary. According to Zhang et al. (2008), the government of all provinces, cities and counties have set up organisations responsible for addressing and coordinating environmental protection issues. There are about 3226 environmental protection administration departments at all levels in China, with 167,000 people engaging in environmental administration, monitoring, scientific research, publicity and education.

There are about 2000 environmental protection bureaus (EPB), which has the responsibility to promote transparency and disclosures of firms that violate environmental regulations (OECD, 2006). When firms are caught on non-compliance, in the cases of environmental violations found in the Chinese Aluminium sector, local EPBs have the authority to charge fines as punishment. The value of fines is often dependent on the level of environmental pollution. Given more stringent environmental regulation and taxes to penalise firms with environmental wrongdoing, and in extreme cases, the local EPBs can suggest that government shut

down operations. Aluminium fabricated product demand has risen steadily in China in recent years, with increasing production volume and increasing number of foreign direct investment in this high environmental impact sector. Many scholars are arguing that the FDI firms in China are motivated by the slack in Chinese environmental laws and regulations, joint with cheaper labour cost. Taking the above issues into consideration, the aluminium fabrication sector in China has seen increasing pressure from more stringent environmental regulations and public pressure towards firms to take drastic actions to clean up their environmental 'mess' from their high environmental impact fabrication cleaning processes and upstream activities. Also, governmental environmental subsidies are preferred to state owned firms that encourages rapid consolidation in the aluminium fabrication sector pushing out environmental inefficient firms from market competition.

With the increasing level of regulatory pressures and the constant environmental regulatory amendments on Chinese manufacturers to take responsible action towards the natural environment, this research proposes the following hypothesis (Figure 12):

Hypothesis 1.1: Regulatory pressures have a positive influence on a firm's intra-organisational environmental practices.

3.2.3 Market effect on NRB-GSCM

Conventional policy discussion has been too narrow, focusing only on the firm and state interaction as the single determinant of environmental performance. Increasingly Chinese manufacturers are influenced on their environmental responsibility, not only by governments but also by market pressure from downstream customers, end consumers and the public. Customer environmental pressure can also be driven within business systems, for example, sub-contractor demand on the production of environmentally friendly products or processes (Green and Morton, 1996).

Globalisation enables customers from developed countries to use environmental performance as a supplier selection criterion, which puts pressure on firms in developing countries to address environmental issues. According to Zhu and Sarkis (2007), customer pressure forms the core normative pressure for Chinese manufacturers to implement GSCM. Particularly, exports and sales to foreign customers are the two main drivers that may convince Chinese manufacturer to adopt GSCM practices (ibid). Similarly, Sharma and Henriques (2005) found that firms will undertake recirculation strategies when subjected to usage influences from major customers. For example, customer demand for information on product sustainability had a positive and significant impact on recirculation of sustainability practices.

In addition, environmental issues can also become an important concern to foreign business investors in China. For instance, foreign joint venture participants increasingly apply environmental due-diligence of any land provided by the Chinese partner as part of its capital contribution, since previously polluted or contaminated property could pose a major future financial burden in terms of environmental control and land improvement (EIU, 2012).

Public opinions and media exposure are increasingly pressuring Chinese manufacturers to be responsible for their pollution activities. For example, China's textile manufacturers are being urged by environmental NGOs to clean up its pollution activities. With China as the largest textile manufacturer in the world, many of its textile production capacity is still primary with environmental concerns including processes such as dyeing, washing, bleaching, and printing which requires high volumes of water as well as heavy metals such as copper, cadmium, and lead (Just-Style, 2010). Public pressure has also been increasing on the Chinese food industry due to a number of illegal chemical additives in food creating particular alarm. In 2008, milk products were found to contain melamine, which can cause kidney stones and renal failure. The incidents resulted in some 300,000 Chinese consumers sickened and with at least six infants fatally so (Schell, 2011). In response to the food supply chain scandals in China, Wal-Mart introduced the Direct Farm Program, where, by dealing directly with farmers, the retailer is better able to control the standards of food it advertises as green or organic. The green and organic products are clearly designated with special labels that name the province and region

where they were grown. Consequently this created trust with Chinese consumers (ibid).

Thus, increasing public and customer pressure can motivate manufacturers to incorporate environmental practices and respond with in-kind performance improvements (Thornton et al., 2003). Public pressure from people's perceptions of environmental problems can be greater with energy and pollution intensive industries (Banerjee et al., 2003). This research proposes the following hypotheses (Figure 12):

Hypothesis 1.2: Market effects have a positive influence on a firm's intra-organisational environmental practices.

Hypothesis 1.3: Market effects have a positive influence on a firm's green purchasing practices.

3.2.4 Competitive effect on NRB-GSCM

According to Bergh (2002), firms were the most strongly influenced to learn and respond to natural environmental issues by paying close attention to other firms such as their competitors. For example, Apple Corporation began to reveal the amount of carbon emissions associated with its product when they realised that their close competitor Dell had better environmental ratings (Engardio et al., 2007). In response, Apple announced that it was abandoning the use of polyvinyl chlorides (PVCs) and bromide flame retardants (BFRs) to reduce the environmental harmful effect of its product. This proactive action by Apple helped them move ahead of their rival Dell, which has set the same goal but without promising results (Burrows, 2009). Similarly, Bansal (2005) argues institutional theory, in particular media and mimicry, influence corporate sustainable development.

Zhu and Sarkis (2007) suggest that competition has allowed the Chinese manufacturers to learn how to implement GSCM in cost effective ways, where encouraging benchmarking and participation in industry associations will provide

greater 'win-win' opportunities (ibid). The example has been with China's Electronic Component Association that provides training on WEEE directives proposed by the European Union. The effort has helped the Chinese manufacturers to gain entry into this rather stringent regulatory EU market.

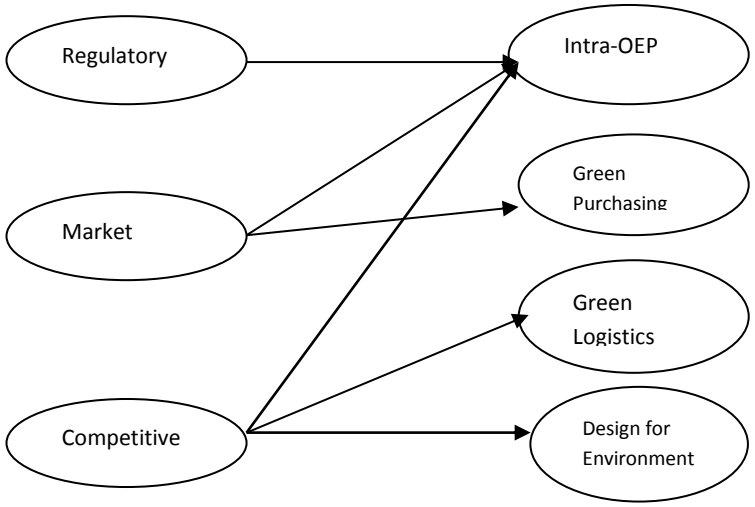
Hofer et al.'s (2012) research argues that competitive actions are signals that lead to competitive response. Environmental management practices are activities that satisfy stakeholder pressure, create operational efficiencies and seize strategic opportunity. Their research found rival firms' environmental management practices can positively influence the focal firm's environmental activity. Based on the above discussion, this research proposes the following hypotheses (Figure 12):

Hypothesis 1.4: Competitive pressures have a positive influence on a firm's intra-organisational environmental practices.

Hypothesis 1.5: Competitive pressures have a positive influence on a firm's DfE practices.

Hypothesis 1.6: Competitive pressures have a positive influence on a firm's green logistic activities.

Figure 12 Institutional effects on GSCM



3.3 NRB-GSCM Interactive effects

This research also proposes that intra-OEPs arguably affect all aspects of inter-OEPs. Firms having surpassed mandated requirements of environmental performance through initiatives focused within their intra-OEPs are creating a behavioural culture that is more proactive in seeking opportunities to pursue more advanced environmental practices and extend environmentalism beyond their organisational boundaries. According to Sarkis (2001), the operational capabilities to adopt an internally based EMS may assist firms in reducing their environmental impact throughout the supply chain. Darnall et al. (2008), also note that EMS adopters are more likely to rely on their complementary knowledge-based capabilities towards working with their network of suppliers to minimise system-wide environmental impacts. The reasoning behind linking intra-OEPs with inter-OEPs is associated with the argument that some organisations may symbolically adopt an intra-OEP in an effort to enhance their reputation without reducing their environmental impact (Bansal and Hunter, 2003).

Delmas et al. (2010) suggest that it is possible that firms taking sustentative action are willing to tolerate those that adopt symbolic action rather than quit, because defection by substantive contributors would attract attention and even conceivably lead to the collapse of agreements (ibid). Delmas et al. (2010) also note that symbolic action could be positively received by stakeholders, where appearance of performance rather than actual performance was sufficient to attain legitimacy (King and Lenox, 2000). In addition, organisations may adopt an intra-OEP such as an EMS to improve environmental performance within its organisational boundaries, but fail to address the environmental impact of their suppliers and customers.

As noted from earlier research, intra- and inter-OEPs share many common principles such as resource efficiency and the product life cycle concept (Vachon and Klassen, 2007, Klassen and Whybark, 1999, Menguc and Ozanne, 2005). Firms that have already implemented intra-OEPs are more likely to collaborate on inter-OEPs to encourage pollution prevention (Darnall, 2006b). For example, an organisation's internal EMS requires conducting internal environmental auditing to reduce energy use and emissions caused by its distribution activities, and thus may lead to

collaborative green distribution practices. International environmental voluntary standards such as ISO 14001 require cross functional collaboration, and this knowledge for intra-functional cooperation may have a synergistic effect for firms and facilitate inter-OEPs concerning eco-design. Similarly, Giovanni (2012) suggests that environmental initiatives need to adopt internal environmental programmes at the initial stage and integration and collaboration with supply chain members at a later stage.

According to Paulraj (2011), environmental capabilities are synergistic in nature and can be complemented to create a more valuable resource to the firm. Their research proposed environpreneurship as a proactive environmental mentality within the organisation and is similar to the Intra-OEPs (Shi et al., 2012), both of which are resource based capabilities that cannot be easily acquired in the market. Organisations need to invest a considerable amount of time and resources to cultivate such an organisational culture (Lee and Pennings, 2001). Paulraj et al. (2011) argue that enviropreneurship can encourage organisations to go beyond the minimum requirement and institutional norms. Proactive environmental attitudes that are deeply embedded within organisational routines can provide the opportunity to achieve supply chain sustainability. Thus, by recognising the opportunity in pollution prevention and product stewardship will enable firms to reach out to supply chain partners to help them adopt inter-organisational environmental practices. Paulraj et al. (2011) found empirical evidence that firms adopting enviropreneurship are also likely to adopt sustainable supply management.

Giovanni (2012) found that both internal and external environmental management contribute significantly to environmental performance. They argue that when planning to improve environmental performance, firms should first concentrate on internal environmental initiatives, since they perform better than external initiatives. Similarly, Rao and Holt's (2005) study found that greening production within the firm led to greening outbound practices. Rao's (2002) research, based on a sample of Southeast Asian firms, found environmental initiatives within the firm can lead to supply chain wide environmental cooperation. The research shows that focal firms taking a environmental initiative to improve their environmental performance then take further steps to help environmental initiatives among supply chain members.

From a NRBV perspective (Hart, 1995), intra-OEPs can generate tacit knowledge that complements the need for transparency among stakeholders. Thus over time, intra-OEPs with the focus on pollution prevention can lead to external legitimacy, based on inter-OEPs (Figure 13). This then leads to the following hypotheses:

H 2.1: Intra-OEPs represented by causally ambiguous resources have a direct and positive impact on inter-OEPs as socially complex resources.

H 2.2: Intra-OEPs represented by causally ambiguous resources have a direct and positive impact on all aspects of Inter-OEPs.

Following the similar notion that Intra-OEPs can have positive effects on Inter-OEPs, Sarkis et al. (2001) argue that environmental training programmes, such as green purchasing in selecting and educating supply chain members, can bridge the gap on soft skills that product developers and engineers require to implement a successful DfE programme. Given that the green purchasing function increasingly practices a more strategic role it is likely to transform process based green supply chain integration into product and design based green integration. Thus, green purchasing practices through extensive training and commitment between buyers-supplier relationships can lead to DfE practices, leading to the following hypothesis (Figure 14):

H 2.3: Green purchasing has a direct and positive impact on DfE.

Figure 13 Intra-OEPs to Inter-OEPs

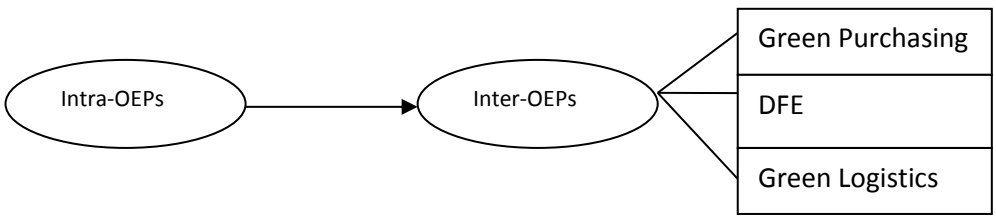
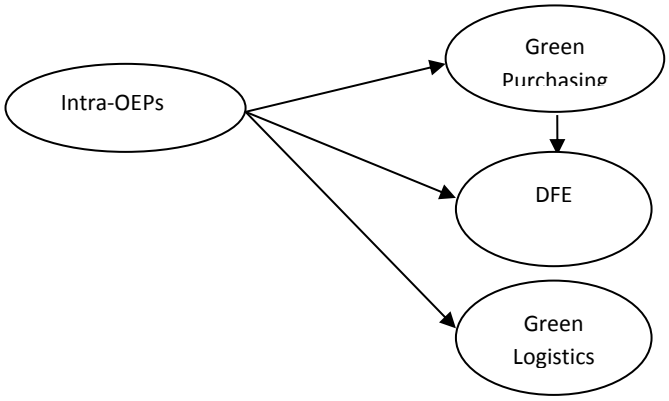


Figure 14 Intra-OEPs with Green Purchasing and DfE



3.4 NRB-GSCM Performance Outcomes

Giovanni's (2012) research argues that GSCM implementation can be shown to be ineffective when targeting short-term economic gain. They found the implementation of internal and external environmental initiatives do not contribute to economic improvement. Similarly, Bowen et al. (2001) found negative effects produced by environmental initiatives on short-term profitability and sales. Giovanni (2012) suggests that firms implementing green strategies should expect to increase economic gains only as a secondary objective, which can be attained only as a postponed target.

Zhu and Sarkis (2004) argue that GSCM initiatives in China are comparatively weaker than their western counterparts. Considering the majority of future manufacturing jobs would be carried out in Asia, Chinese suppliers need to have a deeper understanding on the effect of their GSCM practices, thus to guide future sustainable growth in the country. Their research focuses on the relationship between GSCM, and economic and environmental performance, using quality management and JIT as moderators. Their results show organisations implementing GSCM practices would receive improved economic and environmental performance, and that GSCM can create 'Win-win' opportunities for both the firm and the environment. In addition, Zhu and Sarkis (2004) suggest quality management programmes may support GSCM practices and also lead to better economic and environmental performance. In contrast, JIT was found to have negative moderation effects with environmental management. Rao and Holt (2005) suggest that GSCM programmes

through green purchasing, reverse logistics and internal environmental management would increase profit margin, sales volumes and market share. Rao's (2002) research found environmental initiatives within the organisation and supply chain are both positively associated with environmental performance improvement. The research also found that environmental improvement of firms taking environmental initiatives within the organisation and supply chain can then be translated into improved competitive performance.

3.4.1 NRB-GSCM on Performance Outcomes

Intra-OEPs through proactive initiatives that simultaneously accommodate sustainability values could help a firm to generate positive economic returns as well as long lasting competitive advantage (Menon and Menon, 1997; Palraj, 2011). Drawing on the NRBV framework (Hart, 1995), Menguc and Ozanne (2005) propose natural environmental orientation (NEO) as a higher order construct that comprises of three sub-dimensions: 1) entrepreneurship, which refers to tacit skills and leveraged knowledge that allows a firm the flexibility to address environmental opportunities and challenges posed by the unique green market; 2) corporate social responsibility (CSR) that involves a proactive approach such as pollution prevention rather than end of pipe pollution control; and, 3) commitment to the natural environment defined as an organisational-wide recognition of the importance of environmental issues, such established consensus and shared vision, which are socially complex and dependent on strong moral leaderships within the firm. Their study found that organisations with strong environmental commitment perform strongly on long-term financial indicators such as profit after tax and market share. However, short-term measures, such as sales growth, were negatively linked to environmental performance improvement (Menguc and Ozanne 2005). Similarly, Paulraj (2011) also argues that a firm's resource based capabilities such as environpreneurship is defined as an entrepreneurial orientation that accommodates the needs of the environment and society while simultaneously satisfying the firm's economic objectives. Environpreneurship is thus a firm specific resource that underlines the ability of organisations to tackle impending challenges, opportunities

and obstacles through a high degree of innovation, risk propensity and proactiveness that lead to competitive advantage. The empirical research shows that firms which represent strong environpreneurship can increase sustainability performance (Paulraj, 2011).

Earlier studies on Intra-OEPs focus on environmental technology implementation. As was noted earlier, Klassen and Whybark (1999) identified two types of environmental technology investment: 1) Pollution control technology which associated with remediation projects such as clean up, as well as cost in pollution control technologies such as the installation of equipment at the end of a process, discharge stack or effluent pipes; and, 2) Pollution prevention technology which is associated with both product adaptations to utilise recycled and less harmful materials, and to process adaptations to change acquisition, production and delivery processes to reduce waste. A firm's strategy on environmental technology investment may have a mixed portfolio of pollution control and pollution prevention investments, such as upgrading technological status and promoting information infrastructures to reduce the environmental impact from operations, or building up end of pipe waste treatment facilities and incineration plants. Klassen and Whybark (1999) argue that an environmental technology investment portfolio focus on pollution prevention technologies would increase competitive advantage. In contrast, pollution control technology investments are likely to incur reduced economic performance.

Rao and Holt (2005) found that the minimisation of pollution, reuse of materials and recycling initiatives within the production stage, led to savings in raw materials, water and energy usage, thus increasing competitive and economic performance.

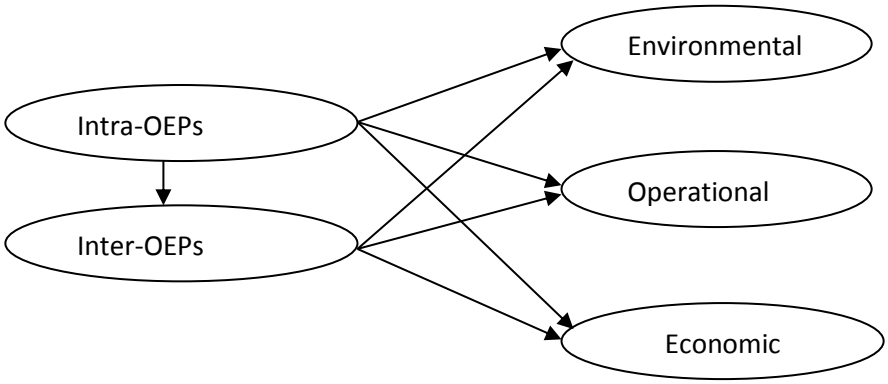
According to Esty and Winston (2009), companies can spend millions of dollars on waste disposal and pollution control equipment, which consumes managerial time and causes excessive financial burdens in terms of fines for mismanaging environmental issues. Instead, firms adopting waste prevention investment will benefit from financial savings in the long run, as opposed to short term waste control investment. Thus, Intra-OEPs serve as causally ambiguous imitable resources that can help organisations gain competitive advantage (Hunt and Morgan, 1996).

The association between Intra-OEPs and performance measures suggests that by adopting pro-active Intra-OEPs, such as an EMS and pollution prevention technologies, would create tacit knowledge and efficient management routines that are causally ambiguous to its competitors and would improve an organisation's performance measures. Organisations implementing Inter-OEPs create socially complex resources that are expected to translate into improved environmental and operational performance that may further lead to improvements in terms of the organisation's financial performance. This point towards the following hypotheses (Figure 15):

H 3.1: Intra-OEPs in the form of causally ambiguous resources have a direct and positive impact on all performance outcomes.

H 3.2: Inter-OEPs represented by causally ambiguous resources have a direct and positive impact on all performance outcomes.

Figure 15 Inter OEPs links with performance measures



3.4.2 Green Purchasing on Performance Outcomes

Green purchasing is an important element of a GSCM strategy. As Sheth and Sharma (1997) suggest, a set of implicit criteria would affect supplier selection

including the competitive environment of the industry, the relative marketing effort of suppliers and the supplier's corporate image, which in turn is influenced by their reputation and product. Although initially green purchasing is considered to be costly to the corporate account, as environmentally friendly suppliers tend to give higher price quotations than those not comparatively environmentally friendly, companies will benefit from a range of tangible and intangible issues, for example, in minimising risk occurrences that can potentially damage its product image. Thus green purchasing can help organisations achieve long term savings from protecting them from any potential damage to their brand value.

Paulraj et al. (2011) suggest that collaboration among supply chain partners can facilitate the formation of inter-firm interaction routines that enable the exchange of idiosyncratic assets, knowledge and capabilities. These interactions can improve the environmental condition and operational efficiency throughout the supply chain. Inter-OEPs create socially complex resources among supply chain partners that create barriers for imitation thus can be transformed into competitive advantage.

Carter's (2005) study assessed whether the socially responsible purchasing (PSR) of companies improved or reduced firm performance. The empirical findings suggest that while no direct relationship existed between PSR and cost reduction, reduced cost does ultimately result from PSR, as a result of increased organisational learning and improved supplier performance.

Rao and Holt (2005) investigated green inbound function involving the integration of suppliers into the green supply chain, such as requiring suppliers to have a certified EMS and operations that would help tremendously to cut down production waste at source. Hence, the company gains in terms of less environmental impact, that leads to reduced cost for disposal, compliance, improved resource utilisation and enhanced economic performance. This then leads to the following hypotheses (Figure 16):

H 3.3: Green purchasing has a direct and positive impact on environmental performance outcomes.

H 3.4: Green purchasing has a direct and positive impact on operational performance outcomes.

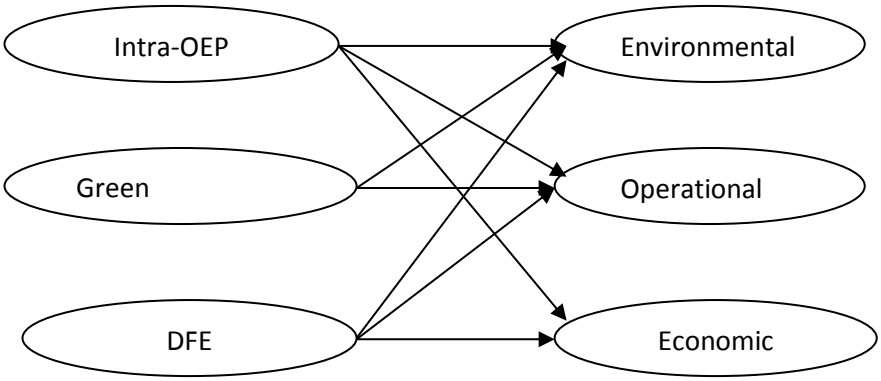
3.4.3 DfE on Performance Outcomes

DfE can help organisations to realise cost savings by taking into consideration recycling and reuse at the design stage (Fiksel, 1996). Recycling refers to the collection of certain materials for re-processing where the resultant recycled products can then be used for providing the same functions of its initial design. On the other hand, the re-use of products does not require reprocessing, and provides the same function or different functions to its original design. Both methods can reduce the amount of materials that need to be landfilled and at the same time achieve financial savings due to a reduced purchase cost for raw materials. According to Tsoulfas and Pappis (2006), recycling and reuse can also help firms to achieve environmental gains and suggest the industrial system can borrow from the biological designs of nature to create a closed-loop production system, wherein every output is returned to the natural system as a nutrient or becomes an input for manufacturing another product. Companies that tackle recycling and reuse can cut the cost of waste disposal.

Eltayeb et al.'s (2011) research found that DfE had significant positive effects on environmental, economic, cost reductions and intangible outcomes. DfE encompasses many activities from design for product disassembly, recycling and reuse, resource efficiency and reduction of hazardous materials of the entire product life cycle, and requires socially complex interactions among other supply chain members. This knowledge and the competencies developed is a capability that can provide a firm with significant competitive advantage (Sarkis, et al., 2010). This leads to the following hypothesis (Figure 16):

H 3.5: DfE has a direct and positive impact on all performance outcomes.

Figure 16 NRB-GSCM links to performance measures



3.5 Mediating Effect

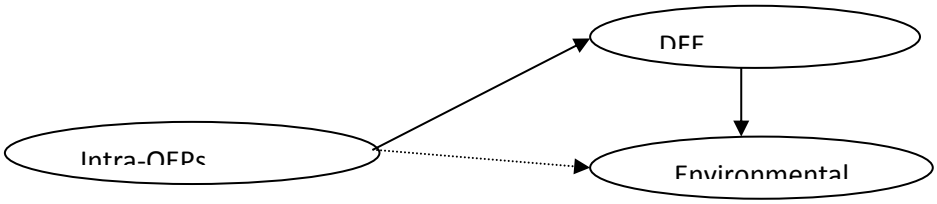
3.5.1 Mediating Effect of DfE

To understand how DfE mediates Intra-OEPs and green purchasing effects on environmental performance outcomes, this research applied a process based mediation model, that allows the research to see, for example, whether A will increase C through its impact upon B. Consequently, its provide a useful lens to understand how GSCM practices interact to benefit environmental performance. According to Sarkis et al. (2010), firms deploy DfE practices to create processes and products that have minimal impact on the environment. Implementing DfE practices is considered to be at a higher environmental proactive level compared to those that focus merely on regulatory compliances at the reactive level (ibid). Other dimensions of proactive environmental practice, such as environmental training, were considered to be mediating the effect of institutional pressures on firms implementing DfE practices (Sarkis et al., 2010). This research extends earlier research, which primarily came from Sarkis et al. (2010) in that the interactive effect does exist among various dimensions of GSCM practices. Although Sarkis et al.'s (2010) research showed empirical evidence that environmental training mediated the stakeholder pressure in the adoption of DfE practices in the Spanish automobile industry, their research showed no further link towards the real effect on

environmental performance measures. This research recognises DfE serves an important role in the improvement of a firm's effective environmental performance on measures, such as waste reduction and hazardous material use, by investigating its mediation effect between other dimensions of GSCM practices and the effectiveness in improving a firm's environmental performances. Thus, this leads to the proposition of the following hypothesis (Figure 17):

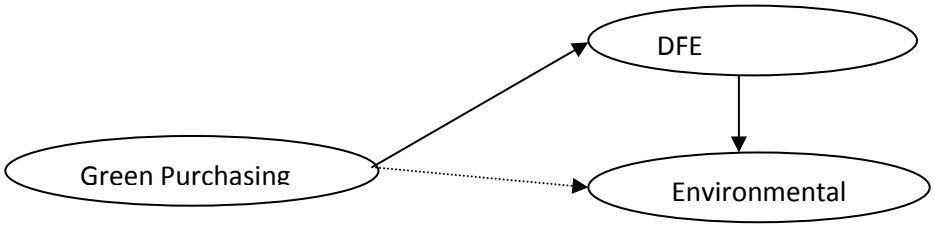
H 4.1: DfE mediates the relationships between Intra-OEPs and environmental performance

Figure 17 DfE mediates the relationships between Intra-OEPs and environmental performance



H4.2: DfE mediates the relationships between Green Purchasing and environmental performance (Figure **18)**

Figure 18 DfE mediates the relationships between Green Purchasing and environmental performance

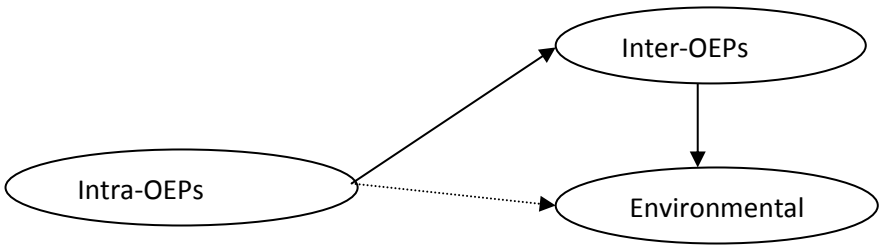


3.5.2 Inter-OEPs Mediating Effect

The link between Inter-OEPs and performance measures suggests that improvements on collaborative Inter-OEPs, such as implementing green purchasing, DfE and green distribution practices, would create socially complex resources leading to improvement of the organisation's performance measures as firms that have already implemented intra-OEPs are more likely to collaborate on inter-OEPs to encourage pollution prevention (Darnall, 2006b). This research proposes the following hypothesis:

H 4.3: Inter-OEPS mediate the relationship between Intra-OEPs and environmental performance (Figure **19)**

Figure 19 Inter-OEPS mediate the relationship between Intra-OEPs and environmental performance



3.5.3 Operational Performance Mediating Effects

Operational waste is due to inappropriate design of facilities and processes, or due to an excessive number of management defects. DfE practice reduces the generation of unnecessary waste and the consumption of global non-renewable energy sources and is relevant to any business operation.

Friedman (2008), in his book 'Hot, Flat and Crowded', sets out the theme that an energy strategy is now necessary as the world is entering the 'Energy and Climate Era'. Increasing population growth, climate change and increasing energy poverty

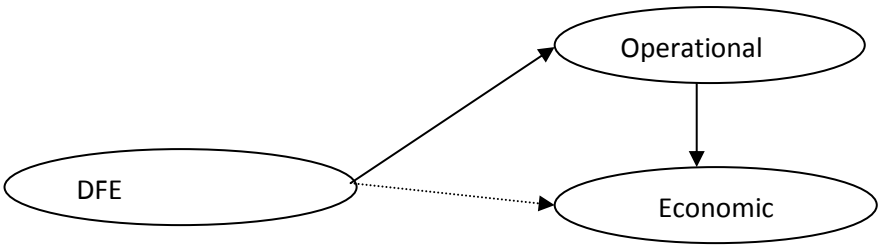
are driving forces for new climate change policies which shy away from fossil fuels in terms of the global political agenda. On the other hand, Esty and Winston (2009) suggest that high oil prices transform the incentives for innovation in the energy marketplace. Many renewable energy sources such as wind power, solar, hydro, bio-based power are becoming more price competitive against the traditional fossil fuels as the changing energy market structure has created new competitive pressures. For businesses with high energy intensity, its energy productivity measure can be a major indicator for its competitive advantage.

Companies that adopt DfE for selling goods and services that promise to customers improved energy efficiency will lead to increase market share. Similarly, companies with more efficient operations will receive a comparative advantage than those companies without such plans (Esty and Winston, 2009). Competitors that have a weak awareness of environmental issues tend to have higher operational costs. Thus, operational performance arguably mediates the relationship between DfE and economic performance.

