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The Influence of Supply Chain Integration and Green Supply Chain Management Practices on Sustainable Firm Performance – in Thai Manufacturing Industry

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by

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ABSTRACT

Sustainability become a new challenge for various dimensions, not only in academic area, but also has managerial perspectives. Consequently, to achieve competitive advantage, leading to sustainable performance, organisations need to explore what are the causes of the sustainable performance of the firm and how to manage them. Currently, natural environmental impact is more likely to be a critical problem for any organisation. Based on natural resource-based view of the firm (Hart, 1995), natural environmental issues can make a firm obtain new potential specific resources that are difficult to imitate by other organisations. Such resources can be created by supply chain integration (SCI) and also green supply chain management (GSCM) practices. However, there is inconclusive about the impact of SCI and GSCM practices on sustainable performance, in terms of evidence environmental and economic perspective. Therefore, the aim of this study is to understand the relationship between SCI, GSCM practices and sustainable performance, both direct and indirect effect of the relations.

Base on survey method, this research used manufacturers in Thailand as a sample of the developing countries to collect data which come from multiple manufacturing industries. The research methodology used the Churchill (1979) framework for specifying and generating measured items. Exploratory factor analysis was employed to extract the main factors before using structural equation modeling (SEM) to test the hypotheses. Measurement model was firstly used to evaluate all measures and structural model was employed to test theoretical hypotheses.

The empirical results of this research conclude that SCI has no direct positive impact on sustainable performance. Nevertheless, environmental and economic outcomes can be achieved by mediating effect of GSCM practices. Therefore, this research contributes to theoretical and practical view. In academic perspective, researchers can extend this finding to study on this issue further, while in managerial view, practitioners or managers can apply this result to their business strategies to improve their organisational performance.

CHAPTER 1: RESEARCH OVERVIEW

1.1. Background

Sustainability is "the satisfaction of basic economic, social, and security needs now and in the future without undermining the natural resource base and environmental quality on which life depends." (Environmental Protection Agency, 2011). It is thus argued that sustainable development must simultaneously take into account environmental, social and economic perspectives or the so-called the triple bottom lines (Piotrowicz and Cuthbertson, 2009, European Commission, 2011). Furthermore, the previous prime minister of the U.K. Gordon Brown expressed his strong view in his speech to the United Nations Ambassadors on April 2006 (Brown, 2006a), that:

> *"Environment sustainability is not an option; it is a necessity. For economies to flourish, for global poverty to be banished, for the well-being of the world's people to be enhanced – not just in this generation but in succeeding generations – we have a compelling and ever more urgent duty of stewardship to take care of the natural environment and resources on which our economic activity and social fabric depends".*

From a business perspective, the goal of sustainability should be to increase long-term shareholder and social value, while decreasing industry's use of materials and reducing negative impacts on the environment (Environmental Protection Agency, 2011). Sustainability is "an inescapable priority for business leaders in every country" (Porter and Kramer, 2006).Sustainability is becoming an important element in a number of businesses(Hart, 1995, Shrivastava, 1995, Porter and van der Linde, 1995, Matos and Hall, 2007). The increasing emphasis towards sustainable development in business is subject to many drivers and pressures, including internal and external factors, such as obeying legal demands or regulations, meeting customer demands, responding to stakeholders' satisfaction, such as supply chain partner's requirements, non –

governmental organisation (NGO)'s requirements, achieving competitive advantage, improving a firm's reputation and being pressured by international markets or foreign customers (Mann et al., 2010, Seuring and Muller, 2008, Zhu et al., 2005). For example, in some countries, governments establish regulations to force businesses to consider and put sustainability in its business strategy. Some industries in Europe are forced to put the sustainability issue in their business policy by the European Union, such as in the electrical and electronic equipment industries (European Union, 2011).

Moreover, in terms of internal drivers, Mann et al. (2010) stated that financial drivers or cost reduction and internal business process factors are the additional drivers of sustainable supply chain management. In terms of financial drivers, sustainable practices which are composed of efficient and effective reverse logistics create possibilities that lead to better financial performance (Langer et al., 2007), and higher profitability (Kulp et al., 2004). Facing considerable competition from other companies in the same industry, firms have to find new strategies to sustain their businesses not only in the present time, but also for the future. Sustainable development is one of the potential strategies that many companies put into their business strategy in order to have a competitive advantage over competitors and importantly leads to sustained competitive advantage (Hart, 1995).

Sustainable development seems to be still a new point of view for the business world at present. A lot of businesses have recently begun to recognize the need to achieve sustainable development in their planning because it can potentially lead to a reduction in costs, including health and safety, labour recruitment and labour turnover costs, labour costs (Carter and Rogers, 2008), energy costs, landfill disposal costs, asset maintenance costs and acquisition costs (Walker, 2008). Besides a reduction in costs, adopting a sustainable development approach may potentially minimize the prosecuted risk, adding understanding of whole life costs of ownership (Walker, 2008), reduce lead time and improve product quality and corporate reputation(Carter and Rogers, 2008),. The literature argues that, in order for a firm to gain and sustain competitive advantage, it should embrace sustainable development in its business strategy by integrating environmental, social, and economical perspectives at the same time (Seuring and Muller, 2008, Piotrowicz and Cuthbertson, 2009). However, in reality, most businesses find it is difficult to find the right balance between economic, social and environmental demands.

The main task for business researchers is to develop strong theories of sustainable business development and to inform best-practice. The initiative of the environment – competitiveness relationship was suggested by Professor Michael Porter and his co-author Class van der Linde (Porter and van der Linde, 1995). They suggested a new conception of the association of environmental issues and competitiveness which become known as the Porter Hypothesis. The Porter Hypothesis considers the relationship between environmental regulations, innovation and firm performance, including environmental and business performance (Ambec et al., 2011). At that time, many firms and industries were unconcerned and inexperienced with environmental matters. Also, knowledge of environmental impacts was still initial. Customers were unaware of the resource inefficiency cost in the packaging that they threw away. Thus, stringent regulation would be an important way to encourage people, not only the general population, but also the business area to be aware of and lead environmental protection further. Therefore, well-designed and stringent environmental regulation would be a necessity to influence the direction of innovation (Porter and van der Linde, 1995). Because pollution is a waste of resources, if a firm can reduce pollution, it will improve productivity with the resources that are used in the company. Also, environmental regulation which is stringent, but well-designed can create pressure that motivates innovation to overcome organisational inertia which may more than fully offset the cost of compliance. Furthermore, according to Ambec et al. (2011), they explained the main causal linkage involved in the Porter Hypothesis. They described the relationship between environmental regulations and firm performance that if environmental regulations are properly designed, they can lead to innovation offsets that will not only enhance environmental performance, but also improve business performance as well.

Beyond the Porter hypothesis as mentioned above, there are many theories that are related to organisational resources, activities and organisational networks; all of them can influence business strategy and leading to firm performance further based on theoretical perspective. Such theories are institutional theory (Hirsch, 1975, DiMaggio and Powell, 1983), resource-based view (Barney, 1991), natural resource-based view (Hart, 1995), and relational view (Dyer and Singh, 1998).

In terms of the institutional theory, the theory examines how external pressures impact a firm to implement organisational activities (Hirsch, 1975, Lai et al., 2006). In institutional theory, there are three forms of isomorphic drivers or pressures: coercive, normative and mimetic (DiMaggio and Powell, 1983). The coercive driver originated from external pressures, such as government agencies which are the key driver that influences the actions of a firm through fine and trade barriers (Rivera, 2004). Thus, coercive pressures can influence organisational strategies such as environmental management strategy, and this can impact environmental practices of a firm as well (Kilbourne et al., 2002). These pressures pass through the law and regulations not only in developed countries (e.g. USA), but also in developing countries, such as China(Zhu and Sarkis, 2007a). For the normative driver, it is a social pressure. Socially normative pressures generate from customer demand and market expectations. For this time, environmental awareness is increasingly concerned, especially from consumers. Consumers often make their decision to purchase products by considering a firm's environmental reputation and are willing to pay more for environmentally friendly products(Carter et al., 2000). Thus, normative pressures are mainly generated from consumers' ecological thinking and ethical values (Ball and Craig, 2010).Beyond consumers' awareness, exports and sales to foreign customers can drive manufacturers to implement green supply chain management practices as well (Christmann and Taylor, 2001, Zhu et al., 2005). For mimetic drivers, they occur when businesses imitate the operation of successful competitors in their industry by replicating successful competitors' paths as the competitive benchmarking. Imitation plays a crucial role for businesses in many countries, not only in the developed countries, such as Canada, France and Germany, to implement green supply chain management practices (Aerts et al., 2006). Furthermore, developing countries, such as China will learn from their foreign competitors to adopt environmental practices (Christmann and Taylor, 2001). In addition, joint ventures can persuade firms to implement environmental management practices because they imitate their parent companies which have environmental policies and then extend their knowledge and experiences to other businesses (Zhu and Liu, 2010). As mentioned above, institutional theory suggests that external pressures originated from different groups, such as government, consumers, competitors and parent companies. Therefore, organisational activities would be affected by all pressures that are related to each group. At this time environmental issues are an increasingly important consideration not only in the academic area, but also in the business area as well. Researchers and practitioners are concerned about environmental awareness, so it will affect organisational actions, especially environmental or green supply chain management practices. Also, institutional theory can impact not only individual institutional roles, but also lead to the whole supply chain member roles as well.

In terms of the resource-based view (RBV), this theory suggests that firms will obtain sustained competitive advantage by harnessing or controlling resources that are valuable, rare, imperfectly imitable and non-substitutable (Barney, 1991).In the RBV, resources are classified into tangible (e.g. financial resources and physical resources – plant, equipment and raw material), intangible (e.g. reputation, technology) and human resources (e.g. culture, training and expertise of employees and firm commitment and loyalty) (Grant, 1991). As mentioned by Russo and Fouts (1997), all of these resources are not productive on their own, but it has to consider capabilities of a firm by assembling, managing and integrating these bundles of resources. For example, a firm can combine or bundle these resources together in various specific ways to achieve competitive advantage, such as a combination of physical assets and technologies, human resources and organisational capabilities and intangible resources of reputation and political acumen (Russo and Fouts, 1997). In addition, Wong and Karia (2010) found that the bundling of resources (including physical, human, information, knowledge and relational resources) by logistic service providers can create inimitable and firm-specific capabilities which achieve competitive advantage for the organisation. Since resources are heterogeneous, they may be scattered around different parts of a supply chain. Therefore, to obtain these resources, integrating resources from one department into another within the same organisation or between organisations is a possible mechanism for business. To do so, a company can facilitate communication, information sharing, knowledge sharing and collaboration. Such mechanisms are provided by supply chain integration (Stank et al., 2001).

In terms of the relational view, as mentioned by Dyer and Singh (1998), the relational view suggests that an individual organisation is unable to compete with other rivals by using only its own resources and capabilities. Based on only the resource-based approach, ownership and control by a single firm (Barney, 1991) is not enough to achieve competitive advantage and importantly sustainable competitive advantage. Consequently, because of the limitations of the RBV concept, interactions among a firm's resources and alliances' resources or networked resources become an increasingly important issue to study the effect of alliance partners on a firm's competitive benefits and performance. Currently, the RBV concept has been applied to the study of alliance partners and network resources. For example, Dyer and Singh (1998) have extended the RBV to the relational view. Moreover, Lavie (2006) also has extended the resource-based approach to resource-based competitive advantage of interconnected firms by integrating the relational view and social network theories.

Accordingly, to increase competitive advantage over its competitors, a firm has to develop its core competencies to differentiate from other firms by applying not only the resource-based view concept, but also the relational view and the resource-based competitive advantage of interconnected firms as well. Also, firms should maintain long-term relationships with their partners (e.g. suppliers) to maintain their relationship for gaining long-term profitability. To improve a firm's core competencies and maintain a long-term relationship, organisations attempt to cooperate with other organisations, especially alliance partners to establish a relational network among companies in the whole supply chain for mobilising resources from alliances with the company (Dyer and Singh, 1998) or vice-versa.

Such resources are known as network resources which are external resources of alliance partners that transferred through direct interorganisational interactions and also these resources have a vital effect on firm performance (Gulati, 1999).As defined by Gulati (1998), an alliance or interfirm alliance is a voluntary arrangement among organisations that exchange or share resources and also develop products, services or technologies between a firm and its alliances (Gulati, 1998; Lavie, 2006). To do so, a firm will have critical resources that are able to differentiate themselves when compared with other firms in the same industry and ultimately lead to increased competitive advantage.

Collaborating with alliance partners or interaction with interfirm alliances can help a firm to generate a relational network through many different ways, such as joint ventures, franchising, long-term marketing and licensing contracts (Lavie, 2006). For example, a firm can create specific assets in conjunction with the alliance partners' assets to gain improved productivity by exchanging physical asset specificity (e.g. customised machinery, tools and so on).To do so, a firm can use the specific asset to create product differentiation that is specialised or unique and also may improve product quality that has a greater advantage over other competitors. Furthermore, interorganisational learning is critical to gain competitive success by collaborating with firm's alliance partners (e.g. suppliers, customers and so-on).For example, initial suggestions or ideas of the customers' or suppliers' firm can encourage a firm innovate products or services, indicating that if the organisations share their knowledge (especially know-how) with alliance partners, they will obtain specialised knowledge that will help create differentiated products or services and ultimately improve competitive advantage further.

As a result, interorganisational relationship becomes a critical element in organisational environments, in particular in networked environments (Dyer and Singh, 1998; Grandori and Soda, 1995; Lavie, 2006). This idea is consistent with Lavie's (2006) suggestion. Lavie (2006) concludes that the nature of relationships is more important than the nature of resources, especially in networked circumstances. The combined or network resources may be more valuable, rarer and more difficult to imitate than they had been before being combined (Dyer and Singh, 1998; Lavie, 2006). Therefore, if an organisation collaborates with its alliance partners, it will have a stronger competitive advantage than other organisations or competitors which operate individually.

Beyond the organisational theories and other theoretical concepts mentioned above, the natural resource based view is one of the other theories that are related to environmental or green supply chain management issues. The natural resource-based view (N-RBV) of a firm explains the importance of natural resources – "In the future, it appears inevitable that businesses (markets) will be constrained by and dependent upon ecosystems (nature). In other words, it is likely that strategy and competitive advantage in the coming years will be rooted in capabilities that facilitate environmentally sustainable economic activity" (Hart, 1995). To obtain competitive advantage, a firm has to take cost leadership or create differentiation in the product or service of a firm relative to competitors (Porter, 1980). Natural resources may become a new differentiation strategy for achieving competitive advantage over competitors, because nowadays environmental issues have become increasingly important. For example, customers make their decision to purchase products by considering environmentally friendly products despite the product price being more than other products. A differentiated product or service generates brand loyalty and good image or positive reputation that can allow a firm to establish a premium price, ultimately leading to increased profitability. Furthermore, external pressures (e.g. from suppliers and customers) can drive a firm to control and prevent pollution by minimizing or eliminating emissions into the atmosphere, and water and solid waste from its operation and production process. To do so, a firm may promote a better image and also positive reputation that can improve environmental performance and ultimately increase economic performance as well. As mentioned above, achieving positive environmental and economic outcomes indicates that a firm has achieved sustained competitive performance.

According to the theoretical perspective mentioned above, the hypothesized relationships in this research are drawn upon several theories, including the Porter Hypothesis, institutional theory, the resource-based view of a firm, relational view and natural resource-based view of a firm. All related theories influence supply chain integration and green supply chain management concepts, *not only* in the academic area for researchers to test related theories on the supply chain integration and green supply chain management practices' impact on sustainable performance (in terms of environmental and economic outcomes), but also in the business world, where practitioners can bring the empirical results of this research to apply to their businesses' operation as well. Importantly, if an organisation is concerned about all three perspectives (-social, environmental and economic perspectives), it will ultimately obtain sustainable development and increase firm performance in the long-term. Sustainability is not a new issue in academic research (WCED, 1987); however, one of the unanswered questions is "what does it take to achieve environmental, social, and economical performance simultaneously?"

1.2. Research Gaps

This research examines the role of supply chain management in sustainable business development. It considers the impacts of supply chain integration and green supply chain management practices on sustainable firm performance, especially in terms of environmental and economic performance. This research is important in many aspects.

Firstly, even though much of the research on sustainable development over the last twenty years is carried out by many disciplines, there are few articles about this topic in the management field (Linton et al., 2007).