This then leads to the following hypothesis:

H 4.4: Operational performance mediates the relationships between DfE and economic performance (Figure **20).**

Figure 20 Operational performance mediates the relationships between DfE and economic performance



3.6 Summary

This chapter proposed the conceptual models (see Figure 21 and Figure 22) and its key assumptions (Table **31**). The next chapter will discuss the research methodological issues and data collection strategies to empirically test the above research hypotheses.

Figure 21 Conceptual Model

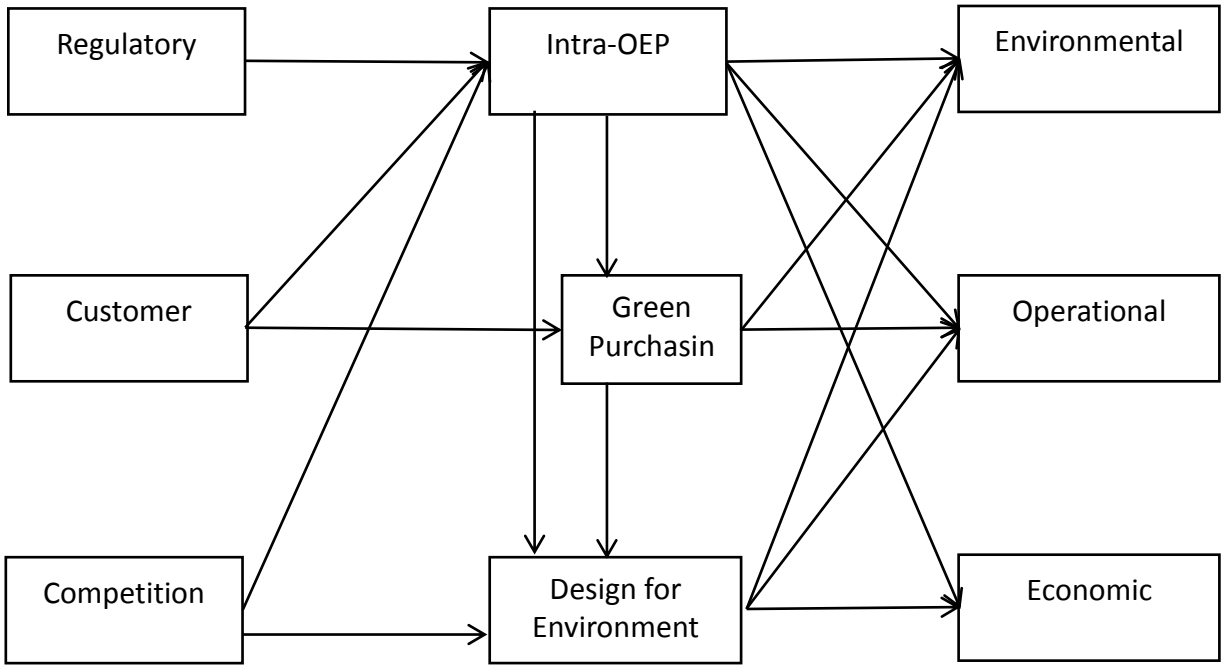


Figure 22 Conceptual Model

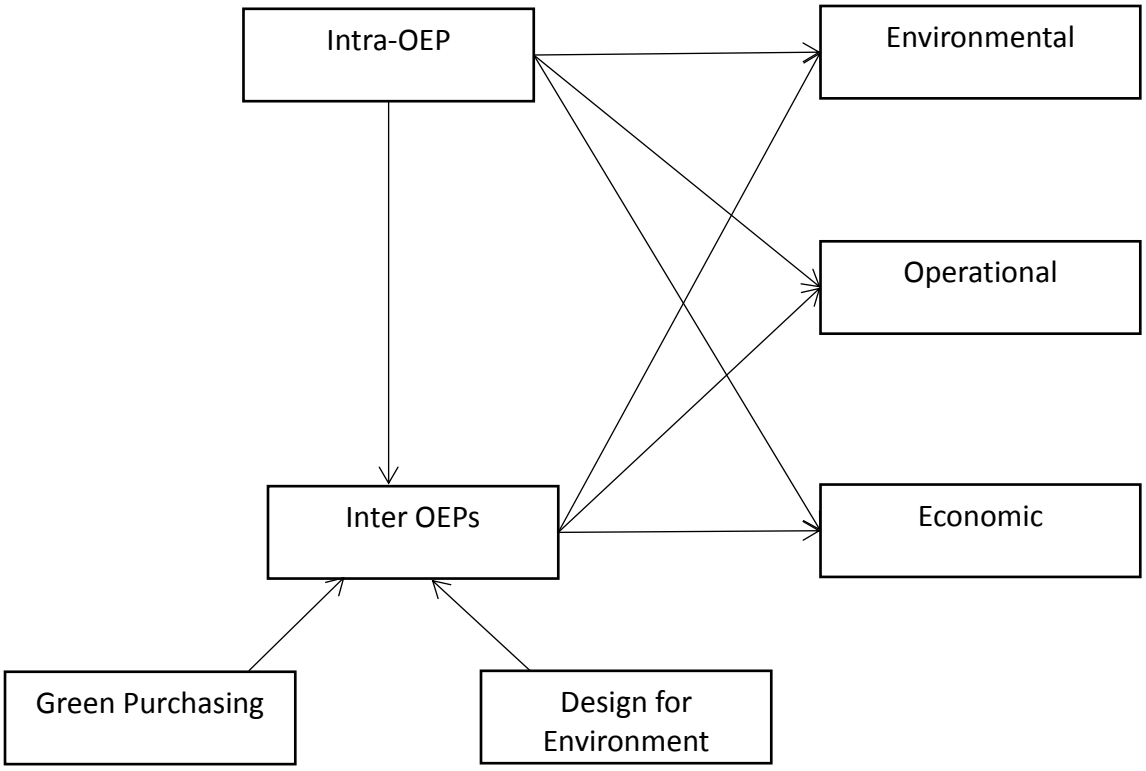


Table 31 Overall Hypothesis

H1.1	Regulatory pressures have a positive influence on a firm's intra-organisational environmental practices.
H1.2	Normative pressures have a positive influence on a firm's intra-organisational environmental practices.
H1.3	Normative pressures have a positive influence on a firm's green purchasing practices.
H1.4	Competitive pressures have a positive influence on a firm's intra-organisational environmental practices.
H1.5	Competitive pressures have a positive influence on a firm's Design for Environment practices.
H1.6	Competitive pressures have a positive influence on a firm's green logistic activities.
H2.1	Intra-OEPs represented by causally ambiguous resources have a direct and positive impact on inter-OEPs as socially complex resources.
H2.2	Intra-OEPs represented by causally ambiguous resources have a direct and positive impact on all aspects of Inter-OEPs.
H2.3	Green purchasing have a direct and positive impact on DfE.
H3.1	Intra-OEPs in the form of causally ambiguous resources have a direct and positive impact on all performance outcomes.
H3.2	Inter-OEPs represented by causally ambiguous resources have a direct and positive impact on all performance outcomes.
H3.3	Green purchasing have a direct and positive impact on environmental performance outcomes.
H3.4	Green purchasing have a direct and positive impact on operational performance outcomes.
H3.5	DfE have a direct and positive impact on all performance outcomes.
H4.1	DfE mediate on the relationships between Intra-OEPs and environmental performance
H4.2	DfE mediate on the relationships between Green Purchasing and environmental performance
H4.3	Inter-OEPS mediate on the relationship between Intra-OEPs and environmental performance
H4.4	Operational performance mediates on the relationships between DfE and economic performance.

Chapter 4 Methodology

4.1 Introduction

This chapter reviews the chosen methodological paradigms that helped achieve the research objectives and to develop methodologies to evaluate the NRB-GSCM Model, which were to firstly conceptualise GSCM in three dimensions involving institutional drivers on GSCM implementation, characteristics of GSCM practices and finally performance measures resulting from GSCM implementation; and secondly, to empirically test causal relationships of GSCM in a structural model to determine how firms in China can successfully implement GSCM to promote sustainable development. For the first aim, a total of nine constructs were established based on previous theoretical support:

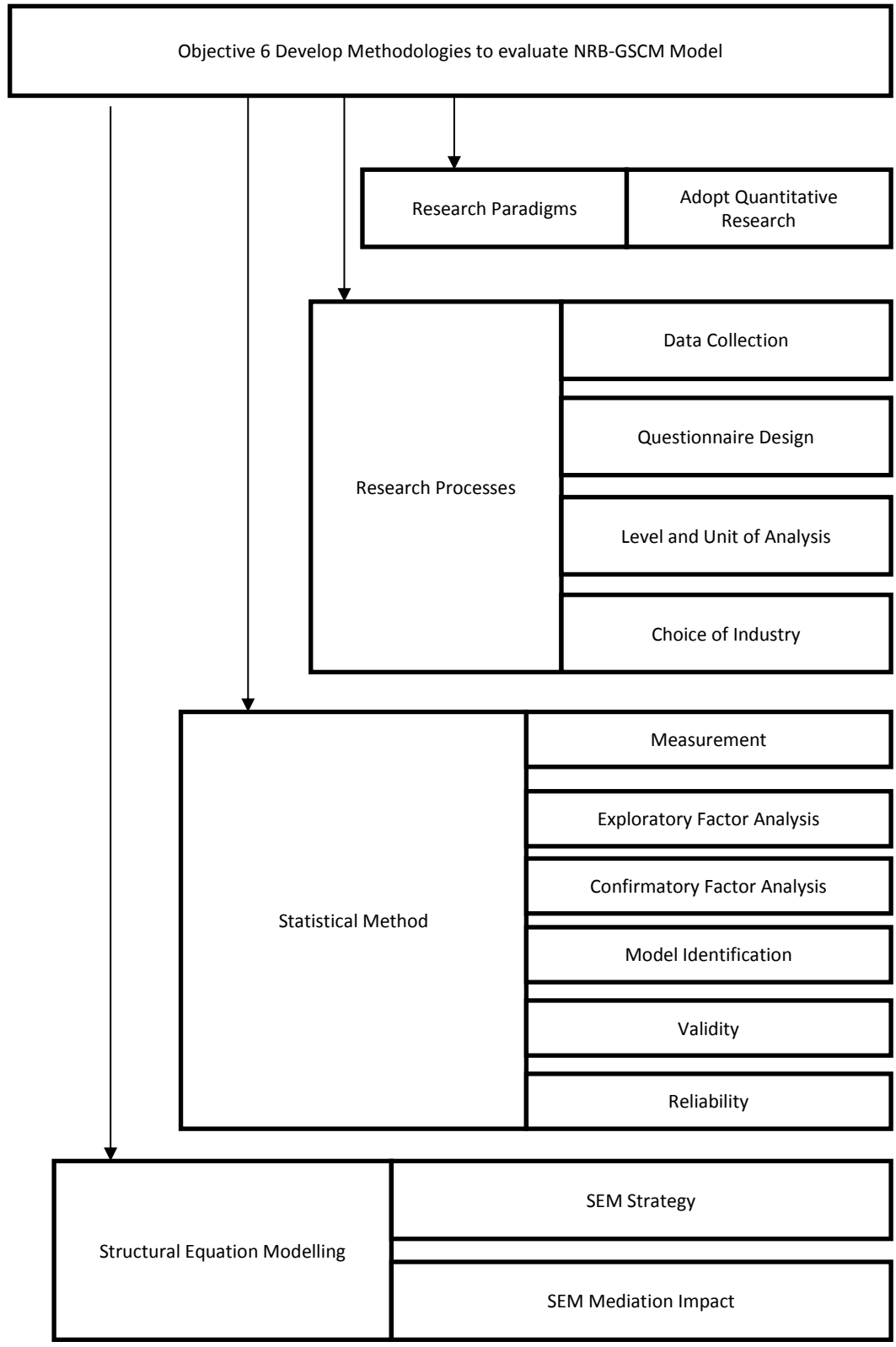
- For institutional drivers on GSCM practices three constructs were identified involving a regulatory (coercive) construct, a customer (normative) construct and a competitive (mimetic) construct.
- For GSCM practices three constructs were identified involving an Intra-OEP construct, a green purchasing construct and a DfE construct.
- For performance measures from GSCM practices three constructs were identified involving an environmental performance construct, an operational performance construct and an economic performance construct.
- In addition, a higher order construct on inter-organisational environmental practices was identified.

Given the usual difficulties in securing industrial participation, the empirical phase utilised convenience sampling, in that established contacts were exploited. For this reason, the aluminium industry in China was selected as the research context. There were several additional reasons for deciding this research context. Firstly, the recent, rapid economic expansion, increasing environmental impact and changing social dynamics in China also figured strongly in the selection, not to mention the environmental burden, and changing nature and challenges facing the aluminium fabrication industry there. Secondly, just by focusing solely on the aluminium

fabrication industry would support a more in-depth understanding of GSCM implementation. Thirdly, the author had existing contacts with key personnel in the industry that helped to increase the response rate.

This research involved a large-scale quantitative survey enabling an advanced statistical analysis using structural equation modelling (SEM) techniques to confirm/refute causal relationships. In focusing on a single industrial sector and country, one foreseen limitation was a lack of generalisability to other sectors and countries/regions. A final reflection of how this limitation can be minimised and addressed in future research is given. This chapter summarises the research design and methodology chosen for the empirical stage, together with the sampling procedure, data collection method, survey instrument development, and questionnaire administration. The reliability and validity of research design is also discussed (see Figure 23).

Figure 23 Flow Chart Methodology Process



4.2 Research Paradigms

There are essentially two research paradigms, the quantitative and the qualitative. The quantitative paradigm refers to when the researcher conducts a deductive and theory driven study, and reflects the philosophical principles of positivism, or the empiricist paradigm (Smith, 1983, Saunders, 2009). The qualitative paradigm refers to when the researcher adopts the interpretive or naturalistic approach (Lincoln, 1985). This research will adopt the quantitative paradigm to study the causal relationships of GSCM drivers, practices and performance in China. This section aims to assess the strength and weaknesses of both qualitative and quantitative research paradigms.

4.2.1 Qualitative Research

The key feature of qualitative research is to take an inductive view of the relationship between research and theory generation, and its emphasis on the understanding of social phenomena by looking into interpretations of the research participants. According to Gubrium and Holstein (2003) qualitative research involves the following four traditions:

1. Naturalism refers to an epistemological view that is specifically concerned with practical methods for acquiring knowledge, irrespective of one's metaphysical or religious views.
2. Ethnomethodology refers to a method for understanding the social orders people use to make sense of the world through analysing their accounts and descriptions of their day-to-day experiences.
3. Emotionalism refers to an approach to conducting research studies to understand about people's experiences through using social inquiry methodologies such as ethnography.
4. Postmodernism refers to the view that reality cannot be known or described objectively, it stresses on methodological issues to capture social reality.

Three are five types of qualitative research:

1. Ethnographic Research is used for investigating cultures by collecting and describing data that is intended to help in the development of a theory (Creswell, 1998).
2. Grounded Theory is an inductive type of research based or "grounded" in the observations or data from which it was developed; it uses a variety of data sources, including quantitative data, review of records, interviews, observation and surveys (Creswell, 1998).
3. Case Study research is an empirical inquiry that investigates a phenomenon within its real-life context (Creswell, 1998)
4. Biographical research is the use and collection of life documents that describe turning point moments in an individual's life (Denzin and Lincoln, 2000)
5. Phenomenological study research is the description of lived experiences for several individuals about a concept or the phenomenon (Creswell, 1998).

Bryman and Bell (2007) identified the following weaknesses of qualitative research:

- Subjectivity: subjectivity criticism means that qualitative findings rely too much on the researcher's often unsystematic weight to significance and also to the reliance upon the personal relationships with the people studied.
- Replication: qualitative research is difficult to replicate because it is unstructured and often reliant upon the qualitative researcher's ingenuity; qualitative researchers also may choose to focus on what strikes them as significant, other researchers may emphasise other issues.
- Generalisation: the scope of the findings of qualitative investigations is restricted because often interviews are conducted with a small number of individuals, the smaller number of cases generated from qualitative approach is limited in its generalisation to other cases.
- Transparency: The process of qualitative data analysis is often unclear; it is difficult to assess how the researcher arrived at the study's conclusions.

4.2.2 Quantitative Research

According to Bryman and Bell (2007), quantitative research is described as entailing the collection of numerical data and as exhibiting a view of the relationship between theory and research as deductive. It involves the development of a theory that is subjected to rigorous test. Robson (2002) indicates the main process of quantitative research involves the following five stages:

1. To suggest a hypothesis with strong theoretical underpinning.
2. To express the hypothesis in operational terms that indicates measurement of variables and proposes relationships among variables.
3. To test the proposed operational hypothesis.
4. To examine the outcomes of the inquiry.
5. To modify the theory in light of the findings.

The strength of adopting quantitative research is that it enables the researcher to focus on establishing the causal relationships between concepts, then the findings of the research investigation can be generalised beyond the confines of the research location and the replication of research findings can provide the means of checking if the findings are applicable to other contexts (Bryman and Bell, 2007, Bell, 2005). Despite its strength, Bryman and Bell (2007) noted quantitative research does have the following weaknesses:

- Social scientists employ the quantitative approach as the natural scientist fails to distinguish people and social institutions from the natural order.
- The measurement process in quantitative research is artificially assumed rather than real.
- Quantitative research relies heavily on administering research instruments to subjects or on controlling situations to determine their effects. This reliance hinders the connection between research and everyday life.

The above discussion of research paradigms concludes the fact that each research approach has its own strengths and weaknesses. According to Peterson (1982), the choice of research design and data collection methods depends on the availability of resources and how best the method can generate the required information. Because

this research aims to conceptualise GSCM into measurement constructs and then to empirically test causal relationships of GSCM in a structural model, quantitative analysis is the most appropriate. SEM is the anticipated method of data analysis. To ensure maximisation of validity and reliability, this study conducted a thorough literature review in all perspectives pertinent to green supply chain drivers, practices and performance outcomes.

4.3 Research Process

The process of the research deals with choosing the best research methods for collecting and analysing appropriate data (Collis et al., 2003). Since this research adopted a deductive approach, only those methodologies that fall under its purview are discussed.

Survey research is the prime vehicle of this study. According to Litwin (1995) a survey is a system for collecting information from or about people to describe, compare or explain their knowledge, attitudes and behaviour in a systematic, standardised way. There are two major types of survey, namely descriptive and analytical (Saunders, 2009).

- Descriptive surveys are concerned with identifying and counting the frequency of a specific phenomenon in a population, either as a snapshot, or spread over a period of time for comparison. They are not designed to show causal relationships between variables.
- Analytical surveys are conducted to determine the existence of any relationship between different variables and often undertaken to test specific hypotheses.

4.3.1 Data Collection

Surveys use questionnaires that ask the same questions in the same way to all respondents. Data collected this way can then be used to make inferences about the

population of interest. There are a number of methods to elicit information from respondents: through mail, over the telephone, in face to face interviews, as handouts, electronically (e-mail or web-based surveys) or a combination of these methods. The mail survey method is adopted in this research, the major advantage is considered below:

- The ability to conduct it at a single point in time, at repeated times or concurrently with multiple samples (Litwin, 1995).
- That they can be used to collect information from all members of a particular group or from a sample of the target population (Saunders, 2009).
- That they provide an economical way for data collection and are authoritative in that they are easily understood (Saunders, 2009).
- Provide for greater control over the research process, the possibility of standardising and comparing scales and of preserving the anonymity of respondents (Thietart, 2001).
- Ability to convey complex information for evaluation (Baker, 1991)
- Allowing sufficient time for respondents to reflect on questions posed, or to check answers before answering (ibid).

The related problems of surveys are closely associated with unrepresentative or biased sampling (Collis et al., 2003). The number of questions that can be asked without testing the goodwill and patience of respondents is also an issue (Saunders, 2009). According to Baker (1991) the main limitation for mail surveys is a low response rate, this is because of the following factors:

- Lack of motivation for respondents to reply.
- Long questions and complex subject matter may deter respondents.
- Unanswered questions due to lack of explanation.
- Mailing list may be out of date.

4.3.2 Questionnaire Design

Due to the complexity of GSCM practices, a questionnaire survey was chosen over other methods to verify the conceptual model, because questionnaire surveys work best with standardised questions that facilitate uniform interpretation (Robson, 2002). Respondents, and not interviewers, fill them out, appointments are not necessary, and once administered the researcher processes the incoming questionnaires. In contrast to telephone and face-to-face interviews, questionnaire surveys do not require decision-making on an immediate, high-pressure basis. They also minimise sampling error at relatively low cost. Furthermore, the aspect of inherent anonymity for the respondent is facilitated (Salant and Dillman, 1994).

One limitation of using survey instruments concerns its sensitivity to non-coverage error, for example not every respondent is willing to participate in the research. Additionally, researchers have little control over what happens to the questionnaire after it is administered. They cannot control whether the questionnaires are filled out completely. Respondents may purposely skip over difficult questions, or inadvertently overlook some items. It is also possible that the respondent might not understand the question clearly or interpret it in a way the researcher unintended and hence may result in erroneous analysis (Robson, 2002). Brassington and Pettitt (2002) recommend a series of general principles whilst drafting questions for the questionnaire, which have been duly considered in this study:

- Making sure that the question is unambiguous.
- Avoiding negatives (E.g. Question: Do you dislike your work? Answer: Yes/No).
- Not asking two questions in one item.
- Avoiding leading questions, which suggest indirectly what the right answer might be.

The design of the questionnaire in this research was also guided by well-established guidelines advocated in the business research literature (Easterby-Smith et al., 2001):

- Including a short covering letter explaining the purpose of the research.

- Varying the type of question occasionally but keeping similar types of questions together in groups.
- Differentiating between instructions and questions through typeface variation.
- Starting with simple factual questions and moving on to items of opinion or values.

It is crucial to identify the appropriate person through whom to request access to the necessary information for the research. This will ensure feedback accuracy of the questionnaire sent. In this survey, the appropriate respondents will include senior management and/or managers involved in EMSs. Research by Dillman (2000) has shown that the content in a self-administered questionnaire's covering letter will affect the response rate. Therefore a covering letter attached to the questionnaire is vital to address the purpose of the survey and also to whom this questionnaire is directed to. This is the first part of the questionnaire that a respondent should look at. The guidelines of Dillman (2000) were used in preparing the covering letter in this survey.

4.3.3 Level and Unit of Analysis

The level and unit of analysis should be on the subject that the research instrument is intended to measure (Nunnally, 1978). The unit of analysis of this study was at the individual plant level, with the informants being environmental managers and/or senior managers within the plant. This research applies the NRBV to discover the effect of GSCM practices on performance outcomes. Earlier empirical research in the resource based view (RBV) has mostly focused on the effects of firm-specific resources on the overall performance of the firm (Barney and Arikan, 2001). However, some limitations in the research design are noted.

First, firm level performance may be an aggregated result of the different effects of different resources (Ray et al., 2004). According to Henderson and Cockburn (1994), using firm-level performance takes the risk of confounding the effects of a certain resource. This research adopts NRBV and hypothesises that inter-OEPs, which are

socially complex resources, have a positive effect on environmental performance, operational performance and economic performance. This research acknowledges the possible confounding effects (ibid). The performance measures of this research are chosen predominantly from previously empirically tested measurements.

Second, since it is difficult for researchers to objectively observe such dimensions as value and inimitability of resources, developing an appropriate survey based on in-depth interviews with focal firms or experts in the industry should mitigate the construct measurement problems in RBV research (Chen et al., 1993). However, Chen et al. (1993) suggest that it is also difficult to directly ask competitors for firm's unique resources, so utilising industry experts should be more widely considered and explored in future research.

Finally, this research adopts NRBV, originally proposed by Hart (1995), for its theoretical underpinnings. This research proposes Inter-organisational environmental practices (Inter-OEPs) as inimitable socially complex resources and can be recognised as a higher order construct involving green purchasing and DfE. A survey methodology is applied to establish its measurement construct. According to Armstrong and Shimizu (2007) research adopting an inimitability construct should be assessed by competitors or outsiders. On the other hand, insiders may believe that a particular technology is valuable and hard to imitate, competitors may not think in the same way (ibid). Also, resources that are taken for granted within the company may serve as a strong barrier against a competitor's imitation effort (Rouse and Daellenbach, 1999).

4.3.4 Choice of Industry

The aluminium fabrication industry was selected for this study because the costs of environmental protection and resource efficiency are among the highest of all industries. Focusing on a single industry approach can help the researcher to control for the following: the type of manufacturing processes and workflow, which are quite standardised in this industry; market expectations; echelons in the supply chain; and, environmental regulations (Vachon and Klassen, 2008). Another reason

for choosing particularly the aluminium fabrication industry is that the value of a firm's resources need to be understood in a specific context (Barney, 2001), as the organisational resources co-evolve with industry or external environments through continuous feedback processes (Levinthal and Myatt, 1994). The value of a particular resource is often industry dependent and industry effects will need to be carefully controlled (Rouse and Daellenbach, 1999). Controlling for industry effects is important because:

- The performance of a firm is often influenced by general industry environments such as the industrial economic cycle.
- The relationship between a firm's performance and resources maybe industry dependent, thus without controlling the industry effect, researchers may obtain erroneous results, such as support for opposite relationships (Barney, 2001, Armstrong and Shimizu, 2007).

Aluminium has been referred to as an energy bank in that once the energy has been invested in it through the smelting process it can be effectively drawn upon again through recycling (Das and Yin, 2007). It requires 16 KWh to produce 1kg of primary aluminium from alumina and 23.8 kWh per kilogram from Bauxite ore. The same amount of secondary aluminium produced from recycled metal requires approximately 5% of the energy as compared to primary aluminium production. In other words, recycling aluminium saves 95% of the energy to produce virgin aluminium (ibid). Primary aluminium production consumes 2% of the global electricity supply, and one third of the total energy consumption in primary aluminium production comes from coal-generated electricity. Air pollution from primary smelting and the production of the necessary electrical power includes hundreds of thousands of tonnes of carbon dioxide, nitrogen oxide, hydrogen fluoride and particulates; they can have strong adverse effects on the ecological environment and human health (ibid). Reducing these levels can be achieved by maximising the use of the GSCM practices. The closed loop aluminium scrap results in the production of only 5% of the carbon dioxide produced in making new primary metal. Thus, the energy savings of recycling aluminium also translates into reduced environmental emissions. For aluminium recycling, the total recycled production was about 3,400,000 tons in China. However, Chinese scrap aluminium is not abundant, which limits the recycled output from scrap aluminium compared to more

developed countries (Das and Yin, 2007). Table 32 illustrates the aluminium product and demand and future opportunities within the business sector.

Table 32 Aluminium Product Demand and Opportunities

Industry	Demand	Opportunities
Aerospace	Aluminium comprises about 80% of the unladen weight of an aircraft. Currently there are approximately 5,300 commercial passenger aircraft and helicopters worldwide, and demand for commercial aircraft is expected to increase by about 60% in next decade.	China will become the driving force behind growth in civil aviation industry, thus driving up the demand for aluminium-fabricated product.
Automotive	Annual global vehicle production is expected to increase by 11 million to reach 67.8 million in 2009; with a 3% annual growth rate, aluminium consumption could be even greater in this industry.	The rise of energy costs and the need for emissions reduction worldwide make aluminium more attractive for automotive use
Packaging	Aluminium packaging industry experienced steady growth in the 1980s but shipments became flat in the 1990s. Worldwide 200 billion aluminium beverage cans are consumed each year. But increasingly, plastics are beginning to take an increasing share of the carbonated soft drink and water market.	Aluminium packaging manufacturing techniques moved from conventional direct-chill casting to continuous casting enable the supply of rolled sheet at a significantly lower cost and can be converted without compromising manufacturing efficiencies or affecting ultimate container performance. Changes in can design such as flat-bottomed containers, could lead to less metal in the dome of the can, saving a predicted 6% in metal cost.

Adapted From(Das and Yin, 2007)

4.4 Statistical Method

4.4.1 Measurement

According to Rose and Sullivan (1993) measurement is the principle element in research, through which validity and reliability can be established. Four types of measurement scale are identified including: nominal, ordinal, interval and ratio scale (ibid). In management research, data using Likert scales, treated as interval scales, is common practice, as this enables the research to establish explanation between variables using inferential statistics (Schumacker and Lomax, 1996). Likert scales are adopted in this research where respondents are asked to give the degree of agreement or disagreement to a proposed statement. Tull and Hawkins (1993) suggest that the interval between each degrees of agreement or disagreement is not perfectly equal, but researchers often treat these data as if they are equal. This is because in statistical analysis minor non-compliance does not seriously affect interval scale requirements.

4.4.2 Exploratory Factor Analysis

Exploratory factor analysis (EFA) is used to examine the underlying structure among variables in the data analysis (Hair et al., 2006). The two main objectives of adopting EFA include: 1) identification of underlying constructs in the data which best explains the correlation among indicators; and 2) factor reduction to reduce to a more manageable set (Aaker et al., 2007). According to Hair et al. (2006) EFA can be performed without prior knowledge about the number of factors in the data set and their correlation characteristics. Factors can be formulated based on statistical results from EFA, and not necessarily having being developed from theory (ibid).

The input of factor analysis consists of a set of indicators that are assumed to be manifested by latent constructs. The outputs include factor loading, factor scores and communalities. According to Hair et al. (2006), factors to be retained in the analysis, include rules of thumb of: communalities greater than 0.50 and factor loadings

greater than 0.50 are considered necessary for practical significance. Although factor loading over 0.40 or lower is acceptable if the sample size is sufficiently large. According to Hair et al. (2006) sample size is preferably over 100 and the ratio of sample size to indicators exceeds a minimum of 5:1. According to Tabachnick and Fidell (2007), a sample size of around 300 is the minimum accepted, lower than 300 would require factor loadings greater than 0.80. Generally EFA with a larger sample size would be preferred in management research.

4.4.3 Confirmatory Factor Analysis

In contrast to EFA, the confirmatory factor analysis (CFA) takes a theory testing approach, which requires a prior-theoretical model a necessary condition (Sharma, 1998). CFA is used to test measurement theory which specifies how well measured variables represent constructs involved in a theoretical model. The confirmation of a CFA model is then a pre-requisite for further research in structural models. Diamantopoulos and Siguaw (2006) identified two types of indicators namely reflective indicators and formative indicators, the differences between the two types of indicators are:

- Reflective measurement assumes latent constructs independent of measures used versus formative measurement where constructs are not assumed to be latent (Hair et al., 2006).
- The direction of causality is different between items and the latent construct. The reflective measures are perceived as an indicator of effect, while formative measures are viewed as causal indicators (ibid).

4.4.4 Model Identification

According to Byrne (2010) the model identification for SEM involves three types of models namely: just-identified, over identified or under identified.

- Just identified model: refers to 1-1 correspondence between data and structural parameters, having no degree of freedom, therefore cannot be rejected.
- Under identified model: refers to the number of parameters exceeding the number of variances and covariance, i.e., insufficient information to provide a unique solution for all the parameters (Rigdon, 1995). Shah and Goldstein (2006) suggest that under identified models may converge, and even in the case of convergence estimates of parameters are not reliable and overall fit statistics can not be interpreted.
- Over identified model: The number of estimate parameters is less than the number of data points, this generates positive degrees of freedom that allow for rejection of the model. This is a necessary condition in SEM (Byrne, 2010). To ensure sound model identification, Hair et al. (2006) suggest four indicators of each construct whenever possible. They also suggest that the use of three indicators for certain constructs is also acceptable.