Secondly, there is emerging evidence suggesting that supply chain management, particularly supply chain integration and green supply chain management practice can contribute to both economic and environmental performance outcomes. The trouble is that most of the research about the relationship between supply chain integration and sustainable performance investigates environmental and economic performance separately. For example, the relationship between supply chain integration and financial performance has been examined (Vickery et al., 2003, Germain and Iyer, 2006, Flynn et al., 2010a) but the impacts of supply chain integration on environmental performance are not included in these studies. Germain and Iyer (2006) found that internal integration and downstream integration positively linked to logistical performance, which in turn is further related to financial performance. In addition, the research of Vickery et al. (2003) concluded that supply chain integration was not significantly related to financial performance.

Thirdly, there has recently been a realization for the need for empirical research to justify the effects of supply chain integration on multiple performance outcomes.

Whereas some research was conducted by considering firm performance, including not only financial performance, but also operations performance (Flynn et al., 2010b, Wong et al., 2011), marketing performance (Droge et al., 2004, Rao and Holt, 2005, Kim, 2009) and business performance (Swink et al., 2007); others considered overall firm performance, which included economic performance and environmental performance (Griffith and Bhutto, 2008, Griffith and Bhutto, 2009, Zhu and Sarkis, 2004). Such efforts help to enhance the understanding of the performance implications of supply chain integration. For example, Droge et al. (2004) examine the impacts of integration practices on time-based performance and on overall firm performance, in terms of financial and market performance. They found that integration practices which are internal and external integration are positively related to time-based performance, which in turn is related to firm performance for both financial and market performance. Also, they found that the interaction of internal and external integration is positively related to both market share and financial performance after controlling all of the other effects, indicating that both of the internal and external integration have synergistic effects on firm performance. (Droge et al., 2004). Some research considers the relationship between supply chain integration and business performance which analyses both the direct and indirect effect of the relationships (Swink et al., 2007). For example, Swink et al. (2007) examine the direct effect of the strategic integration-business performance relationship and also the indirect effect by considering the intervening roles of manufacturing-based competitive capabilities play in mediating on the strategic integration-business performance relationship. They found that the positive effect of product-process technology and corporate strategy integration on business performance, which contains customer satisfaction and market performance, is attributable to an indirect effect through manufacturing-based competitive capabilities (including quality, delivery and new product flexibility capability). But for the direct effect association of supplier integration with quality is negative, indicating that the indirect effect of supplier integration on both market performance and customer satisfaction is negative as well (Swink et al, 2007).

However, the impacts of supply chain integration on environmental performance are still unclear. Based on interview and survey data, Griffith and Bhutto (2008) concluded that integration of management systems could make a company gain benefits, not only in economic and organisational performance, but also environmental performance. This finding is just an indication; thus, more empirical evidence and appropriate theoretical foundation are required.

The roles of green supply chain management practices have become another focus of recent supply chain research. Again, the empirical evidence about the impacts of green supply chain management practices on environmental performance and economic performance are often presented separately (Rao and Holt, 2005, Rao, 2002). Other researchers concluded that green supply chain management practices are positively related to both the environmental performance and economic performance (including positive and negative performance)(Zhu and Sarkis, 2004, Zhu et al., 2005) as well as other performances, such as quality performance (Pullman et al., 2009), delivery, and flexibility performance (Vachon, 2003, Vachon and Klassen, 2008). Still it is unclear if green supply chain management can directly affect both environmental performance and financial performance, or its effect on financial performance is mediated by environmental performance. For example, Rao and Holt (2005) found that green supply chain management, including greening of inbound function, greening of the production phase and greening of the outbound function, lead to competitive advantage and finally positively linked to economic performance. Whereas, Zhu and Sarkis (2004) found that the businesses which have higher levels of adoption of green supply chain management practices will improve both environmental and economic performance (positive and negative performance). Furthermore, Pullman and her colleagues found evidence that environmentally sustainability practices (facility resource conservation and land management) are related to environmental, quality and cost performance respectively (Pullman et al., 2009).

In summary, whilst there are some indications about the relationship between supply chain integration and firm performance(Griffith and Bhutto, 2008) and the relationship between green supply chain management practices and firm performance as mentioned above (Rao and Holt, 2005, Zhu and Sarkis, 2004, Zhu et al., 2005, Pullman et al., 2009), there are still many unanswered questions. Since most previous literature did not include all three performance dimensions (triple bottom lines) into the same study (Seuring and Muller, 2008), it is difficult to understand the total effect of supply chain integration and green supply chain management practices on sustainable performance in terms of environmental, social and economic performance at the same time (Carter and Rogers, 2008).

Another unanswered question is: What is the relationship between supply chain integration and green supply chain management practice? Whilst there are very few studies, there is some evidence and argument suggesting that supply chain integration can have a positive influence on green supply chain management practices and the impact of supply chain integration on the environment can be mediated by green supply chain management practices (Vachon and Klassen, 2006, Vachon, 2003). However, such an exact mediating mechanism has not been theoretically explained and empirically proven.

In summary, the relationship between supply chain integration, green supply chain management practices and sustainable firm performance are yet to be fully understood. Therefore, this research focuses on the study of the linkages between these three constructs. This research examines the direct and indirect effect which consists of the direct effect of supply chain integration-sustainable firm performance (including environmental and economic performance) relationship and GSCM practices-sustainable firm performance relationship and environmental-economic performance relationship and the indirect effect (or mediation effect) of green supply chain management practices on the supply chain integration-sustainable firm performance relationship.

1.3. Research Questions

This research sets out to answer the following research questions:

RQ 1: Does supply chain integration have a direct effect on sustainable firm performance in terms of economic and environmental performance simultaneously? If so, how?

RQ 2: Does green supply chain management practices have a direct effect on sustainable firm performance in terms of economic and environmental performance? If so, how?

RQ 3: Does environmental performance have a direct effect on economic performance? If so, how?

RQ 4: Are supply chain integration and green supply chain management practices related? If so, how do they influence each other?

RQ 5: What are the combined effects of supply chain integration and green supply chain management practices on sustainable firm performance in terms of economic and environmental performance?

This research focuses on sustainable performance in terms of environmental and economic performance. Social performance is excluded, although this does not mean it is unimportant. It is excluded because it could add complexity to the research model and thus potentially make the findings less conclusive, and it is believed that supply chain integration and green supply chain management may not be adequate in making meaningful impacts on the social aspects. Therefore, it is taken out of the scope of this research.

Nevertheless, if this research can answer all of the above questions, we will know whether supply chain integration and green supply chain management practices can simultaneously improve sustainable firm performance and if so, how they relate to each other. Furthermore, we will know whether environmental performance is an antecedent for economic performance and if so, how they are related to each other. In addition, we will know whether supply chain integration is related to green supply chain management practices and how they are linked to each other. Moreover, by collecting data from respondents who know the reasons for the links between supply chain integration, green supply chain management practices and sustainable performance, the results of this research will generate knowledge beyond the current empirical evidence and theory. Furthermore, and importantly in practice, if this research can answer all of the above questions, many managers who are directly responsible for achieving sustainable firm performance can bring the results and insights from this research into their business strategy and policy.

1.4. Research objectives

The main objective of this study is to understand the independent and combined effects of supply chain integration (SCI) and green supply chain management (GSCM) practices on sustainable firm performance in terms of economic and environmental performance. The main aim of this study can be divided into four sub-objectives. The first of these is to develop the necessary constructs and construct measurements by reviewing related literature. The second objective is to develop a conceptual model about the linkage among all the above constructs. The third objective is to analyze the relationships among all of the constructs, including sustainable firm performance, especially environmental performance and economic performance, supply chain integration, and green supply chain management practices. The final objective of this research is to provide recommendations to manufacturers on how to achieve sustainable performance – environmental and economic performance – integrated with the supply chain integration and green supply chain management practices.

1.5. Potential Contributions of this research

This study will develop the constructs and measurement scales related to sustainability, particularly in supply chain management discipline and clarify the concept of sustainable supply chain management. Answers to the research questions mentioned above will assist researchers in the academic area and managers in the business area to clearly understand the sustainable development concept more than in the past through an understanding of the relationship between the three main constructs, including supply chain integration, green supply chain management practices and sustainable performance (especially environmental performance and economic performance). Based on management literature, the relevant theories and concept that are examined in this study include: the Porter hypothesis, a resource-based view of a firm, a natural resource-based view of a firm, and relational view will be considered with all of constructs in this dissertation. Finally, the last contribution of this study is that any top managers can bring the conceptual model to apply to the real situation of their organisations. This study can be useful to the real business world, especially as firms encounter a highly competitive marketplace at this time.

1.6. Overview of this dissertation

The remainder of this dissertation is divided into chapters as follows:

Chapter 2 discusses and reviews the literature about the relevant theories that are used to examine the concept of sustainability in supply chain management. This chapter reviews the literature to explain the main constructs for this research, including supply chain integration, green supply chain management practices and sustainable firm performance. In addition, this chapter reviews the relevant literature to discuss the relationship between related theories and each construct and also to develop a conceptual framework on the relationship among all of these constructs.

Chapter 3 presents the development of hypotheses for the links among supply chain integration, green supply chain management practices and sustainable performance constructs. Based upon the literature review, the main constructs are identified, conceptualized and measured, including supply chain integration, green supply chain management practices and sustainable performance in terms of environmental and economic performance. All of them are measured with multidimensional constructs. Furthermore, this chapter presents the related theories behind the hypotheses in detail considering the linkage between one construct and another construct mentioned above. In addition, this chapter discusses both the direct effect of the relationship among the main constructs and the indirect effect (or mediation effect).

Chapter 4 addresses the research methodology and research design that is employed in this thesis. A survey method is used to conduct this research and accomplish the research objectives. This chapter also defines all of the constructs and develops measurement instruments based on the existing literature before developing the questionnaire design. Furthermore, this chapter explains the research design, including units of analysis, target respondents, and data collection. Finally, this chapter presents data analysis techniques that are used before and after hypothesis testing. Structural equation modelling (SEM) analysis is used for testing hypotheses of this research.

Chapter 5 provides the data collected from the survey method and its findings. The company profiles are presented and analyzed by using descriptive statistics to explain the profiles of the target respondents. Beginning with the general characteristics of samples, such as response rate, non-response bias, common method bias, company and respondent profiles are presented. Next, this chapter also presents the results of factor analysis of this research which contain the factors of supply chain integration, green supply chain management practices and sustainable performance in terms of environmental and economic performance.

Chapter 6 presents construct validation and hypothesis testing of this research. Construct validity includes content validity, unidimensionality, reliability, convergent and discriminant validity. All the content of construct validity is presented for each of the main constructs, including supply chain integration, green supply chain management and sustainable performance. The last section is all about the hypothesis testing of this dissertation which is related to the relationship among all the main constructs. This chapter separates the hypothesis testing into two main findings: direct and indirect relationships among the constructs mentioned above.

Chapter 7 presents discussion and implications of the research results. The chapter presents the discussion of the findings based on the results from data analysis (as shown in Chapter 5) and hypothesis testing (as shown in Chapter 6). This chapter presents the answers of the research questions RQ1 to RQ5 to achieve the objectives of this dissertation. All of them are supported by existing theory and literature. In addition, this chapter provides the novel empirical evidence to support the research hypotheses and for conducting future research.

Chapter 8 presents the conclusion of this thesis. This chapter presents the summary of the main results, research contributions to theory and practices and also the limitations and suggestions for future research. The first section concludes the main results of the research, such as the factor of each construct (supply chain integration, green supply chain management practices and sustainable performance) and the extent of the influence of supply chain integration and green supply chain management practices on sustainable performance that includes direct and indirect effects of the relationships among these constructs. Also, this chapter presents the contributions of this research for theory generating, empirical evidence and a managerial point of view for managers and practitioners based on the discussion of the results (as presented in Chapter 7). The last section presents the limitations of this research and also suggestions for future research on supply chain integration, green supply chain management practices and sustainable firm performance, in terms of environmental and economic performance.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

Chapter 1 presented the background of the research, research questions, research objectives and also the potential contributions of this research. This chapter begins with a review of the literature that is related to operation management, and supply chain management disciplines. The author has systematically searched related literature by searching electronic library databases or other academic databases (e.g. Google scholar) and finding many relevant articles, journals and books. For electronic library databases, initially, the author was interrogated with keywords for finding. The author focuses down on the exact topic of the research that he/she wants to study to set out the keywords to find out related academic journal articles. The keywords - searching are examined from the chosen topic of the research and also similar, nearly or related term. To research electronic academic databases, the author employed a specific keyword search such as 'supply chain integration (SCI)', 'green supply chain management (GSCM) practices' and 'sustainable firm performance', in terms of environmental performance (ENP) and economic performance (EP). Other terms (similar or related in meaning) were 'supply chain collaboration', 'supply chain management practices', 'green supply chain practices', 'environmental management practices', 'environmental performance', 'economic performance', 'social performance', 'sustainable performance', 'sustainability', 'sustainable development' and so on. Before selecting the related academic journal articles, reliability of the sources should be taken into account. To gain reliable sources, checking the author(s)' names (not anonymous), academic sources and relevance of the content should be important considerations. For example, the leading journal article that related to logistic and supply chain management discipline was selected first. The five leading logistics and supply chain management journals (Menachof et al., 2009) are ‘International Journal of Logistics Management’, ‘International Journal of Physical Distribution & Logistics Management’, ‘International Journal of Logistics: Research and Applications’, ‘Supply Chain Management Review’ and ‘Journal of Business Logistics’.

According to the related journal articles, there are several types of journal which were used for this thesis, such as literature review-based paper, conceptual paper, case study-based paper and survey-based papers. Although this research has reviewed all of these types of articles to clarify and understand the content of all constructs and related theories, the researcher has focused on survey-based papers because this thesis employed a survey method to conduct this research as mentioned in Chapter 4. For example, for the first kind of journal, literature review-based papers that were employed in this thesis are the article of Fabbe – Costes and Jahre (2007), Sarkis et al. (2011), Molina – Azorin et al. (2009) and Shaw et al. (2010). The case study-based journals comprise the article of Wong and Boon-itt (2008) and Griffith and Bhutto (2008). The last kind of paper is survey-based papers, such as the article of Green Jr. et al. (2012), Hu and Hsu (2010),Zhu and Sarkis (2004), Zhu et al. (2005；2010), Rao and Holt (2005), Holt and Ghobadian (2009) and Lee et al (2012b).

Beyond electronic journal articles from the library database, published literature and related books from libraries are the other sources for the literature review. Also, the researcher follows-up references from the chosen articles, books or reading lists to find out more relevant articles or books.

2.2. Background

The achievements of each organisation can be measured by considering its performance. In the past, firm performance focused on only financial performance, such as net profit, return on assets and return on equity. In recent years there is a realization that financial performance measurement alone is not enough to represent corporate outcomes. Moreover, any organisations wishing to survive in a highly competitive marketplace need to sustain the business for the present and the future as well. In addition, no organisation can stand alone, and it is necessary to communicate, collaborate and integrate with other companies. This is because business processes required to achieve sustainable performance are not controlled by one business, but they are managed by many members in the whole supply chain. Thus, organisations need supply chain management to gain sustainable supply chain performance. To truly achieve sustainable development, this performance comprises three components: environmental performance, social performance and economic performance (Carter and Rogers, 2008).

This chapter is divided into sections as follows. First, a discussion about sustainability, sustainable supply chain management, sustainable firm performance and related theories such as the resource-based view (RBV) of a firm and relational views are presented. Second, a discussion about green supply chain management practices and related theories such as the natural resource-based view (N-RBV) and stakeholder theory are provided. Lastly, SCI and related theories and SCI-sustainable firm performance relationships are examined. All of these are explained in detail in the next section, respectively.

2.3. Sustainable Firm Performance

For understanding the fundamentals of sustainability, the author will first address sustainable development or sustainability. Then, studies of sustainability in the field of supply chain management and sustainable firm performance will be examined in detail, respectively.

2.3.1. Sustainability

From reviewing previous literature of sustainability and sustainable development, a number of definitions were found in many sources and many disciplines, such as in the fields of management, operations management, engineering, and supply chain management. The definition of sustainability that is broadly adopted and often cited was defined in the Brundtl and Report under the issue 'Our Common Future' by the World Commission on Environment and Development (WCED, 1987). The report defines sustainable development as "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs"; however, this definition can be difficult to interpret by many. It is difficult to understand because the conceptual terms of the definition are quite ambiguous (Mihelcic et al., 2003).

In addition, The Environmental Protection Agency (EPA) defines sustainability as "the satisfaction of basic economic, social, and security needs now and in the future without undermining the natural resource base and environmental quality on which life depends. From a business perspective, the goal of sustainability is to increase long-term shareholder and social value, while decreasing industry's use of materials and reducing negative impacts on the environment" (Environmental Protection Agency, 2011). This definition has been expanded to three essential performance outcomes, including economic, environmental and social perspectives that affect the basic quality of life of human beings.

Moreover, The Dow Jones Sustainability Indexes (DJSI) supports the EPA's definition by separating the categories of sustainability into social, environmental and economic sustainability. The DJSI represents corporate sustainability as "a business approach that creates long-term shareholder value by embracing opportunities and managing risks deriving from economic, environmental and social developments. Corporate sustainability leaders achieve long-term shareholder value by gearing their strategies and management to harness the market's potential for sustainable products and services while at the same time successfully reducing and avoiding sustainability costs and risk" (Dow Jones Sustainability Indexes, 2010). However, still different definitions are used by different disciplines; for example, from the literature in the engineering field, Mihelcic (2003) defines sustainability as "the design of human and industrial systems to ensure that humankind's use of natural resources and cycles do not lead to diminished quality of life due either to losses in future economic opportunities or to adverse impacts on social conditions, human health and environment".

In the operations and supply chain management literature, most of the conceptualizations of sustainability are concentrated on the natural environment perspective (Rao, 2002, Zhu and Sarkis, 2004, Zhu et al., 2005, Holt and Ghobadian, 2009, Hart, 1995). In addition, the issues of environmental and economic responsibilities have been included in the literature since the 1990s (Shrivastava, 1995). Shrivastava (1995) defined sustainability as "the potential for reducing long-term risks associated with resource depletion, fluctuations in energy costs, product liabilities, and pollution and waste management". It is worth noting that this definition considers the environmental and financial perspectives of sustainability excluding the social dimension. From operation management literature, most of the researchers have focused on only the ecological dimension; it has not included the social dimension of sustainability (Sarkis, 2001). In the literature of the supply chain management field, authors have considered many issues which are associated with natural environment, society and economic aspects, but they have not integrated all of these topics into the same study. As mentioned by Carter and Jennings (2002), most logistics and supply chain management literature has increasingly investigated the issues about environment, safety and human rights in a stand-alone, without examining the interrelationship among these issues and also the relationship between them and other issues that are about social responsibility (Carter and Jennings, 2002). Some research has focused only on the environmental issue; whereas others have concentrated on only the social dimension or the economic dimension separately. Thus, integration of all three aspects will provide a more complete understanding of the sustainability of businesses and the world. Recently, therefore, many researchers have attempted to fill the gap by examining the stand-alone topic as mentioned earlier as a broader conceptualization and also as a higher-order construct of logistics social responsibility and purchasing social responsibility (Carter and Jennings, 2002, Carter and Jennings, 2004, Murphy and Poist, 2002). Also, nowadays, integration of social and environmental and economic responsibility has begun to increasingly appear in the research of business disciplines, e.g. management and operations literature. Furthermore, the term ‘sustainability’ has begun to be adopted in a lot of organisations through annual reports or separate annual sustainability reports of a firm (Carter and Roger, 2008).

In conclusion, most of the sustainability definitions are pictured as dividing the main topic into three perspectives: environmental, social, and economic. This concept relates to the idea of the triple bottom line (TBL) which was developed by Elkington (Elkington, 1998). The triple bottom line concept balances natural environment, social, and economic perspectives at the same time (Figure 2.1). Thus, this idea leads managers to consider their firm performance in all sustainability aspects. Moreover, in theory, if they consider all of these aspects, they will be likely to achieve sustainable development in their businesses and ultimately obtain a sustainable competitive advantage (Hart, 1995).

2.3.2. Sustainable Supply Chain Management

In the supply chain management literature, Carter and Rogers (2008) developed a definition of sustainable supply chain management based on the triple bottom line: "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".

Additionally, they include other sub-concepts which relate to sustainability in the framework of sustainable supply chain management, including risk management, transparency, strategy, and organisational culture (Hart, 1995, Sarkis, 2001, Elkington, 1998, Carter and Rogers, 2008) All of these supporting facets are explained respectively (as presented in Figure 1.2).

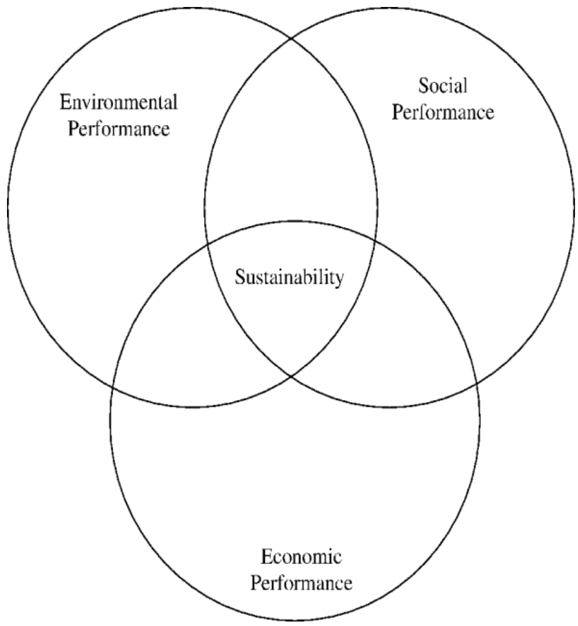


Figure 2.1 Sustainability: The Triple Bottom Line

Source: Elkington (1998), Carnibal with Forks: The Triple Bottom Line of the 21st Century

The first facet is supply chain risk management which is defined as the ability of a firm to understand and manage its economic, environmental and social risk in the supply chain (Carter and Rogers, 2008). It can be achieved through contingency planning for upstream and downstream supply chains. The second facet is transparency. Transparency is enabled by the rapid speed of communication through internet and satellite television (Elkington, 1998).

Transparency is achieved by engaging and communicating with stakeholders by presenting reports to them and using their feedback in order to improve supply chain processes, including upstream and downstream supply chain operations. The third facet is strategy.

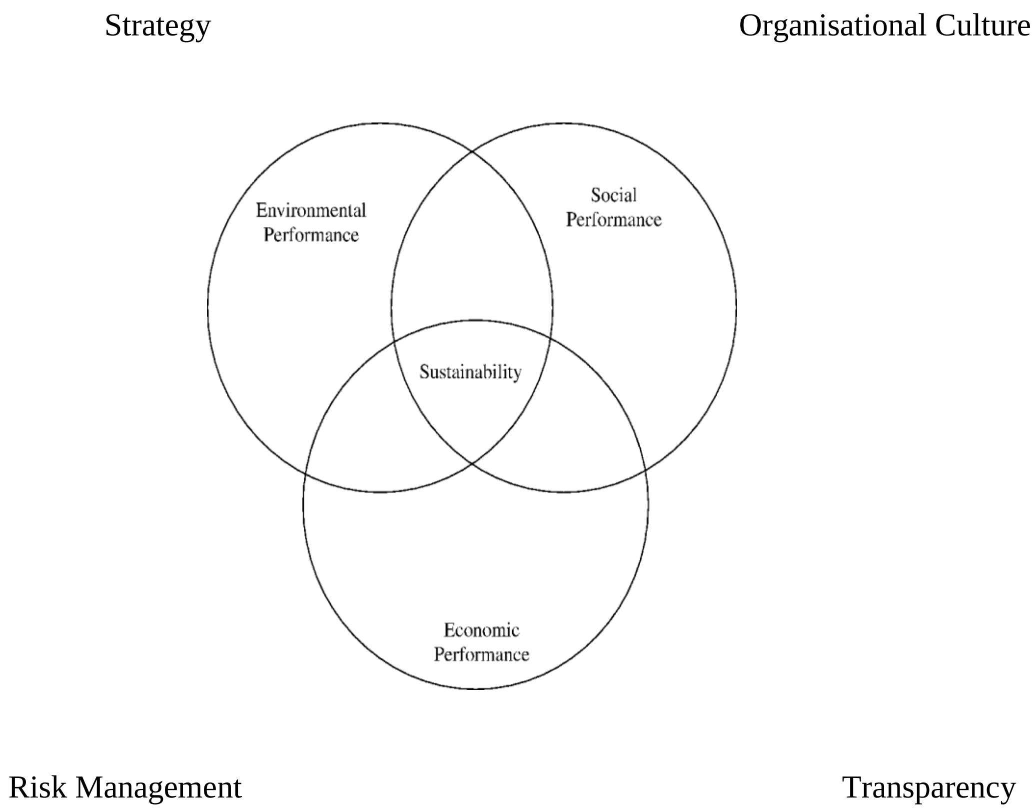


Figure 2.2 Sustainable Supply Chain Management

Source: Carter and Roger (2008), A Framework of Sustainable Supply Chain Management: Moving Toward New Theory

An organisation's sustainable supply chain management initiatives have to support its business strategy (Shrivastava, 1995). In general, individual sustainable supply chain management initiatives align with and support the overall organisation's sustainability strategy. For example, many companies, such as Nike and IBM, stated that their sustainability initiatives were integrated into their business strategies (Carter and Roger, 2008). The last facet is an organisational culture which has to be deeply ingrained and encompass organisational citizenship by integrating ethical standards and expectations about society and natural environment issues.

2.3.3. Sustainable Firm Performance

The term ‘sustainable supply chain management’ has been clarified by Carter and Roger (2008) as “an integration of strategy, transparency, and accomplishment not only in individual organisation, but also in the whole key business processes of its supply chains which are concentrated on three main issues: environmental performance, social performance, and economic performance and importantly, for long-term performance”. Moreover, Carleton (2009) expanded the concept of sustainability by stating that sustainable performance has been composed of six-P elements. These aspects are perception, potential, practice, planet, people and profit. The first three aspects are for short-term objectives which is to enhance productivity, reduce inventory and cycle time, whereas the last three aspects are for long-term objectives to improve customer satisfaction, market share and profit for all members of the supply chain and ultimately achieve sustainable firm performance (Tan et al., 1998). In other words, ‘planet’ refers to the natural environment dimension, ‘people’ refers to the social dimension and ‘profit’ refers to the economic dimension (Carleton, 2009), indicating that if a firm needs to achieve sustainable performance, it should concentrate on its business operation and strategy on three dimensions: social, environmental and economic performance not only for the short-term, but also planning for the long-term as well. Furthermore, many related theoretical concepts can explain the importance of sustainable supply chain management and sustainable firm performance which are explained in the next section.

However, this research focuses on sustainable firm performance, in terms of environmental and economic performance. Social performance is excluded, but this should not imply that this performance is unimportant, but because it could complicate the research model. And importantly, it will make the results or findings of this research less conclusive. In addition, supply chain integration (SCI) and green supply chain management (GSCM) practices may be insufficient in making significant effects on the societal aspect. Therefore, social performance is taken out from the scope of this research.

2.3.3.1. Theories of Sustainable Supply Chain Management and Sustainable Firm Performance

There are many theories which have been applied by existing literature for studying sustainable supply chain management (Carter and Rogers, 2008, Gold et al., 2010, Pullman et al., 2009) and sustainable firm performance, in terms of environmental performance and economic performance (Russo and Fouts, 1997) or financial performance (Clemens and Bakstran, 2010). For example, Carter and Roger (2008) developed a framework of sustainable supply chain management based on many theories, such as resource dependence theory, transaction cost economics, population ecology and resource-based view (RBV) of a firm. Furthermore, Gold et al. (2010) explores sustainable supply chain management through collaboration of environmental and social aspects as a catalyst of building valuable inter-organisational resources and ultimately lead to sustained inter-firm competitive advantage. They developed the concept of sustainable supply chain management based on the RBV of a firm and the relational view (RV). Moreover, Russo and Fouts (1997) examine the association of environmental performance with economic performance based on the RBV of a firm and also its relationship is moderated by industry growth.

Therefore, there are many theories that can explain the importance of sustainability in management literature, especially in supply chain management and also firm performance issues. In this research, the author has integrated distinct, but complementary theories, including the RBV of a firm, relational view (RV) and natural resource-based view (N-RBV) of a firm in order to clearly explain sustainable supply chain management, supply chain integration, green supply chain management practices and sustainable firm performance (in terms of environmental performance and economic performance) based on these theories. The theoretical perspective for each issue is explained in the next section respectively.

In strategic management literature, the theory of competitive advantage that is very popular is the RBV of a firm (Barney, 1991, Wernerfelt, 1984). The RBV of a firm is a theoretical concept that attempts to explain how an organisation can achieve competitive benefits and lead to sustained competitive advantage through acquisition of and harnessing or controlling of resources. According to Barney (2007), "a firm is said to have a competitive advantage when it is implementing a value creating strategy not simultaneously being implemented by any current or potential competitors. A firm is said to have a sustained competitive advantage when it is implementing a value creating strategy not simultaneously being implemented by any current or potential competitors and when these other firms are unable to duplicate the benefits of this strategy".

In addition, Fahy (2000) emphasizes "the organisation's key resource and the role of management in converting these resources into positions of sustainable competitive advantage, leading to superior performance in the marketplace". From his articles, planning to include key resources in corporate strategy is a very important process for organisations, so they should themselves learn what the core competences of a firm are. After that, they should focus on the right points which are related to the core capabilities at the right time in order to improve competitive advantage and enhance overall firm performance (Fahy, 2000).

As discussed by Barney (1991), the characteristics of organisational resources are divided into four attributes: value, rareness, inimitability and non - substitutability. Furthermore, resources can be classified into two categories, tangible and intangible resources (Grant, 1991, Mentzer et al., 2004). Tangible resources or physical and technology resources (Karia, 2011), e.g. plant, equipment, raw material, land, building, technology and facilities (software, computer system) and intangible resources and capabilities of a firm or organisational, relational, and management expertise resources (Karia, 2011), e.g. relationships, corporate culture, training and education, management skills, experience, knowledge employees, know-how, customer loyalty and reputation (Mentzer et al., 2004, Karia, 2011).

Generally, most organisations can easily acquire tangible assets because they can buy these resources from anywhere. Thus, these resources are not difficult to acquire. However, these resources can be a source of competitive benefit to companies, if they outperform equivalent resources when compared with their competitors (Russo and Fout, 1997). On the other hand, intangible assets and capabilities of each firm are difficult to imitate because they come from "accumulated firm-specific activities" (Fahy, 2000). Also, they can generate from a member's knowledge within each firm. In addition, they are often developed by members' learning and their experiences in each department and other departments which share information together. Both of these assets can create differentiation in terms of a firms' product and/or service which adds a competitive advantage for each firm (Porter, 1980).

Furthermore, when any organisations achieve competitive advantage, they will obtain superior firm performance. Since resources are heterogeneous, they may be scattered around different parts of a supply chain. Resources and capabilities can add value by bundling tangible and intangible assets together to help the organisation accomplish its performance (Barney, 2001, Karia, 2011, Karia and Wong, 2013,Wong and Karia, 2010). Organisational resources cannot be evaluated in isolation (Collis and Montgomery, 1995) and also they are not productive on their own; as a result, organisations should consider firms' capabilities to integrate and manage these bundles of resources (Russo and Fouts, 1997). There are many ways to combine or bundle resources; for example, a combination of physical assets and technologies, human resources and organisational resources and intangible resources of reputation and political acumen (Russo and Fouts, 1997). When bundling some resources together, including physical, technology, management expertise, relational and organisational resources (Karia, 2011) in various specific manners. For example, bundling of organisational and technology resources can make an organisation obtain enhanced customer service innovation and bundling of organisational and management expertise resources can lead a firm to gain improved cost leadership (Karia, 2011). It indicates that the bundling of various resources in diverse specific manners can allow a firm to create inimitable and firm-specific capabilities which make a firm achieve competitive advantage and ultimately lead to improved logistics performance (Wong and Karia, 2010).

Furthermore, the process of capability development is often referred to the relational view (Dyer and Singh, 1998). As suggested by Dyer and Nobeoka (2000), the relational view suggests that organisational capabilities can be developed by combination or bundling of resources from different companies in the supply chain. As a result, it is possible to create exchange relationships among different organisations in the supply chain through different organisational resources and capabilities. This concept has expanded the relationship from an individual firm into two or more firms which are in the same network and combine them together. This concept is known as an interorganisational or network relationship (Dyer and Singh, 1998).

The RBV of a firm and relational view have several different aspects which are presented as follows. The RBV emphasizes how an individual organisation creates maximized profits based on a firm's resources, assets and/or capabilities that are possessed of a firm. It indicates that an individual firm as a unit of analysis in the concept of the RBV of a firm. In contrast, the relational view (Dyer and Singh, 1998) considers the pair or network of a firm as a unit of analysis.

Furthermore, the primary sources of firms' profit returns for both of these concepts are quite different. For the RBV concept, the main resources come from physical resources (e.g. land, raw material etc.), human resources or know-how (e.g. managerial talents), technological resources (e.g. process technology), financial resources and intangible resources (e.g. reputation). Whereas, the relational view considers the key resources of a firm's profit which are generated from relation-specific assets (e.g. site specificity, physical asset specificity and human asset specificity), interorganisational knowledge-sharing routines (e.g. information and know-how), complementary resources endowments and effective governance (Dyer and Singh, 1998).