4.4.5 Reliability

Reliability measures if the research can be repeated with the same outcomes. The measurement of reliability indicates the extent to which it is without bias; meaning 'error free' and hence ensures consistent measurement across various items used to execute the research (Yin, 1994). Bell (2005 p.117) defines reliability as '*the extent to which a test or procedure produces similar results under constant conditions on all occasions*'. De Vaus (1986) suggests a reliable instrument is one free from random error and able to yield consistent results. Reliability, or the consistency of the data collected from a survey, can be seriously affected by poorly worded and imprecise questions and directions. Measures with high reliability scores indicate future research can achieve similar results given similar research conditions. It is possible to have an instrument that is valid but not reliable, but if an instrument is unreliable, it is also invalid, because it is impossible to obtain accurate findings with inconsistent data. In reality, the true score usually does not exist since the research is measuring an abstract concept (Hair et al., 2006).

According to Peter (1979), Cronbach's alpha is the most commonly accepted approach to assess construct reliability. Churchill (1979) recommends that Cronbach's alpha should be the first measure to calculate the quality of an instrument. It is a measure of internal consistency of a set of items which is based on the average correlation among items (Nunnally, 1978). According to Hair et al. (2006), a rule of thumb with Cronbach's alpha of 0.70 is usually the minimum acceptable level.

Composite reliability and average variance extracted (AVE) also serves as alternative measures of construct reliability. Composite reliability can be calculated with the standard factor loadings generated from a CFA. Bagozzi and Yi (1988) recommend a minimum level of composite reliability of 0.60. The AVE above 0.50 indicates good reliability (ibid). It is possible for researchers to adopt different estimates of reliability. Gerbing and Anderson (1988) suggest unidimensionality should be acceptably established before reliability testing.

The reliability of this research will be achieved through the following measures: minimising the source of unreliability, multi-item indicators, and the use of questions from reputable studies.

1. Minimising the source of unreliability: De Vaus (1986) argues that a question may be unreliable due to bad wording: people may understand a question differently on different occasions. In the survey, poor wording will be minimised by extensive piloting of the questionnaire. Difficult questions will be reworded, ambiguous questions and repetitive questions will be removed.
2. Multi-item measure: De Vaus (1986) argues that multi-item indicators are the best way to create reliability, as well as offering an easier method of assessing their reliabilities.
3. Use of questions from reputable studies: Measures are extracted and modified based on previous empirical research; reliability of the instrument will be checked using Cronbach's Alpha coefficient.
4. Cronbach's Alpha test of reliability: Tests internal consistency based on average inter-item correlation.

4.4. 6 Validity

Validity is one of the concepts used to determine how good an answer is provided by research data (Yin, 1994). It reflects the accuracy of a measure. The research instrument must measure what it is intended to measure. The operational definition of measurement needs to be consistent and comprehensive covering the abstract concept in the research. De Vaus (1986) argues that it is not about the measure that is valid or invalid, rather it depends on how the research defines the concept that it is designed to measure. An instrument may be a good measure, but not necessarily valid for the concept to be measured.

There are five different types of validity (Yin, 1994, Anderson and Gerbin, 1988, Churchill, 1987), namely, face validity, content validity, construct validity, predictive validity and external validity.

Face validity concerns how closely the operationalisation appears to measure what it is supposed to measure or whether it is a good translation of the construct or not. In this research face validity is optimised through extensive literature research and the adoption of measures that have been empirically tested. In addition to the use of existing measures, new measures were created from interviews with industrial experts.

Content validity addresses the adequacy with which the domain of the characteristics is captured by the measure (Churchill, 1987). Each measurement item is checked against the relevant content domain to ensure an adequate description of the research domain is captured by the measure (Churchill, 1995).

Construct validity is '*the degree of correspondence between constructs and their measures*' (Peter, 1981 p.133). The validity of a measure is maintained if '*it measures what it is supposed to measure*' (Heeler and Ray 1972, p361). According to Hair et al. (2006) evidence of construct validity provides confidence that measurement items in a sample actually represent the actual score that exists in the population. There are three issues related with construct validity:

1. Unidimensionality refers to the degree to which a set of items forming an instrument measures an underlying construct.

2. Convergent validity refers to '*the degree to which multiple attempts to measure the same concept are in agreement*' (Bagozzi et al., 1991, p425). Anderson and Gerbing (1988) recommend convergent validity is supported if each indicator's estimated factor loading is significant. Hair et al. (2006) suggest an acceptable level of standard loading should exceed 0.50.
3. Discriminant validity refers to '*the extent to which a given construct is different from other constructs*' (John and Reve, 1982, p520). Campbell and Fiske (1959) suggest discriminant validity is confirmed if correlation between variables designed to capture the same construct be greater than the correlation between those variables and any other variables in the model. Another approach is to compare the AVE for each construct with the squared correlation between any two constructs in the model (Fornell and Larcker, 1981). If AVE for each construct is larger than the squared correlation between any two constructs then discriminant validity is confirmed (ibid).

In this research, construct validity is empirically tested in two steps. Firstly, convergent validity is tested through CFA. Then, discriminant validity is tested using Pearson correlation. By establishing convergent and discriminant validity, the unidimensionality of the measurement constructs is supported.

Predictive validity refers to whether a measurement predicts what it supposes to predict. Pennings and Smidts (2000) suggest that if measures of the constructs are related in a way that is theoretically meaningful, then nomological validity is supported. It is suggested for researchers to search for evidence of the relationships among constructs in prior research or from established theories. Bobby et al. (1983) noted that convergent validity and discriminant validity should be satisfied prior to nomological validity. In this research the predictive validity is empirically tested and reported. SEM is used to establish causal relationships between variables.

External validity is closely related to generalisability (Sackett et al., 1990) which refers to the extent to which any research findings can be generalised beyond the immediate research sample. Scandura and Williams (2000) suggest that external validity can be achieved through adopting formal theory and sample surveys. External validity of this research is achieved through generating a model from literature review and testing the model using a survey instrument.

This research recognises the importance of reliability and validity in generalising findings. Guba (1978) argues that it is rare to have generalisable results since circumstances can change drastically and that generalisability and replication is difficult. Despite this issue, aims to produce generalisable results is widely accepted (Black, 1993). Black (1993, p55) notes that '*without generalisability of results, social science research in general will tend to limp along, not benefiting from the efforts of others, collecting research results on a piecemeal basis'*.

4.4.7 The measurement model vs. the structural model

SEM can be divided into measurement models and a structural model. The measurement models address the reliability and validity of the indicators in measuring the latent variables or hypothetical constructs, while the structural model specifies the direct and indirect relations among the latent variables and describes the amount of explained and unexplained variance in the model (Byrne, 2010). Joreskog and Sorbom (1993) suggest a two step approach to assessing the fit of the structural independent variables of the measurement models.

The two step approach to SEM emphasises the analysis of two conceptually distinct latent variable models: measurement and structural. According to Anderson and Gerbing (1988), focusing on the measurement model provides an assessment of convergent and discriminate validity as the structural model provides an assessment of predictive validity. Joreskog and Sorborm (1993) suggest that the measurement model should be tested before the structural relationships are tested. It is useful to do this for each construct separately, then for the constructs taken two at a time, then for all constructs simultaneously.

This research follows this advice, i.e., before testing the structural model, the measurement model for each construct will be tested and reported. The convergent and discriminate validity of measurement constructs will be established before moving on to the analysis of the structural model.

4.4.8 Measurement Model Validity

The validity of a measurement model relies on the acceptable fit statistics and evidence of construct validity. Confirmatory factor analysis uses chi-square measures to quantify the difference between the observed and estimated covariance matrices (Hair et al., 2006). The statistical significance of Cmin (Chi square) can be calculated with critical values and degrees of freedom (df); a non-significant value indicates good fit to the model. According to Tabachnick and Fidell (2007), one issue related with Cmin measures is it is sensitive to an increase in sample size and often results in a larger value. Therefore, the difference between the sample and estimated covariance matrices are often significant when the sample size becomes large (ibid). To overcome this limitation of Cmin statistics, alternative methods have been developed such as absolute fit indices, incremental fit indices and parsimony fit indices. The Comparative Fit Index (CFI) and RMSEA are the two most frequently used and reported fit indices (Hair et al., 2006). It has been suggested that the report of Cmin with degrees of freedom, CFI and RMSEA can provide sufficient and unique information to an estimated model (ibid). According to Bentler (1990) CFI is insensitive to sample size, it can avoid the underestimation of model fit due to smaller samples. Hair et al. (2006) recommend that the rule of thumb on generally accepted levels include both: 1) The value of CFA should exceed 0.90 to indicate an acceptable model; 2) The RMSEA index of less than 0.08 to indicate a reasonable fit.

4.5 Structural Equation Modelling

4.5.1 SEM Introduction

This research aims to identify the causal relationships among three dimensions of GSCM: motivating GSCM drivers, actual GSCM practices and performance outcomes. Quantitative analysis is considered the most appropriate method for testing the hypotheses. Specifically, the SEM technique will be applied. SEM is a multivariate statistical technique for testing structural theory that has gained popularity in many business disciplines (Byrne, 2010). The methodology uses various types of models to depict relationships among observed variables, and for providing a quantitative test of a theoretical model proposed by the researcher (Schumacker and Lomax, 2004). SEM takes a confirmatory (i.e. hypothesis-testing), rather than an exploratory approach to data analysis as it typically represents 'causal' processes that generate observations on multiple variables (Bentler and Bonett, 1980). According to Fornell (1982), SEM demonstrates several advantages over traditional multivariate procedures, which makes it a popular methodology for non-experimental research. Advantages include:

- SEM takes a confirmatory approach, which is particularly effective for hypothesis testing. By a priori specifying patterns of inter-variable relations the SEM can be used for inferential purposes (Byrne, 2010). Whilst other multivariate procedures such as factor analysis makes hypothesis testing difficult (ibid).
- SEM can take measurement error into account as it reflects not only the construct that is intended to be represented, but also random and systematic error (Byrne, 2001, Mackenzie, 2001, Byrne, 2010).
- SEM can incorporate both unobserved and observed variables; whilst traditional methods are based on observed measurements only (Byrne, 2010).
- There are no widely and easily applied alternative methods for modelling multivariate relations or internal indirect effects. These important features are only available using SEM methodology (ibid).

4.5.2 Type of Variables

Byrne (2010) distinguishes terminologies of different types of variables used in SEM, namely latent variables vs. observed variables; and exogenous vs. endogenous variables. Latent variables are those variables that cannot be observed and measured directly. It is the role of the researcher to operationally define the meaning of the latent variable it is supposed to represent. The observed variables serve as indicators of the underlying construct that they are presumed to represent in SEM (Byrne, 2010). Exogenous variables are synonymous with independent variables. Endogenous latent variables are synonymous with dependent variables, thus it is influenced by the exogenous variables in the model, either directly or indirectly (Byrne, 2010).

4.5.3 Strategies for structural equation modelling

Joreskog and Sorborm (1993) suggest three generic strategies for testing models, namely strictly confirmatory, alternative models and model generating:

1. With the strictly confirmatory strategy, the researcher postulates a single model based on theory. Based on the test result, the research either rejects or fails to reject the model. No further modification to the model is made.
2. With alternative models, the researcher proposes several alternatives, all of which grounded in theory. Following an analysis of a single set of empirical data, the researcher selects the model that is most appropriate in representing the sample data.
3. With the model generating strategy, when a hypothesised model is rejected on the basis of its poor fit to the sample data, the researcher proceeds in an exploratory fashion to modify and re-estimate the model.

As suggested by Byrne (2001) the model generating strategy is the most commonly used among all three, because given the cost associated with the collection of data, the researcher would rarely afford to terminate the research on the basis of a rejected hypothesised model.

This research adopted a mixture of strictly confirmatory and model generating strategies, the model generating strategy is used to analyse the measurement model for new and existing measurement constructs from the literature. The confirmatory strategy is then applied to the structural model analysis.

4.5.4 Mediation Effect

This research hypotheses that Inter-OEPs mediate the relationships between Intra-OEPs on all the performance dimensions. In testing the mediation effects, the following conditions need to be met:

1. The independent variable has significant influence on the dependent variable.
2. The independent variable has significant influence on the mediator.
3. The mediator has influence on the dependent variable.
4. The effect of the independent variable on the dependent variable needs to be diminished after controlling for the effects of the mediator.

Scenario 1: All of above conditions are met and the influence of the independent variable becomes non-significant in the presence of the mediator, then the effects of the independent variable are fully mediated by the mediator.

Scenario 2: All of the conditions are met, but the influence of the independent variable remains significant in the presence of the mediator, the effects of the independent variable is partially mediated.

Scenario 3: None of conditions are satisfied, i.e., there is no mediation (Baron and Kenny, 1986; Tepper et al., 1996).

The use of SEM has been applied in this study. By reducing measurement error through the application of latent variables also attenuates concerns that method effects may be confused with actual substantive results when testing for mediation (Hopwood, 2007).

4.6 Summary

This chapter first reviewed the different research paradigms and their strengths and weaknesses in different types of studies, and identified the appropriate research design and methodology for this particular research. Due to the quantitative nature, the statistical method adopted in this research was discussed, followed by discussions on reliability and validity issues associated with quantitative research. Solutions to maximise reliability and validity were also discussed in this chapter. Finally, rationales for adopting the SEM technique and its benefit for this research were identified.

Chapter 5 Theory Testing: Analysis and Results

5.1 Introduction

This chapter outlines the detailed analytical process to achieve objective 6 which is to validate NRB-GSCM Model. Consequently, the chapter provides answers to all the research objectives set out earlier in this research. The chapter begins with discussions of the detailed procedures in data analysis, from handling missing data and outliers, to issues associated with multicollinearity and singularity in the data. Also bias through common method variance in this research is discussed. After the data screening, steps are taken to purify the measurement scale. Following the suggestion by (Anderson and Gerbin, 1988), the two step approach is adopted to evaluate the measurement and structural models independently. Individual construct measurement models were assessed before moving on to all constructs. Given satisfactory results with validity and reliability of all measures, the structural model is estimated against the proposed hypotheses. Finally, issues related to structural models including model mis-specification, model re-specification and model cross validation are discussed (see Figure 24).

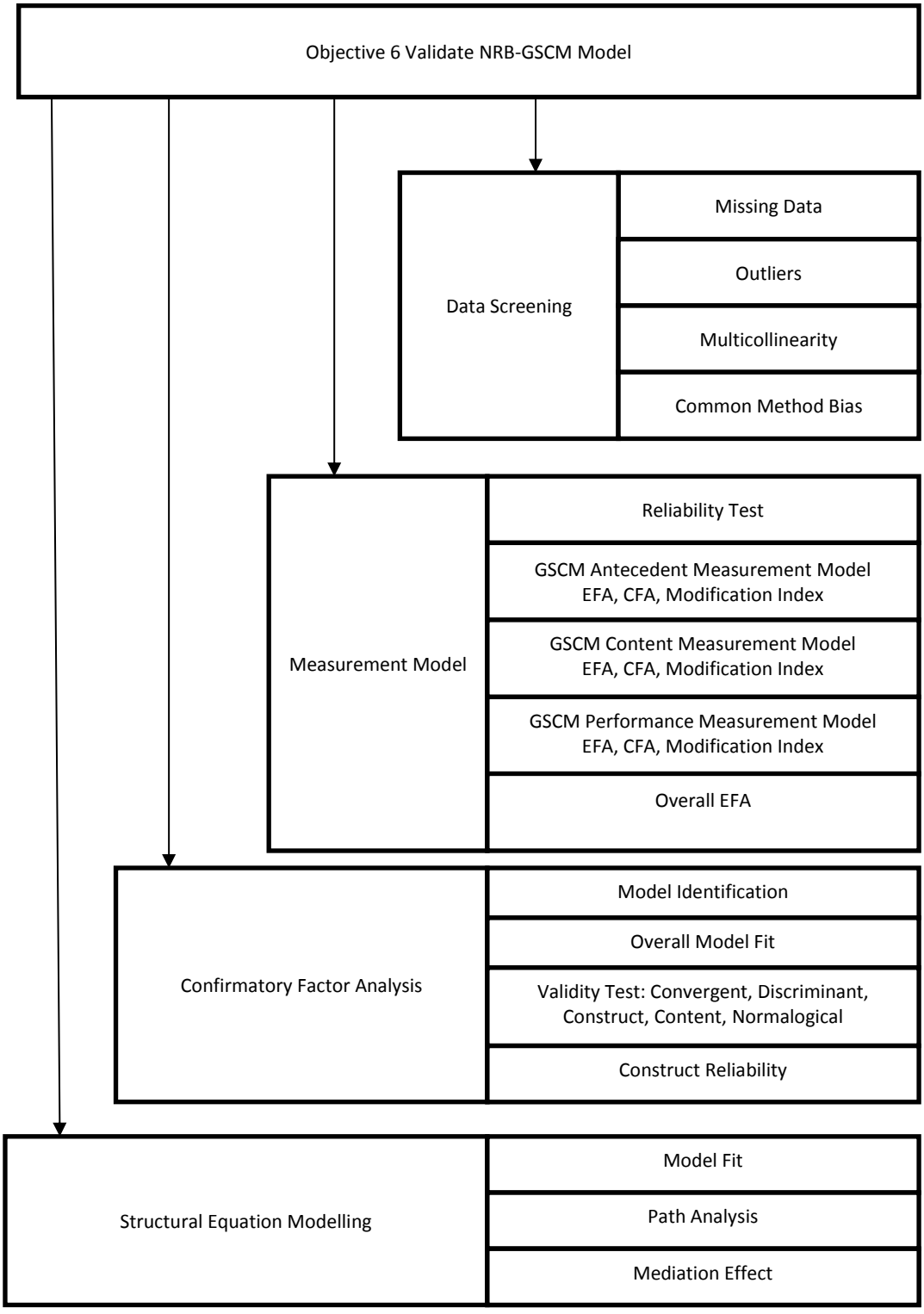
5.1.1 Sample Frame

The survey was conducted within the Chinese aluminium fabrication industry, between February 2011 and August 2011. The identification of a single sector at a national level, which is similar to Sarkis et al. (2010), enables this research to isolate country specific and sector specific factors that may influence GSCM behaviour.

From a pre-survey analysis, the Chinese aluminium industry was found to be highly fragmented with a majority of small firms (less than 50 employees) without any basic environmental treatment facility. Similarly, according to Hicks and Dietmar (2007) the awareness and willingness to improve industrial environmental

performance depends on external pressures. As bigger companies attract more attention, are more exposed to external pressures and have a bigger impact they will

Figure 24 Flow Chart Theory Testing



naturally become more aware and be more willing to improve their environmental performance. For this purpose, they will also allocate more resources than smaller companies. Large companies in China are demonstrating an increasing willingness to address environmental and social responsibility issues. Thus, the company database for this study was created based on the following criteria:

- Revenue over 20 million RMB
- Companies that had over 100 employees (from the Chinese Statistic Bureau classification on C3351 for aluminium fabrication and C3340 for non-ferrous metal fabrication)

This resulted in a total of 391 companies, employing 193,908 and accounting for over 60 percent of the entire industry in China.

5.1.2 Key Informants

Contact information for all 391 companies was collected including the telephone number, address and email. The participants of this survey are expected to be people who hold senior positions in the company and who are knowledgeable of environmental programmes. The participants were identified based on a good contact list generated from supporting companies as well as the Chinese non-ferrous standard organisation and a number of senior editors in the top industrial journal, who are also very kind to help with the survey circulation. All 391 companies were then contacted by phone to determine the most appropriate person to direct the survey to.

5.1.3 Survey response

As shown in Table **33** a total of 132 companies participated in the survey, resulting in a 33.7% response rate. The high response rate is due to the use of pre-notification, assurance of confidentiality and good contacts with leading firms.

Among the 132 participating companies, 4 companies supplied 6 responses, 11 companies supplied 5 responses, 11 companies supplied 4 responses, 30 companies supplied 3 responses, 43 companies supplied 2 responses and 33 companies supplied 1 response. This gave a total of 332 responses.

Table 33 Survey response description

Company	Response	Total
4	6	24
11	5	55
11	4	44
30	3	90
43	2	86
33	1	33
132		332

5.2 Data Screening

This research follows a rigorous statistical procedure to examine the survey data. The process begins with examining the issues with regards to missing data, outliers, multicollinearity, and common method bias. All these issues are considered important in multivariate data analysis.

5.2.1 Missing Data

According to Hair et al. (2006) special attention should be paid to missing data issues prior to the examination of the data set. The key impact from missing data is the reduction of the sample size, which can produce biased results with non-random missing data fed into the statistical analysis (ibid).

The listwise deletion method is a typical technique to deal with missing data. This technique is a particularly effective deletion method to produce consistent results while data are known to be missing completely at random (MCAR). According to

Sinharay et al. (2001), MCAR refers to the case where the pattern of missing data is independent of all the characteristics of variables under study. Kim and Curry (1977) suggest that if it is assumed that the pattern of missing data does not deviate significantly from the random model, then the listwise deletion method is a priority choice. This research adopts the listwise deletion method by simply omitting cases with missing data and then running the analysis for the remaining data. The main disadvantage in listwise deletion is that it can eliminate a significant amount of data. This analysis showed that missing data across the variables resulted in a total of 12 cases, a small rate of 3.6%. Roth and Switzer (1995) recommend that the use of deletion methods represent the most logical choice when the amount of missing data falls below 5% of the total cases.

5.2.2 Outliers

Hair et al (2006 p.73), describe outliers as '*observations with a unique combination of characteristics identifiable as distinctly different from the other observations*'. An outlier is not an error, and is rather treated as a special case that should be evaluated within the context of the data analysis (Churchill, 1999). According to Hair et al. (2006), outliers can occur in the following situations:

- Procedural error caused by mistakes in data entry
- Extraordinary event
- Sample does not represent the population from which the sample is drawn
- Values that are not particularly high or low on the variables

Given the potential problems with outliers, researchers should decide on the retention or exclusion of each outlier based on their characteristics and objectives of the analysis. For example, respondents may fill in the questionnaire with the same answers across all the scale items. Since the respondent is just providing answers without necessary attention, these cases should be deleted. Retention of these cases in the sample not only compromises the validity of the construct, but also biases the estimate of the relationships among constructs. To remove these cases, descriptive analysis is used through calculating the standard deviation of each case across the

scale items. The conservative level of 0.50 was applied as the threshold value for designation of outliers. As a result, no extreme cases were deleted owing to the standard deviation below 0.50.

5.2.3 Multicollinearity

Multicollinearity can impact on the data set when a set of variables is too highly correlated. Hair et al. (2006 p.103) describes multicollinearity as '*the extent to which a variable can be explained by the other variables in the analysis*'. In reflective scales, it is expected that the intercorrelations among indicators are as high as possible to indicate strong convergent validity. Therefore, some degree of multicollinearity is desirable within a factor. However, discriminant validity of constructs in a measurement model requires that items measuring different constructs should not be strongly correlated (John and Reve, 1982). Hence it becomes necessary to examine the degree of collinearity (relationship between two variables) for all pairs of items belonging to different constructs. Collinearity is a matter of degree since it is almost always present, resulting in the real issue of determining its magnitude (Mason and Perreault, 1991). Tabachnick and Fidell (2007) provide a guideline for assessing the significance of bivariate correlation with values of 0.90 or higher indicating significant collinearity. In this research the issue of collinearity does not exist in the sample since all the bivariate correlations are below the threshold value of 0.80.

5.2.4 Common Method Bias

Bias caused by common method variance has been well recognised as a problem in behavioural research (Bagozzi et al., 1991, Kline, 1998, Podsakoff and Organ, 1986, Edwards, 2008). Common method variance (CMV) refers to '*variation in measures of different constructs that result from sharing the same method of measurement*' (Edwards, 2008 p476). Common method biases are caused by the fact that the predictor and criterion variables are obtained from the same source, while others are

due to the measurement items themselves (Podsakoff et al., 2003). According to Pauraj (2011), confirmatory factor analysis can be applied to assess the potential for CMV. Common method bias is an issue if a single factor accounts for all indicators. On the other hand, a worse fit for the single factor model suggests that CMV does not pose a serious threat. This research assesses indicators for all 9 theoretical constructs. The fit for the single factor was considerably worse than the 9 factor model. Thus, this suggests that CMV does not create a problem in the data set.

5.3 Measurement Model

5.3.1 Reliability tests

The reliability of constructs was tested with Cronbach's alpha measure. Individual items that can greatly improve overall reliability should be deleted (Field, 2005). In Table 34 several items are candidates for exclusion. Items deleted to improve internal consistency were as follows:

1. Competition (Compt4) improving internal consistency from 0.519 to 0.603
2. Intra OEP (Intra5) improving internal consistency from 0.675 to 0.754
3. Green Purchasing (GP4) improving internal consistency from 0.506 to 0.65
4. Green Logistics (GL4) improving internal consistency from 0.431 to 0.496

Further enhancement on construct reliability is necessary for competition and green logistics, thus Cronbach's Alpha on both constructs are further screened. The results are shown in (Table 35).

1. The competition construct was improved by deleting item Compt4 improving from 0.519 to 0.603. Further improvement on the competition construct is possible by deleting Compt3, which increases reliability from 0.603 to 0.733.
2. The green logistics construct can be further improved by deleting GL3, which increases reliability from 0.496 to 0.728.

Table 34 Reliability Tests Table and Description which variable deleted

Constructs	Items	Cronbach's Alpha if Item Deleted	Construct reliability
Regulation	Reg1	.655	0.707
	Reg2	.650	
	Reg3	.668	
	Reg4	.647	
	Reg5	.673	
Customer	Cust1	.725	0.764
	Cust2	.681	
	Cust3	.671	
	Cust4	.758	
Competition	Compt1	.273	0.519
	Compt2	.219	
	Compt3	.549	
	Compt4	.603	
Intra	Intra1	.534	0.675
	Intra2	.533	
	Intra3	.582	
	Intra4	.648	
	Intra5	.754	
Design for Environment	DFE1	.669	0.741
	DFE2	.657	
	DFE3	.740	
	DFE4	.667	
Green Logistics	GL1	.313	0.431
	GL2	.190	
	GL3	.406	
	GL4	.496	
Green Purchasing	GP1	.387	0.506
	GP2	.455	
	GP3	.289	
	GP4	.650	
	GP5	.392	
Environmental	Envi1	.623	0.774
	Envi2	.632	
	Envi3	.758	
	Envi4	.816	
Operation	Oper1	.879	0.91
	Oper2	.883	
	Oper3	.909	
	Oper4	.883	
	Oper5	.892	
Economy	Econom1	.849	0.896
	Econom2	.869	
	Econom3	.877	
	Econom4	.872	
	Econom5	.898	

Table 35 Further Reliability Tests

Constructs	Items	Cronbach's Alpha if Item Deleted	Construct reliability
Competition	Compt1	0.349	0.603
	Compt2	0.305	
	Compt3	0.733	
Green Logistics	GL1	0.157	0.496
	GL2	0.07	
	GL3	0.728	

As shown in Table 36, 6 out of a total 45 items from Cronbach's Alpha reliability test were deleted with 39 items remaining for further screening.

Table 36 Summary of items excluded from Cronbach's Alpha Reliability Test

Compt3	Q4.8	Our firm can enter lucrative new markets by adopting environmental strategies.	Banerjee, Iyer and Kashyap (2003)
Compt4	Q4.9	Our firm can increase market share by making our current products more environmentally friendly.	Banerjee, Iyer and Kashyap (2003)
GL3	Q3.12	We provide consumers with information on environmentally friendly products and/or production methods	Rao and Holt (2005)
GL4	Q3.13	We use more environmentally friendly transportation methods	Rao and Holt (2005)
GP4	Q3.4	We periodically evaluate our suppliers' environmentally friendly practices	Paulraj (2009)
Intra5	Q2.5	We make a concerted effort to make every employee understand the importance of environmental preservation.	Benerjee, Iyer and Kashyap (2003)

5.3.2 Measurement Model GSCM Drivers

After the reliability tests, as guided by Byrne (2010), the measurement model development begins with the examination of simple measurement models before

testing the large measurement model composed of all measures. To refine measurement items, three simple measurement models were tested with both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). These three measurement models separately consist of conceptually related constructs that can form higher-order constructs.

5.3.2.1 EFA: Regulation, Competition, Consumer

Regulatory, competitive and consumer pressure on GSCM practices are conceptually related but have differences in meaning. In this study, all three constructs were operationalised with existing items, only following two items (Cust1 and Cust3) were developed from earlier research.

- Cust1: Greening the supply chain can improve trust from our customers
- Cust3: Media exposures for pollution activities is strong in our industry

EFA was applied first to examine the pattern of factor loadings. Table 38 presents the three-factor solution from the principal component analysis (PCA) with oblique factor rotation. Given the large sample size, factor loadings smaller than 0.30 are not significant (Hair et al., 2006) and thus are not displayed in the table. After deleting two items for the construct of competition from the construct reliability test (Compt3 and Compt4), the EFA for the remaining 11 items was conducted. The results showed that items Reg5 and Reg4 had significant cross loadings with more weight on the customer construct. As suggested by Hair et al. (2006), items in Table 37 with significant cross loadings should be excluded.

Table 37 Factor analysis Institutional Theory Items Deleted

Reg4	Q4.4	Tougher environmental legislation is required so that only firms that are environmentally responsible will survive and grow.	Banerjee, Iyer and Kashyap (2003)
Reg5	Q4.5	Our industry is faced with strict environmental regulation	Banerjee, Iyer and Kashyap (2003)

Table 38 EFA for three dimensions of Institutional Drivers

	Component		
	1	2	3
Cust3	.864		
Cust2	.839		
Cust4	.580		
Cust1	.563		
Reg5	.508	.332	
Reg4	.487	.418	
Reg2		.839	
Reg3		.675	
Reg1		.648	
Compt2			.872
Compt1			.765

The revised EFA model (Table 39) shows no signs of cross loading, the cumulative percentage of total variance explained in the revised three-factors model is 63% which indicates sufficient amount of variance by three-factor constructs (generally accepted value is 0.50). The factor structure is also satisfactory in which all items are successfully loaded to their related construct.