As mentioned above, the RBV of a firm and the relational view are different in several ways. The relational view is like a concept that shifts or expands the unit of analysis from the individual organisation to inter-organisational relationship or network relationship. This indicates the individual firm's resources and capabilities are shared with other firms, especially in the same networks. Also, the relational view can improve relationships among organisations because of mutual trust, reciprocity and membership of a knowledge community.

As suggested by Dyer and Singh (1998), they addressed that competitors are unable to imitate partnering behaviour because of collaboration between a firm and its alliance partners through investments in relation-specific assets, the sharing of substantial knowledge, the combination of complementary but scarce resources or capabilities and having lower transaction costs than competitors of a firm, due to effectiveness of a firm's governance mechanisms and mutual trust between a firm and its partners.

However, there are some limitations to develop relational rents, including interorganisational asset interconnectedness, partner scarcity (rareness), resource indivisibility or socially complex and institutional environment.

Firstly, interorganisational asset interconnectedness is one of the limitations of development on relational rent. This aspect will be found when an organisation creates investment in initial or previous relation-specific assets with its alliance partners. Because of that, it will generate conditions that make subsequent investment in specialized assets**.**

Secondly, partner scarcity is another limitation of relational rent improvement. Generally, relational rent is generated from an ability of a firm to collaborate with its alliance that has complementary strategic resources and a relational capability, but in some situations, many potential partners that have complementary strategic resources have collaborated with other organisations already. In addition, potential alliance partners may have insufficient relational capabilities or skills which are employed with mechanisms of effective governance and also are used to make decisions on investment of relation-specific assets or to improve routines of sharing of knowledge (Dyer and Singh, 1998).

Thirdly, resource indivisibility is the other limitation for development of resource or capabilities. Due to the fact that organisational resources have specialized characteristics of idiosyncrasy and indivisibility, a firm and its partners can create unique resources which make differentiated products or services. They had created indivisible and idiosyncratic resources to increase their profit and returns for their alliance partners. Each bank was able to access the VISA brand name and network by deploying participation of the alliance partners. To do so, it would generate a long-term relationship between all banks in the network, resulting in improving resource combination which can increase profits from the specific characteristics of the idiosyncratic and indivisible resources (Dyer and Singh, 1998).

Lastly, the institutional environment can be one of the limitations of a firm's interorganisational relation resources. It can foster trust between a firm and its alliance partners in many countries. Generally, there are different institutional environments in different countries. An organisation in Japan, for example, has an institutional environment which supports mutual trust and cooperation among alliance partners more than a firm in U.S. Based on empirical research on transaction relationships (Molina and Dyer, 1999), the Japanese organisations will more likely employ the extra-hybrid social controls within the institutional environmental in Japan more than in the organisations in USA and Russia. Because of that, firms in Japan do not necessarily write (legal) contracts, resulting in lower transaction costs when compared with firms in

USA and Russia. In addition, they have more investments in relation-specific resources and share their knowledge willingly with their partners.

On the other hand, organisations in USA have less social control than in Japan; they have to rely on legal contracts which create many processes and have higher transaction costs relative to Japanese firms (Molina and Dyer, 1999).Therefore, Japanese firms have lower transaction costs than U.S. firms because of relational rents in different institutional environments as mention above. As a result, firms in the countries which fostered trust and cooperation with their alliances will be more successful in relational rents than other organisations in other countries without trust encouragement in an institutional environment.

Therefore, the RBV of a firm and relational view have been applied in much literature that is related to firm performance (Karia, 2011, Karia and Wong, 2013, Russo and Fouts, 1997, Rungtusanatham et al., 2003). For example, according to Rungtusanatham et al., 2003, the researchers have applied the RBV of a firm in their research to examine the association of supply chain linkages with operational performance based on the RBV of a firm. The RBV of a firm has been applied in the research because it can explain that the supply chain interactions as a resource can provide operational performance improvement to a firm that represents an aspect of inter-organisational relationships. In addition, it has been successfully applied to develop understandings in other aspects of inter-organisational relationships such as alliances and networks (Dyer and Singh, 1998) because supply chain linkages can be a capability to acquire a resource that leads a company to benefit in the internal operation of the firm as well.

The results of this study conclude that the conceptual framework of the supply chain linkages – operational performance based on the RBV of a firm and relational network can help a manager to justify a decision that a firm may develop and protect integration on both sides of the supply chain with suppliers and customers. For example, firms can use the conceptual model to evaluate make or buy decisions, so that the transaction cost does not become the only method to assess the critical connection with suppliers and customers. Furthermore, the researchers found that supply chain linkages to suppliers and customers can provide a chance to gain knowledge to make the management of internal operations of a firm easier. This research also concludes that the digital economy or business model (e.g. business-to-business and business-to-customer model) can increase opportunities for growth and improve financial performance (Rungtusanatham et al., 2003).

Furthermore, organisations should identify new resources besides those available resources (tangible and intangible assets) and capabilities to be integrated into their business's strategies in order to create a new and innovative way to compete with other companies. Hart (1995) noted that existing competencies of a firm can be obsolete or outdated because of technological discontinuities or changing in external conditions. Thus, firms have to develop new resources. Moreover, Hart argues that one of the most essential drivers of new resources and capabilities development is the natural environment (Hart, 1995). As a result, the natural environment becomes one of the most vital issues that all of us have to consider, not only for the present time, but also for the future. This concept is known as the natural-resource based view (N-RBV) of a firm (Hart, 1995).

For all of these many reasons, the natural environment is increasingly considered as one of the most important dimensions that businesses should be concerned with and include into their corporate strategies. In addition, it is seen as a new resource that companies can use to create differentiated products or services, leading to brand loyalty and a good reputation for them. Therefore, according to the N-RBV of a firm, companies which consider environmental issues will have a competitive advantage that leads to a sustainable competitive advantage and ultimately sustainable firm performance (Hart, 1995).

The N-RBV of a firm has been applied in research to study a firm's performance, in terms of environmental and economic performance; for example, the article of Pullman et al. (2009), Vachon (2003) and Vachon and Klassen (2008). For example, The N-RBV approach is a theoretical foundation for Vachon and Klassen (2008)'s study that involves environmental collaboration which focuses on the inter-organisational interaction between supply chain members impact on manufacturing performance, including product-based performance and process-based performance. Empirical results of this research show that upstream practices positively associate with process-based performance, whereas downstream practices are positively related to product-based performance.

Based on the above discussions, the resource-based view (RBV) of a firm, relational view and natural-resource-based view (N-RBV) of a firm seem to be the most relevant theories for explaining sustainable performance, and especially a clear understanding sustainable supply chain management issues.

As discussed, this research will concentrate only on environmental and economic performance. To provide further understanding, the following sections discuss existing literature on environmental and economic performance. All of these will be explained in detail, respectively.

2.3.3.2. Environmental Performance

The natural environment has become one of the most vital issues that any organisation and all of us have to consider not only for the present time, but also for the future. In addition, according to a quote from the previous prime minister of the UK Gordon Brown, he confirmed this point in his speech to United Nations Ambassadors on April 20, 2006 (Brown, 2006a)

> *"Environment sustainability is not an option – it is a necessity. For economies to flourish, for global poverty to be banished, for the well – being of the world's people to be enhance - not just in this generation but in succeeding generations – we have a compelling and ever more urgent duty of stewardship to take care of the natural environment and resources on which our economic activity and social fabric depends".*

Nowadays, our world encounters many kinds of environmental problems, such as toxic substances, air pollution, water pollution, global warming, ozone depletion and nuclear waste(Liu, 2010). These problems have influenced and impacted not only human-beings, but also all living creatures everywhere around the world. In addition, the effects of environmental destruction seem likely to worsen and become more severe than in the past. Hence, many people are paying more attention to such natural environmental issues. Furthermore, most countries have developed environmental policies in order to control and try to protect the environment from these problems. Also, they would like to improve and sustain natural resources and the quality of life for their populations at present, and importantly, for the next generation. From sources mentioned previously, a majority of organisations have been concerned about the natural environment that they have to use for manufacturing their products. Consequently, they attempt to find many ways to preserve and manage the environment. All green activities or programmes of each company can in theory influence a business's image and corporate environmental performance. If they gain better environmental outcomes, it means they will attain the sustainable performance that each firm needs to accomplish.

In the literature there are many different definitions of environmental performance. In general, environmental performance is the outcome of an organisation to establish compatible relationships among various stakeholders who are concerned with environmental issues (Burns, 2000). The existing performance measurement on environmental issues is growing, but may not be adequate to fully evaluate green supply chain management (Hervani et al., 2005). From practices and literature, there are many tools, such as balanced scorecard, life cycle analysis, activity-based costing, design for environmental analysis and the analytical hierarchy process. Some tools could be applied to green supply chain management issues, but others need development and further extension.

Environmental performance measurement is a core requirement for green supply chain management issues (Hervani et al., 2005) for an organisation to assess the environmental performance of activities, processes, hardware and services. The Department for Environment, Food and Rural Affairs (DEFRA) has identified 22 environmental key performance indicators (reporting guidelines for UK business) that can be categorised into four key elements: emissions into air, emissions into water, emissions into land and resource use and two additional elements on how business influences the environmental performance of its supply chain and products (Defra, 2013). Furthermore, reactive organisation might focus on complying with new regulations and law; they may concentrate on the amount of regulated emissions or disposal of hazardous waste that would be core environmental performance measures (Hervani et al., 2005).

In addition, The Internal Organisation for Standardization (ISO) has developed ISO 14031: 1999 which is an environmental performance evaluation tool to provide a firm with specific guidance (but not a standard for certification) on the design and use of environmental performance evaluation and on the identification and selection of environmental performance indicators. Regardless of size, complexity, location and type, any organisation can apply this guidance to measure its environmental performance on an on-going principle (ISO, 2009). ISO 14031: 1999 defines environmental performance indicators as "a specific expression that provides information about an organisation's environmental performance".

ISO 14031 divides the environmental performance metric into three key classifications: management performance indicators, operational performance indicators and environmental condition indicators. The management performance indicator is an indicator of an organisation's effort to influence the environmental performance of a firm, e.g. environmental costs or annual budget (dollars per year), the percentage of environmental targets achieved and time spent responding to environmental incidents (person-hours per year). The operational performance indicator is an indicator of an organisation on operational environmental performance, e.g. raw materials used per unit of product (kilograms per unit), hours of preventive maintenance (hours per year) and average fuel consumption of a vehicle fleet (litres per 100 kilometres). The environmental condition indicator is an indicator of the local, regional, and national condition of the environment and is useful for assessing the organisational impact on the local environment, e.g. frequency of photochemical smog events (number per year), contaminant concentration in ground or surface water (milligrams per litre) and the area of contaminated land rehabilitated (hectares per year).

There are many researchers who look into the different environmental performance measures. For example, Zhu and Sarkis (2004) suggest an environmental performance measurement which consists of six measurement items: air emission reduction, waste water reduction, solid wastes reduction, consumption for hazardous/harmful/toxic materials reduction, frequency for environmental accidents reduction and an enterprise's environmental situation improvement. According to de Burgos Jimenez and Cespedes Lorente (2001),environmental performance can be classified into four perspectives: internal systems measurement, external stakeholder relations, external impacts, and internal compliance (de Burgos Jimenez and Cespedes Lorente, 2001). Henri and Journeault (2010) expanded the concept of environmental performance developed by Ilinitch et al. (1998) and Lober (1996) by dividing green performance into four aspects: environmental impact and corporate image, stakeholder relations, financial impact, and process and product improvement (Burns, 2000). Accordingly, all aspects should be incorporated together, since one aspect alone is not enough for environmental performance. Each of these four aspects will be explained in detail as follows.

The first aspect concerns the environmental impact which affects corporate image; it refers to the relationship between a business's reputation and the environmental standard which is assigned by legal regulations, particularly, those which relate to air emissions, releasing pollutants, waste emissions, solid emissions, and consumption of hazardous materials (Zhu and Sarkis, 2004). The second issue concerns stakeholder relations: it concerns communications about environmental issues between an individual business and its stakeholders, such as customers, suppliers, shareholders, community, and government etc. The financial impact is the third aspect. This refers to the financial results which are related to environmental activities, such as decreases in material costs, production costs and regulatory compliance costs. The last component concerns process and product improvement: it is about the incorporation of environmental matters into a firms operation, such as by improving product/process quality, increasing productivity, and developing innovations in the business.

As discussed above, environmental performance measures are plentiful, but it is difficult to consider which is the most suitable to use, when to measure them, and how to measure them. Importantly, before selecting a performance measurement, a firm should know and identify the key stakeholders in the environmental performance process because stakeholders' expectations are a fundamental issue (Shaw et al., 2010)that every organisation has to be concerned with and respond to environmental pressures.

2.3.3.3. Economic Performance

Economic performance is the most crucial driver for all businesses, particularly businesses in developing countries as stated by Zhu and Sarkis, 2004. They noted that economic performance is one dimension of total performance which is a part of the framework of sustainable supply chain management. Normally, all companies need to achieve long-term economic performance, but it is very difficult to succeed in that objective in the real world. Therefore, most organisations attempt to find a potential corporate strategy to create a better bottom line for the business. At the same time, a suitable firm performance that companies choose to measure is very important as well.

From reviewing the literature of not only economic performance, but also overall firm performance, some research has been concentrated only on financial performance (Freedman and Jakki, 1988), while others have addressed not only financial performance, but also other measures such as marketing performance (Rao and Holt, 2005, Thompson, 2004, Stevens, 2002). Thus, there is ambiguity in the definition of economic performance. Most people understand both financial and economic components to have the same meaning. As a result, before identifying the measurement of total performance, organisations should be concerned about sustainability, and thus both of these performance measures need to have their definitions clarified.

In fact, there are remarkable differences between financial and economic performance. Jennings (2004) explained their different meanings. He considered that the financial point of view is about the provision of money considering the time and the place of consuming or for investment into the business and importantly pointed out that financial results must pass through a firm's books and annual report before being presented. On the other hand, the economic component is "the means by which society uses human and natural resources in the pursuit of human welfare". As a result, economics extends beyond the boundaries of a single organisation and is linked to environmental and social elements of sustainable development.

This means that profitability or financial performance measurement is only one dimension of economic performance; it is not all of it. Hence, the economic performance construct in this dissertation will consider not only financial performance, but will also address the marketing component as well.

In prior literature of economic performance, many researchers have mentioned several indicators about firm performance. For instance, Maydeu-Olivares and Lado (2003) classified economic performance into three measures: market share, premium growth (such as sales growth), and profitability per year averaged over the last three years (such as ROI). Furthermore, Rao and Holt (2005) have addressed all of the indicators mentioned above and added two new indicators in their economic performance, consisting of new market opportunities and product price increases.

In conclusion, based on the concept of sustainable supply chain management, the last indicator, economic performance, will measure not only financial performance, but also non-financial performance as addressed above. All of these measurements represent accomplishments of the organisation. Economic performance is influenced by several sustainable supply chain management practices in the whole supply chain, including within an organisation and between the organisation and external stakeholders. Thus, each firm should consider those activities that relate to stakeholders of a firm and attempt to respond to their satisfaction. All practices should generate better firm reputation and eventually enhance a firm’s competitive advantage and performance.

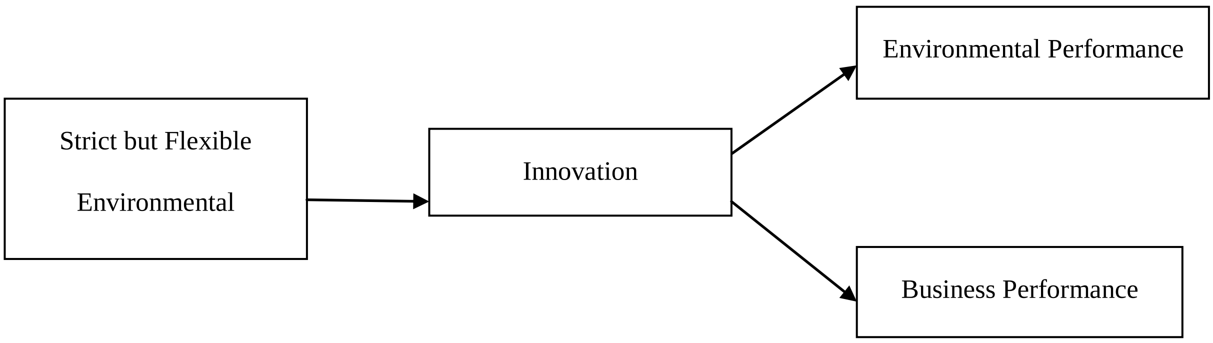
2.3.3.4 The relationship between environmental performance and economic performance

The concept of sustainability was introduced into strategic management which considers environmental preservation, social-wellbeing, or human rights and economic outcomes (Environmental Production Agency, 2011) as mentioned in the previous section. Therefore, an organisation needs to be concerned about all three aspects, including the environmental, social and economic perspective, not only maximizing the shareholder's value. Nowadays, organisations need to be concerned about corporate social responsibility to manage its strategies for meeting stakeholders' expectations in order to contribute to the environment, social wellbeing and also financial success of a firm. Thus, many researchers attempt to examine the relationship between social responsibility and financial performance. For example, as concluded in previous articles, the relationships are found that there is a positive impact of social performance on financial performance (Ruf et al., 2001, van Beurder and Gossling, 2008). On the other hand, research about the relationship between environmental performance and economic performance has been inconclusive results (Clemens and Bakstran, 2010,Moneva et al., 2007, Moneva and Ortas, 2010).

According to Moneva and Ortas (2010), from the managerial perspective, stakeholders have become concerned about environmental impacts more than in the past, so stakeholder pressures lead organisations to include environmental issues in their policies and also in strategic business management. To do so, companies need to maintain efficiency and attain improved environmental performance. In the mid-long term perspective, if managers ignore environmental factors when creating the organisation's strategic management policies, they could cause a loss of competitive advantage (Porter and Kramer, 2006). For example, the Body Shop improved its financial performance after developing environmentally friendly products for consumers (Livesey and Kearins, 2002).

Furthermore, the environmental performance/economic performance relationship has been influenced by Porter and van der Linde (1995) formulating a concept which is known as the Porter hypothesis. This concept examines the relationship among three main constructs, including environmental regulations, innovation and firm performance, in terms of environmental performance and business performance (Ambec et al., 2011) as presented in Figure 2.3.

Figure 2.3 Schematic Representation of the Porter Hypothesis



Source: Ampec et al., (2011)

Figure 2.3 indicates that stringent but well-designed environmental regulations can improve innovation of a firm, therefore, leading to a positive linkage between environmental performance and economic performance.

Porter and van der Linde (1995) suggest that reducing pollution may improve the way resources are used, leading to improved product quality and/or related processes. Also, innovation of a firm create a differentiation for organisations' products or services, resulting in companies obtaining a competitive advantage over competitors, ultimately leading to enhanced economic performance (Hart, 1995).

2.4. Green Supply Chain Management Practices

When defined in 1987 by the World Commission on Environment and Development (WCED, 1987), the concept of sustainability was not broadly recognized in the business world. Nowadays, many researchers have consented to the idea that sustainable practices can improve corporate performance and more importantly long-term performance outcomes. Since all businesses are concerned about their future profitability and the profitability of the whole supply chain, sustainable supply chain management has become important in recent years. As a result, it is imperative to examine the sustainable practices which are related to supply chain management. As noted previously, based on the concept of sustainable supply chain management and the triple bottom line, this section concentrates on sustainable supply chain management practices, especially green supply chain management (GSCM) practices.

2.4.1. Natural-Resource-Based View of a firm and Green Supply Chain Management Practices

For a long time, people around the world have been facing many serious environmental problems, such as toxic substances, air and water pollution, global warming, ozone depletion, and nuclear waste (Liu, 2010). Importantly, all of these problems seem to have become more severe as time passes. Actually, most environmental complications come from human activities in their daily life. Therefore, people should be concerned about these problems. To achieve pollution abatement, organisations can control and prevent emissions and effluent (Hart, 1995). Pollution control seems to be an expensive, non-productive approach, whereas pollution prevention is more likely to require involvement from employees and continuous improvement of emissions reduction. Prevention is better than expensive “end-of-pipe” pollution-control technology (Hart, 1995). This world is not just for people, but for all creatures existing in it, so there must be cooperation among all people to sustain natural resources, not just for this generation but for future generations as well. From an organisational viewpoint, firms that have realized the importance of environmental circumstances should include this consideration in their business strategies.

As mentioned above, one of the most important resources for this time is natural resources(Hart, 1995). This perspective has been named the natural-resource-based view (N-RBV) of a firm. According to Hart's article (1995), the environment is one of the essential kinds of resources that many firms will have recognized and natural resources will be an unavoidable topic in the future. In addition, this resource can assist organisations to achieve sustainable performance which all firms need to succeed. According to Hart (1995), when any firm needs to attain a sustainable competitive advantage, they should apply the natural resource issue in their business activities in order to facilitate their enhanced outcomes and differentiate their products and services (Shi et al., 2012, Hart, 1995). According to this theory, all of these resources can help an organisation to improve brand loyalty, reputation and premium pricing (Porter, 1980, Porter, 1985). Many researchers have written about a natural-resource-based view of firms and applied this conceptualisation in their research (Sarkis, 2001, Vachon, 2003, MacKenzie, 2003, Pullman et al., 2009, Vachon and Klassen, 2006, Vachon and Klassen, 2008).

Based on N-RBV theory, Shi et al. (2012) proposed hypotheses about the causal relationship between intra- and inter-organisational environmental practices and firm performance in terms of environmental, operational and financial performance. However, the main aim of this research is that building the conceptual framework for understanding GSCM in terms of N-RBV of a firm which is called natural resource-based green supply chain management (N-RBV GSCM) and also develops the conceptualisation about the association of GSCM with GSCM performance measure and institutional drivers. However, the researchers have not tested their hypotheses to support their conceptual framework. Consequently, this study has not obtained empirical results to confirm the theoretical hypotheses (Shi et al., 2012). Thus, the next step for this research is the development of measurement instruments through reliability and validity of the N-RBV GSCM via a large scale survey to empirically test the proposed hypotheses further.

Moreover, much research has presented positive relationships between an organisation's environmental activities and a firms operational performance (Vachon, 2003, Vachon and Klassen, 2008, Zhu and Sarkis, 2004, Rao and Holt, 2005, Pullman et al., 2009, Green Jr. et al., 2012, Giovanni, 2012). For example, Zhu and Sarkis's article (2004) concluded that there is a positive relationship between green supply chain management practice (which consists of internal environmental management and external environmental practices) and environmental performance and economic performance (positive and negative economic performance). Furthermore, according to Giovanni (2012), internal and external environmental management practices are positively related to environmental performance, but they are not positively related to the economic performance of a firm.

In conclusion, the N-RBV of a firm is one of the essential theories that many researchers have accepted and applied in their research (Sarkis, 2001, Vachon, 2003, MacKenzie, 2003, Vachon and Klassen, 2008, Pullman et al., 2009); Shi et al, 2012). Therefore, much research can expand this theoretical concept to business strategies and policies by developing novel organisational practices, especially environmental management practices or green supply chain management practices.

2.4.2. Green Supply Chain Management Practices

The literature on environmental management, sustainable supply chain and green supply chain management (GSCM) has increased in recent years owing to the natural environment becoming a very important issue that is strongly related to organisations' image or reputation (Hart, 1995). As a result, a number of businesses have incorporated this issue into their strategy during recent years. In fact, they have attempted to confront the environmental impacts of their supply chain activities. Not only organisations but also many creatures face environmental disaster and it seems inevitable they will encounter more, and worsening, natural resource disasters in the future around the world. Examples of environmental impacts include pollution, global warming, earthquake, flooding, volcanoes and tsunamis. According to Fiksel (1996), the operations of all businesses and manufacturing in many industries has the highest impact upon the natural environment, through the creation of pollutants, disruption of ecosystems and depletion of natural resources (Borchardt, et al., 2009). As a result of these problems, many businesses realise that GSCM is an important issue to be incorporated into their business strategy, in order to eliminate or reduce these problems.

The GSCM concept comes from both environmental management and supply chain management literature (Srivastava, 2007). It indicates that a green element has been included in supply chain management. Furthermore, Srivastava (2007) also defined GSCM as "integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing process, delivery of the final product to the consumers as well as end of life management of the product after its useful life." In addition, Liu, et al. (2011) confirm and expand the GSCM concept of Srivastava, stated above. They add that, "GSCM emphasizes the concerns for the environment along the whole supply chain and requires long–term and strategic collaborations between the supply chain members. GSCM covers the management of the life cycle of the product from its manufacture and consumption until the end–of–life."

It can thus be seen that the GSCM concept focuses on environmental aspects of every process in the supply chain, not only in an individual organisation, but within other relevant organisations, by integrating suppliers and customers into the life cycle of a product; from material procurement, through product design, manufacturing, delivery of products, to the customers and also reverse products. Thus, if companies undertake proactive management of environmental programmes, or engage in activities leading to pollution prevention (such as reducing air emissions and water pollution), customers will be attracted to businesses which consider these problems, rather than to companies who do not care about them. When customers pay additional attention to these businesses, such businesses will be more likely to achieve a sustained competitive advantage (Hart, 1995) because customers develop brand loyalty, which will also improve the firm's performance. Many researchers have indicated that GSCM practices can enhance environmental performance (Rao, 2002; Rao and Holt, 2005; Pullman, et al., 2009; Zhu, et al., 2005; Green, Jr., et al., 2012; Giovanni, 2012).

Within green supply chain management literature, there are many different conceptualisations of GSCM practices. Some researchers classify GSCM practices into the categories of greening inbound, greening production, and greening outbound (Rao and Holt, 2005). Other researchers state that the main environmental activities include both internal activities and external activities (Giovanni, 2012; Shi, et al., 2012; Zhu and Sarkis, 2004). For this study, the author separates GSCM practices into internal and external practices in order to correspond to groups of stakeholders considered as internal and external stakeholders, as addressed in the previous section. Thus, GSCM practices in this study can be categorised into two aspects: internal green supply chain management (IGSCM) practices and external green supply chain management (EGSCM) practices. Both of these constructs will be explained in detail, respectively.

2.4.2.1. Internal Green Supply Chain Management Practices

According to Srivastava's (2007) definition of GSCM, internal green supply chain management (IGSCM) practices are defined as integrating environmental thinking within a firm, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers and end-of-life management of the product following the completion of its usage. Within environmental management literature, there is agreement that internal environmental management is the main avenue through which to enhance organisational performance (Carter, et al., 1998). The starting point for implementing internal environmental management practices is gaining support from company executives; not only senior managers but also mid-level managers (Zhu, et al., 2005; Carter, et al., 1998). Furthermore, an environmental standard, such as ISO 14001 certification, should be implemented so that organisations can protect the natural environment, demonstrating that they have an environmental policy for preventing pollution, such as waste management, reducing emissions, reducing soil and water impacts, and decreasing deforestation (Boehlje, 1993). In addition, some researchers have discussed investment recovery and eco-design as vital practices to adopt (Zhu and Sarkis, 2004; Zhu, et al., 2005; Zsidisin and Hendrick, 1998).

Investment recovery is the process of recovering the value of unused or end-of-life assets through effective reuse or surplus sales (Zhu and Sarkis, 2004). It can extend the life of a product since it can be reprocessed into other products or parts. Eco-design is defined as, “a concept that integrates multifaceted aspects of design and environment considerations into product development in order to create sustainable solutions that satisfy human needs and desires” (Karlsson and Luttropp, 2006). Many companies now take into consideration more eco-design activities because they perceive several benefits from designing environmentally friendly products or services. Many researchers have addressed the benefits of eco–design such as reduced cost, improvement of competitive advantages, creation of a better business image, improvement of product quality and a reduction in the regulations that they have to observe. Borchardt, et al. (2009) and Vercalsteren (2001) have found that implementation of eco-design in organisations can: reduce product costs and environmental management costs; reduce the number of products due to increases in product multi–functionality; improve knowledge management; decrease the number of raw material items in stock; and reduce the need for investment in the industrial process.

2.4.2.2. External Green Supply Chain Management Practices

According to the definition of GSCM provided by Srivastava (2007), external green supply chain management (EGSCM) practices are defined as integrating environmental thinking into supply chain management, including product design, material sourcing and selection, the manufacturing process, delivery of the final product to consumers, and end-of-life management of the product, by interaction with both suppliers and customers. By reviewing green supply chain management and environmental management literature, the EGSCM practice construct can be separated into two sub-issues: supplier perspective and customer perspective. Zhu, et al. (2010) calls these constructs green purchasing and customer cooperation with environmental consideration, respectively. For the first step of EGSCM practices, the key factor of supplier GSCM practices or green purchasing (Rao and Holt, 2005; Shi, et al., 2012; Zhu, et al., 2010) is to provide and enforce environmental requirements to suppliers (Zhu, et al., 2005).

Moreover, companies should: integrate with suppliers in order to achieve common environmental goals; monitor their suppliers using internal audits, especially around enforcing environmental policy; and persuade them to adopt an environmental management standard, such as ISO 14001 certification (Zhu and Sarkis, 2004; 2005). Measures of EGSCM practices also include holding awareness seminars for suppliers and contractors, guiding suppliers to set up their own environmental programme, bringing together suppliers within the same industry to share their know–how and problems, informing suppliers of the benefits of cleaner production and technologies and pressuring suppliers to take action on environmental issues (Shi, et al., 2012).

For the second aspect of EGSCM practices, in terms of customer green supply chain management practice or green distribution, this practice refers to the greening of the forward distribution of products that is closely related to customer requirements (Shi, et al., 2012). Therefore, green distribution needs a large number of supply chain partners to collaborate with or integrate environmental management into their distribution functions of labelling, packaging, transportation modes and reverse logistics. The usage of packaging can have an impact on the amount of solid waste added to landfill. Many countries (e.g. within the EU and Asian countries) have a number of packaging directives on legislative measures to support the recycling and reuse of product packaging (Rao, 2002). Beyond green packaging, organisations also manage environmentally friendly distribution practices by considering sources of alternative fuel or using navigation systems to reduce distances and overall environmental impact (Kim, et al., 2003). According to Sarkis (2003), reverse logistics (with an environmental focus) is initially focused upon recycling and reuse of products and materials. Similarly, Roger and Tibben–Lembke (1999) define reverse logistics as “the process of planning, implementing and controlling the efficient, cost–effective flow of raw material, in–process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal.”

According to existing research, there are a number of measures of customer GSCM practices or green distribution. For example, companies should cooperate with customers on environmentally friendly design or eco–design, green products, cleaner production, green packaging, eco-labelling, take-back packaging and recovery of the company’s end-of-life product, and provide consumers with information on environmentally friendly products and the use of environmentally friendly transportation (Rao and Holt, 2005; Shi, et al., 2012; Zhu and Sarkis, 2004).

In summary, because of the increasing interest in environmental issues, many companies have currently included natural environment issues in their business strategy. Under the influences of stakeholder pressure, there is a need to adopt new organisational practices, especially green supply chain management practices. Presently, the supply chain management literature considers green supply chain management practices as some of the most important for businesses to adopt. While there are already some conceptualisations, theories and evidence, more empirical evidence is required to fully understand the impacts of such practices upon both environmental and financial performance.

2.5. Supply Chain Integration

Supply chain integration (SCI) is not a new concept in the field of supply chain management research. Supply chain integration is considered an important practice in enabling businesses to achieve superior performance (Flynn, et al., 2010; Wong, et al., 2011). From reviewing the existing literature on supply chain management, supply chain integration involves integration within an individual manufacturer (internal integration) and collaborating with its suppliers and customers (supplier integration and customer integration respectively). Supply chain integration is generally defined as the degree to which manufacturers strategically collaborate with their supply chain partners and collaboratively manage intra- and inter-organisation processes (Flynn, et al., 2010). If they work together, they are expected to reach mutually acceptable outcomes (Maydeu-Olivares and Lado, 2003).

For many years, a large number of organisations have been concerned with integrating suppliers, manufacturers and customers into the strategic management of their business processes (Klassen and Whybark, 1999a). In their research, Ragatz, et al. (1997) have emphasised that "the effective integration of suppliers into product value or supply chain will be a key factor for some manufacturers in achieving the improvements necessary to remain competitive."

There is a great deal of research that confirms the relationship between supply chain integration and other constructs. For example, Koufleros, et al. (2005) cite that not only internal integration, but also external integration, positively influences product innovation and quality. However, Flynn, et al. (2010) have argued that only internal integration positively relates to operational and business performance, and in turn customer and supplier integration, and they partially relate to the operational performance. Internal integration tends to improve process-related performance outcomes such as quality and cost (Wong, et al., 2011). Furthermore, Frohlich and Westbrook (2001) have argued that organisations which have the widest arcs of supplier and customer integration will have the largest rates of performance improvement. This type of integration has been labelled “outward-facing.” Such types of supply chain integration are known to have more significant effects on time-based performance outcomes such as delivery and flexibility (Wong, et al., 2011).