Table 39 Revised EFA for three dimensions of Institutional Drivers

	Component		
	1	2	3
Cust2	.890		
Cust3	.862		
Cust4	.607		
Cust1	.565		
Reg2		.871	
Reg3		.747	
Reg1		.570	
Compt2			.888
Compt1			.795

5.3.2.2 CFA: Regulation, Competition, Consumer

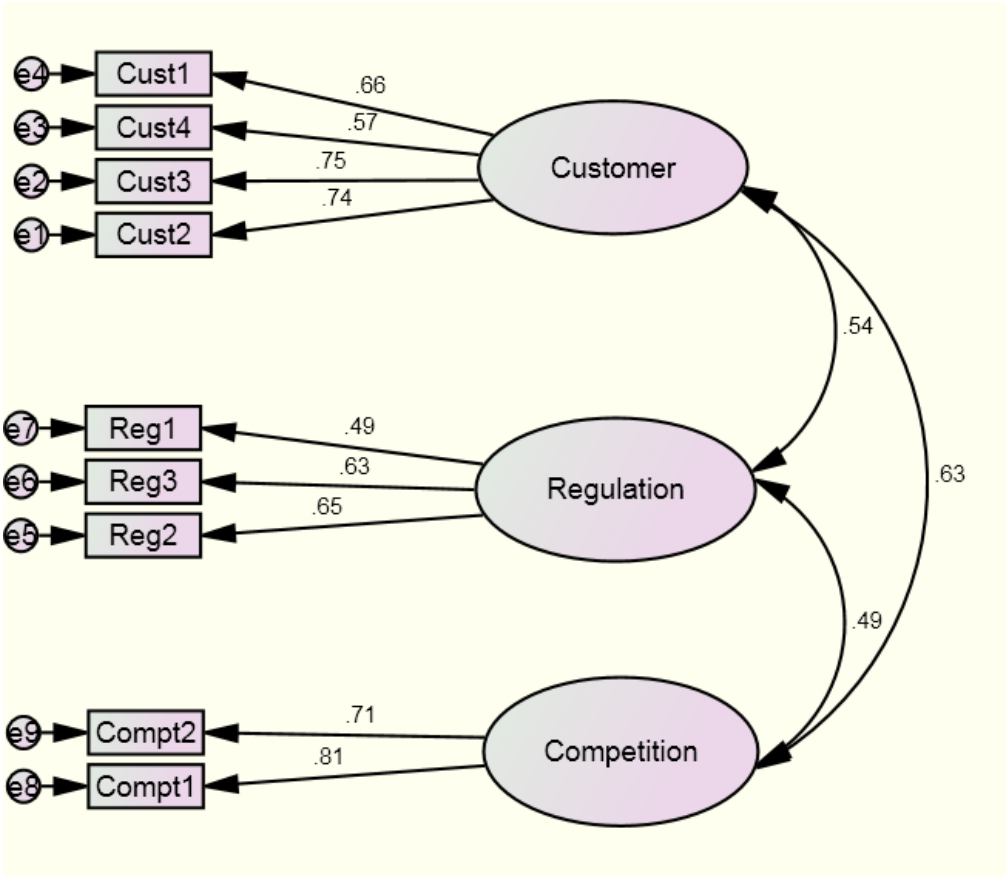
An analysis based on CFA was also performed to confirm the factor structure as derived from the EFA. The CFA results are shown in Table 40, which supports the three-factor model shown in Table 40 presents the standardised factor loadings. The three bivariate correlations are: 0.54 for customer and regulation, 0.63 for customer and competition, and 0.49 for regulation and competition. This implies that all three constructs are moderately correlated.

Table 40 CFA Result GSCM Driver Model

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
61	24	2.542	0.61	0.959	0.95	0.07

The analyses based on both EFA and CFA showed that no measurement items are subject to further deletion. In this simple measurement model, convergent validity and discriminant validity of the constructs are maintained. However, this needs to be further examined in the larger measurement model with all constructs involved in this study.

Figure 25 CFA GSCM Drivers



5.3.3 Measurement Model GSCM Practices

5.3.3.1 EFA: Intra-OEP, Green Purchasing, Design for the Environment and Green Logistics

Similar to the assessment of the above three factors, this study examined the three facets of GSCM practices. After dropping three items, i.e., two items for the construct of Green Logistics (GL3 and GL4), one item for the construct of Green Purchasing (GP4), the EFA was conducted for the remaining 15 items.

As shown in Table 41 the entire Green Logistics (GL) construct is loading significantly on the DfE construct, which suggests the GL construct should be merged with the DfE construct. Table 42 shows the two items on the GL construct that were developed. There is strong emphasis on the engage and design systems for material recovery activities, that is consistent with other items from the DfE

construct. Thus the factor analysis based on the three-factor extraction is further examined as shown in Table 43.

Table 41 EFA GSCM Practices

	Component			
	1	2	3	4
GL2	.821			
DFE3	.742			
GL1	.724			
DFE2	.700			
DFE4	.682			
DFE1	.592			
Intra2		.844		
Intra3		.759		
Intra1		.749		
Intra4		.658		
GP3			.825	
GP1			.724	
GP5			.711	.301
GP2			.385	-.478

Table 42 Green Logistic Items Merged with DFE

GL1	Q3.10	We engage and establish collection networks for reuse, recycling and remanufactured products from other organisations	Developed
GL2	Q3.11	We have a regular supply base in the secondary market	Developed

Table 43 Revised EFA GSCM Practices Model

	Component		
	1	2	3
GL2	.810		
DFE3	.749		
GL1	.707		
DFE2	.706		
DFE4	.677		
DFE1	.586		
Intra2		.845	
Intra3		.756	
Intra1		.742	
Intra4		.667	
GP3			.816
GP1			.791
GP5			.628
GP2			.525

The revised EFA model shows (Table 43) no signs of cross loading. The cumulative percentage of total variance explained in the revised four factors model is 55%, which indicates sufficient amount of variance by three-factor constructs (generally accepted value is 0.50). The factor structure is also satisfactory in which all items are successfully loaded to their related construct.

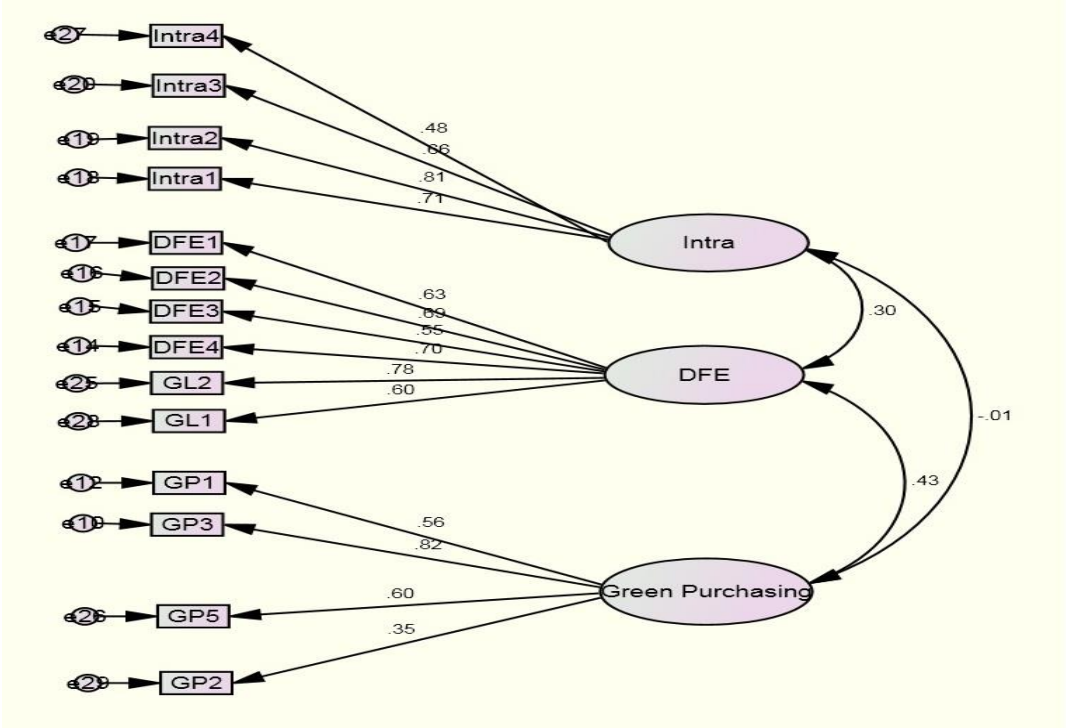
5.3.3.2 CFA: Intra-OEP, Green Purchasing and Design for the Environment

The revised model consists of 3 constructs and 14 items shown in Figure 26. The CFA results are shown in Table 44 which suggests the CFI<0.90 accepted level and three-factor model needs to be re-examined. As Figure 26 below also presents the standardised factor loadings. The three bivariate correlations are: 0.43 for Green Purchasing and DfE, 0.30 for DfE and Intra-OEP, and insignificant correlation for Green Purchasing and Intra OEP.

Table 44 CFA Result GSCM Practice Model

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
205.422	74	2.776	.075	0.920	0.896	0.075

Figure 26 CFA GSCM Practices



According to Hair et al. (2006), a CFA factor loading of less than 0.5 should be deleted to improve on the model fit. From Figure 26 shown above, the smallest loadings of less than 0.5 are deleted, resulting in the following items shown in Table 45 to be further excluded from the revised CFA model.

Table 45 GSCM Items excluded from CFA Model

Intra4	Q2.4	We have a clear policy statement urging environmental awareness in every area of operations.	(Banerjee et al., 2003)
GL1	Q3.10	We engage and establish collection networks for reuse, recycling and remanufactured products from other organisations	Developed
GP2	Q3.2	Suppliers are selected based on their ability to support our environmental objectives	(Paulraj, 2011)

5.3.3.3 Revised GSCM Practice CFA Measurement Model

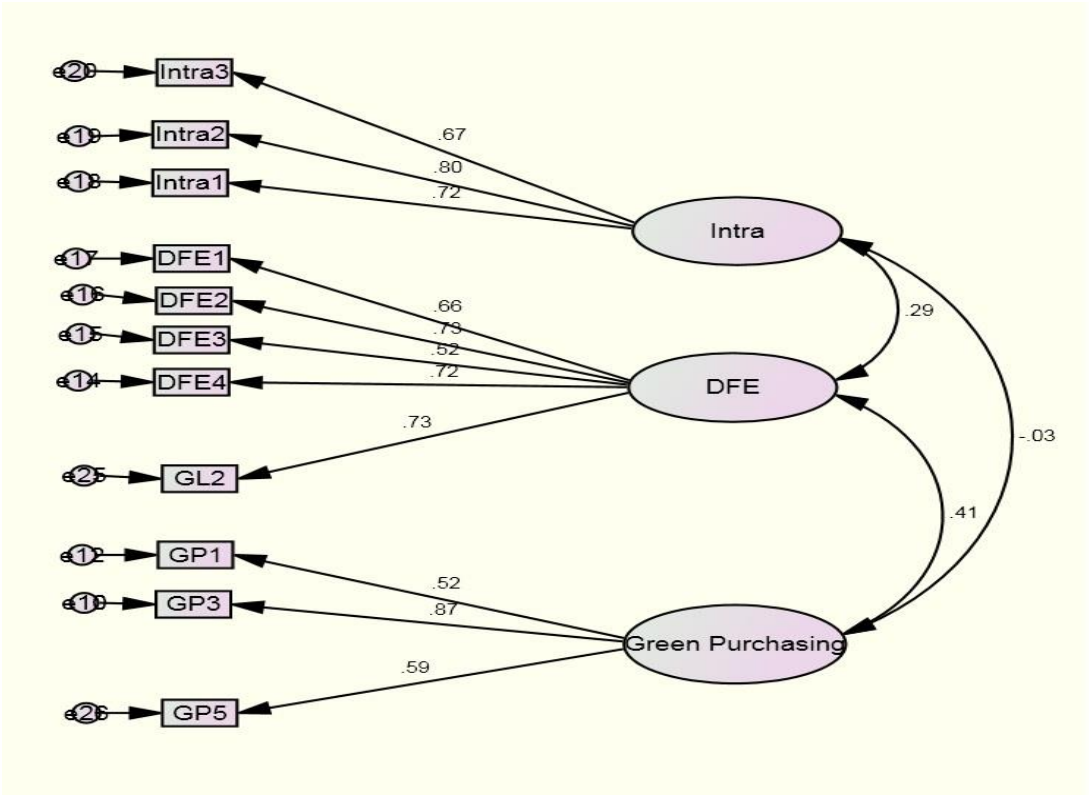
The revised model consists of 3 constructs and 11 items. The CFA results are shown in Table 46 which supports the three-factor model. Figure 27 presents the standardised factor loadings. The three bivariate correlations are: 0.41 for Green Purchasing and DfE, 0.29 for DfE and Intra-OEP, and no significant correlation for Green Purchasing and Intra OEP.

Table 46 Revised CFA Result GSCM Practice Model

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
72	41	1.758	.066	0.962	0.968	0.049

The revised CFA results showed a stronger model fitting result. For example, Chi-square improves from 205 to 72, Cmin/DF decreased from 2.776 to 1.758, RMR decreased from 0.075 to 0.066, and GFI improved from 0.920 to 0.962 which suggests the revised model should be adopted for further analysis.

Figure 27 Revised GSCM Practice CFA Measurement Model



5.3.4 Measurement Model Performance Outcomes

5.3.4.1 EFA: Environmental, Operational and Economic

Environmental, operational and economic performances are purportedly related to strong GSCM practices. These three dimensions of performance are examined based on the pattern of factor structure among the 14 items. From Table 47 below, there is a clear pattern of factor structure in which all measurement items are effectively loaded to their related factor without any significant cross loading. Thus, no items are subject to deletion, the cumulative percentage of total variance explained in the three-factors model is 69% which indicates a sufficient amount of variance by three-factor constructs (the generally accepted value is 0.50). The factor structure is also satisfactory in which all items are successfully loaded to their related construct. As suggested from the literature, operational performance and economic performance are related but inherently different from each other.

Table 47 EFA Performance Outcomes

	Component		
	1	2	3
Oper1	.913		
Oper2	.897		
Oper4	.857		
Oper5	.810		
Oper3	.786		
Envi1		.901	
Envi2		.895	
Envi3		.712	
Envi4		.542	
Econom1			.924
Econom4			.856
Econom2			.852
Econom3			.814
Econom5			.746

5.3.4.2 CFA: Environmental, Operational and Economic

The CFA results are shown in Figure 28, which indicates ENVI4 on the Environment construct needs to be deleted as it is below the 0.5 level. The Operational construct OPER4 and OPER5 are correlated from examining the modification index M.I 60.308, Par Change 0.169. The Economic performance construct, Econom3 and Econom4 are highly correlated with M.I 30.601, Par Change 0.169. Thus Envi4, Oper5 and Econom4 are deleted from the CFA measurement to enhance the model fit (Table 48).

Figure 28 CFA Performance Outcomes

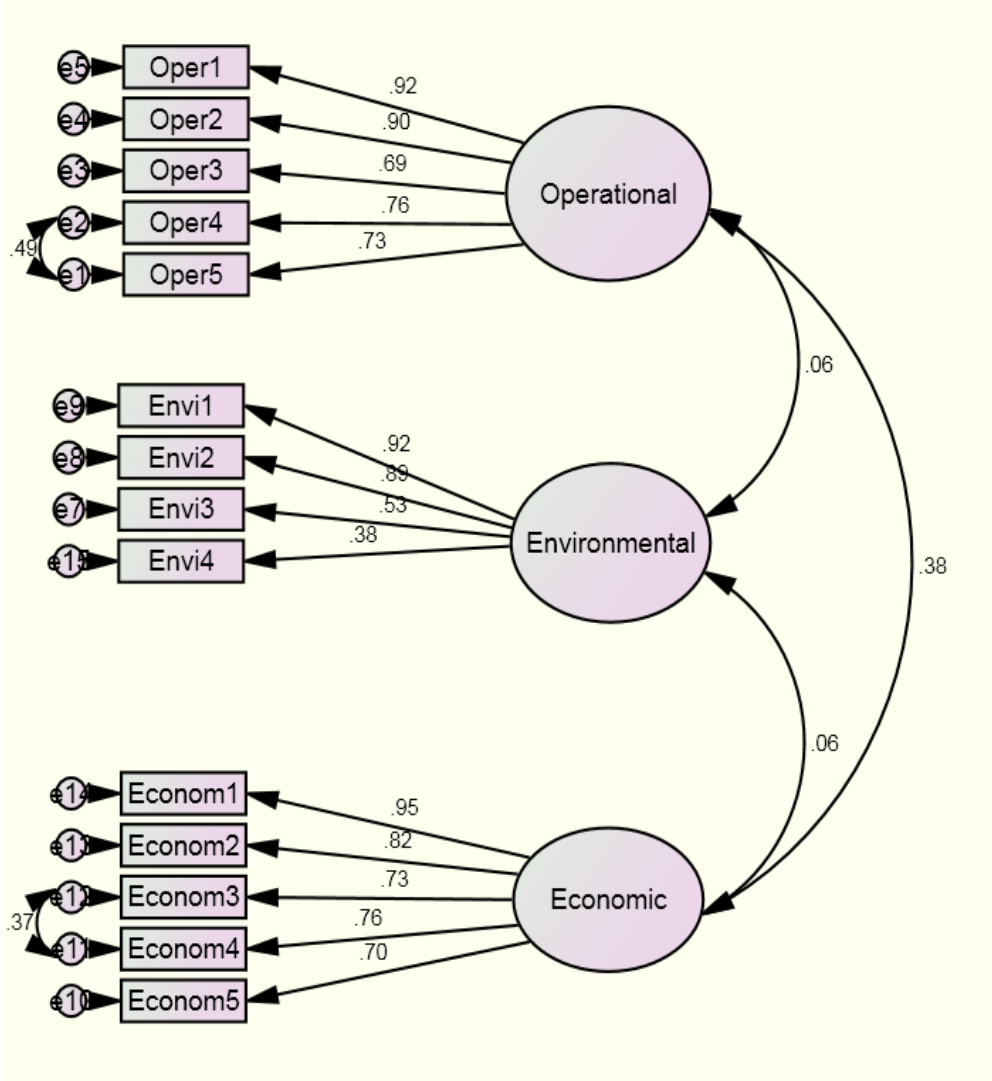


Table 48 Performance Items excluded from CFA

OP5	Q5.5	Ability to change product mix	Vachon (2003)
Econo4	Q5.17	Product price increase	Rao and Holt (2005)
ENVI4	Q5.9	Reduced solid waste disposal	Vachon (2003)

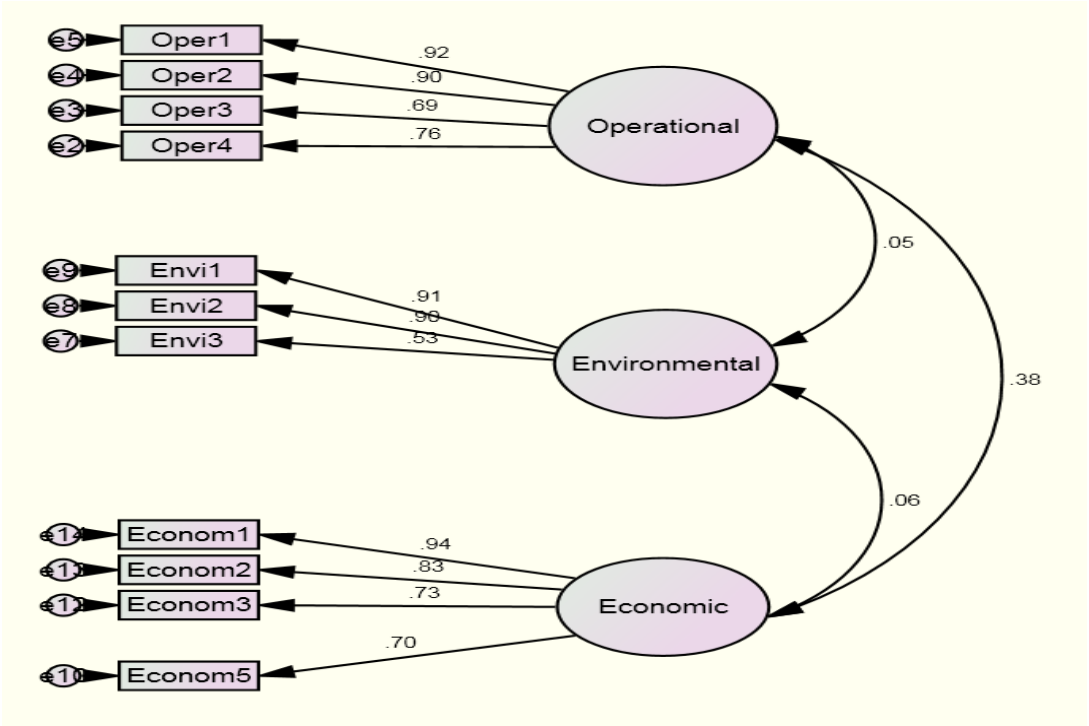
5.3.4.3 Revised CFA Performance Measurement Model

The revised CFA results are shown in Table 49: Chi-square of 137.7 improves to 54.5, and the Cmin/DF decreases from 1.912 to 1.33; RMR decreases from 0.43 to 0.33; GFI improved 0.943 to 0.97; all of which suggest a better model fit and support for the three GSCM practice measurement model. Figure 29 presents the standardised factor loadings. The bivariate correlations between operational performance and economic performance are: 0.38. The results show no significant correlation for environmental performance on economic and operational constructs.

Table 49 Revised CFA Result Performance Outcome Model

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
54.542	41	1.330	.033	0.970	0.993	0.032

Figure 29 Revised CFA Performance Measurement Model



5.3.5 Measurement items excluded

Through the step of scale purification, 14 of total 45 items were excluded to improve scale validity and reliability. Table 50 summarises the excluded items and their sources. This step of refinement was conducted with small measurement models. This means that the measurement items retained are subject to further tests in a large measurement model.

Table 50 Total measurement items excluded

Reg4	Q4.4	Tougher environmental legislation is required so that only firms that are environmentally responsible will survive and grow.	Banerjee, Iyer and Kashyap (2003)
Reg5	Q4.5	Our industry is faced with strict environmental regulation	Banerjee, Iyer and Kashyap (2003)
Compt3	Q4.8	Our firm can enter lucrative new markets by adopting environmental strategies.	Banerjee, Iyer and Kashyap (2003)
Compt4	Q4.9	Our firm can increase market share by making our current products more environmentally friendly.	Banerjee, Iyer and Kashyap (2003)
GL1	Q3.10	We engage and establish collection networks for reuse, recycling and remanufactured products from other organisations	Developed
GL3	Q3.12	We provide consumers with information on environmentally friendly products and/or production methods	Rao and Holt (2005)
GL4	Q3.13	We use more environmentally friendly transportation methods	Rao and Holt (2005)
GP2	Q3.2	Suppliers are selected based on their ability to support our environmental objectives	Paulraj (2009)
GP4	Q3.4	We periodically evaluate our suppliers' environmentally friendly practices	Paulraj (2009)
Intra4	Q2.4	We have a clear policy statement urging environmental awareness in every area of operations.	Benerjee, Iyer and Kashyap (2003)
Intra5	Q2.5	We make a concerted effort to make every employee understand the importance of environmental preservation.	Benerjee, Iyer and Kashyap (2003)
OP5	Q5.5	Ability to change product mix	Vachon (2003)
Econo4	Q5.17	Product price increase	Rao and Holt (2005)
EN4	Q5.9	Reduced solid waste disposal	Vachon (2003)

5.3.6 Overall Factor Analysis

After the building and testing of each simple measurement model, the final step is to examine the large measurement model involving all the measurement items. Exploratory factor analysis was firstly used to examine the factor structure so as to identify possible items for deletion. EFA requires the minimum absolute sample size of 50, and a minimum of 5 and preferably 10 observations per variable (Hair et al., 2006). The refined measurement model has a total of 31 variables, which ideally requires a sample with 300 observations. Using listwise deletion, 12 cases were excluded, resulting in an effective sample size of 320 which is sufficient to perform the EFA. Table 51 below shows the result of the EFA derived from principal component analysis and oblique rotation (factors are assumed to be correlated). It can be seen that only 1 item of 0.496 is less than the 0.50 level to be considered as statistically significant given the large sample size. Thus, this suggests that item Reg1on regulation construct be deleted from EFA model.

Table 51 Exploratory Factor Analysis for the measurement model

	1	2	3	4	5	6	7	8	9
GL2	.771								
DFE2	.748								
DFE3	.730								
DFE4	.710								
DFE1	.656								
Oper1		.919							
Oper2		.901							
Oper4		.818							
Oper3		.790							
Cust2			.870						
Cust3			.865						
Cust4			.593						
Cust1			.560						
Intra2				.881					
Intra3				.806					
Intra1				.778					
Econom1					-.918				
Econom2					-.878				
Econom5					-.781				
Econom3					-.779				
Envi1						.918			
Envi2						.917			
Envi3						.646			
GP3							.857		
GP1							.735		
GP5							.686		
Reg2								.883	
Reg3								.745	
Reg1								.496	
Compt2									.877
Compt1									.750

Table 52 shows the revised EFA. Deleting Reg1 provided a satisfactory solution to the measurement items with each of them being sufficiently loaded to their expected construct and with no significant cross-loadings.

Table 52 Revised Exploratory Factor Analysis for the measurement model

	Component								
	1	2	3	4	5	6	7	8	9
GL2	.772								
DFE2	.752								
DFE3	.729								
DFE4	.706								
DFE1	.646								
Oper1		.917							
Oper2		.899							
Oper4		.819							
Oper3		.795							
Cust3			.873						
Cust2			.835						
Cust4			.606						
Cust1			.591						
Intra2				.879					
Intra3				.808					
Intra1				.780					
Econom1					-.918				
Econom2					-.877				
Econom5					-.784				
Econom3					-.778				
Envi1						.920			
Envi2						.920			
Envi3						.645			
GP3							.863		
GP1							.752		
GP5							.682		
Reg2								.878	
Reg3								.790	
Compt2									.885
Compt1									.762

5.4 Confirmatory Factor Analysis

5.4.1 Model Specification and Identification

Following the exploratory analysis, CFA is used to validate the factor model. The effective sample size of 320 is sufficiently large to perform CFA for the measurement model with 9 constructs and 30 measurement items (Hair et al., 2006). AMOS (version 18), a statistical software package, was used for analysing structural equation models, because the programme provides a user friendly interface for presenting the structural models with path diagrams, and analysing the specified relationships between the measurement items and the latent constructs. In the measurement model, all measured items were only allowed to load on to one construct. The constructs of Design for Environment were indicated by 5 items, while the three constructs of Operational Performance, Economic Performance and Customer Environmental Driver were individually indicated by four items. Four constructs representing Environmental Performance, Intra Organisational Environmental Practices and Green Purchasing were indicated by three items. The construct of Competitive Environmental Pressure and Regulatory Environmental Pressures was specified by a two-item scale. Given the nature of reflective scales for all constructs in this study, the direction of causality is from the latent construct to the measured items. Since a latent factor has no metric scale, it is necessary that it is mapped to a reference item or its variance is set to a fixed value. To assess the significance for all indicators, the latter method is used by setting the variance of each construct to 1. The measurement model involves 9 constructs for hypothesis testing. Without any assumption that constructs are independent, the 36 covariances among the nine constructs are freely estimated.

Another issue that needs to be discussed is model identification. A necessary condition for the estimation of a measurement model is that it is over identified with more data points available than the total number of parameters to be estimated (Ullman, 2006). The measurement model has a total of 30 items which produce 447 distinct sample moments. This amount of information is adequate to estimate the parameters in the model, resulting in 365 degrees of freedom. Therefore, the

measurement model is over identified to provide unique estimation results (Byrne, 2010).

5.4.2 Overall Model Fit

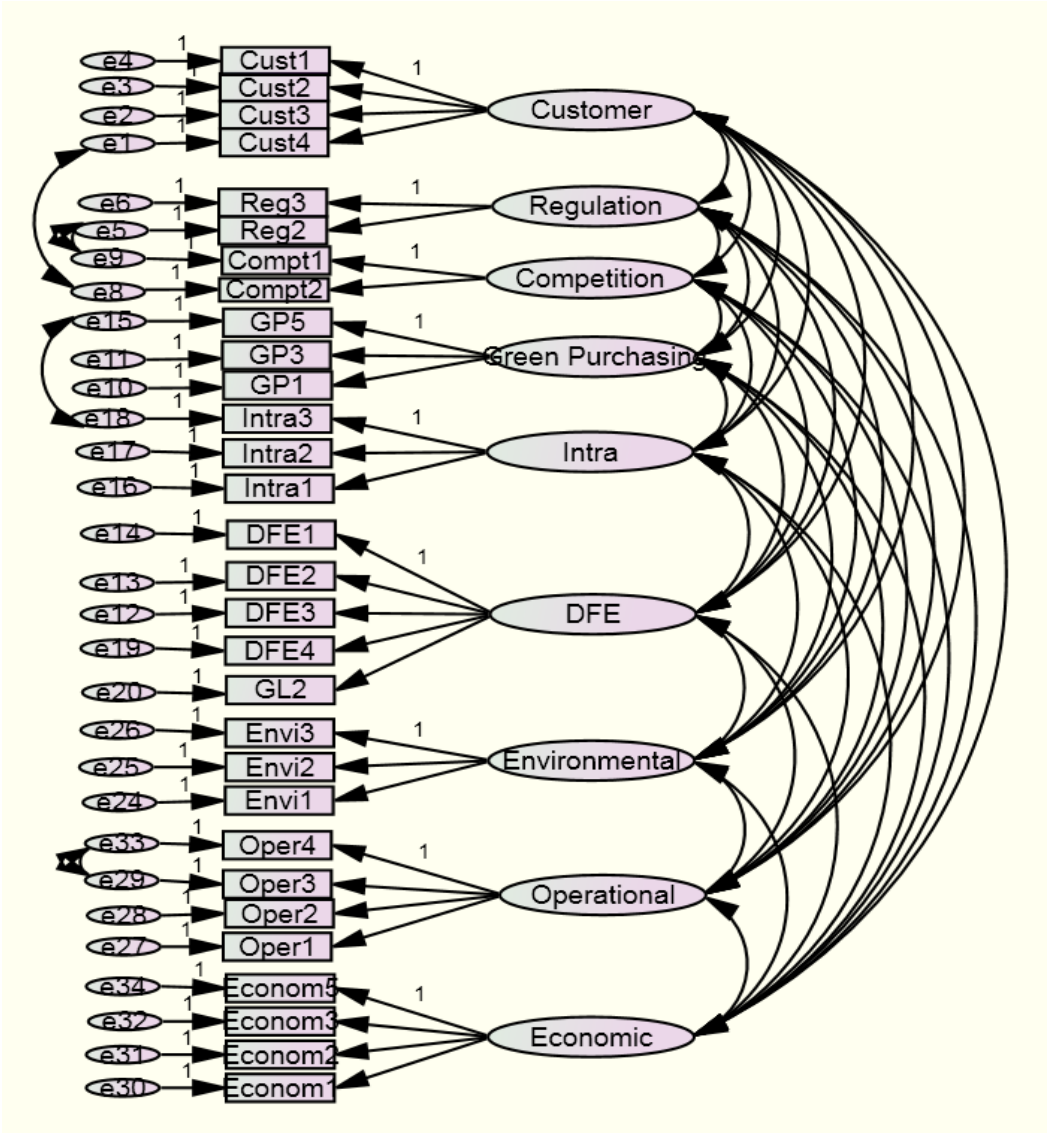
The measurement model shown in Figure 30 was estimated with the Maximum Likelihood (ML) method and the sample covariance matrix as the input matrix. As a traditional method, ML estimation is preferable in most cases (Hair et al., 2006), which is accompanied with a good range of statistics to assist in the assessment of the model.

To evaluate the overall fit of the measurement model, multiple indices should be used to provide evidence of goodness-of-fit. Hair et al. (2006) suggest that researchers should at least report the Comparative Fit Index (CFI), which is an incremental index, the Root Mean Square Error of Approximation (RMSEA), which is an absolute index, x^2 and df to provide sufficient and unique information for the assessment of a model. The measurement model has good fit with the key statistics as shown in Table 53: $x^2(368)= 447.3$ (p-value=0.02), CFI = 0.978, RMSEA= 0.027. The CFI is larger than the threshold value of 0.90, and the RMSEA is smaller than 0.05 to indicate an excellent fit. Although the x^2 value is significant at the 0.05 significance level, this is not considered to be a problem given the sample size of 320. It has been well recognised in the literature that x^2 is overly sensitive to sample size, i.e. even trivial differences between the sample and estimated covariance matrices are often significant when the sample size becomes large (Tabachnick and Fidell, 2007).

Table 53 CFA with 9 Construct Model

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
447.272	365	1.225	.054	0.918	0.978	0.027

Figure 30 Confirmatory Factor Model



5.4.3 Factor Loadings

The size of a factor loading indicates the strength of the relationship between the indicator and the factor. To support convergent validity, a rule of thumb requires that all standardised factor loadings should be at least significant, and the values are expected to be greater than 0.50 and ideally 0.70 or higher (Hair et al., 2006). Besides, the use of standardised factor loadings can sometimes demonstrate a misfit in the model. For instance, standardised factor loadings out of the feasible range between -1 and +1 suggest a problem in the data. Problems can also be identified if factor loadings are estimated to be with different signs although their corresponding

items are worded in both a positive or negative way. The standardised factor loadings for all the measured items are provided in Table 54 below, together with the standardised regression weight to indicate their significance.

Table 54 Standard Factor Loading for all measures

Compt1	<---	Competition	0.831
Compt2	<---	Competition	0.7
Cust1	<---	Customer	0.657
Cust2	<---	Customer	0.756
Cust3	<---	Customer	0.747
Cust4	<---	Customer	0.554
DFE1	<---	DFE	0.659
DFE2	<---	DFE	0.736
DFE3	<---	DFE	0.508
DFE4	<---	DFE	0.724
Econom1	<---	Economic	0.936
Econom2	<---	Economic	0.829
Econom3	<---	Economic	0.732
Econom5	<---	Economic	0.705
Envi1	<---	Environmental	0.895
Envi2	<---	Environmental	0.913
Envi3	<---	Environmental	0.54
GL2	<---	DFE	0.726
GP1	<---	Green Purchasing	0.527
GP3	<---	Green Purchasing	0.843
GP5	<---	Green Purchasing	0.617
Intra1	<---	Intra	0.721
Intra2	<---	Intra	0.795
Intra3	<---	Intra	0.668
Oper1	<---	Operational	0.929
Oper2	<---	Operational	0.907
Oper3	<---	Operational	0.674
Oper4	<---	Operational	0.747
Reg2	<---	Regulation	0.582
Reg3	<---	Regulation	0.758

5.4.4 Standardised Residuals

Residuals in the CFA refer to the individual differences between the observed and fitted covariance terms (Hair et al., 2006). The standardised residual is independent of the metric scale, which is calculated as a ratio between the absolute value and the standard error of the residual. The measurement model can adequately fit the data with relatively small standardised residuals. In the symmetric matrix displayed here, each residual covariance, has been divided by an estimate of its standard error (Joreskog and Sorbom, 2001). In sufficiently large samples, these *standardised residual covariances* have a standard normal distribution if the model is correct. So, if the model is correct, most of them should be less than two in absolute value. Among the 465 standardised residuals, 11 cases in which the value is larger than 2.0 with the largest value at 4.026. Given that there are no measurement items consistently leading to large residuals, no items were further excluded.

5.4.5 Construct Validity

Construct validity refers to the '*degree of correspondence between constructs and their measures*' (Peter, 1981, P.133). The validity of a measure is maintained if it can accurately measure what it is supposed to measure (Heeler and Ray, 1972). Evidence of construct validity provides confidence that measurement items in a sample actually represent the actual score that exists in the population (Hair et al., 2006). Four types of construct validity are further examined: convergent validity, discriminate validity, nomological validity and content validity.

5.4.5.1 Convergent Validity

Convergent validity is '*the degree to which multiple attempts to measure the same concept are in agreement*' (Bagozzi et al, 1991, p.425). Three methods were applied to assess convergent validity of the constructs in this research. First, results from the

EFA showed that all items loaded significantly on their hypothesised factor without high cross-loadings, supporting convergent validity of the measures (Doney and Cannon, 1997). Second, all the standardised factor loadings are statistically significant and adequately larger than the minimal accepted level of 0.50. Anderson and Gerbing (1988) suggest that convergent validity is supported if each indicator's estimated factor loading is significant, while Hair et al. (2006) tighten this condition by requesting that all factor loadings be greater than 0.50.

The third approach to assess convergent validity required that for each construct the AVE by the measured items should be greater than 0.50 (Fornell and Larcker, 1981). Table 55 below shows that the following constructs have issues with AVE: customer environmental pressure (0.467), regulatory environmental pressure (0.457), green purchasing (0.456), and Design for environment (0.457) all have an AVE less than required level at 0.50. This research acknowledges this limitation. Similarly, Sarkis et al.'s (2010) study on the environmental training and its mediating effects on environmental practices, reported that the AVE for environmental training construct was 0.437. Considering this research, the convergent validity results satisfy approaches in EFA without cross loading and all the standard factor loadings are greater than 0.50, thus the items within each construct remain unchanged.

Table 55 Construct Convergent Validity

	CR	AVE
Operational	0.891	0.674
Customer	0.776	0.467
Regulation	0.623	0.457
Competition	0.741	0.590
Green Purchasing	0.708	0.456
DFE	0.805	0.457
Intra	0.773	0.533
Environmental	0.837	0.642
Economic	0.880	0.649

5.4.5.2 Discriminant Validity

Discriminant validity refers to '*the extent to which a given construct is different from other constructs*' (John and Reve, 1982 p.520). A common approach to assess discriminant validity is to compare the AVE for each construct with the squared correlation between any two constructs in the model (Fornell and Larcker, 1981). If the AVE for each construct is larger than the squared correlation between any two constructs (i.e. the variance shared between them), then discriminant validity is confirmed. Table 56 below represents the squared correlation between all pairs of constructs (off-diagonal values) and the AVE for each construct (diagonal values). We can see that all the AVEs are greater than any squared correlation. Passing this test provides good evidence of discriminant validity of the constructs (Hair et al., 2006, Fornell and Larcker, 1981). It can be noted that the squared correlation between customer environmental pressure and competitive pressure (0.599) is fairly close to the AVE of customer pressure (0.683). This indicates that customer and competitive environmental pressures residing at the two sample levels are strongly correlated. As hypothesised in the model development, customer environmental pressure and competitive environmental pressure can be considered in a higher order construct of institutional environmental pressure model.

Table 56 Construct Correlation Matrix

	Operational	Customer	Regulation	Competition	Green Purchasing	DFE	Intra	Environmental	Economic
Operational	0.821								
Customer	0.020	0.683							
Regulation	-0.001	0.490	0.676						
Competition	0.043	0.599	0.372	0.768					
Green Purchasing	0.041	-0.027	-0.030	0.031	0.676				
DFE	0.155	-0.094	-0.039	-0.128	0.430	0.676			
Intra	-0.048	-0.003	0.089	-0.103	-0.029	0.285	0.730		
Environmental	0.045	-0.086	-0.077	-0.202	0.159	0.252	0.214	0.801	
Economic	0.376	0.103	-0.014	0.039	0.070	0.114	-0.037	0.061	0.806

5.4.5.3 Nomological Validity

Nomological validity refers to '*the relationship between measures representing theoretically related constructs*' (Ruekert and Churchill, 1984 p.231). Nomological validity of a construct can be assessed by testing its relationships with other constructs in a nomological net (Steenkamp and Van Trijp, 1991). If measures of the constructs are related in a way that is theoretically meaningful, then nomological validity is supported (Ruekert and Churchill, 1984, Pennings and Smidts, 2000). Nomological validity is supported in this study given the facts that most constructs theoretically related have strong correlation in the measurement model.

5.4.5.4 Content Validity

Content validity is '*the degree to which elements of an assessment instrument are relevant to and representative of the targeted construct for a particular assessment purpose*' (Haynes et al., 1995, p.238). The validation process should start before the construct has been constructed (Nunnally, 1978). It begins with the formulation of construct definitions, and then prepares measurement items to fit the definitions (Anastasi, 1986). This research proposes a total of 10 constructs, of which:

- 3 constructs (regulatory, market and competitive) are related to institutional effects measurement.
- 4 constructs (Intra-OEPs, DfE, green purchasing and green logistics) are related to NRB-GSCM measurement; also the research proposes that constructs for DfE, green purchasing, and green logistics can be categorised into a higher order construct that represents Inter-organisational environmental practices (Inter-OEPs)
- 3 constructs (environmental, operational and economic) are related to performance measurement.

All of above construct are clarified with definitions based on literature reflections from earlier research. Then each construct and its measurement items are introduced. This is also based on a comprehensive review of earlier literatures in the field.

5.4.6 Construct Reliability

Reliability is '*the degree to which measures are free from random error and thus reliability coefficients estimate the amount of systematic variance in a measure*' (Peter and Churchill, 1986 p.4). It concerns '*the extent to which measurements are repeatable*' (Nunnally, 1967, p.172) and that the measurement error is slight. Conceptually it is the '*correlation between a measure and itself*' (Peter, 1981, p136). Reliability is a necessary but not sufficient condition for validity, since validity is not guaranteed even if there is a complete absence of measurement error (Peter, 1979).

The most commonly accepted approach to assess construct reliability is the Cronbach's alpha (Peter, 1979). Also known as coefficient alpha (Anderson and Gerbin, 1988), it has been argued that Cronbach's alpha '*absolutely should be the first measure one calculates to assess the quality of the instrument*' (Churchill, 1979, p.68). It is a measure of the internal consistency of a set of items which is based on the average correlation among items (Nunnally, 1967). Cronbach's alpha is one of '*the most important deductions from the theory of measurement error*' (Nunnally, 1967, p.196). In the literature, a threshold of 0.70 is usually required as the minimally acceptable reliability measured with Cronbach's alpha (Byrne, 2010).

This study applied Cronbach's alpha given its relevance and importance in the measurement of reliability. Table 57 below provides the reliability estimates for all constructs. Seven of the constructs achieved good reliability with alpha values exceeding 0.70; 2 constructs include environmental regulatory pressure and green purchasing with Cronbach's alpha less than 0.70. This research acknowledges this limitation. However, Darnall et al. (2008) suggest that it is feasible to retain meaningful constructs that are below the 0.70 level. Their research retained business performance constructs including a profit and growth measurement with a Cronbach's alpha estimate equal to 0.61 and a market pressures construct with a Cronbach's alpha estimate equal to 0.63.

Table 57 Reliability of Construct with Cronbach's alpha

Customer	0.764
Competition	0.733
Regulation	0.609
Green Purchasing	0.666
Intra OEP	0.765
DFE	0.794
Environmental	0.816
Operational	0.892
Economic	0.872

5.5 Inter-OEP Higher Order Construct

Inter organisational environmental practices in this study are conceptualised as a multidimensional, higher order construct which reflects the inter-organisational environmental relationships of green purchasing and DfE practices that are perceived to be socially complex and inimitable by competitors thus create competitive advantage for an organisation pursuing inter-OEP practices. The EFA was applied to examine the factor structure for the two components of Inter-OEPs. The pattern matrix in Table 58 below illustrates that all measured items effectively load on their hypothesised construct without any high cross-loadings. The cumulative percentage of total variance explained in the two factors model is 59%, which indicates a sufficient amount of variance by three-factor constructs (the generally accepted value is 0.50). The factor structure is also satisfactory in which all items are successfully loaded to their related construct.

Table 58 EFA on Inter-OEPs

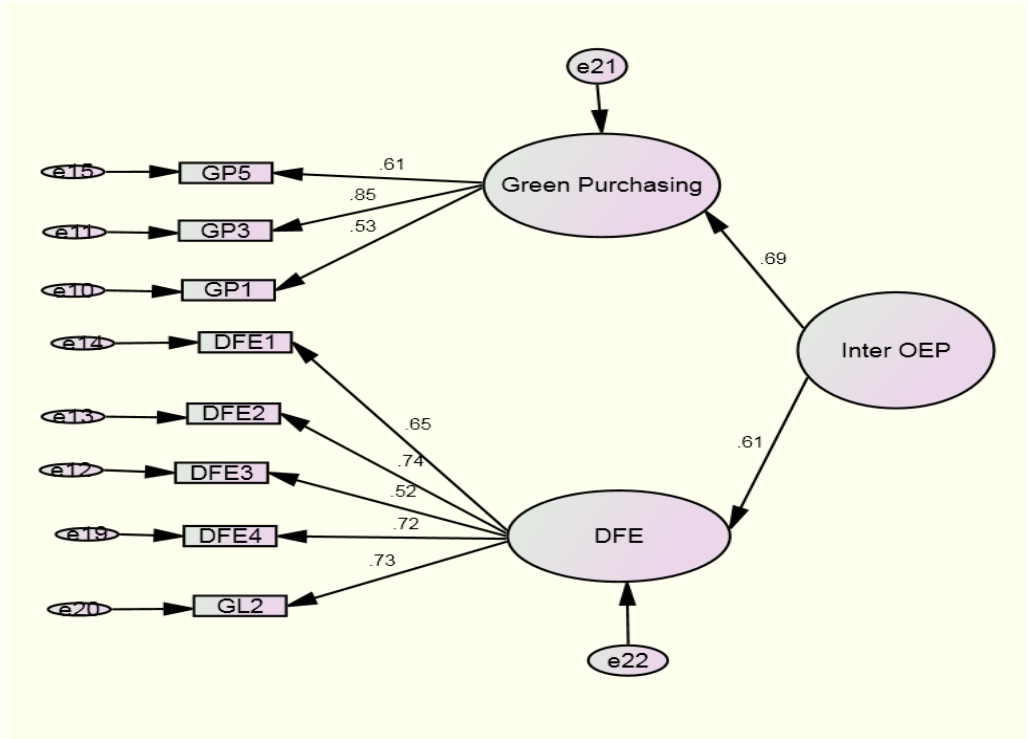
	Component	
	1	2
GL2	.796	
DFE2	.779	
DFE4	.720	
DFE3	.711	
DFE1	.692	
GP3		.867
GP1		.734
GP5		.714

To confirm the factor structure as displayed by EFA, a second-order factor model was run to test the hypothesis that Inter-OEPs is a second-order reflective construct described by the two first-order constructs (Figure 31). The overall fit of the model, shown in Table 59, confirms the hypothesis with the fit statistics.

Table 59 Measurement Model CFA Second Order Inter-OEPs

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
447.272	365	1.225	.054	0.918	0.978	0.027

Figure 31 Inter-OEPs Second Order Measurement

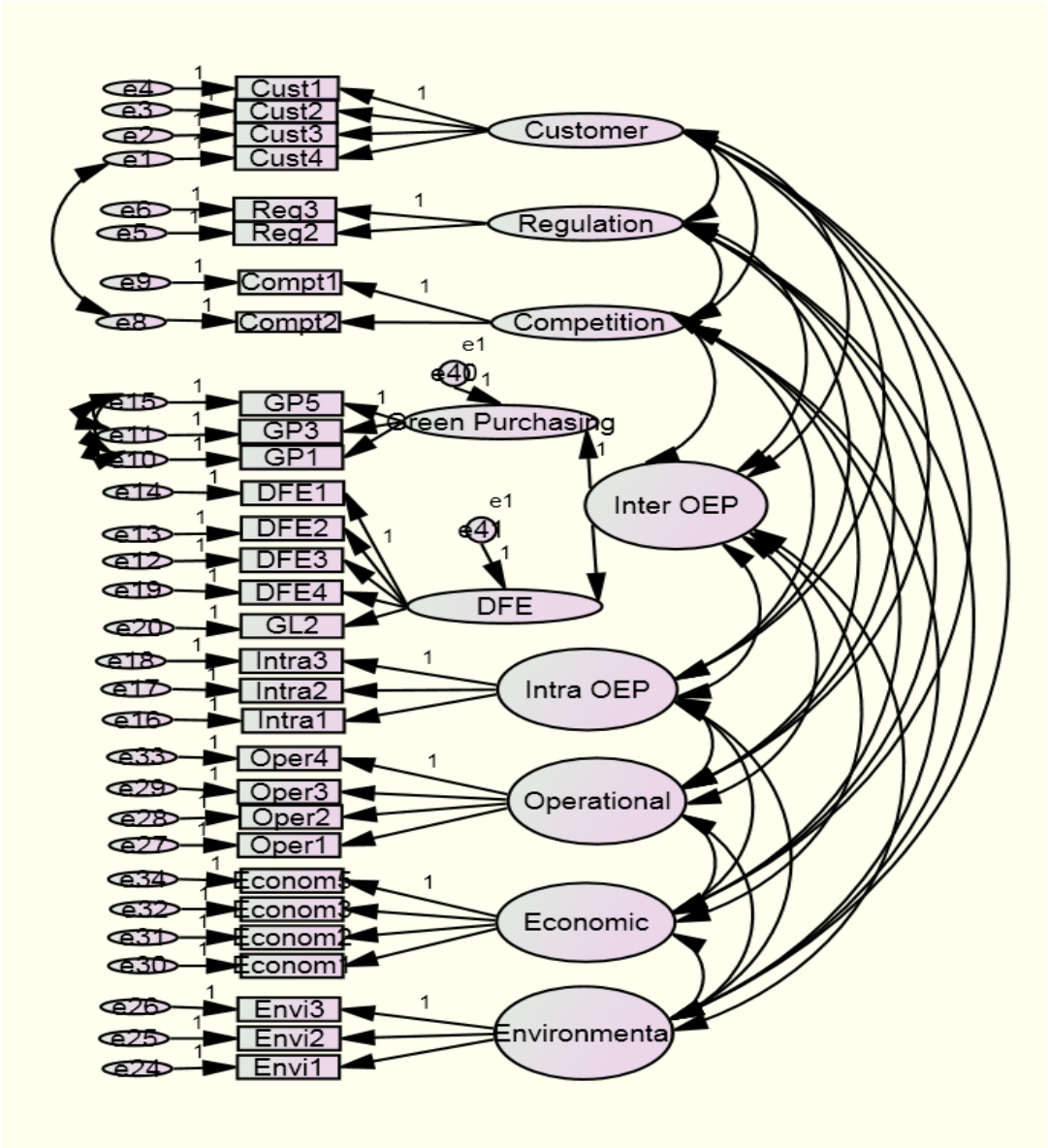


As confirmed by the CFA, Inter-OEPs is a higher order construct (Figure 32). Further analysis is conducted to integrate Inter-OEPs in a higher order model with all other 7 constructs to confirm the factor structure. The overall fit of the model shown in Table 60 confirms the hypothesis with the fit statistics.

Table 60 Complete CFA Model Inter-OEP as Second Order Factor

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
477.964	372	1.285	.055	0.913	0.972	0.030

Figure 32 Complete CFA Model Inter-OEP as Second Order Factor



5.6 Structural Equation Model

5.6.1 Model Specification and Identification

SEM is the technique used in this study to have a quantitative test of the conceptual model hypothesised earlier against empirical data. The causal relationships were translated into a series of structural equations in AMOS for each endogenous variable. To estimate the structural model, a total of 12 incomplete cases were excluded using listwise deletion. This resulted in an effective sample size of 320. Given the complexity of the nomological model, the sample size of 320 is sufficiently large to estimate the model with SEM (Hair et al., 2006).

As discussed earlier in the measurement model, SEM needs to be over-identifed with more pieces of information than the total number of parameters to be estimated. Since SEM models generally have fewer parameter estimates than the corresponding measurement model, it follows that the structural model has no problem related to model identification. Information on the degrees of freedom (387) confirms this assumption that the structural model is over-identified.

5.6.2 Overall Model Fit

The structural model was estimated with the Maximum Likelihood (ML) estimation, which is the most widely used technique in SEM. Multiple measures of fit indices were employed to evaluate the structural model (Figure 33). The overall fit of the structural model shown in Table 61 is acceptable with the fit statistics as x^2 (381) = 452.8 (p-value =.007), Comparative Fit Index (CFI) = 0.981, Root Mean Square Error of Approximation (RMSEA) =0.024. GFI = 0.917. The CFI is notably larger than the commonly accepted value of 0.90.

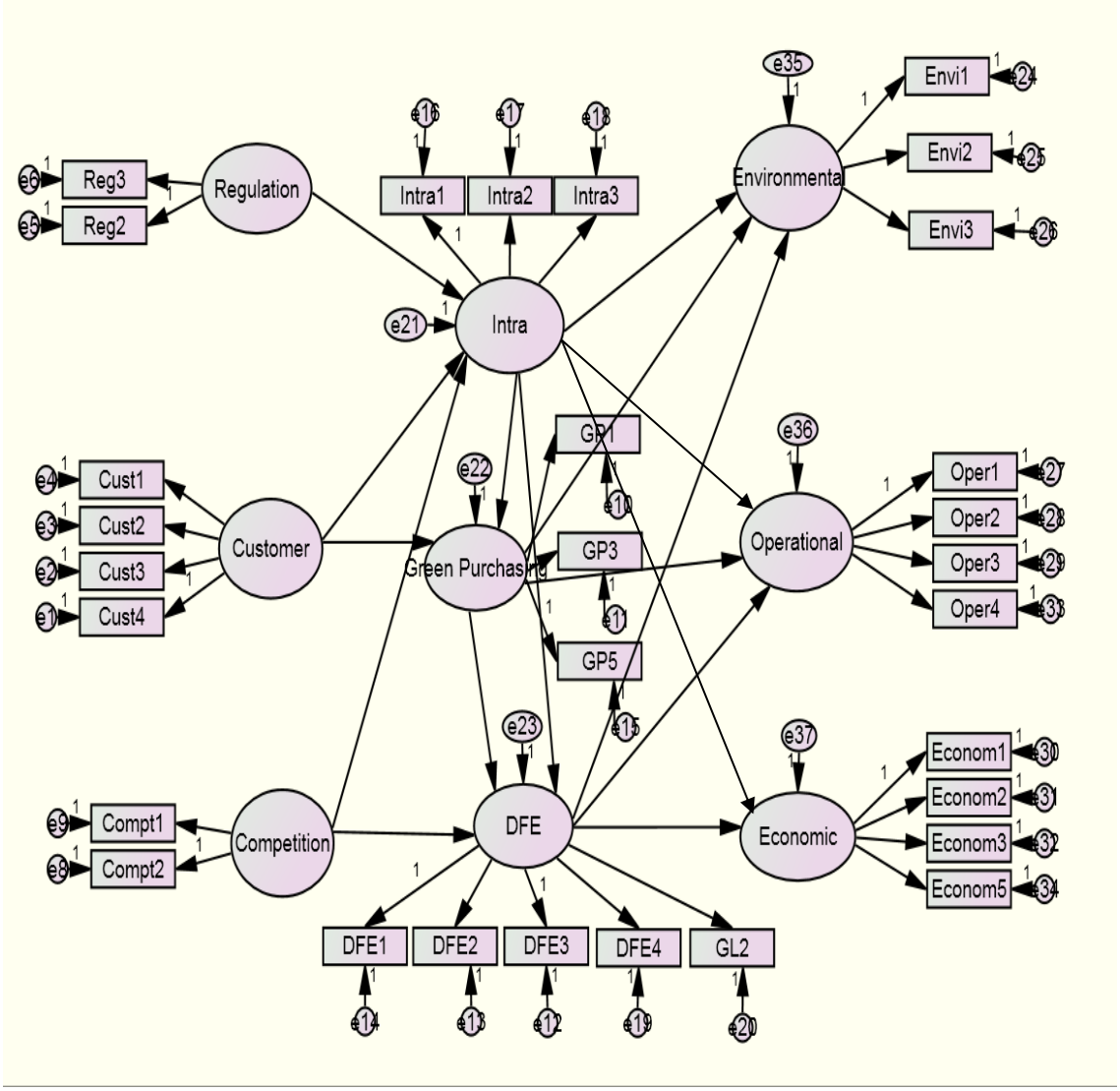
Table 61 SEM 9 Construct Model

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
452.8	381	1.188	.060	.917	.981	.024

Following Hair et al.'s (2006) recommendations that the CFI fit provides a useful baseline to assess the structural model. As a recursive structural model cannot fit better than the overall CFA, it can be concluded that the hypothesised model lacks validity if its fit is substantially worse than the CFA fit (Anderson and Gerbing 1992). The fit statistics for the CFA model are: $x^2(368)= 447.3$ (p-value=0.02), Comparative Fit Index (CFI) = 0.978, Root Mean Square Error of Approximation (RMSEA)= 0.027.

A comparison of model fit showed that the structural model does not fit considerably worse than the CFA model. Hence, there is no reason to reject the hypothesised model.

Figure 33 SEM 9 Construct Model



5.6.3 Estimates of path coefficients

Table 62 below shows estimates of the structural paths hypothesised in the structural model. Among 16 path coefficients 6 are significant as it supports the hypothesis, with 10 path coefficients showing insignificant results.

Table 62 Research Hypothesis Summary

			Estimate	S.E.	C.R.	P	Finding
Intra	<---	Regulation	.225	.155	1.455	.146	
Intra	<---	Competition	-.135	.078	-1.734	.083	
Intra	<---	Customer	.040	.137	.288	.773	
Green Purchasing	<---	Customer	-.038	.092	-.414	.679	
Green Purchasing	<---	Intra	-.067	.074	-.904	.366	
DFE	<---	Competition	-.079	.047	-1.691	.091	
DFE	<---	Intra	.269	.063	4.304	***	Support
DFE	<---	Green Purchasing	.385	.068	5.678	***	Support
Economic	<---	DFE	.177	.088	2.017	.044	Support
Operational	<---	DFE	.234	.089	2.620	.009	Support
Environmental	<---	DFE	.219	.102	2.154	.031	Support
Operational	<---	Green Purchasing	-.054	.072	-.750	.453	
Environmental	<---	Intra	.201	.083	2.427	.015	Support
Environmental	<---	Green Purchasing	.098	.087	1.134	.257	
Operational	<---	Intra	-.114	.073	-1.576	.115	
Economic	<---	Intra	-.091	.081	-1.128	.260	

5.7 Inter-OEPs as Higher Order Construct SEM Model

The structural model with Inter-OEPs as a higher order construct is shown in

Figure **34**. Multiple measures of fit indices were employed to evaluate the model. The overall fit of the structural model shown in

Table **63** is acceptable with the fit statistics as x^2 (201) = 327.741 (p-value <0.000), Comparative Fit Index (CFI) = 0.958, Root Mean Square Error of Approximation (RMSEA) =0.044. GFI = 0.918.

Table 63 SEM 7 Construct with Intra-OEPs and Inter-OEP on Performance

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
327.741	201	1.631	.087	0.918	0.958	0.044

Figure 34 Intra-OEPs and Inter-OEP on Performance SEM Model

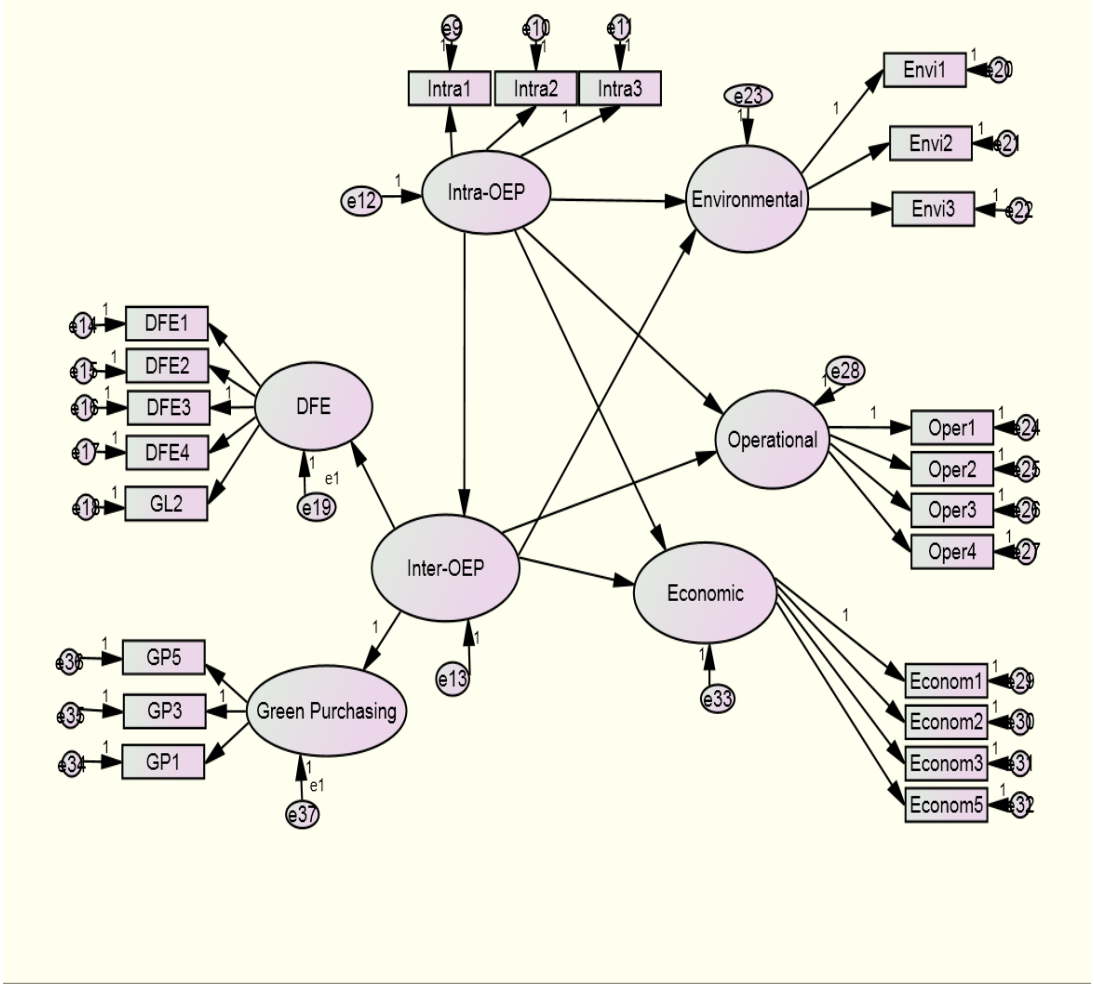


Table 64 below shows estimates of the structural paths hypothesised in the conceptual model. Among 7 path coefficients, 5 are significant and support the hypotheses, with only 2 hypotheses showing insignificant results.

Table 64 Intra-OEPs and Inter-OEPs on Performance Path Coefficients

			Estimate	S.E.	C.R.	P	Result
Inter-OEP	<---	Intra-OEP	.151	.056	2.704	.007	Support
Environmental	<---	Intra-OEP	.149	.074	2.006	.045	Support
Operational	<---	Intra-OEP	-.113	.066	-1.719	.086	
Economic	<---	Intra-OEP	-.115	.076	-1.517	.129	
Operational	<---	Inter-OEP	.421	.147	2.868	.004	Support
Economic	<---	Inter-OEP	.470	.169	2.781	.005	Support
Environmental	<---	Inter-OEP	.553	.172	3.210	.001	Support

5.8 Mediation Effect

5.8.1 Mediation Effect of DfE on relationships between Intra-OEPs and Environmental Performance

In the model for testing DfE mediation effects, the following variables are selected:

1. Dependent variable: Environmental Performance
2. Independent variable: Intra-OEPs
3. Mediation variable: DfE

This research proposes two models to evaluate the mediation effect of DfE, with both models showing satisfactory model fit statistics. The first model focuses on the direct relationships between the Intra-OEPs and Environmental Performance and the second model incorporates the mediating effects of DfE.