In addition, Kim (2009) has concluded that supply chain integration clearly plays a vital role in enabling sustainable supply chain management to achieve competitive capabilities in terms of cost leadership, customer service, innovation in marketing, and differentiation. Additionally, it seems that there is very little empirical research into the relationship between supply chain integration and supply chain management practices, especially green supply chain management and sustainable organisational performance. Therefore, there is a need to find out whether or not supply chain integration can lead to green supply chain management practices and sustainable performance, and if they are associated with each other, how they relate to green supply chain management practices and sustainable performance.

The aims of supply chain integration are to accomplish effective and efficient flows of products and services, information, money, and decision making in order to provide the greatest value for customers at a lower price and with higher speed (Klassen and

Whybark, 1999a). Moreover, supply chain integration can create mutual reliance and increase long-term relationship communication with organisational partners, where they can collectively solve problems whilst also sharing information, rewards and risks with each other (Flynn, et al., 2010). Classification of the supply chain integration construct has emerged in many different ways. For example, certain research has addressed the idea that supply chain integration consists of customer integration, internal integration, material integration, service integration, technology planning integration, measurement integration and relationship integration (Stank, et al., 2001). Some researchers have separated supply chain integration into two dimensions: internal integration and external integration (Droge, et al., 2004; Gimenez and Ventura, 2003). Furthermore, most researchers seem to agree that supply chain integration is categorised into three dimensions: internal integration, supplier integration, and customer integration (Zailani and Rajagopal, 2005; Boon-itt and Paul, 2006; Kim, 2006; Kim, 2009, Wong and Boon-itt, 2008; Flynn, et al., 2010a; Wong et al., 2011).

For this thesis, the definition of supply chain integration (SCI) as described above highlights the importance of strategic coordination or collaboration through continuous partnership to meet the strategic goals of a firm. The definition also focuses on business processes, not only within an organisation, but also with other supply chain members, including customers and suppliers as well. Furthermore, supply chain literature is more likely to have reached the consensus that SCI is involved internally in a business, within and across departments, and externally with other supply chain partners across customer and supplier organisations (Frohlich and Westbrook, 2001). Consequently, SCI for this research can ultimately be separated into three dimensions: internal integration, supplier integration and customer integration. Internal integration (II) emphasises activities within a firm. Normally, each manufacturer incorporates its own business strategies, practices and processes into integrative processes to accomplish its customers' requirements (Kahn and Mentzer, 1996) and also increase the efficiency of supplier relationships. On the other hand, supplier integration (SI) and customer integration (CI) commonly involve external integration, where an organisation has to interact with its external partners over time. Thus, it incorporates inter-organisational strategies, practices and processes into integrative processes (Stank, et al., 2001) or has interactive relationships with suppliers and customers (Flynn, et al., 2010). Supplier integration focuses on collaboration with the main suppliers of a firm, while customer integration places an emphasis on cooperation with the main customers of a firm. All three aspects of SCI will be explained in detail in the next section, respectively.

2.5.1. The Relationship between Supply Chain Integration and Sustainable Firm Performance

The potential of supply chain integration for gaining competitive advantages and improving a firm's performance has been discussed in business and management literature over an extended period of time. Many problems that businesses and manufacturers encounter during their operation and processing, such as scarcity of material, delivery problems, product quality issues and the inevitable increase of costs, can be caused by the lack of effective supply chain integration, not only internally but also externally (Wong and Boon-itt, 2008; Welker, et al., 2008). To resolve these problems, it is recommended that companies develop a high level of supply chain integration so that they can reduce or eliminate non–value added activities and improve product quality and delivery and thus, increase sales growth (Rosenzweig, et al., 2003).

There is much research determining the relationship between supply chain integration and firm performance, around the issues of financial performance (Vickery, et al., 2003;

Droge, et al., 2004; Kim, 2009; Rosenzweig, et al., 2003; Frohlich, 2002); non–financial performance such as customer satisfaction (Vickery, et al., 2003; Rosenzweig, et al., 2003); market-based performance (Droge, et al., 2004; Rosenzweig, et al., 2003); and environmental performance (Griffith and Bhutto, 2008; 2009). The findings from these articles have different results; some studies have found that supply chain integration is positively related to firm performance, including economic performance (Griffith and Bhutto, 2008; 2009), financial performance (Chen, et al., 2009; Droge, et al., 2004), market performance (Droge, et al., 2004), environmental performance (Griffith and Bhutto, 2008; 2009) and organisational performance (Griffith and Bhutto, 2008; 2009). Nevertheless, other studies have found that there is no direct positive relationship between SCI and financial performance (Vickery, et al., 2003). From the article of Kim (2009), the research findings show that there is a positive link between supply chain integration and organisational performance, including market performance, financial performance and customer satisfaction.

In addition, Griffith and Bhutto (2008), using multiple collection methods (survey, interview and case studies), have contended that an integrated management system within an organisation can provide many benefits from an economic and environmental perspective. They have argued that the integration of the management system can reduce fines and the environmental costs related to litigation arising from processing activities; reduce costs associated with clean-up and modified work; reduce the costs of purchasing parts which were wasted during production; and reduce the costs of waste removal and disposal. From an environmental perspective, integration of management systems could reduce environmental impacts such as usage of land; pollution of and through ground, water, noise and vibration; contamination of animals and plants; the use of the natural environment during processing, such as oil, fuels and natural minerals; and the impact upon communities, including the local area and neighbourhood.

There is also research concluding both positive and negative results about the relationship between supply chain integration and firm performance. For instance, according to Droge, et al. (2004), external strategic design integration is positively related to market performance after accounting for the indirect effects on market share, whereas internal design process integration is positively related to financial performance. External integration has a positive impact upon market performance (market share) due to the fact that firms have a closer relationship with customers, and so can understand their customers' expectations. Thus, they can create a product or service to meet their customers' requirements (Powell, 1995), meaning that organisations can improve sales, leading to an enhanced market share for the firm.

Also, Drickhamer (2002) found that organisations that excelled in total supply chain integration, especially establishing collaborative relationships with customers, cultivated an improved and timely responsiveness to their customers. The other result shows that internal integration has a positive influence upon financial performance, indicating that companies that are able to improve product and process quality through concurrent engineering or product or process design activities, in order to achieve process development, also have a closely coordinated design with manufacturing capabilities that enables increased financial performance.

In summary, supply chain integration appears to be a useful resource or capability for organisations to consider and incorporate into their business strategy in order to produce reliance and long–term relationships with members of the whole supply chain; not only within departments of the same organisation, but also with other groups in the supply chain, including suppliers and customers that the organisation has to communicate with. SCI also appears to be able to improve both financial and environmental performance. However, due to the varying results explored above, it is necessary for researchers to prove whether or not the theorised positive relationship between supply chain integration and sustainable organisational performance, exists.

CHAPTER 3: RESEARCH APPROACH AND HYPOTHESES DEVELOPMENT

3.1. Introduction

The preceding literature review on supply chain integration, environmental management and firm performance provides the background of the main constructs, including supply chain integration (SCI), green supply chain management (GSCM) practices and sustainable performance (SP) for this research. Besides, the existing research encourages the examination of the research questions presented in Chapter 1. The research questions enquire about the association between SCI, GSCM practices and sustainable performance in different ways. The main objective of this study is to understand the independent and combined effects of SCI and GSCM practices on sustainable firm performance in terms of environmental and economic performance. Therefore, before developing the hypotheses, this study presents the research philosophy and strategy to understand the philosophical underpinning of this research with a focus on the paradigms in supply chain management disciplines and a deductive approach for this thesis. After that, this research proposes the theoretical model according to the relationship between the main constructs, which are SCI, GSCM practices and SP, in order to understand the overall contents of these relationships. The theoretical model is presented in Figure 3.1.

3.2. Research Philosophy and Approach

This section presents the theoretical and paradigmatic issues that are concerned with management research, especially supply chain management research. In general, different researchers have different purposes and perspectives. Because of that, there are various ways in which people view the world which also influence their research, not only in terms of strategy, but also in the choices of method, research techniques as well as research procedures.

The world view of a researcher is a potential gateway to a research philosophy or paradigm of thought. The philosophy or paradigm will be impacted by practical considerations. The main impact is more likely to be a researcher's view of the relationship between knowledge and research processes. Kuhn (1996) described a paradigm as "an entire constellation of beliefs, values and techniques and so on, shared by the members of a given community", and Bryman (1988) expanded on the notion of paradigm by stating that "it is a cluster of beliefs and dictates which for scientists in a particular discipline influence what should be studied, how research should be done and how results should be interpreted".

It is a way of examining social phenomena from which a particular understanding of these phenomena can be gained and explanations attempted (Saunder et al., 2009). Before explaining and understanding the paradigm of this research, it is important to understand the assumptions used in research philosophy. The key assumptions include matters relating to epistemology, ontology and axiology (Saunder et al., 2009).

3.2.1. Epistemology, Ontology and Axiology

There are three key assumptions that a researcher has to consider before understanding research philosophy: epistemology, ontology and axiology (Saunder et al., 2009). Each assumption comprises important differences which will affect the way in which a researcher thinks about the research processes. Firstly, epistemology is concerned with the researcher's view regarding what constitutes acceptable knowledge in the discipline

(Bryman, 2012; Saunders et al., 2009). Also, this assumption considers the study of knowledge and what a researcher accepts as being valid and acceptable knowledge, indicating that epistemology is about how a researcher views the world and the relationship between him/her and the known or knowledge. The two extreme positions in the epistemological perspective are positivism and interpretivism.

Secondly, ontology is concerned with a researcher's view of the nature of reality (Saunder et al., 2009). The two extreme positions in the ontology perspective are objectivism and subjectivism. Objectivism presents the position that social entities exist in reality external to social actors or stakeholders who are concerned with their existence. A researcher who adopts a positivist stance is likely to view reality as an objective approach. By contrast, the subjectivist view comprises social phenomena that are generated from the perceptions and results of social actors' actions. A researcher who adopts an interpretive stance is likely to view reality as a subjective and socially constructed approach (Saunders et al., 2009). Therefore, individual social actors will perceive different situations in various ways as a result of their own view of the world. These different interpretations seem to impact researchers' decisions and affect their actions as well as the nature of their social interaction with others.

Lastly, axiology is a branch of philosophy that studies judgements about values (Saunders et al., 2009). In general, a researcher's choice of philosophical approach is reflected in his/her values. In addition, axiology examines the roles of the researchers' values in research processes and techniques of data collection. These value judgements can lead to conclusions that may differ from those of other researchers who hold different values. Positivist researchers conduct their study by believing in a value-free approach, implying that the researchers are independent of the data or the objects they have been studying, and the objects are not impacted by their research activities. By contrast, on the other extreme position, interpretivist researchers (also known as phenomenologist researchers) determine that their values help to examine what are recognised as the facts and interpretations that are drawn from them (Collis and Hussey, 2003). Unlike positivists, interpretivists are interested in gaining an understanding of a specific context in-depth. Consequently, the appropriate methods for an interpretivist approach involve using exploratory tools, such as case studies, focus groups, in-depth interviews and ethnography in order to understand the world in detail or understand it from the inside out, not from the outside in, like the positivist approach.

3.2.2. Paradigms

A paradigm is defined as a typical example or pattern of something; a pattern or model (Oxford English Dictionary, 2010). Thomas Kuhn (1996) described a paradigm as "an entire constellation of beliefs, values and techniques and so on, shared by the members of a given community" and Bryman (1988) also defined paradigm as "a cluster of beliefs and dictates which for scientists in a particular discipline influence what should be studied, how research should be done and how results should be interpreted". Therefore, research paradigms will affect the research methodology of individual researchers. In practice, there is no right or wrong paradigm or philosophy, but it is necessary that a researcher should be concerned about their own decisions on paradigmatic preferences. In general, when a researcher is thinking about which research paradigm or philosophy is better than the other, the validity depends on the research questions that he/she needs to answer (Ellaram, 1996; Saunder et al., 2009; Yin, 2003).

Base on an objective-subjective perspective, Burrell and Morgan (1982) suggested the framework that focuses on the difference between the paradigms of positivism and non-positivism (or phenomenological paradigm). According to the first paradigm, positivism, the researcher generally believes that human beings are likely to be studied as a part of the natural scientific world. They usually have an objective consideration. The research can be conducted in the physical realm (King, 2010) or using objective methods, such as surveys and questionnaires. For example, a survey by mailing a questionnaire to a large sample of managers will be a suitable method to quantify and test what variables are employed in their manufacturing industry. To do so, a researcher will know which variables are used and he/she can test the relationship among measurement items or variables.

On the other hand, interpretivism is known as the inconsistency with the scientific method or anti-positivism. Thus, the epistemological assumption of interpretivism suggests that social science is concerned with the subject matter, while natural science is concerned with the experimental matter. Accordingly, the study of the scientific world via a research method will be different from the study of the social world (Bryman, 2012). Because of that, an interpretivist researcher will employ exploratory methods, such as case studies, in-depth interviews, focus groups, observation and ethnography to understand the world from a subjective position (Saunder et al., 2009). This can help a researcher gain an in-depth comprehension of what he/she would like to study.

In this thesis, the research relates to supply chain management research which follows the scientific method (Mentzer and Kahn, 1995). The objective of science is to solve problems in order to answer the interesting questions of a researcher. Consequently, to answer the questions from a scientific or social scientific stance, objective methods were employed, such as surveys and questionnaires, to obtain creditable data and facts or empirical findings. According to Saunder et al. (2009), the objective position was usually used by positivist researchers in ontology, whereby he/she adopts a value-free approach in his/her study, indicating that researchers do not affect and are not affected by the subject of the research. Because of that, the philosophical standing or paradigm used for this research is positivism.

3.2.3 Research Approach

The research philosophy mentioned in the previous section can impact the research approach that a researcher chooses to conduct his/her study. Research approaches can be categorised into two: deductive and inductive approach (Bryman, 2012). They are suitable for different research philosophies or paradigms. Deduction is suitable for positivism, while induction for interpretivism (Saunder et al., 2009).

The deductive approach involves testing a theory as shown in Figure 3.1. Generally, it is the key research approach in the natural sciences which portrays the fundamentals of the explanation and anticipates the phenomena or occurrence (Collis and Hussey, 2003). Therefore, deductive research is more likely to be an approach to test a theory through theoretical hypotheses. On the other hand, the inductive approach is likely to be concerned with the context in which such events were taking place (Bryman, 2012; Saunder et al., 2009). With an inductive stance, theory is the outcome of the research; it implies that the process of induction involves building theory or generating generalisable conceptions or inferences out of observations or findings of the research as presented in Figure 3.2 (Bryman, 2012). Consequently, the inductive study conducted by collecting data from a small sample of subjects is more appropriate than a large sample, as with deductive stance. Also, inductive researchers seem to work with qualitative data and use diverse research methods to collect data in order to generate different perspectives of circumstances (Easterby-Smith et al., 2008).

Figure 3.1 Deductive approach based on the relationship between theory and research (source: Bryman, 2012)

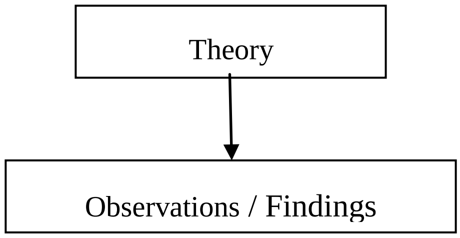
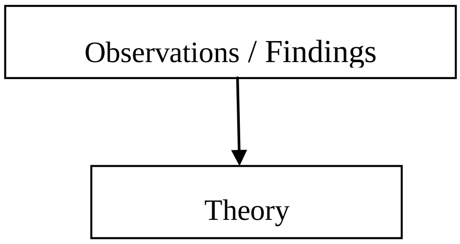


Figure 3.2 Inductive approach based on the relationship between theory and research (source: Bryman, 2012)



In operations management or supply chain management disciplined, many researchers have acquired the empirical data by using field observation from industries to develop and test theories through theoretical hypotheses (Forza, 2002). Furthermore, to reduce the gap between management theory and practice, and increase the scientific recognition of supply chain management research, this thesis was based on empirical research, particularly on survey research (Forza, 2002). In addition, in supply chain management research, as mentioned by Mentzer and Khan (1995), this literature is chiefly based on a quantitative approach through a positivist paradigm. To study supply chain management measures, the most popular research method has been the survey questionnaire. Thus, beyond the literature review, the survey method was used to fill the research gap and answer the research questions (RQ1 to RQ5) by collecting data and testing the related theories through proposed hypotheses to increase reliability and validity for this study. Moreover, the survey research is the most suitable method to generalise the research findings that have been studied (Bryman, 2012; Collis and Hussey, 2003).

Moreover, this thesis attempts to develop a theoretical framework to establish theoretical hypotheses and finally to test these hypotheses through a survey questionnaire. To achieve that, the deductive approach is the most suited to examine causal linkages among the main constructs, including SCI, GSCM practices and sustainable firm performance. Also, this approach will test the relevant theories for this research (Saunder et al., 2009). Generally, survey research can provide the development of scientific knowledge in various ways: exploratory, confirmatory and descriptive survey research (Forza, 2002). For this thesis, the exploratory survey research has been conducted in the first stage to gain an initial understanding of the topic and have ideas for more in-depth surveys in other stages. Additionally, the author has used the exploratory survey research to develop theoretical models and concepts for this research, as explained in the next section.

After developing the theoretical model by using well-defined concepts for this study, the confirmatory survey research (or explanatory or theory testing survey research) has been employed to test relevant theories through hypothesised relationships among the concepts of each construct, such as SCI – sustainable firm performance relationship, GSCM practices – sustainable firm performance relationship, and SCI – GSCM practices relationship. Furthermore, the confirmatory survey research is able to verify the validity of the theoretical models of this research by using a structural equation modelling (SEM) technique as explained in detail in chapter 6.

After that, the survey research design was generated. For this study, it contains a number of sub-stages, including the stage of translating a theoretical domain into an empirical domain in each construct, the stage of pilot testing, collecting data, data analysis and ultimately the stage of interpreting the findings and writing the research (Forza, 2002), as explained in detail in chapter 4 to chapter 8, respectively.

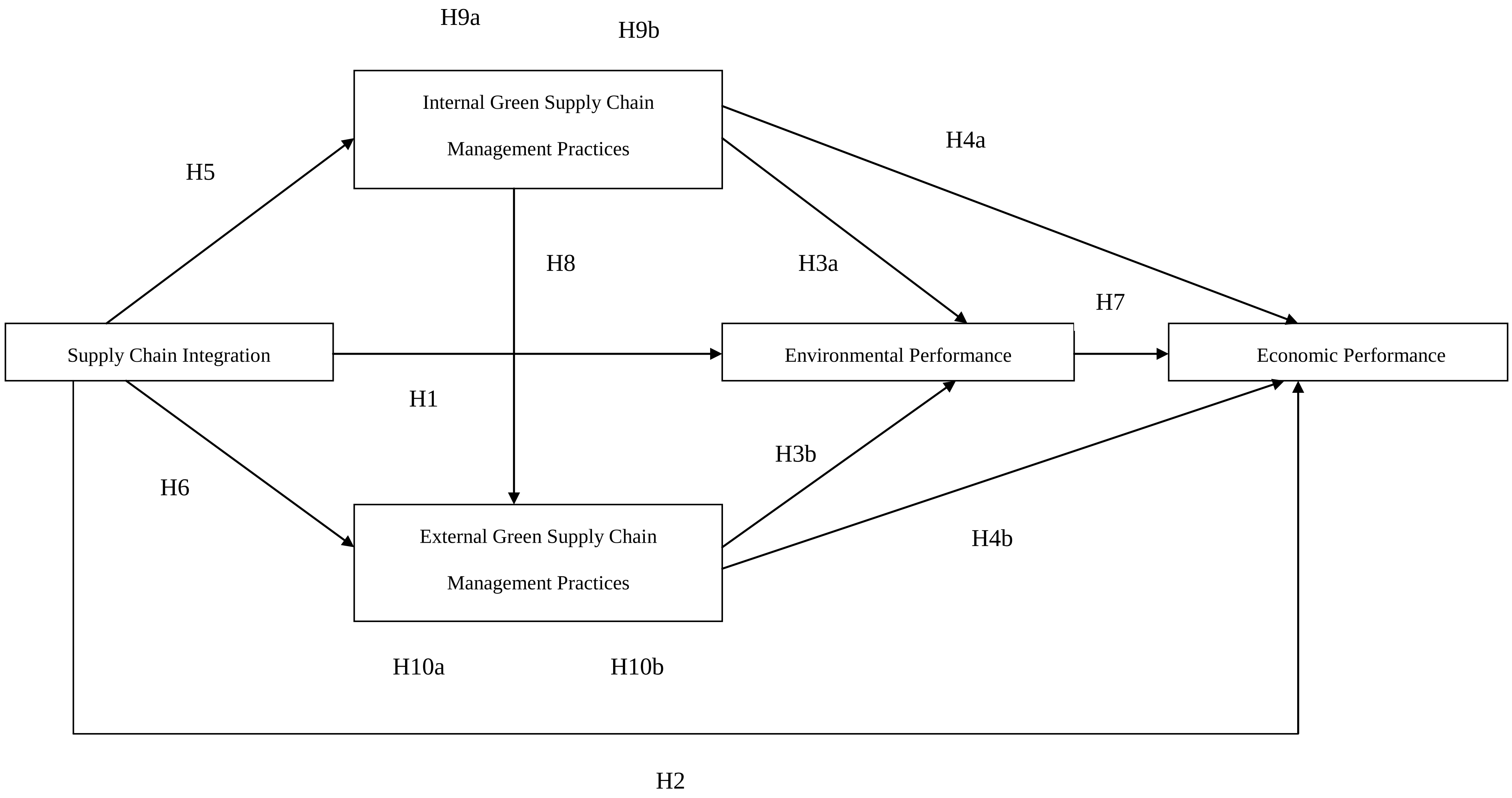
In conclusion, a deductive approach was used to conduct the research through survey research, as mentioned above. Deduction was employed because the main objective of this research to explain and understand casual relationships between three main constructs: SCI, GSCM practices and sustainable firm performance, as there are relevant theories about them. For example, GSCM is conceptualised from the theory which is known as natural-resource-based view (N-RBV) of the firm (MacKenzie, 2003; Pullman et al., 2009; Sarkis, 2001; Vachon, 2003; Vachon and Klassen, 2006; 2008). Consequently, the researcher would like to test the theory through theoretical hypotheses (as explained further in the next section). Also, the GSCM concept needs to be operationalised in a way that the researcher can gain empirical findings which can be measured by quantitative data to answer the research hypotheses and the initial research questions. Furthermore, the researcher would like to generalise the empirical findings of this research to contribute knowledge not only in the academic area, but also in the real business world simultaneously. As mentioned above, the deductive stance is more likely to be an appropriate approach for this thesis than the inductive approach.

As a result, the research paradigm and approach have been influenced not only by how researchers view the world, but also by how researchers establish their research methodology in all related processes to conduct their research.

3.3. Theoretical Model

After examining the research philosophy and approach, this research aims to employ a deductive approach which tests the relevant theories through the theoretical hypotheses. The research hypotheses are presented in the theoretical model shown in Figure 3.3. The model involves the influence of supply chain integration and green supply chain management practices, which are IGSCM and EGSCM practices on sustainable firm performance, in terms of environmental and economic performance. SCI is portrayed as an antecedent to GSCM practices and sustainable firm performance as an outcome of the model. Simultaneously, GSCM practices play their role as an antecedent of sustainable firm performance. In addition, IGSCM and EGSCM practices are examined as mediators of the relationships among SCI and sustainable performance constructs. The theoretical model leads to theoretical hypotheses which are explained in the next section.

Figure 3.3 Theoretical Model



3.4. The Relationship between Supply Chain Integration and Sustainable Performance

3.4.1. Supply Chain Integration and Environmental Performance

The resource-based view (RBV) of the firm and the relational view concept suggest that the possession of business resources can contribute to capabilities of any firm for generating and maintaining competitiveness and also enhanced firm performance (Barney, 1991). Resources and capabilities for providing competitive advantage should meet criteria, which are rare, valuable, difficult to replicate and have only few substitutes (Grant, 1996). If such resources and capabilities become valuable, they will allow organisations to exploit opportunities and reduce threats in the businesses' environment (Barney, 1991). Moreover, combining relation-specific resources or capabilities with other alliance partners of a firm can create unique, new products, services or technologies and also lower transaction costs compared to other firms, especially competitors. As mentioned by Dyer and Singh (1998), the relational rent can generate maximum profit for many organisations because it can create joint idiosyncratic assets, leading to differentiated products or services, and resulting in increased competitive advantage.

Nowadays, the issue of natural environment has become a primary topic for all businesses and individuals, because the environment can affect not only human beings, but all creatures around the world. Therefore, many organisations need their business strategies to take into account environmental concerns to achieve competitive advantage.

Environmentally conscious strategies will likely be rooted in the resources and capabilities of the firm to facilitate environmentally sustainable economic activity (Hart, 1995). This concept is known as the natural resource-based view (N-RBV) of the firm. To achieve competitive advantage, organisations can integrate and combine or bundle resources to improve logistics performance (Karia, 2011) and profitability. In particular, when companies include the environmental issues in their strategic business policy, this can be a new potential resource that enhances firms' internal methods for the reduction of waste, and increases operational and fuel efficiency, ultimately leading to better environmental performance (Russo and Fouts, 1997).

The development of new and environmentally friendly products requires internal integration. When departments such as research and development (R & D), production and marketing work together, they understand what customers want in terms of sustainable products and ways to reduce the environmental impacts of production. Internal integration helps cross-functional teams to improve product and process designs that help a firm reduce production costs (Ettlie and Stoll, 1991) and develop product quality at the same time (Rosenzweig et al., 2003). In addition, it can improve internal business processes which might lead a company to greater efficiency and effectiveness. As an environmental advantage, the integration of the management system can reduce the effects on the natural environment, by reducing the use of natural resources, such as land, air, ground and water (Griffith and Bhutto, 2008; Griffith and Bhutto, 2009). Organisations can apply these new insights, especially on the environment, to their products and processes to achieve an environmental competitive advantage.

Furthermore, the integration of a management system with supply chain partners can help a firm reduce the risk of environmental penalties, such as fines and relevant environmental costs, by reducing environmental accidents from work done during production processes. Integration with other members in the supply chain can force a company to consider environmental issues more fully, and it has been used to create environmental policy in many businesses (Griffith and Bhutto, 2009). To achieve this, other companies can investigate and audit the subject company. Thus, since a business has to observe carefully its operations all the time, it has the opportunity to reduce the risk of environmental penalties.

Collaborating with other manufacturers who are concerned about the natural environment can encourage a firm to think about environmental issues. This may cause them to cooperate with others in the planning about recycling, reusing, recovery and reducing the use of hazardous materials/parts. In doing so, the organisation can reduce clean-up costs, remedial work, waste material, and waste removal. Through integration with customers and other stakeholders, the business can closely monitor real customers' needs rapidly, so as to improve opportunities for a long-term relationship with customers and other stakeholders (e.g. regulators, environmental authorities and the public).

Moreover, supply chain integration can reduce the use of natural resources because of rethinking about innovating products and/or packaging by using few materials with the same quality, and these parts have multi-functionality. It can assist a company to reduce its effect on communities by helping the firm communicate with other people, so it can understand their requirements and how to meet their needs at the same time.

Given the reasons mentioned above, it can be argued that integration in supply chain activities can improve firm performance, particularly environmental performance. Consequently, supply chain integration can be associated with environmental performance. Hence, the first hypothesis in this study is:

H1: Supply Chain Integration is positively related to the environmental performance of the firms within a supply chain.

3.4.2. Supply Chain Integration and Economic Performance

The sharing of knowledge and bundling of resources within each department in the same organisation, and with the alliance partners of each organisation, can be one kind of resource acknowledged in a RBV of the firm (Barney, 1991) and a relational view concept (Dyer and Singh, 1998). Such resources available to each organisation can be a core competence or capacity which makes the firm appear to differ from other firms and ultimately lead to competitive benefits, resulting in sustainable competitiveness. Integrating the resources, not only tangible assets but also intangible ones, of each department within one organisation, or with two or more organisations in the same network that relate to firm’s operation, can generate not only differentiation strategy, but also cost leadership strategy (Karia and Wong, 2013; Karia, 2003). Organisational resources and capabilities would be improved when organisations manage their resources in different businesses in the whole supply chain (Schroeder et al., 2002). Generally, each department cannot stand alone; it is necessary that it communicate with other departments in the same organisation. For example, when a production department produces products for the following year, it has to know the sales forecast from the marketing department. The procurement department will order materials/parts or products; it has to know the level of inventory from the warehouse.

Moreover, sharing information between departments can make them each do their work more quickly and easily because they receive relevant information at the right place and at the right time. Planning by cross-functional teams can highlight departments' problems and help reach a solution, which ultimately leads to an improved work system. Thus, if each department integrates or collaborates with others, they will all receive many advantages.

If firms understand the other partners better, they will increase their potential communication and reduce communication errors because they can develop experience working together and share specialised information and know-how with their alliance partners (Dyer and Singh, 1998). In addition, creating commitment and trust between organisations makes them build long-term relationships and achieve long-term profitability, leading to sustainable performance. Supply chain integration facilitates the information exchange among supply chain entities. When a business interacts with others who are its suppliers, they can then closely communicate with each other. They can share information, such as product designs, inventory levels, production schedules and production plans (Wong and Boon-itt, 2008). By doing so, they can develop a strong partnership with suppliers, which allows each company to meet its requirements better. They can solve their problems together. If the suppliers know the level of inventories or the production plan of the firm, they can deliver materials/parts or products to the firm on time in order to produce new products and sell them to customers faster. Moreover, by developing an understanding of the organisations' operation, the suppliers will provide a better level of customer service. Supplier integration has been found to be an effective supplier integration link to product innovation performance, and then product quality performance, and finally profitability (Koufteros et al., 2005). Information sharing with other supply chain members helps suppliers gather information about the time when manufacturers need materials or products in real time. Consequently, information sharing can lead to improved delivery lead time, ability to change volumes quickly, and quality consistency (Armistead and Mapes, 1993).

In terms of customer service, a close relationship with customers can clearly improve communication, help understand the customers' needs, respond rapidly to their requirements, and even anticipate their expectations. Furthermore, it can improve the accuracy of demand information, which leads to a reduction of the time spent designing products and planning production, and it can also reduce out-of-date inventories because the firm knows the customers' needs directly from them. Customer integration can therefore reduce costs, produce greater value and anticipate changes in customer demand immediately.

These arguments have been supported by numerous researches which present a positive relationship between supply chain integration (e.g. internal integration, supplier integration and customer integration) and economic performance (Koufteros et al., 2005; Germain and Iyer, 2006). For example, supplier integration has been identified as an effective supplier integration link to product innovation performance, and then product quality performance, and finally profitability (Koufteros et al., 2005). However, others have found that there was a negative relationship between supplier integration and business performance, including market performance and customer satisfaction (Agresti and Finlay, 2009) and product quality performance (Koufteros et al., 2005). In terms of customer integration, Homburg and Stock (2004) found that customer integration directly related to customer satisfaction. Besides, according to Koufteros et al. (2005), customer integration positively correlates to product innovation, and then product quality, which ultimately leads to profitability. However, downstream integration is indirectly linked to logistical performance and leads to better financial performance (Germain and Iyer, 2006).

As a result, after reviewing the articles cited above, it emerges that inter-organisational relationships in the supply chain or the correlation between supply chain integration and firm performance can produce both positive and negative results at the same time. The hypothesis adopted in this study is the following:

H2: Supply Chain Integration is positively related to the economic performance of the firms within a supply chain.

3.5. The Relationship between Green Supply Chain Management Practices and Sustainable Performance

3.5.1. Green Supply Chain Management Practices and Environmental Performance

An environmental orientation concerns a knowledge-learning process in the firms' consciousness about environmental responsibility (Shrivastava, 1995). Organisational values and culture come from an environmental initiative which impacts the generation and implementation of environmental management systems in the firm (Fraj-Andres et al., 2009). Furthermore, environmental issues are able to persuade organisations to seek new opportunities for competition with other companies and also add value in their core competence (Kansmann and Kroger, 2001). In addition, an inter-organisational relationship provides formal and informal mechanisms that support risk reduction, trust improvement and in turn enhance innovation and profitability (Zhu and Sarkis, 2004).

Moreover, integrating environmental thinking within a firm is more likely to be a crucial starting point in developing an environmental consciousness. Encouragement from top-level (Rice, 2003) and mid-level managers (Carter et al., 1998) is the key driver to implement environmental management system practices. Managers have a responsibility to persuade their employees to recognise environmental problems. Without support from managers, the activities in an organisation cannot succeed in practice. If they are not concerned about the importance of the natural environment and do not motivate their employees to engage in environmental activities, no one will be interested in becoming involved in these activities, which will finally lead to a loss of competitive advantage and a loss of the good image of the firm. After that, employees will share their thoughts with other people within their department and other departments. Furthermore, when they interact with other departments, they can work and plan together; for example, designing environmentally friendly products by thinking about reusing, recycling and recovering materials or component parts, and avoiding or reducing the use of hazardous materials or products. By doing so, the organisation can reduce manufacturing costs by reducing waste, and, importantly, it can create a better image and reputation that will ultimately lead to improved firm performance (Zhu et al., 2005; 2007).