The overall fit of the model, shown in Table 65 and Table 66, confirms the hypothesis with the fit statistics.

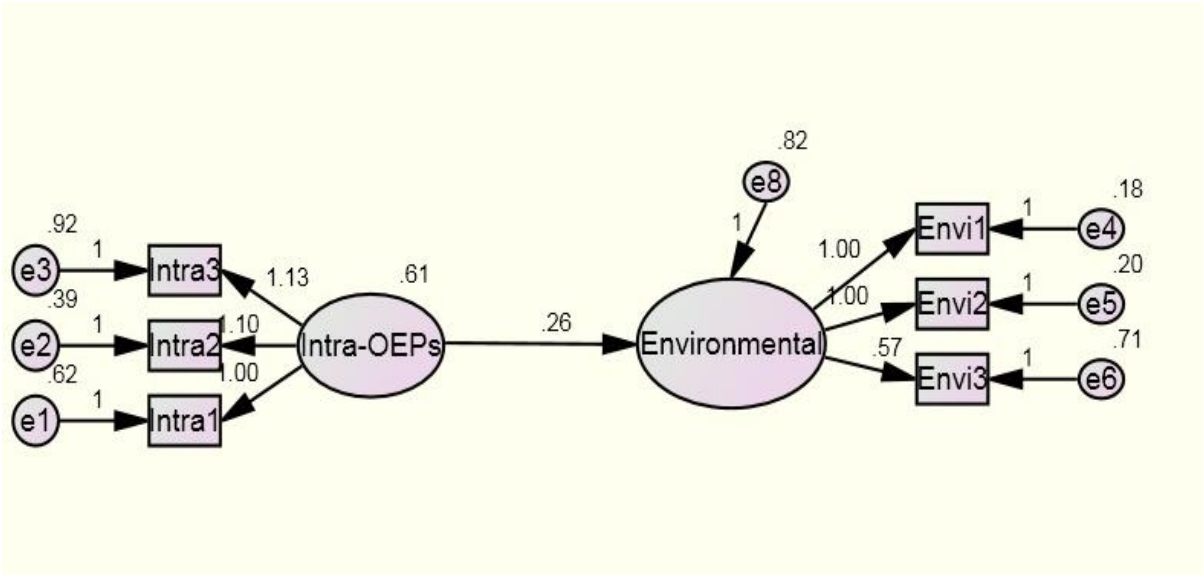
Table 65 Direct relationships between the Intra-OEPs and Environmental performance

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
11.621	8	1.453	.041	.988	.995	.038

Table 66 DFE as Mediator between Intra-OEPs and Environmental Performance

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
76.396	41	1.863	.073	.959	.971	.052

Figure 35 Direct relationships between the Intra-OEPs and Environmental performance



The first step in evaluating the mediation effect, is to test the independent variable Intra-OEPs influence on the dependent variable Environmental Performance. As shown in

Figure **35**, the direct effect relationships between Intra-OEPs and Environmental Performance are significant at $p<0.001$ level.

The second step for mediation evaluation is to show that the direct relationship between the independent variable Intra-OEPs and the mediator variable DfE is significant, as shown in

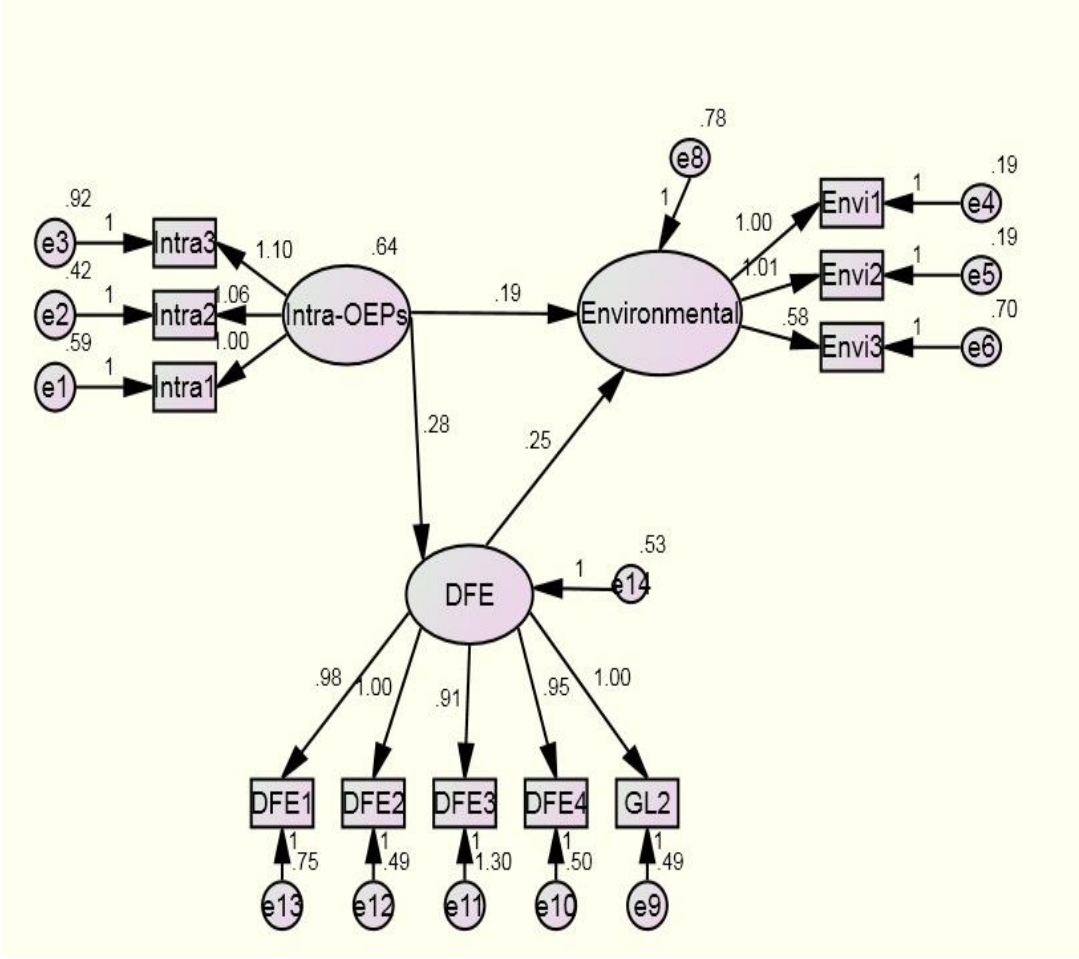
Figure **36** with a significant relationship at $p<0.001$ level.

The third step for mediation evaluation is to show that the mediator variable DfE's influence on the dependent variable Environmental Performance, as shown in

Figure **36** with a significant relationship at the 0.005 level.

The final step in testing for mediation, is to evaluate the original direct relationship between the independent variable Intra-OEPs and the dependent variable Environmental Performance. The result shows evidence that DfE has a partial mediation effect on the relationship between Intra-OEPs and Environmental Performance. The effects of the independent variable Intra-OEPs on the dependent variable Environmental Performance standard regression weight decreased from 0.26 to 0.19 after controlling for the effects of the DfE mediator.

Figure 36 DfE as Mediator between Intra-OEPs and Environmental Performance



5.8.2 Mediation Effect of DfE on relationships between Green Purchasing and Environmental Performance

In the model for testing DfE mediation effects, the following variables are selected:

1. Dependent variable: Environmental Performance
2. Independent variable: Green Purchasing
3. Mediation variable: DfE

This research proposes two models to evaluate the mediation effect of DfE, with both models showing satisfactory model fit statistics. The first model focuses on the direct relationships between Green Purchasing and Environmental Performance (Figure 37) and the second model incorporates the mediating effects of DfE (Figure 38).

The overall fit of the model, shown in Table 67 and Table 68, confirms the hypothesis with the fit statistics.

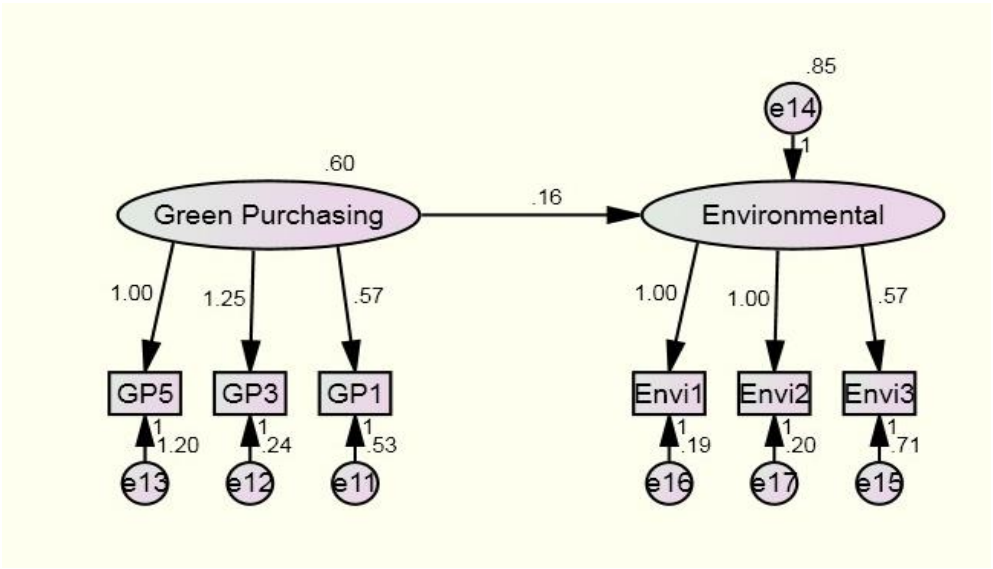
Table 67 Direct relationships between the Green Purchasing and Environmental performance

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
33.013	8	4.127	.090	.968	.961	.099

Table 68 DFE as Mediator between Green Purchasing and Environmental Performance

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
94.009	41	2.293	.083	.952	.955	.064

Figure 37 Direct relationships between the Green Purchasing and Environmental performance



The first step in evaluating the mediation effect, is to test the independent variable Green Purchasing's influence on the dependent variable Environmental

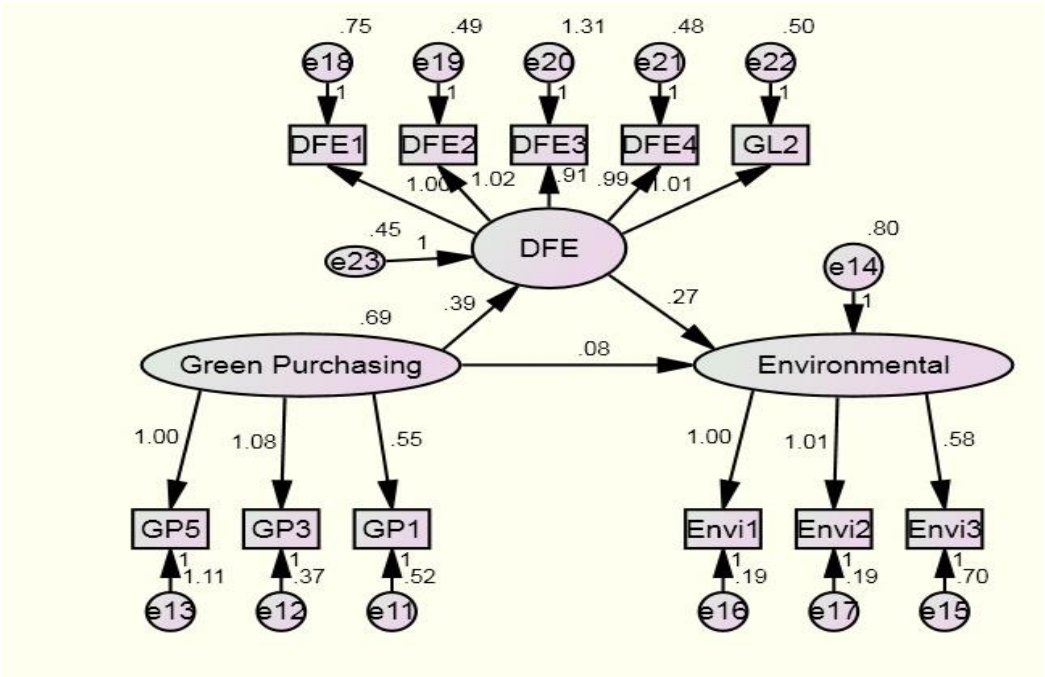
Performance. As shown in Figure 37 the direct effect relationships between Green Purchasing and Environmental Performance are significant at $p<0.05$ level.

The second step for mediation evaluation is to show that the direct relationship between the independent variable Green Purchasing and the mediator variable DfE is significant, as shown in Figure 38 with a significant relationship at $p<0.001$ level.

The third step for mediation evaluation is to show that the mediator variable DfE's influence on the dependent variable Environmental Performance, as shown in Figure 38 with a significant relationship at the $p<0.005$ level.

The final step in testing for mediation is to evaluate the original direct relationship between the independent variable Green Purchasing and the dependent variable Environmental Performance. The result shows evidence that DfE has a full mediation effect on the relationship between Green Purchasing and Environmental Performance. The effects of the independent variable Green Purchasing on the dependent variable Environmental Performance diminished from statistically significant to statistically insignificant, with the standard regression weight dropping from 0.16 to 0.08 after controlling for the effects of the DfE mediator.

Figure 38 DfE as Mediator between Green Purchasing and Environmental Performance



5.8.3 Mediation Effect of Inter-OEPS on relationship with Intra-OEPs and environmental Performance

In the model for testing Inter-OEPs mediation effects, the following variables are selected:

1. Dependent variable: Environmental Performance
2. Independent variable: Intra-OEPs
3. Mediation variable: Inter-OEPs

This research proposes two models to evaluate the mediation effect of Inter-OEPs, with both models showing satisfactory model fit statistics. The first model focuses on the direct relationships between the dependent and independent variable (Figure 39) and the second model incorporates the mediating Inter-OEPs (Figure 40).

The overall fit of the model, shown in Table 69 and Table 70, confirms the hypothesis with the fit statistics.

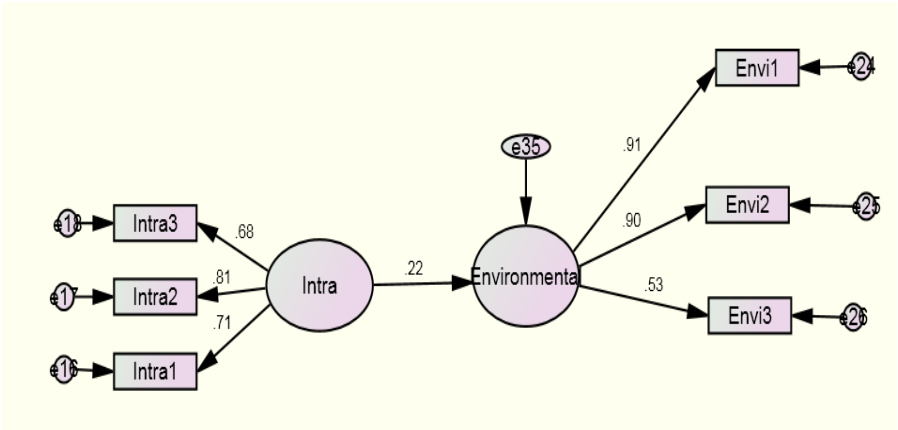
Table 69 Intra-OEPs Direct Effect on Environmental Performance

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
11.621	8	1.453	.041	.988	.995	.038

Table 70 Inter-OEPs mediation effect between Intra-OEPs and Environmental Performance

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
154.234	74	2.084	.085	.937	.946	.058

Figure 39 Intra-OEPs Direct Effect on Environmental Performance



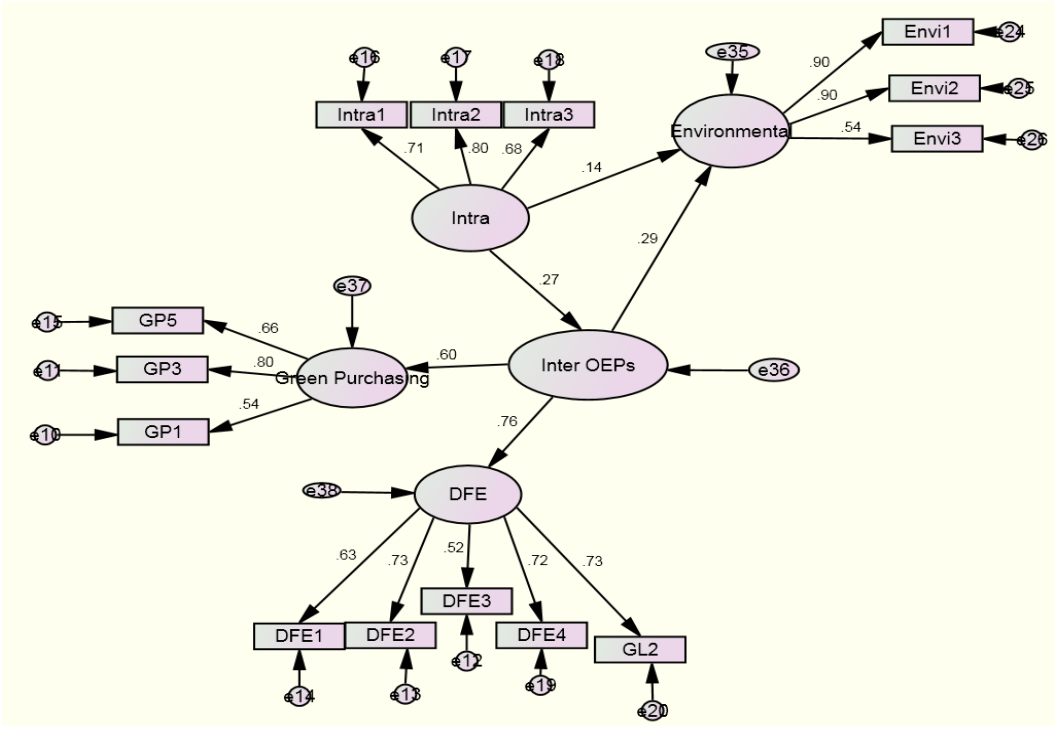
The first step in evaluating the mediation effect is to test the independent variable Intra-OEPs' influence on the dependent variable Environmental Performance. As shown in Figure 38 the direct effect relationships between Intra-OEPs and Environmental Performance are significant at p<0.001 level.

The second step for mediation evaluation is to show that the direct relationship between the independent variable Intra-OEPs and the mediator variable Inter-OEPs is significant, as shown in Figure 40with a significant relationship at p<0.005 level.

The third step for mediation evaluation is to show that the mediator variable Inter-OEPs' influence on the dependent variable Environmental Performance, as shown in Figure 40 with a significant relationship at the p<0.001 level.

The final step in testing for mediation is to evaluate the original direct relationship between the independent variable Intra-OEPs and the dependent variable Environmental Performance. The result shows evidence of partial mediation of the relationship between Intra-OEPs and the Environmental Performance. The effects of the independent variable Intra-OEPs on the dependent variable Environmental Performance decreases from 0.22 to 0.14 after controlling for the effects of the Inter-OEPs mediator.

Figure 40 Inter-OEPs as Mediator between Intra-OEP and Environmental Performance



5.8.4 Mediation Effect of Operational Performance on relationships between Design for Environment and Economic Performance

In the model for testing Operational Performance mediation effects, the following variables are selected:

1. Dependent variable: Economic Performance
2. Independent variable: DfE
3. Mediation variable: Operational

This research proposes two models to evaluate the mediation effect of operational performance, with both models showing satisfactory model fit statistics. The first model focuses on the direct relationships between DfE and Economic Performance, as well as direct relationship between DfE and Operational Performance (Figure 41) and the second model incorporates the mediating effects of Operational Performance (Figure 42).

The overall fit of the model, shown in Table 71 and Table 72 confirms the hypothesis with the fit statistics.

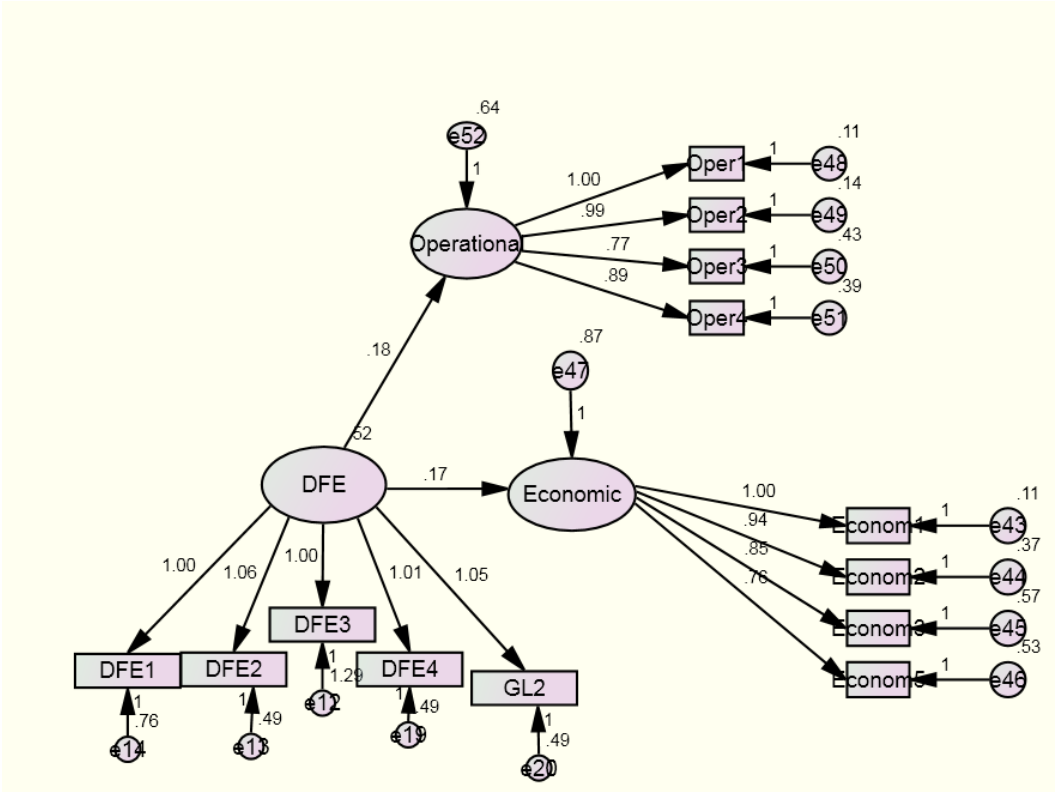
Table 71 DfE Direct Effect on Operational and Economic Performance

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
113.227	64	1.769	.114	.949	.975	.049

Table 72 Operational Performance as Mediator between DfE and Economic Performance

Chi-square	DF	Cmin/DF	RMR	GFI	CFI	RMSEA
74.322	63	1.118	.039	.965	.994	.024

Figure 41 DfE Direct Effect on Operational and Economic Performance

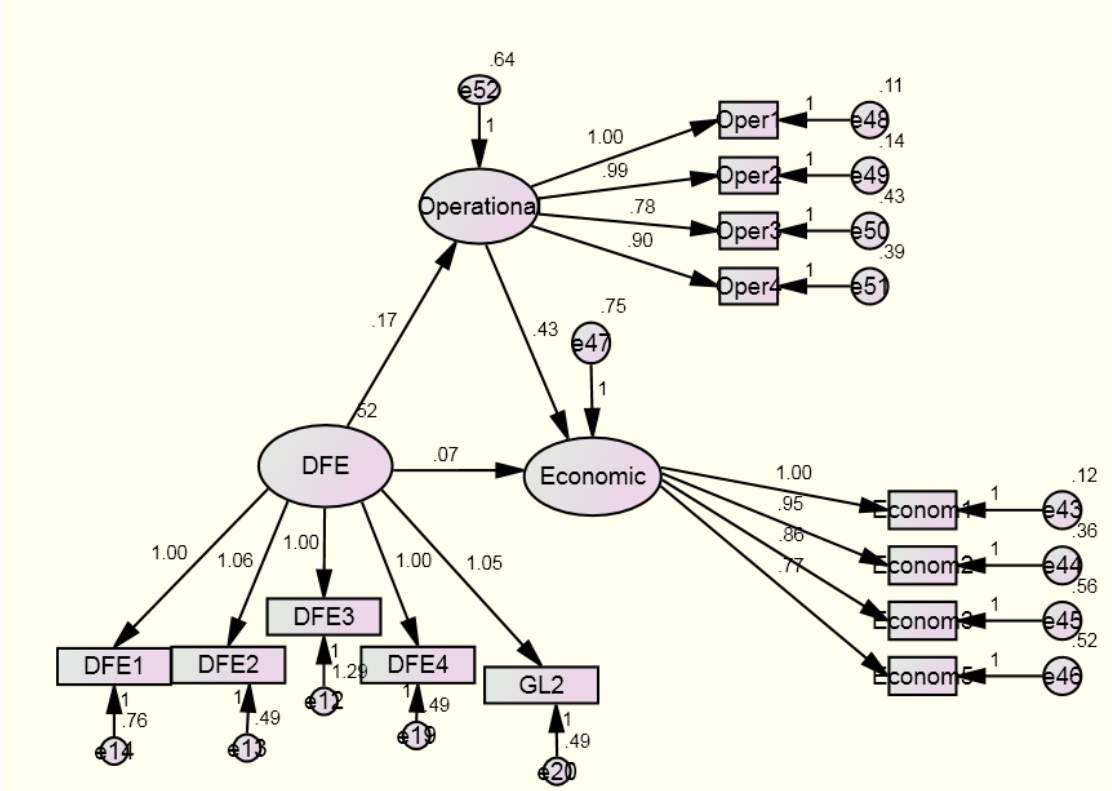


The first step in evaluating the mediation effect is to test the independent variable DfE's influence on the dependent variable Economic Performance. As shown in Figure 41 the direct effect relationships between DfE and Economic Performance are significant at $p<0.05$ level. The second step for mediation evaluation is to show that the direct relationship between the independent variable DfE and the mediator variable Operational Performance is significant, as shown in Figure 41 with a significant relationship at $p<0.05$ level. The third step for mediation evaluation is to show that the mediator variable Operational Performance's influence on the dependent variable Economic Performance, as shown in Figure 42 with a significant relationship at the 0.001 level.

The final step in testing for mediation is to evaluate the original direct relationship between the independent variable DfE and the dependent variable Economic Performance. The result shows evidence that Operational Performance has a full mediation effect on the relationship between DfE and Economic Performance. The

effects of the independent variable DfE on the dependent variable Economic Performance diminished from statistically significant to insignificant after controlling for the effects of the DfE mediator.

Figure 42 Operational Performance as Mediator between DfE and Economic Performance



5.9 Summary

This chapter conducted a number of statistical tests for analysing the survey data including checking for missing values, outliers and multivariate normality. Issues with regards to common method bias and non-response bias were both checked with satisfying results. Measurement models were established based on two steps. Firstly, an exploratory factor analysis was conducted on each individual measurement model before assessing the large confirmatory model. The result showed that the measurement model has good fit with all constructs satisfying validity and reliability. The structural model was then tested with a satisfactory model fit result, followed by hypothesis testing based on the specified path model. Finally this research examined a number of moderating effects. Table 73 summarised the 17

hypotheses that were tested, with 11 empirical findings that support the hypothesis, 5 hypotheses proposed mainly regarding institutional effects on NRB-GSCM found to have no significant effect and 1 hypothesis proposed regarding green purchasing on operational performance found to have no significant effect.

Table 73 Hypothesis Result

H1.1	Regulatory pressures have a positive influence on a firm's intra-organisational environmental practices.	
H1.2	Normative pressures have a positive influence on a firm's intra-organisational environmental practices.	
H1.3	Normative pressures have a positive influence on a firm's green purchasing practices.	
H1.4	Competitive pressures have a positive influence on a firm's intra-organisational environmental practices.	
H1.5	Competitive pressures have a positive influence on a firm's Design for Environment practices.	
H2.1	Intra-OEPs represented by causally ambiguous resources have a direct and positive impact on inter-OEPs as socially complex resources.	Support
H2.2	Intra-OEPs represented by causally ambiguous resources have a direct and positive impact on all aspects of Inter-OEPs.	Partial Support
H2.3	Green purchasing have a direct and positive impact on DfE.	Support
H3.1	Intra-OEPs in the form of causally ambiguous resources have a direct and positive impact on all performance outcomes.	Partial Support
H3.2	Inter-OEPs represented by causally ambiguous resources have a direct and positive impact on all performance outcomes.	Support
H3.3	Green purchasing have a direct and positive impact on environmental performance outcomes.	Support
H3.4	Green purchasing have a direct and positive impact on operational performance outcomes.	
H3.5	DfE have a direct and positive impact on all performance outcomes.	Support
H4.1	DfE mediate on the relationships between Intra-OEPs and environmental performance	Support Partial Mediation
H4.2	DfE mediate on the relationships between Green Purchasing and environmental performance	Support Full Mediation
H4.3	Inter-OEPS mediate on the relationship between Intra-OEPs and environmental performance	Support Partial Mediation
H4.4	Operational performance mediates on the relationships between DfE and economic performance.	Support Full Mediaiton

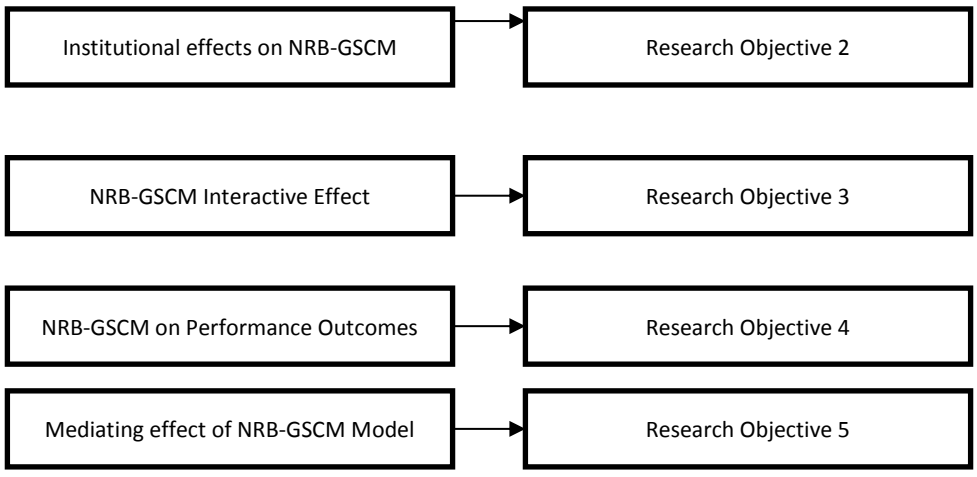
Chapter 6 Discussion

6.1 Introduction

The structural model has good validity which fits the data adequately. It also has satisfactory statistical power to assess the significance of the relationships hypothesised among the constructs. Thus, research objective 1 is achieved which was to identify the measurement scales of GSCM content, antecedents and consequences, as well as research objective 6 which was to construct methodologies for and validate NRB-GSCM structural model.

In total, 17 hypotheses were tested, with 11 empirical findings that support the proposed hypotheses, and with 6 hypotheses that were statistically insignificant. This section, outlined in Figure 43, begins with the discussion of the insignificant results of the institutional effects on NRB-GSCM (addressing research objective 2), and then moves on to discuss more supportive findings of the NRB-GSCM model's interactive effects (addressing research objective 3) and the NRB-GSCM model on performance outcomes (addressing research objective 4). Finally, the mediating effects are discussed (addressing research objective 5).

Figure 43 Flow Chart Empirical Discussion



6.2. Institutional Effects on NRB-GSCM

6.2.1Regulatory Effect on NRB-GSCM

This research found no support for the hypothesis H1.1 that regulatory pressures have a positive influence on a firm's intra-organisational environmental practices. This is despite earlier research that found coercive forces, through regulation when exporting to foreign markets, encouraged firms to implement proactive environmental practices (Zhu et al., 2008). Stakeholder pressure in the Spanish automobile industry is having positive effects on firms adopting environmentally responsible practices such as DfE, source reduction and EMS (Sarkis et al., 2010). Banerjee et al. (2003), argue that regulatory pressures have a strong influence on corporate environmental strategy (as integration of environmental values into corporate strategic planning process). Darnall et al. (2008) found that greater institutional pressure encourages a firm to adopt a more comprehensive EMS. This research found regulatory pressure had no direct effect on Intra-OEPs in the Chinese aluminium fabrication sector. Other research has also produced similar findings. For example, Menguc et al. (2010) reported that the intensity of government regulations has no direct effect on a firm's proactive environmental strategy. They argue that the environmental proactive nature of New Zealand firms does not rely on the bureaucratic institutions such as government to exert regulatory pressures. This is also consistent with the results of Sharma and Henriques (2005) who found no direct relationships between regulatory pressure and adoption of environmental pollution control strategies. They suggest no significant influence exists because most of the Canadian forestry firms are already beyond regulatory requirement.

Menguc et al. (2010) also argue that not all stakeholders are equally important, as some may carry more weight than others. For example, their research found other stakeholders such as customers are having a more direct impact on a firm's proactive environmental strategy.

Reflecting on the null findings of this research, no direct effects of regulatory pressure on Intra-OEPs may be due to the fact that the research sample relied on large and medium size companies. An organisation's size is an important factor in

understanding stakeholder influence on a firm's environmental strategy (Darnall et al., 2010). It is possible that large manufacturers have more complicated decision-making processes compared to smaller firms and can be slow in response to environmental change. Because of their large resource base, large organisations are also more likely to resist environmental regulation than smaller firms (ibid). Similarly, Correa et al. (2008) suggest that small firms can adopt proactive environmental practices based on their specific organisational capabilities, such as shorter lines of communication and closer interactions. As such, small firms' capabilities, including shared vision, stakeholder management and strategic proactivity, were significantly related to firm's environmental proactiveness.

In terms of other literature relating to the actual effectiveness of regulatory enforcement, Beyer's (2006) research found that environmental laws in China have not been as successful due to statutory and enforcement deficiencies (Table 74). This finding has raised a number important key issues.

First, in developing countries, economic growth along with environmental protection often presents long-term concerns for policymakers. For example, the Ministry of Environmental Protection (MEP) in China has introduced plans to establish a "green GDP" number, to include environmental costs in its calculations of the growth of the Chinese economy. The plans have met with a largely negative reaction from local governments, which are usually more concerned about lifting growth and creating new jobs (EIU, 2012).

Table 74 Deficiencies of environmental laws in China

Statutory Deficiencies	Significant element of many major environmental measures seems general and encouragement statement rather than concrete duties with procedures and specific goals.
	Current environmental laws was insufficient to cover wide range of corporate and other entities that are part of China's contemporary legal systems, with transition from planned economy to market economy it is not clear how key propositions apply to non-state enterprises
	China's environmental regulatory system fails to capture many important issues, for example, pre-existing pollutions such as policy that require polluters to restore degraded property and recover its pre-degradation status was not established. Neither clean-up standards concerning contaminated soil, nor liability in relation to toxic waste

	remediation been introduced.
	Lack of demarcations of responsibilities amongst government bodies and few details on the implementation process.
Enforcement Deficiencies	Local government are often major shareholders of polluting enterprises creating an inherent conflict of interest for EPB to enforce environmental policy.
	Lack of administrative cohesion the interests might diverge between local government and environmental department that create obstacle for enforcing environmental legislation.
	Pollution compensation fees are rarely determined authoritatively, they are often negotiated below the cost of damage, as well as below expenses for pollution control facilities.
	Inadequate supervisory mechanisms to enforce polluters to invest on neither pollution control facilities nor enough incentive to pollution prevention activities, firms appear to see fees as entitlements for pollutions.
	Lack of unified management and supervision, inadequate coordination of environmental protection from central government to local EPB and administrative authorities.

Source: Adapted from Beyer 2006

Second, Chinese manufacturers produce many forms of emissions such as water, air and solid waste that exceed official standards which are not considered legal violations. Instead, a compensation fee is charged according to the quantities and concentration of the pollutants released. Often, it is too costly for firms to install environmental pollution treatment technologies (end of pipe) solutions. For example, in the pollution intensive power generating industry, the punishment for excessive discharges of sulphur dioxide, deactivating emission-monitoring equipment, as well as fabricating emissions data, is often minimal. One organisation was ordered to pay only up to 50,000 RMB for fabricating emissions data, and between 10,000 and 100,000 RMB for excessive discharges of sulphur dioxide (News, 25 November 2011). This indicates that the cost for being caught is lower than installing pollution treatment and pollution prevention technologies.

Third, in addition to cost, firms that intend to take a proactive stance, such as installing pollution prevention technologies, need to have knowledge capability and the research and development necessary for implementing pollution prevention

technologies (reduce pollution before occurring). When firms are facing choices between reducing pollution and paying compensation fees, many Chinese manufacturers prefer to pay fees rather than reduce their pollution.

Lastly, China's local government and sub-national EPBs often prioritise economic development over environmental protection and are ineffective to enforce environmental laws on non-compliance firms. There is a lack of transparency and unified management for environmental laws in China, local government and firms in some cases are closely intertwined with cross shareholder and management responsibilities at multiple levels. For example, with Zijin Mining, China's largest gold producer and second largest copper producer, ranking in the world top 500 companies, the company director has a seat in the local governmental financial directorate. In 2000, a company-owned truck carrying 10 tons of sodium cyanide tumbled down and leaked at the base of Zijin Mountain, poisoning 102 people. Ten years after the pollution incident, the company again caused a massive leak involving 500 cubic meters of wastewater that turned a river's water crimson red and killed off nearly 1,900 tons of fish. According to Li (2011), the local government of Shanghang County is a major shareholder (holding 28.96%) of Zijin Mining. The company has also contributed over 60% of tax to local government, after the incidents. The company and local government attempted to cover up the pollution incidents and told local fishermen the pollution came from blue-green algae and waited nine days to make the incident public (Gong and Xu, 2010). The company has been ordered to pay 30 million RMB ($4.62 million) by a local court in Fujian province for the toxic spills and prison sentences ranging between 3 years to 42 months to five of Zijin staff involved in the accidents (CERP, 2011).

6.2.2 Market Effect on NRB-GSCM

This research found no support for the hypothesis H1.2 that market pressures have a positive influence on a firm's intra-organisational environmental practices. Similarly, no support was found for H1.3 that market pressures have a positive influence on a firm's green purchasing practices. Earlier research have mixed results for the influence of market pressure on a firm's environmental behaviour. For example a

number of research studies, based on an international context, found market pressures having a positive effect on a firm's adoption of environmentally friendly practices (Sarkis et al., 2010) and increased pressures from market, downstream customers, and public on Chinese manufacturers to implement GSCM (Zhu and Sarkis, 2007). Darnall et al. (2008) found that social pressures and market pressures had significant impact on the extent of a firm's EMS implementation. Similar empirical evidence shows that customers are among the most important stakeholders to exert influence on firm's environmental behaviour (Menguc et al., 2010, Buysse and Verbeke, 2003). In contrast, Banerjee et al. (2003) found no direct relationship between public concern and corporate environmental strategy, their research suggested that top management plays a critical role in mediating public concerns and a firm's adoption of green practices. Instead, an environmental marketing strategy, such as green niche marketing, is based on a firm's ability to obtain immediate and quick benefits when there is public concern of a firm's green practices (Banerjee et al., 2003). This research found market pressure had no direct effect on Intra-OEPs and green purchasing practices within the Chinese aluminium fabrication sector. The insignificant result of market pressure on Intra-OEPs and green purchasing practices, may due to several reasons.

First, customers' environmental demand in the current business environment in China, is still in the early stage. Consumer power to drive the need for green products, through organising boycotts and taking legal actions to rectify a firm's irresponsible conduct, is still lacking. Similarly, in the business-to-business environment, the buyer's power to command a supplier adopt GSCM practices, is ineffective, because suppliers may perceive GSCM initiatives unnecessary for their operation. Thus, without convincing suppliers that GSCM practices can help realise organisational benefits, and provide support from the buyer's organisation, it is less likely to see that market pressures could push suppliers to be environmentally responsible.

Second, the lack of buyer influence on their supplier's environmentally friendly practices may due to the transaction dimensions of given inter-organisational governance structures. For example, Jiang (2009) suggests that buyer-supplier relationships with less asset specific investment does not encourage compliance with their supplier code of conduct. Because a supplier's adherence to environmental

initiatives imposed by the buyer often raises the supplier's operation costs. Without commitment from suppliers on asset specific investment and contractual rewards, only encourages the supplier to comply with the buyer's requirement for not being caught, which will not fundamentally change the supplier's environmental behaviour.

Third, there is a lack of incentive from the environmental service provider to adopter. Many manufacturers are unconvinced that cleaner production can provide economic benefits as well as improving environmental performance (Hicks and Dietmar, 2007). Arguably, the prices for resources, such as water and energy, as well as the cost of emitting waste, are still too low to act as a strong incentive for pollution prevention. Consequently, managerial awareness of environmental protection focuses purely on end-of-pipe treatment and the application of pollution control technologies. Environmental protection is therefore often viewed as a technical and necessarily expensive outlay that is primarily required to meet pollution control standards (Hicks and Dietmar, 2007).

6.2.3 Competitive Effect on NRB-GSCM

This research found no support for the hypothesis H1.4 that competitive pressures have a positive influence on a firm's intra-organisational environmental practices. Similarly, no support was found on H1.5 that competitive pressures have a positive influence on a firm's DfE practices. Despite earlier empirical research, Zhu et al. (2007a) argue that competition with foreign enterprises has allowed the Chinese manufacturers to learn how to implement GSCM in a cost effective way. Hofer et al. (2012) found a positive relationship between a rival firm's environmental activity and the focal firm's environmental activity. Banerjee et al. (2003) found competitive advantage to positively influence internal environmental orientation (described as important for preserving the environment and diffusing such value company wide) and external environmental orientation (the perception of environmental issues in relation to firm's financial health) among medium sized companies. This research

found no direct causal influence from competitive pressures to encourage Chinese manufactures to implement Intra-OEPs and DfE practices. This may be due to several speculative reasons.

First, the participants in this study's survey consisted of largely state-owned firms, which are comparatively large in size, and receive strong government economic subsidies and technological subsidies. This in turn can create a lack of competitive aggressiveness, as they already perceive themselves to be leaders in the industry. Thus there is no need to look back to weaker competitors. This is consistent with the argument made by Hofer et al. (2012) where market leader's environmental management activity is lower than that of its challengers. This is because good past performance contributed to competitive inertia and a lack of competitive aggressiveness among leading firms. In contrast, challengers recognise the opportunity to improve their market positions by competing more aggressively (ibid).

Secondly, only large and medium sized firms were selected in the sample frame. Smaller firms were not selected in the sample, given that the environmental projects require firms to have a substantial investment, and the long-term pay off can be uncertain. Profitable firms that have stronger finance and more resources are likely to implement GSCM (Hofer et al., 2012). Thus when participants answer questions relating to their competitors they may perceive those competitors to be smaller firms that lack environmental responses. In addition, according to Banerjee et al. (2003), competitive advantage perceived by firms varies from medium environmental impact industries to higher environmental impact industries. This is because, in the medium environmental impact sector, regulations are few and plenty of strategic options can differentiate other firms to gain competitive advantage through environmental practices. In contrast, firms in a high environmental impact sector may experience cost savings initially but cannot sustain the competitive advantage because the regulations tend to level the playing field very soon (Sharma and Vredenburg, 1998). Thus, the aluminium fabrication industry receives less competitive pressure, because regulations may reduce competitive pressures.

Third, pressure from intense global competition and with the absence of domestic environmental protection industries, may result in an environmental protection effort

among many Chinese manufacturing firms who do not have the knowledge pool and financial resources to acquire environmental technologies (Christmann and Taylor, 2001). Many Chinese aluminium manufacturers lack resources to assess the best environmental technology compared to other leading firms. Consequently, many Chinese aluminium manufacturers are locked into competition based on economies of scale, where profits are obtained through mass production rather than in high value added production. Thus, the difference in the market segment may explain the lack of a direct relationship between competitive pressures and NRB-GSCM practices.

Fourth, because intra-organisational and inter-organisational resources are inimitable in nature, it makes benchmarking difficult. In addition, globalisation and its related practice convergence may not be necessarily happening in actual practice. As firm's often adopt a PR strategy or some kind of narrative storytelling to ensure that they speak the same language with their foreign counterpart to conform to competitive pressure.

Finally, it has been a long debate with regards to an environmental policy direction towards reducing a firm's environmental impact - the so-called 'Carrot' and 'Stick' approach. The first 'Carrot' approach is using market mechanisms to incentivise firms adopting environmental friendly practices. Such a policy can encourage organisations to copy the practice of successful competitors in the industry (Zhu et al., 2007a). The issue associated with the 'Carrot' approach to incentivise a firm's environmental practice through globalisation and market mechanisms tend to increase competitive pressure on Chinese firms. Typically international competitors have standards surpassing local practices. Manufacturers in the Chinese automotive industry are one of biggest industrial consumers of Aluminium fabricated products. Currently the Chinese domestic automobile sector has experienced increasing pressure from international competitors to implement environmental management (Harwit, 2001). Unfortunately, due to a lack of experience and technology, Chinese manufacturers in the automotive industry have allocated increasing resources to environmental initiatives while failing to gain significant economic benefit (ibid). In addition, foreign enterprise in China restricts the purchasing component to their home country, leaving Chinese enterprises with few customer-supplier relationships with these foreign enterprises based in China. The main reason is that Chinese

enterprises cannot meet the quality and environmental requirements of these enterprises (Zhu and Geng, 2001). Given the highly competitive industrial characteristics of the aluminium fabrication sector, firms may perceive competition as a barrier to their environmental initiative implementation. This is because of an initiative on environmental practices requires a certain organisational 'slack' that is necessary for firms to spend time and resources for R&D activities. Fierce competition in the aluminium sector can result in firms adopting an exploitation strategy on their current resources to compete to survive in the market place, with very limited resources directed to the exploration of GSCM activities.

6.3 NRB-GSCM Interactive Effects

6.3.1 Intra-OEPs effects on Inter-OEPs

Hypothesis H2.1 states that Intra-OEPs represented by causally ambiguous resources have a direct and positive impact on inter-OEPs as socially complex resources. This hypothesis is supported with the significant path estimate (table 62) with the standard regression weight = .151, $p < .05$. This result supports the natural resource based theory that causally ambiguous proactive environmental practices within the firm can be transformed into socially complex resources in inter-organisational environmental collaborative relationships with its supply chain members. The strong support for this hypothesis suggests that intra-OEPs can help a firm acquire inter-OEPs that would disrupt existing sustainability norms (Paulraj, 2011) to achieve a higher level of GSCM practices. This result is consistent with the findings of earlier research (Paulraj, 2011, Rao, 2002, Darnall, 2006a, Darnall et al., 2008, Shi et al., 2012), that there is a positive relationship between implementing EMSs or ISO 14000 and greening the supply chains. EMS adopters are more likely to rely on their complementary knowledge-based capabilities towards working with their network of suppliers to minimise system-wide environmental impacts (Darnall et al., 2008). This also indicates that organisations go beyond the minimum requirement and institutional norms, and have developed a proactive environmental attitude that is deeply embedded within organisational routines and can provide an opportunity to

achieve supply chain sustainability (Paulraj, 2011). Thus managers can exploit the opportunities in pollution prevention and product stewardship that will enable firms to reach out to supply chain partners to adopt inter-organisational environmental practices (Shi et al., 2012). As such, positive findings in this research clarify the empirical properties of Intra-OEPs and Inter-OEPs.

6.3.2 Intra-OEPs effects on all aspects of Inter-OEPs

Hypothesis H2.2, that Intra-OEPs represented by causally ambiguous resources have a direct and positive impact on all aspects of Inter-OEPs, is partially supported. Although Intra-OEPs does not have a direct link with green purchasing practices, the path estimate between Intra-OEPs on DfE practices is statistically significant (table 60) with the standard regression weight = .269, $p < .005$. This demonstrates a good level of consistency with earlier research (Hart, 1995, Shi et al., 2012), i.e., that pollution prevention strategies, through implementing EMS and cleaner production, can lead to product stewardship. This supports the natural resource based (NRBV) argument that a firm with a proactive attitude towards the natural environment is represented by the adoption of voluntary environmental standards which goes beyond the mere compliance to environmental regulations. Such an environmental proactive stance can thus be transformed into DfE with a consideration of the environmental impact of the entire product life cycle, which often involves cross-organisational boundaries and requires firms to work together in achieving this goal.

6.3.3 Green Purchasing effects on DfE

Hypothesis H2.3 proposes that green purchasing has a direct and positive impact on DfE. This hypothesis is supported with a significant path estimate (table 60) the standard regression weight = .385, $p < .005$. This positive result opens the possibility for an investigation into the interactive effects on the sub-components of inter-organisational environmental practices. Bowen and Cousins (2001) identified: 1) process based environmental strategies, including conserving raw materials,

eliminating toxic raw materials and reducing toxicity of all emission and wastes; and, 2) product based environmental strategies involving the reduction of the negative impacts along the life cycle of a product. Similarly, Hagelaar and Vorst's (2001) analysis of LCA with regard to GSCM, also suggests process and product types of life cycle analysis: 1) process oriented LCA focuses on controlling the environmental impact caused by production processes by means of integration of production systems and compliance with regulations; and, 2) market oriented LCA focuses on innovating product design to reduce environmental burdens of the product, in order to achieve competitive advantage. Thus, based on the above categorisation, the green purchasing measures adopted in this study involving supplier evaluations and selections, are consistent with the process based approach, and in contrast, that the DfE measures are specifically product based. Although, both the green purchasing and DfE constructs are taken as Inter-OEPs, this research clarifies the existence of an empirically positive relationship between green purchasing and DfE. This indicates support for the idea that process based strategies can lead to product based strategies. This can not only can be explained within the organisation (Bowen et al., 2001, Hagelaar and Van der Vorst, 2001) but also can be extended into supply chains.

6.4 NRB-GSCM on Performance Outcomes

6.4.1 Intra-OEPs on Performance Measures

Hypothesis H3.1 proposes that intra-OEPs represented by causally ambiguous resources have a direct and positive impact on all performance outcomes. This hypothesis is partially supported. Intra-OEP effects on environmental performance were found to be significant. Table 60 shows firms implementing their Intra-OEPs, such as by having a clear policy statement for their environmental responsibility, adopting the voluntary environmental standard ISO14000 and implementing an EMS to encourage cleaner production within their firm, are all positively associated with sound environmental performance results. The standard regression weight = .201, $p < .05$ shows consistency with earlier empirical research that supports this finding. For example, Rao's (2002) research, based on a Southeast Asian context, found that

by adopting environmental initiatives within the firm, leads to improved environmental performance. Paulraj's (2011) research found that enviropreneurship – internal focused environmental practices – leading to positive effects on sustainable performance including economic, environmental and social measures. Thus, this research further empirically verifies that by adopting Intra-OEPs – minimising pollution, the reuse of materials, and recycling initiatives within the production stage – can lead to emission reductions, waste reductions and less pollution to water resources.

However, intra-OEPs were found to have no direct links with operational and economic performance. This research finding is not surprising given Rao's (2002) earlier empirical research based on Southeast Asian context. Rao's (2002) conceptualisation of environmental initiatives within the firm is similar to the intra-OEP construct adopted in this research. Rao's (2002) research shows no direct link between environmental initiatives and competitiveness and economic performance measures. Similarly, Christmann's (2000) research within the U.S chemical industry also found no direct effect of environmental 'best practices', such as using pollution prevention technologies and early adoption of environmental initiatives, with cost advantages to the firm. However, this is in contrast to other research which suggests that proactive environmental practices, such as a comprehensive EMS, are significantly related to business performance including profit and growth (Darnall et al., 2008).

This research argues that the non-significant influence of Intra-OEPs on operational and economic measures is therefore due to a number of reasons. First, the level of effectiveness for Intra-OEPs implementation can be inconsistent (Darnall and Edwards, 2006, Melnyk et al., 2003). This is largely due to the measures that were adopted. Those inconsistencies can originate from adopting either informal or formal EMSs (Darnall and Edwards, 2006).

Second, inconsistency can also originate from the types of technologies being implemented, either pollution control (end of pipe) technologies or pollution prevention technology (Klassen and Whybark, 1999).

Third, external institutional pressure, such as government environmental regulations, can also influence economic performance through implementing Intra-OEPs. For

example, firms are required to bear the environmental costs associated with product disposal only if government regulations require them to do so. Thus inconsistencies from environmental regulatory enforcement can have a significant impact on Intra-OEP effects on operational and economic performances.

Fourth, internal resources and capabilities such as complementary assets need to be incorporated to study the link between Intra-OEPs and operational and economic performance measures. Firms implementing environmental strategies should look into their complementary assets, and their environmental strategies need to fit with existing resources and capabilities. This leveraging can be achieved to increase performance. For example, Christmann's (2000) research found empirical evidence indicating that a firm's capabilities for process innovation and implementation are complementary assets that can moderate the competitive cost advantage of environmental practices.

Lastly, the Intra-OEP measures adopted in this study have mainly focused on the firm's EMS, as suggested by Darnall et al. (2008). Considering that an EMS is a signal to regulators and customers of their environmental behaviours, there is a potential decoupling from what firm's says and actual does. Thus, it is possible that when Intra-OEPs lean towards more symbolic actions, then such systems would have less impact on the performance outcomes (ibid).

6.4.2 Inter-OEPs on Performance Measures

Hypothesis H3.2 predicts that Inter-OEPs represented by causally ambiguous resources have a direct and positive impact on all performance outcomes. The above predictions are supported by the findings (table 62). The path linking Inter-OEPs to environmental performance has an estimate of standard regression weight = .553, $p < .005$. The path Inter-OEPs to operational performance has an estimate of standard regression weight =.42, $p < .005$. Finally, the path linking Inter-OEPs to economic performance has an estimate of standard regression weight = .47, $p < .005$).

Inter-OEPs reflect socially complex resources through the interaction with supply chain members which takes form of a higher level construct and includes two

dimensions: 1) green purchasing and 2) DfE. The positive result from Inter-OEPs on different dimensions of performance measures add further support to the growing body of literature espousing the NRBV (Hart, 1995). This research found a positive result on Inter-OEPs on all directions of performance measures. This is not surprising, given previous support for DfE on performance measures (Zhu and Sarkis, 2004b, Rao and Holt, 2005, Vachon and Klassen, 2007, Eltayeb et al., 2011). Zhu and Sarkis' (2004b) study suggested that Chinese manufacturers adopting GSCM practices can lead to positive environmental and economic performances. However, their economic measures are mostly operational related. Similarly, Vachon and Klassen's (2007) research focuses on the environmental collaboration between suppliers and customers, and found environmental collaboration significantly related to operational and environmental performances. Vachon and Klassen's (2007) and Rao and Holt's (2005) research both adopted operational measures including productivity, quality, flexibility, and delivery measures, which is consistent with operational measures adopted in this research. Rao (2002) research found supply chain environmental management can help firms improve environmental performance. This research contributes to earlier empirical findings, that Inter-OEPs are socially complex resources and can help a firm realise positive benefits on all dimensions of performance.

6.4.3 Green Purchasing on Performance Outcomes

Hypothesis H3.3 proposes that green purchasing represented by socially complex resources has a direct and positive impact on environmental performance outcomes. This hypothesis is supported. Green purchasing effects on environmental performance was found to be significant (Figure 32) with the standard regression weight = .16 , $p < .05$. This shows that firms implementing their green purchasing, such as selection of suppliers based on green criteria and evaluation of the green practices of suppliers, can lead to enhanced environmental performance. Finding a significant link between green purchasing and environmental performance provides empirical support for managers in that by extending green initiatives into the supply base can enhance a firm's environmental performance. This result is consistent with

Rao and Holt (2005) who found that the green inbound function involves the integration of suppliers into the green supply chain, such as requiring suppliers to have a certified EMS and operations that would help the organisation to cut down production waste at source. Hence, the company gains in terms of less environmental impact.

No support was found with H3.4 that Green purchasing has a direct and positive impact on operational performance outcomes. The previous research linking green purchasing and operational performance has mixed results. For example, Rao and Holt (2005) found that with less environmental impact through green purchasing leads to reduced costs for disposal, compliance, improved resource utilisation and enhanced economic performance. Paulraj (2011) found empirical evidence that a sustainable supply management based on supplier selection, collaboration and evaluation to be positively linked to sustainable performance. However, Eltayeb et al. (2011) found green purchasing and reverse logistics to have little effect on the internal performance of the firm. They suggest that the benefits may extend to external parties rather than the firm. Carter (2005) also found no direct relationships between purchasing social responsibility and cost reduction, and similarly suggest that the benefit from green purchasing goes first to the supplier before its reflected on the focal firm.

Sound labour and environmental supply chain practices can increase a firm's reputation and profit, increase productivity, reduce the turnover of workers, and saves costs in recruiting, training and replacement (Nike, 2009). However, implementing green purchasing still faces many challenges: 1) inter-firm level collaborations are still rooted in the different firms' conflicting operational goals and priorities, particularly as different members may not directly enjoy the same benefits (Sarkis, 2003); 2) revealing supply factories would put buyer firms in a competitive disadvantage. This lack of transparency hinders the monitoring process with some factories undergoing multiple audits, while others escaping completely (Economist, Mar 31st 2012); 3) corruption prevention with factory managers sometimes bribing auditors, some using fake books showing shorter hours and higher pay (Harney, 2008, Economist, Mar 31st 2012); 4) the buyer organisation may adopt just in time (JIT) manufacturing and cut costs, but with a lack of support for last minute design changes and price pressures disrupting routine operations on supplier organisation as

they have to put over time on workers and find other means to cut costs, which would potentially cause environmental harm (Jiang, 2009, Zhu and Sarkis, 2004a).

This research found no direct link between implementing green purchasing with improved operational performance in the Chinese aluminium fabrication sector. This may due to the fact that the initial effort towards implementing green purchasing can be costly to Chinese manufacturers, as environmentally friendly suppliers tend to give higher price quotations than those not comparatively environmentally friendly. Given the intensity of cost competitions in the Chinese aluminium fabrication sector, the result shows no support for the direct link bewtween green purchasing and operational performance outcomes. In addition, the green purchasing measurement items adopted in this study are based on supplier selection and evaluation of the green practices of suppliers, which does not represent strong commitment in the form of collaboration with suppliers in terms of co-investing in asset specific environmental initiatives and organisational support from the buyer's organisation. For example, Vachon and Klassen's (2008) research conceptualised an environmental collaborative approach positively associated with operational performance measures such as quality, flexibility, delivery and environmental performance. Comparatively, measures used in this research that include the selection, evaluation and monitoring of suppliers environmental performance, represent less resource commitment from focal firms to the suppliers. Consequently, the lack of motivation and support are not enough to generate improvement on operational performance.

6.4.4 DfE on Performance Measures

Hypothesis H3.5 predicts DfE to have a direct and positive impact on all performance outcomes. All of the above predictions are supported by the data. Table 62 the path linking DfE to environmental performance has an estimate of standard regression weight = .219, $p < .05$. The path linking DfE to operational performance has an estimate of standard regression weight = .234, $p < .05$. Finally, the path linking DfE to economic performance has an estimate of standard regression weight = .177, $p < .05$.

DfE refers to the integration of supply chain members for the collaboration on product development and recycling with attention to its environmental impact. Consequently, the benefit of such practice can lead to improved environmental performance, increased operational efficiencies and improvements in quality. Finally, the economic benefit in terms of market shares and sales can be reflected. This research verifies that DfE has a positive effect on all dimensions of the performance measurement constructs. This implies that a firm's focus on the collaboration with supply chain members can enhance their product environmental performance and that such effort can yield additional positive operational and economic benefits.

6.5 Mediation Effect

6.5.1 Mediation Effect of DfE

Hypothesis H4.1 states that DfE positively mediates the relationship between Intra-OEPs and environmental performance measures. The results show that DfE has a partial mediation effect on the relationship between Intra-OEPs and environmental performance measures. The effects of the independent variable Intra-OEPs on the dependent variable environmental performance decreased from standard regression weight from 0.26 to 0.19 after controlling for the effects of the DfE mediator. These results show that Aluminium fabrication manufacturers that implement Intra-OEPs can enhance their environmental performance if DfE is in effect.

Hypothesis H4.2 states that DfE mediates the relationship between Green Purchasing and environmental performance. The results support this. This is because the effects of the independent variable green purchasing on the dependent variable environmental performance diminished from statistically significant to statistically insignificant, with a standard regression weight drop from 0.16 to 0.08 after controlling for the effects of the DfE mediator. Thus, the development of DfE practices with supply chain members is required for the purpose of achieving better environmental performance.

6.5.2 Mediation Effect of Inter OEPs

Hypothesis H4.3 proposes that Inter-OEPs mediate the relationship between Intra-OEPs and environmental performance. The result of this study shows that Inter-OEPs, partially mediate the relationship between Intra-OEPs and environmental performance measures. The effects of the independent variable Intra-OEPs on the dependent variable environmental performance decreases from 0.22 to 0.14 after controlling for the effects of the Inter-OEPs mediator. These result shows that Aluminium fabrication firms can enhance their environmental performance if Inter-OEPs are in effect. Thus, development of the Inter-OEPs creates socially complex knowledge with supply chain members and can help organisations to enhance environmental performance.

6.5.3 Mediation Effect of Operational Performance

Hypothesis H4.4 proposes that operational performance mediates the relationship between DfE and economic performance. The result shows that operational performance has a full mediation effect on the relationship between DfE and economic performance measures. The effects of the independent variable DfE on the dependent variable economic performance diminished from statistically significant to insignificant after controlling for the effects of the DfE mediator. These result shows that Aluminium fabrication firms implementing DfE practices can enhance their economic performance through better operational improvement. Thus, improvements in operational performance with supply chain members is required to gain better economic performance outcomes.

6.6 Summary

This chapter discussed the proposed structural model of natural resource based green supply chain management (NRB-GSCM), and its relationship, with an indication of

cause and effect, to relevant performance measures and drivers. On empirical verification, this research endorsed its main propositions, particularly that Inter-OEPs were positive significant determinants of environmental, economic and operational performance. Design for environment (DfE), as part of the Inter-OEPs, was also found to significantly relate to all performance measures. Green purchasing was positively associated with environmental improvement, but not with operational performance measures. Intra-OEPs were also found to be significantly related to environmental performance, but its effects on economic and operational performance are minimal.

This chapter recognises the importance of the leveraging effects of Intra-OEPs represented by causally ambiguous resources and Inter-OEPs represented as socially complex resources. The results show they have positive relationships. In addition, this research tested the effects of Intra-OEPs on DfE and were found to be significant, but not related to green purchasing practices. This research also found DfE to partially mediate the relationship between Intra-OEPs and environmental performance, and fully mediate the relationship between green purchasing and environmental performance. Operational performance was found to fully mediate the relationship between DfE and economic performance, and Inter-OEPs to partially mediate the relationship between Intra-OEPs and environmental performance. Unlike earlier studies, this research found no direct relationship among the institutional antecedents in terms of regulatory, market and competitive effects on a firm's motivation to adopt GSCM practices.

This chapter helps to establish a better understanding of GSCM from within the NRBV perspective, and incorporates performance measures and institutional drivers and addresses the limitations of earlier empirical research, which was yet to be comprehensively synthesised in a coherent model. The result furnishes managers with validated measurement scales to evaluate their strengths and weaknesses in their GSCM implementation and determine how firms can successfully implement GSCM to promote sustainable industrial development.

Chapter 7 Conclusions

7.1 Contribution to Research

The first contribution of this research is the identification of valid and reliable GSCM measurement scales (achieving research objective 1), which involves GSCM content with its antecedents and consequences using empirical research. With a better understanding of the meaning and contents of the strategic attribute of NRB-GSCM, consequently enables researchers to establish and evaluate causal effect in NRB-GSCM.

The second contribution of this research is the reflection of institutional effects on adoption of green supply chain management (achieving research objective 2). This research found that external influences such as regulatory, market and competitive impacts on the adoption of GSCM was insignificant. The result of such a finding suggests that future research should involve combined effects of organisational internal based theories that incorporate resource based views and dynamic capabilities which in turn encourage firms to develop and sense capabilities to capture opportunities in GSCM.

The third contribution of this research validates the proposition that intra-organisational environmental practices (Intra-OEPs) and inter-organisational environmental practices (Inter-OEPs) are both inimitable resource constructs and identified a number of positive causal relationships between Intra-OEPs with Inter-OEPs, and Intra-OEPs with DfE practices (achieving objective 3). That is, increasing environmental responsibilities within the organisation which in turn synergises environmental values and practices among other supply chain members. In addition, this research found that a positive relationship exists between green purchasing and DfE practices.

The fourth contribution of this research is the empirical demonstration of the performance outcomes of GSCM (achieving research objective 4). By examining

their effects on environmental, operational and economic performance, this research reinforces the existence of the positive effect of Intra-OEPs on environmental performance measures and Inter-OEPs, as well as the DfE construct, on all performance dimensions.

The fifth contribution of this research was the identification of the positive mediating effect of DfE and Inter-OEPs on relationships between Intra-OEPs and environmental performance (achieves research objective 5). Also, this research found the existence of a positive mediating effect of operational performance and on the relationships between DfE/Inter-OEPs and economic performance measures.

The final contribution of this research establishes a viable methodological approach (achieves research objective 6) that enables researchers to empirically identify and evaluate strategic characteristics of GSCM and to inform practitioners of the various antecedents, internal mechanisms, performance outcomes and mediating effects of their green supply chain. Table 75 summarises the contributions of this research:

Table 75 Contribution to Research

	Contributions to Research
Measurement Model	
1	Validated three measurement models from institutional perspective, including: (1) Regulatory, (2) Customer and (3) Competitive effect.
2	Validated measurement model on Inter-OEPs as higher order construct as social complex resources, including: (1) Green Purchasing, (2) Design for Environment.
3	Validated measurement model on Intra-OEPs as causally ambiguous resources
4	Validated three performance measurement models, including: (1) Environmental performance, (2) Operational performance, (3) Economic performance.
Structural Model	
5	Confirm the existence of positive relationship between Intra-OEPs with Inter-OEPs.
6	Confirm the existence of positive relationship between Intra-OEPs with Design for Environment practices.
7	Confirm the existence of positive relationship between green purchasing with Design for Environment practices.
8	Confirm the existence of positive relationships of Design for Environment with all performance measures.
9	Confirm the existence of positive relationship between Intra-OEPs with environmental performance.
10	Confirm the existence of positive relationship between Inter-OEPs with all performance measures.
11	Confirm the existence of positive relationship between green purchasing with environmental performance measures.
Mediation Model	
12	Confirm the existence of positive partial mediation effect of DfE on relationships between Intra-OEPs and environmental performance
13	Confirm the existence of positive full mediation effect of DfE on relationships between green purchasing and environmental performance
14	Confirm the existence of positive partial mediation effect of Inter-OEPS on relationship with Intra-OEPs and environmental Performance
15	Confirm the existence of positive full mediation effect of operational performance on relationships between Design for Environment and economic performance

7.2 Contribution to Practice

Upon its empirical verification, the practical implication of this research can furnish managers with validated measurement scales from a natural resourced based green supply chain management perspective. The following research findings can support managers to determine how firms can successfully implement GSCM to promote sustainable industrial development.

First, this research informs managers that by implementing GSCM opens up opportunities that can create the firm's unique inimitable resources such as causally ambiguous resources from Intra-OEPs and socially complex resources from Inter-OEPs.

Second, this research informs managers that organisations can leverage the capabilities from their Intra-OEPs for obtaining Inter-OEPs capabilities for a higher-level environmental sustainability with supply chain members.

Third, this research informs managers that Intra-OEPs and green purchasing practices would increase a firm's environmental performance, but not necessarily lead to operational and economic based organisational benefit. Thus, it is necessary for managers to consider Inter-OEPs and DfE practices which show positive relationships with environmental, operational and economic performance outcomes.

Fourth, this research informs managers that DfE and Inter-OEPs mediate the effect of Intra-OEPs and green purchasing on environmental performance. This implies that further improvements on environmental performance can be made by leveraging the capabilities from DfE and Inter-OEPs with other GSCM practices. Further, this research informs managers that operational performance mediates the relationship between DfE and economic performance. This implies that managers can leverage improved operational performance with DfE and improve on the firm's financial bottom line.

Finally, although this research found no support for the impact from the institutional effect on GSCM implementation in the Chinese aluminium fabrication industry, the research did recognise the increasing pressure from regulations, the market and

competitors which can have a potential effect on future GSCM implementation. From the literature discussion, this research informs managers that institutional effects already have significant impacts on a number of business sectors. With the spread of global trade and information transparency, managers should be convinced that any violation of environmental issues could reflect negatively on the firm's brand and reputation and consequently affect bottom line performance.

7.3 Limitations and Implication for Future Research

This research has a number of limitations. The first limitation relates to the research being both country specific and industry specific. The Chinese aluminium fabrication industry, was chosen because: 1) the costs of environmental protection and resource efficiency are among the highest of all industries; 2) the value of a firm's resources need to be understood in a specific context as without controlling the industry effect, researchers may obtain erroneous results, such as support for opposite relationships (Barney, 2001, Armstrong and Shimizu, 2007); and, 3) the performance of a firm is often influenced by general industry environments such as the industrial economic cycle. The use of single country and sector set the context for developing the measurement scales and survey data to test conceptual models. This raises the issue of generalisability of the survey results, as the conceptual model applied in different countries and industries can lead to different result, thus future research should look into cross country and sector comparisons.

The second limitation of this research relates to the lack of coverage of smaller firms. This research included only large and medium sized firms in the sample frame because large and medium sized manufacturers are likely to receive more institutional pressure on environmental issues. Also environmental projects require substantial investment, and the return on investment can be uncertain. Thus more profitable firms that have stronger finances and slack resources are more likely to implement GSCM (Hofer et al., 2012). Despite the benefits for only selecting large and medium sized manufacturers, China's large and rapidly expanding group of

smaller firms are neglected. Thus, future research should include smaller manufacturers and apply firm size as a control variable.

The third limitation of this research relates to the neglect of GSCM's mediating and direct effects on institutions. This research relies on a conceptual model based on institutional affects as antecedents of NRB-GSCM. Despite its theoretical contributions, future research should explore the direct and mediating effects between NRB-GSCM with institutional theory, as successful GSCM implementation can inform regulators to set higher environmental regulations. Leading GSCM adopters could lobby government for the adoption of industrial best practice. Successful GSCM adopters with good media exposure can raise the expectations from customers and the general public to demand more sustainable products and services.

The fourth limitation of this research relates to the neglect of resource based capabilities within the firm to influence NRB-GSCM. This research relies on the conceptual model based on external institutional effects such as regulations, the market and competitors. A firm's internal capabilities are also important dimensions that could effect the success of GSCM. For example, Zhu and Sarkis (2007) suggest that Chinese organisations with experience in TQM and ISO 9000 could leverage their accumulated system-based knowledge to implement effective GSCM. Bowen and Cousins (2001) use resource based theory to argue that a firm's internal resources are perceived as a predictor of green purchasing behaviour. Thus future research should combine institutional theory with the resource based view to explain GSCM.

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Appendix 1 Questionnaires Items

On each individual measurement items the respondent was asked: Please rate in your experience how does following question reflect to your organisation? 1 = not at all, 3 = moderate, 5 = great extent			
Construct	Q ID	Items	Author
Intra1	Q2.1	We optimise processes to reduce solid waste and emissions	Rao (2002)
Intra2	Q2.2	We use cleaner technology processes to make savings in energy, water, and waste	Rao (2002)
Intra3	Q2.3	We use internal recycling of materials within the production phase	Rao (2002)
Intra4	Q2.4	We have a clear policy statement urging environmental awareness in every area of operations.	Benerjee, Iyer and Kashyap (2003)
Intra5	Q2.5	We make a concerted effort to make every employee understand the importance of environmental preservation.	Benerjee, Iyer and Kashyap (2003)
GP1	Q3.1	We select potential suppliers based on their environmental competence and environmental performance	Paulraj (2010)
GP2	Q3.2	Suppliers are selected based on their ability to support our environmental objectives	Paulraj (2009)

GP3	Q3.3	We ask if suppliers have an implemented environmental system	Vachon (2006)
GP4	Q3.4	We periodically evaluate our suppliers' environmental friendly practices	Paulraj (2009)
GP5	Q3.5	We conduct regular environmental audits into our suppliers' internal operations.	Paulraj (2009)
DFE1	Q3.6	Participates in the design of products for disassembly	Eltayeb, Zailani and Ramayah (2011)
DFE2	Q3.7	Participates in the design of products for recycling or reuse	Eltayeb, Zailani and Ramayah (2011)
DFE3	Q3.8	Participates in the design of product for resource efficiency, including reduction of materials and energy consumption	Eltayeb, Zailani and Ramayah (2011)
DFE4	Q3.9	Participates in the design of product for reduction to avoid use of hazardous materials	Eltayeb, Zailani and Ramayah (2011)
GL1	Q3.10	We engage and establish collection networks for reuse, recycling and remanufactured products from other organisations	Developed
GL2	Q3.11	We have a regular supply base in the secondary market	Developed
GL3	Q3.12	We provide consumers with information on environmentally friendly products and/or production methods	Rao and Holt (2005)
GL4	Q3.13	We use more environmentally friendly transportation methods	Rao and Holt (2005)

Reg1	Q4.1	Regulation by government agencies has greatly influenced our firm's environmental strategy.	Banerjee, Iyer and Kashyap (2003)
Reg2	Q4.2	Environmental legislation can affect the continued growth of our firm	Banerjee, Iyer and Kashyap (2003)
Reg3	Q4.3	Stricter environmental regulation is a major reason why our firm is concerned about its impact on the natural environment.	Banerjee, Iyer and Kashyap (2003)
Reg4	Q4.4	Tougher environmental legislation is required so that only firms that are environmentally responsible will survive and grow.	Banerjee, Iyer and Kashyap (2003)
Reg5	Q4.5	Our industry is faced with strict environmental regulation	Banerjee, Iyer and Kashyap (2003)
Compt1	Q4.6	By regularly investing in research and development on cleaner products and processes, our firm can be a leader in the market.	Banerjee, Iyer and Kashyap (2003)
Compt2	Q4.7	Being environmentally conscious can lead to substantial cost advantages for our firm	Banerjee, Iyer and Kashyap (2003)
Compt3	Q4.8	Our firm can enter lucrative new markets by adopting environmental strategies.	Banerjee, Iyer and Kashyap (2003)
Compt4	Q4.9	Our firm can increase market share by making our current products more environmentally friendly.	Banerjee, Iyer and Kashyap (2003)
Cust1	Q4.10	Greening the supply chain can improve trust from our customers	Developed

Cust2	Q4.11	The public is very concerned about environmental destruction	Banerjee, Iyer and Kashyap (2003)
Cust3	Q4.12	Media exposures for pollution activities is strong in our industry	Developed
Cust4	Q4.13	Our customers expect our firm to be environmentally friendly.	Banerjee, Iyer and Kashyap (2003)
OP1	Q5.1	Perceived overall product quality	Vachon (2003)
OP2	Q5.2	Promptness in solving customer complaints	Vachon (2003)
OP3	Q5.3	Meeting delivery due date	Vachon (2003)
OP4	Q5.4	Ability to change output volume	Vachon (2003)
OP5	Q5.5	Ability to change product mix	Vachon (2003)
EN1	Q5.6	Reduced Air emissions	Vachon (2003) Paulraj (2011)
EN2	Q5.7	Reduced waste water discharges to receiving water bodies	Vachon (2003) Paulraj (2011)
EN3	Q5.8	Reduced disposal of hazardous materials	Paulraj (2011)

EN4	Q5.9	Reduced solid waste disposal	Vachon (2003) Paulraj (2011)
Econo1	Q5.14	Production costs	Rao and Holt (2005)Paulraj (2011)
Econo2	Q5.15	New market opportunities	Rao and Holt (2005)
Econo3	Q5.16	Market share	Rao and Holt (2005)
Econo4	Q5.17	Product price increase	Rao and Holt (2005)
Econo5	Q5.18	Sales increase	Rao and Holt (2005)

Appendix 2 Previous Empirical Research Findings

Author	Year	Independent	Mediating	Control	Dependent	Positive	Negative	No Effects
Arago and Correa	2008	Environmental proactive practice		SME	financial improvement	p		
Arago and Correa	2008	shared vision		SME	Environmental proactive practice	p		
Arago and Correa	2008	Stakeholder management		SME	Environmental proactive practice	p		
Arago and Correa	2008	Strategic proactive		SME	Environmental proactive practice	p		
Banerjee	2003	public concern			internal environmental orientation			0
Banerjee	2003	public concern			External environmental orientation			0
Banerjee	2003	public concern			environmental corporate strategy			0
Banerjee	2003	public concern			environmental marketing strategy	p		
Banerjee	2003	public concern	Industry type		environmental marketing strategy			0
Banerjee	2003	Regulatory Pressure			internal environmental orientation			0
Banerjee	2003	Regulatory Pressure		High environmental impact industry	External environmental orientation	p		
Banerjee	2003	Regulatory Pressure			environmental corporate strategy	p		
Banerjee	2003	Regulatory Pressure			environmental marketing strategy			0
Banerjee	2003	Regulatory Pressure	Industry type		External environmental orientation	p		
Banerjee	2003	Regulatory Pressure	Industry type		environmental corporate strategy			0
Banerjee	2003	Competiveness Advantage		Moderate environmental impact industry	internal environmental orientation	p		
Banerjee	2003	Competiveness Advantage		High environmental impact industry	External environmental orientation	p		
Banerjee	2003	Competiveness Advantage		Moderate environmental impact industry	environmental corporate strategy	p		
Banerjee	2003	Competiveness Advantage			Environmental marketing strategy	p		
Banerjee	2003	Competiveness Advantage	Industry type		External environmental orientation	p		
Banerjee	2003	Competiveness Advantage	Industry type		internal environmental orientation			0
Banerjee	2003	Competiveness Advantage	Industry type		environmental corporate strategy	p		
Banerjee	2003	Competiveness Advantage	Industry type		environmental marketing strategy			0

Banerjee	2003	Top Management Commitment			internal environmental orientation	p		
Banerjee	2003	Top Management Commitment			External environmental orientation	p		
Banerjee	2003	Top Management Commitment			environmental corporate strategy	p		
Banerjee	2003	Top Management Commitment			environmental marketing strategy	p		
Banerjee	2003	Top Management Commitment	Industry type		internal environmental orientation			0
Banerjee	2003	Top Management Commitment	Industry type		External environmental orientation			0
Banerjee	2003	Top Management Commitment	Industry type		environmental corporate strategy			0
Banerjee	2003	Top Management Commitment	Industry type		environmental marketing strategy			0
Banerjee	2003	public concern	Top Management Commitment		External environmental orientation	p		
Author	Year	Independent	Mediating	Control	Dependent	Positive	Negative	No Effects
Banerjee	2003	public concern	Top Management Commitment	High environmental impact industry	internal environmental orientation	p		
Banerjee	2003	public concern	Top Management Commitment		environmental corporate strategy	p		
Banerjee	2003	public concern	Top Management Commitment	High environmental impact industry	environmental marketing strategy	p		
Banerjee	2003	Regulatory Pressure	Top Management Commitment		External environmental orientation	p		
Banerjee	2003	Regulatory Pressure	Top Management Commitment		environmental corporate strategy	p		
Banerjee	2003	Competiveness Advantage	Top Management Commitment		External environmental orientation	p		
Banerjee	2003	Competiveness Advantage	Top Management Commitment		environmental corporate strategy	p		
Banerjee	2003	public concern	Industry type		Top Management Commitment	p		
Banerjee	2003	Regulatory Pressure	Industry type		Top Management Commitment			0
Banerjee	2003	Competiveness Advantage	Industry type		Top Management Commitment	p		
Banerjee	2003	External environmental orientation			environmental marketing strategy			
Banerjee	2003	internal environmental orientation			environmental corporate strategy			
Banerjee	2003	internal environmental orientation	Industry type		environmental corporate strategy			0
Banerjee	2003	External environmental orientation	Industry type		environmental marketing strategy			0
Carter and Jenning	2002	Purchasing social responsibility			supplier performance	p		
Carter and Jenning	2002	Purchasing social responsibility			Buyer's relationship commitment	p		

Carter and Jenning	2002	Purchasing social responsibility			Buyer's trust in supplier	p		
Carter and Jenning	2002	Buyer's trust in supplier			Cooperation between buyer ans supplier	p		
Carter and Jenning	2002	Cooperation between buyer and supplier			supplier performance	p		
Carter and Jenning	2002	Buyer's trust in supplier			Buyer's relationship commitment			0
Carter and Jenning	2002	Buyer's relationship commitment			Cooperation between buyer ans supplier			0
Carter, Kale and Grimm	2000	Environmental Purchasing		Firm size, Leverage and Primary earning per share	Net income	P		
Carter, Kale and Grimm	2000	Environmental Purchasing		Firm size, Leverage and Primary earning per share	Cost of Good sold		N	
Christmann	2000	Innovation of proprietary pollution prevention technologies			Cost advantage	p		
Christmann	2000	Pollution prevention technologies	Complementary Assets		Cost advantage	p		
Christmann	2000	Innovation of proprietary pollution prevention technologies	Complementary Assets		Cost advantage			
Christmann	2000	Complementary Assets	Early timing of environmental strategy		Cost advantage	p		
Christmann	2000	Use of pollution prevention technology			Cost advantage		N	
Christmann	2000	Unsystematic Risk	Disclosure of environmental liability		Corporate environmental legitimacy			0
Cordeiro and Sarkis	1997	Environmental Performance			Economic Performance		N	
Doweel, Hart and Yeung	2000	Environmental Standard			Tobin's q	p		
Henriques and Sadorsky	1996	Customer Pressure			Formulate Environmental Plan	p		
Henriques and Sadorsky	1996	Shareholder Pressure			Formulate Environmental Plan	p		
Henriques and Sadorsky	1996	Regulatory Pressure			Formulate Environmental Plan	p		
Henriques and Sadorsky	1996	Community Pressure			Formulate Environmental Plan	p		
Henriques and Sadorsky	1996	Lobby group pressure			Formulate Environmental Plan		N	
Henriques and Sadorsky	1996	Formulate environmental plan			Sales to asset ratio		N	
Menguc and Ozanne	2003	NEO			Profitability	p		
Menguc and Ozanne	2003	NEO			Market Share	p		
Menguc and Ozanne	2003	NEO			Sales Growth		N	
Paulraj	2011	Environpreneurship			Sustainable supply management	p		

Paulraj	2011	Environpreneurship			Sustainability Performance	p		
Paulraj	2011	Strategic purchasing			Sustainable supply management	p		
Paulraj	2011	Environpreneurship	Strategic purchasing		Sustainable supply management			0
Paulraj	2011	Sustainable supply management			Sustainability Performance	p		
Paulraj	2011	Strategic purchasing	Sustainable supply management		Sustainability Performance	p		
Paulraj	2011	Environpreneurship	Sustainable supply management		Sustainability Performance	p		
Rao	2002	Environmental initiatives			Environmental Performance	p		
Rao	2002	Environmental initiatives			Supply chain environmental management	p		
Rao	2002	Supply chain environmental management			environmental performance	p		
Rao	2002	Competitiveness			economic performance	p		
Rao	2002	Environmental Performance			Economic Performance			0
Rao	2002	Supply chain environmental management			Economic Performance			0
Rao	2002	Supply chain environmental management			Competitive			0
Rao and Holt	2005	Green Purchasing			Green Logistics	P		
Rao and Holt	2005	Green Production			Green Logistics	P		
Rao and Holt	2005	Green Purchasing			Economics	P		
Rao and Holt	2005	Green Logistics			Competitive	P		
Rao and Holt	2005	Competitive			Economics	P		
Sharma and Henriques	2005	Firm size			Pollution Control	P		
Sharma and Henriques	2005	Withholding influence from regulation			Pollution Control			0
Sharma and Henriques	2005	Usage influence from major customers			Recirculation Strategy	P		
Sharma and Henriques	2005	Withholding strategies from social and ecological stakeholder			DFE	P		
Sharma and Henriques	2005	Environmental groups releasing report to media and protest at company facilities			DFE		N	
Sharma and Henriques	2005	Usage strategy of economic stakeholder			DFE	P		
Sharma and Henriques	2005	Customer demand for information on product sustainability			DFE		N	
Sharma and Henriques	2005	Withholding influence from social and ecological stakeholders			Ecosystem stewardship	P		

Sharma and Henriques	2005	Environmental groups releasing report to media			Sustainable harvesting practices	P		
Sharma and Henriques	2005	Environmental group lobbying provincial government			Sustainable harvesting practices		N	
Sharma and Henriques	2005	Certification			Sustainable harvesting practices	p		
Sharma and Henriques	2005	Usage strategy of economic stakeholder			Ecosystem stewardship	P		
Sharma and Henriques	2005	Customer demand for product certification			Sustainable harvesting practices		N	
Sharma and Henriques	2005	Employee information via taskforce recommendations			Sustainable harvesting practices		N	
Rao and Holt	2005	Green Purchasing			Green Production			0
Russo	2007	Early ISO 14001 adopter			Lower emission	p		
Russo	2007	Longer experiences in ISO 14001			Lower emission	p		
Sarkis, Torre and Diaz	2010	External stakeholder Pressure	Environmental training		Eco-design	p		
Sarkis, Torre and Diaz	2010	External stakeholder Pressure	Environmental training		EMS	p		
Sarkis, Torre and Diaz	2010	External stakeholder Pressure	Environmental training		Source reduction	p		
Sharma and Vredenburg	1998	Environmental Responsive Strategy			Organisational Capabilities	p		
Sharma and Vredenburg	1998	Organisational capability			organisational Benefit	p		
Vachon	2007	Environmental Collaboration			Pollution Prevention Technology	P		
Vachon	2007	Parent Company Size			Pollution Prevention Technology		N	
Vachon	2007	Size of Supply Base			Pollution Prevention Technology	p		
Vachon	2007	Extent of investment in Environmental technologies			Pollution Control Technology	p		
Vachon	2007	New equipment investment			EMS	P		
Vachon	2007	Age of Equipment			EMS	P		
Vachon	2007	Environmental Collaboration			EMS		N	
Vachon	2007	Environmental Monitoring of Suppliers			Types of environmental technologies			0
Vachon	2007	Pollution control technologies			Environmental monitoring from customers			0
Vachon and Klassen	2007	Logistical Integration			Environmental collaboration with suppliers	p		
Vachon and Klassen	2007	Technological integration			Environmental collaboration with both customer and suppliers	P		
Vachon and Klassen	2007	Supply base reduction			environmental collaboration	p		

Vachon and Klassen	2007	Logistical Integration			Environmental monitoring	p		
Vachon and Klassen	2007	Technological integration			Environmental monitoring	p		
Vachon and Klassen	2006	Green Project partnership			Operational performance	p		
Vachon and Klassen	2006	Green Project partnership			Delivery	p		
Vachon and Klassen	2006	Green Project partnership with customer			Operational performance	p		
Vachon and Klassen	2006	Customer concentration			Higher cost	p		
Vachon and Klassen	2006	Customer concentration			Poor Delivery	P		
Vachon and Klassen	2006	Age of Equipment			Poor quality	p		
Vachon and Klassen	2006	Plant Size			Delivery		N	
Vachon and Klassen	2006	Plant Size			Environmental Performance		N	
Vachon and Klassen	2007	Environmental Collaboration			Quality	p		
Vachon and Klassen	2007	Environmental Collaboration			Delivery	p		
Vachon and Klassen	2007	Environmental Collaboration			Flexibility	p		
Vachon and Klassen	2007	Environmental Collaboration			Environmental Performance	p		
Zhu and Sarkis	2004	GSCM Practices			Environmental Performance	p		
Zhu and Sarkis	2004	GSCM Practices			Economic Performance	p		
Zhu and Sarkis	2004	Internal EMS			Environmental Performance	p		
Zhu and Sarkis	2004	External Relation			Environmental Performance	p		
Zhu and Sarkis	2004	Eco-Design			Environmental Performance	p		
Zhu and Sarkis	2004	External GSCM practices	Quality Management		Economic Performance	p		
Zhu and Sarkis	2004	External GSCM practices	Quality Management		Environmental Performance	p		
Zhu and Sarkis	2004	Internal EMS	Quality Management		Economic Performance	p		
Zhu and Sarkis	2004	JIT			Internal EMS		N	
Zhu and Sarkis	2004	JIT			Environmental Performance		N	
Zhu and Sarkis	2004	Firm Size			Performance Measures			0
Zhu and Sarkis	2004	Investment recovery			Economic Performance			0
Zhu and Sarkis	2004	Internal EMS	Quality Management		Environmental Performance			0
Zhu and Sarkis	2004	GSCM	JIT		Economic Performance			0
Zhu and Sarkis	2004	GSCM	JIT		Environmental Performance			0
Zhu and Sarkis	2004	Quality Management		SME in China	Organisational Support for Environmental Management	p		
Zhu and Sarkis	2004	TQM		Medium Size Firm in China	ISO 14001	p		
Zhu and Sarkis	2004	ISO 9000		SME in China	ISO 14001	p		
Zhu and Sarkis	2004	Quality Management		Large Firm in China	Organisational Support for Environmental Management			0
Zhu and Sarkis	2004	ISO 9000		Small and Large firm in China	Organisational Support for Environmental Management			0
Zhu and Sarkis	2004	ISO 9000		Large Firm in China	ISO 14001			0

Zhu, Sarkis, Cordeiro and Lai	2007	Organisational learning			GSCM Practices	P		
Zhu, Sarkis, Cordeiro and Lai	2007	Management Support			GSCM Practices	p		
Zhu, Sarkis, Cordeiro and Lai	2007	Cost Pressure			Investment Recovery Practices			
Zhu, Sarkis, Cordeiro and Lai	2007	Industry Level			External Relation building	p		
Zhu, Sarkis, Cordeiro and Lai	2007	Industry Level			Investment Recovery Practices	p		
Zhu, Sarkis, Cordeiro and Lai	2007	Regulatory Pressure			GSCM Practices			0
Zhu, Sarkis, Cordeiro and Lai	2007	Supplier Pressure			GSCM Practices			0
Hofer et al.,	2012	Rivals EM activity			Focal firm's EM activity	p		
Hofer et al.,	2012	Rivals EM activity	Firms Size		Focal firm's EM activity	P		
Hofer et al.,	2012	Rivals EM activity	Market Leadership		Focal firm's EM activity	P		
Hofer et al.,	2012	Rivals EM activity	Profitability		Focal firm's EM activity		N	
Zhu, Sarkis, Cordeiro and Lai	2007	Customer Pressure			GSCM Practices			0
Carter	2005	Purchasing social responsibility			Organisational Learning	p		
Carter	2005	Organisational learning			supplier performance	p		
Carter	2005	Supplier Performance			Cost reduction	p		
Carter	2005	Purchasing social responsibility			supplier performance			0
Eltayeb, Zailani and Ramayah	2011	Eco-Design			Environmental Performance	p		
Eltayeb, Zailani and Ramayah	2011	Eco-Design			Economic Performance	p		
Eltayeb, Zailani and Ramayah	2011	Eco-Design			Cost reduction	p		
Eltayeb, Zailani and Ramayah	2011	Eco-Design			intangible	p		
Eltayeb, Zailani and Ramayah	2011	reverse logistics			cost reduction	p		
Eltayeb, Zailani and Ramayah	2011	reverse logistics			Environmental Performance			0
Eltayeb, Zailani and Ramayah	2011	reverse logistics			Economic Performance			0
Eltayeb, Zailani and Ramayah	2011	reverse logistics			intangible			0
Eltayeb, Zailani and Ramayah	2011	Green purchasing			Environmental Performance			0
Eltayeb, Zailani and Ramayah	2011	Green purchasing			Economic Performance			0
Eltayeb, Zailani and Ramayah	2011	Green purchasing			Cost reduction			0
Eltayeb, Zailani and Ramayah	2011	Green purchasing			intangible			0
Bansal	2005	International experience			Corporate sustainable development	p		
Bansal	2005	Capital management capabilities			Corporate sustainable development			0

Bansal	2005	Organisational slack			Corporate sustainable development			0
Bansal	2005	Media attention			Corporate sustainable development	p		
Bansal	2005	Mimetic			Corporate sustainable development	p		
Bansal	2005	Fines and Penalties			Corporate sustainable development			0
Bansal	2005	Larger Firms			Corporate sustainable development			
Bansal	2005	Financial performance			Corporate sustainable development		N	
Jiang	2009	Peer to peer governance			Supplier codes of conduct	P		
Jiang	2009	Buyer to supplier governance			Supplier codes of conduct			0