Furthermore, currently many companies are under great pressures from suppliers, customers and regulations requests that need them to respect to green products and green production. For example, Taiwan, as one of the industrially developed countries in the Asia-Pacific area, is affected by the Waste Electrical and Electronic Equipment (WEEE) Directive of the European Union which forces manufacturers in Taiwan to return used products from customers (Widmer et al., 2005). Also, the Restriction of Hazardous Substance (RoHS) Directive forbids the use of hazardous substances, such as cadmium, chromium, lead, mercury, hexavalent (Hu and Hsu, 2010). Moreover, to take a developing country, such as China, the government has imposed stringent environmental regulations on manufacturers. Thus, stakeholder pressures have influence on the strategic management of each organisation. Many companies therefore recognise the role of GSCM, which is very important in helping them meet supply chain partners' quality and environmental requirements (Zhu et al., 2005).

In terms of a collaborative approach, based on the relational view concept, any firm has to link with its alliances in the same network (not only suppliers, but also customers) all the time in order to enhance profits (Dyer and Singh, 1998). For instance, suppliers and customers will plan together with manufacturers to reduce the environmental impact from the production processes of products. Furthermore, environmental collaboration involves information sharing to learn about other companies' operations and set aims about environmental development together. This implies that organisations are able to reduce the environmental impacts related to material flows in the whole supply chain (Bowen et al., 2001; Carter and Carter, 1998).

There is much literature on environmental management discipline which is related to the relationship between GSCM practices and environmental performance (Carter et al., 1998; Zhu and Sarkis, 2004; Zhu et al., 2005; 2007). For example, Carter et al. (1998) stated that environmental management is the crucial factor to enhancing corporate performance. In addition, Zhu and Sarkis (2004) found that internal environmental management is positively impacted to alter environmental performance, positive economic performance and negative economic performance. Moreover, Zhu et al. (2010) compared the results of large Japanese and Chinese companies and found different results between these two countries. Internal green supply chain management among the Japanese companies has a positive result in environmental and economic performance, while operational performance is not positive. However, the result of this study was different in the case of Chinese manufacturers. In China, internal and external environmental supply chain management practice has positively influenced only environmental performance, and it was negatively related to economic and operational performance (Zhu et al., 2010). Furthermore, Giovanni (2012) concluded that there is a positive relationship between internal environmental management practices and environmental and social performance, but no relationship with economic performance.

According to numerous studies on environmental management and supply chain management which relate to the environmental issue, green supply chain management practices have greatly impacted business outcomes, including financial performance and non-financial performance. For these purposes, the hypotheses on the relationship between green supply chain management practices and environmental performance are:

H3a. Internal green supply chain management practices are positively related to the environmental performance of the firms within a supply chain.

H3b: External green supply chain management practices are positively related to the environmental performance of the firms within a supply chain.

3.5.2. Green Supply Chain Management Practices and Economic Performance

Supply chain management practices have been clarified here as the set of activities which are important for each organisation in order to foster effective management of its supply chain (Li et al., 2006). Organisations that implement a pollution prevention strategy take a proactive approach to environmental issues. Whereas a reactive approach involves policies that require achieving the minimum set of actions by government regulations or customer needs on environmental concerns. Reactive organisations implement end-of-pipe solutions, which may reduce environmental performance (Klassen and Whybark, 1999b). From a proactive perspective, a pollution prevention approach is knowledge intensive. Knowledge intensive approaches are generated from experiences of employees. Furthermore, the strategy improves continuous learning and leads to repeat organisational activities (Hart, 1999). Based on RBV of the firm, pollution prevention through experience and learning creates unique resources for the firm. Such resources can be presented by IGSCM practices, such as green production and environmentally friendly design (Shi et al., 2012). Unique resources can be specific assets that competitors are unable to imitate; this allows organisations to gain a competitive advantage over other companies. The concept of continuous improvement that is related to total quality management and voluntary standard implementation, e.g. the ISO 14001 certification, can make firms develop their process design, resulting in waste reduction through pollution prevention strategies (Handfield et al., 2005).

External environmental practices have become increasingly significant in many major countries, such as Germany, the UK and the USA (Zhu et al., 2005). Also, many areas around the world have now considered EGSCM more fully than in the past. For example, businesses in many big countries regard environmental purchasing as one of the main factors for environmental policy in their strategies. They think about environmentally friendly design when they cooperate with suppliers (Zsidisin and Hendrick, 1998). Based on the relational view (Dyer and Singh, 1998), any organisation unable to stand alone has to link with its alliances all the time. Therefore, inter-organisational relationships need to be improved in order to increase competitive advantage and lead to enhanced firms' performance. To improve relations effectively and efficiently, there are many environmental practices, such as cooperation with suppliers on environmental objectives, environmental audits for suppliers' internal management, and cooperation with customers for eco-design, cleaner production and green packaging. If a firm works with suppliers and customers and shares ideas about environmental topics, such as producing environmentally friendly products, generating environmental product designs and innovating green packaging (Zhu and Sarkis, 2004), it can reduce many environmental problems and ultimately improve environmental outcomes, such as a reduction of CO2 emissions, waste water, solid waste, (Zhu and Sarkis, 2004), leading improved profitability.

These arguments have been encouraged by much research which shows the association between green supply chain management practices and overall firm performance, such as the financial and marketing dimensions (Li et al., 2006; Carr and Pearson, 1999; Shin et al., 2000). Most researchers discuss the relationship between environmental practices and economic performance with the understanding that it is not only financial performance, but also marketing performance. Some research has shown a positive correlation between GSCM practices and economic performance (Kim, 2009; Zhu and Sarkis, 2004; Pallant, 2006; Li et al., 2006), while other research has produced different results (Kim, 2009; Zhu et al., 2005; Pallant, 2006; Pullman et al., 2009). According to Zhu and Sarkis (2004) and Li et al. (2006), organizations with a high level of green supply chain management practices would also have a high level of economic performance. On the other hand, Pullman et al. (2009) concluded that environmental practices, including facility resource conservation, waste recycling and reuse, and land management practices, are indirectly related to cost performance. In addition, Zhu et al. (2005) found that the green supply chain management practice adopted in Chinese businesses has not been directly related to economic performance. On the other hand, Giovanni (2012) concluded that the internal and external green supply chain management practices do not positively relate to economic performance in terms of reflective mode, but in terms of formative mode; only internal GSCM practices represent a positive direct impact on economic performance. Hence, the hypotheses on this issue are:

H4a: Internal green supply chain management practice is positively related to the economic performance of the firms within a supply chain.

H4b: External green supply chain management practice is positively related to the economic performance of the firms within a supply chain.

3.6. The Relationship between Supply Chain Integration and Green Supply Chain Management Practices

Supply chain integration is one of many ways to solve the problems of material and information flows among supply chain members. When an organisation coordinates with its customers and/or suppliers in the whole supply chain, it can communicate with other partners easily by sharing information, such as its production schedule, production plan, product design, demand forecast, and so on. In doing so, it can also generate a higher level of trust within the network, increase long-term relationships with its partners and solve problems at the right place and the right time (Flynn et al., 2010). In addition, supply chain integration can reduce uncertainty in a firm's operation, not only on upstream integration, but on downstream integration as well. For upstream integration, collaborating with suppliers makes a firm receive products or materials more efficiently, because suppliers know the company's inventory level or production plan at all times. Furthermore, according to Vachon and Klassen (2006) logistical integration is able to achieve cooperative solutions by reducing the environmental effect of the material flows between an organisation and its supply chain members. Also, by gaining more information from suppliers, organisations can reduce the need for environmental monitoring activities, and this will lead to reduced monitoring costs (Vachon and Klassen, 2006).

For downstream integration, sharing customer information makes an organisation know the customers' requirements, so they can produce products which directly respond to customers' needs at the right time. For example, nowadays customers often have considerably more environmental concerns, so the organisations should design their products by considering environmentally friendly processes, such as reusing, recycling, recovering, reducing the use of hazardous materials or parts, using green packaging, and integrating them into the business strategy.

These arguments are supported by many empirical studies. The researches state that supply chain coordination positively relates to green purchasing action (Carter and Carter, 1998) and environmental logistical collaboration with suppliers (Bowen et al., 2001). Moreover, according to Vachon (2003) and Vachon and Klassen (2006), supply chain integration, logistical integration, and technological integration positively correlate with green supply chain practices, whereas it was found that there was only weak evidence to support the relation between integration and monitoring activities. From many previous literatures on supply chain integration, there is much evidence which supports the result of the relationship between supply chain integration and environmental cooperation (Canning and Hanmer-Lloyd, 2001; Roy et al., 2001). Given the reasons mentioned above, supply chain integration can correlate to green supply chain management practices. Thus, the next hypotheses for this study are:

H5: Supply chain integration is positively related to internal green supply chain management practices of the firm.

H6: Supply chain integration is positively related to external green supply chain management practices of the firm.

3.7. The Relationship between Environmental Performance and Economic Performance

Based on environmental management literature, when firms adopt GSCM practices, it means that they are concerned about the environmental impact of their business processes, production, and the processes of the entire supply chain. Firms try to reduce the negative impact of their activities (Rao, 2002; Zhu and Sarkis, 2004; Zhu et al., 2005) and conform to regulation requirements. Porter and van der Linde (1995) argue that there are pressures to innovate from an environmental perspective which stem from government regulatory measures. Thus, any organisation tries to minimise or eliminate environmentally harmful elements according to such an environmental standard for its industry group. To achieve this objective, a company uses fewer materials and more recyclable and renewable resources at the same time. For example, the International Organisation for Standardization (ISO) developed ISO 14031:1999, which provides guidance on environmental performance indicators for organisations (ISO, 2012). Thus, beyond the requirements of CEOs and top management's objectives, organisations have to abide by the regulations to green the whole supply chain. Therefore, many organisations attempt to create innovative products to gain differentiation. To do so, they will have differentiated products which can achieve competitive benefits (Hart, 1995), which in turn improve firm performance, not only environmental performance, but also business performance (Ambec et al., 2011).

Nowadays, many organisations are concerned about the environmental perspective, so their innovation reflects the environmental awareness in their new products. A business which has developed product innovation can increase product performance, e.g. new product introduction rate, new product success rate and degree of product differentiation (Zhang and Duan, 2010), leading to increased competitive advantage over its competitors, and ultimately improved profitability of the firm.

To innovate or create a new idea, organisations can make changes not only in their products, but also in their business activities in order to make them either different, better or new. There are many ways to innovate organisational resources, such as reusing and recycling materials, components or finished products. Recycling and reusing can lead to reduced materials and reduced waste, not only solid waste but waste water as well. Recycling refers to waste material recovery and reprocessing for use in new products (Shi et al., 2012). The basic recycling phase involves the collection of waste materials; their processing is used for manufacturing new products with the same functions and initial designs (Britannica, 2012). By contrast, reuse of material is not necessary to re-process; it can have the same functions or different functions from its initial design (Shi et al., 2012). Consequently, both methods can simultaneously minimise the amount of materials used to produce the products, and reduce waste that needs to be land filled.

For that reason, the firm will improve its image, especially its environmental reputation. By reducing waste and using recycled materials, the company can decrease waste production and controlling and material costs, ultimately enhancing its profitability further.

In addition, the firms with greater concerns about environmental issues, such as how to use energy efficiency in their operation and production, attempt to introduce environmental management strategies in their business policies to develop manufacturing processes from an environmental perspective to address issues of reduction, reuse, recycling and remanufacturing (Sarkis, 2001). To do so, organisations can improve internal productivity and gain a competitive advantage over those firms which do not have such environmental concerns (Esty and Winston, 2009). Additionally, nowadays customers consider the environmental impact more than in the past, by saving energy and reducing harmful substances or using environmentally friendly materials. They will buy products from the firms with those plans even if the products are more expensive than other less green products. Thus, organisations can improve environmental performance, which is a potential source for competitiveness because it can lead to more efficient processes, improved productivity, lower cost of compliance and increased new market opportunities (Porter and van der Linde, 1995; Ambec et al., 2011).

From the reasons that mentioned above, environmental performance, such as gas emissions reduction, solid waste disposal reduction, and wastewater discharge reduction have an influence on economic performance, in terms of profit, return on investment (ROI) and market share (Zhu et al., 2004; Shi et al., 2012).

The arguments on the link between environmental and economic performance are examined by numerous researchers. For instance, many studies conclude that environmental performance has a positive impact on firm performance, including financial performance (King and Lenox, 2002; Nakao et al., 2007; Moneva and Ortas, 2010) and economic performance (Alvarez Gil et al., 2001; Green Jr. et al. 2012;

Giovanni, 2012). By contrast, other researchers found that environmental performance has a negative relationship or no relationship with economic performance (Link and Naveh, 2006; Rao, 2002; Wagner et al., 2001; Wagner et al., 2002).

For instance, according to Alvarez Gil, et al. (2001) there is a positive relationship between environmental initiatives and economic performance. Also, Moneva and Ortas (2010), Giovanni (2012), and Green Jr. et al. (2012) concluded that environmental performance is positively associated with economic performance. Furthermore Al-Tuwaijri et al. (2004) argue that there is a significant positive relationship between environmental performance, including ratio of toxic waste, recycled to total toxic waste generated and economic performance, which is measured in the stock price. Also, they pointed out that the companies which are good performers disclose pollution-related environmental information more than poor performers.

In addition, according to Aragon Correa and Rubio-López (2007) environmental performance, which is the emission of organic carbon, is not related to financial performance, which is ROI and ROE. Furthermore, Rao (2002) suggested that when a company adopts internal and external green supply chain management practices, including environmental initiatives and greening the suppliers, the environmental improvement may not directly influence economic performance. However, he found that the environmental activities could indirectly impact economic performance through competitiveness.

Given the reasons mentioned earlier, the hypothesis of the relationship between environmental performance and economic performance is:

H7: Environmental performance is positively related to economic performance.

3.8. The Relationship between Internal Green Supply Chain Management Practices and External Green Supply Chain Management Practices

According to environmental management and green supply chain management (GSCM) research, GSCM practices can be divided into two sub-categories: IGSCM and EGSCM practices, as mentioned in the previous chapter (Rao, 2002; Rao and Holt, 2005; Zhu and Sarkis, 2004; Zhu et al., 2005, 2010; Giovanni, 2012; Shi et al., 2012). IGSCM practices refer to integrating environmental thinking within a firm, comprising product designing, sourcing, manufacturing, delivery and also reversing logistics. EGSCM practices, on the other hand, refer to integrating environmental thinking into supply chain management, or integrating with supply chain members, such as suppliers and customers (Shi et al., 2012).

The greening process in a firm is the first stage to be implemented in order to reduce the impact of internal processes and practices (Rao, 2002), increase environmental targets and also comply with regulations and supply chain management's requirements. In other words, organisations implement internal environmental practices because they attempt to achieve a mission statement, department goals and firm-specific targets which are set out by senior or middle-level managers (Carter et al. 1998). Hervani et al. (2005) suggest that GSCM needs to become rooted within organisations. Top management focuses on the significance of GSCM performance management and also measurement evaluation; rewards at all levels can encourage the improvement of environmental management in the firm. Giovanni (2012) also puts forward the argument that internal business activities are a first step before integration and collaboration with other supply chain partners. When firms adopt IGSCM practices in their operations, they can implement EGSCM practices more easily.

Thus, internal environmental management will be successfully practised; involving top and mid-management is an initial step that any organisation has to be aware of. The executives of the firm need to support environmental policy or include environmental criteria in the firm's objectives by developing environmental awareness programmes in the organisations. After that, employees will care about the environmental impact of their business processes and production as well.

Environmental initiative is likely to be a mindset that an organisation creates in its employees' mind, which can lead to firm value. Therefore, employees will try to do anything to support their environmentally friendly products, not only in the production process, but also in the procurement from their suppliers up until the distribution of products to their customers. The consideration of environmental criteria influences all business activities that are implemented to green a single firm, such as the use of green materials or components, the use of cleaner technologies and reduction of waste and gas emissions. Organisations employ the capabilities obtained to adopt internal environmental activities to integrate and collaborate with their partners by greening all processes of the supply chain (Bowen et al., 2001). Therefore, greening within the firm alone cannot produce an environmentally friendly product, but greening all over the whole supply chain can create such a green product and lead a firm to improve environmental outcomes and economic performance further (Giovanni, 2012; Shi et al., 2012).

There are many environmental management studies which support the argument on the relationship between internal green supply chain management and external green supply chain management practices. For example, many researchers found that the IGSCM practices have a positive effect on EGSCM practices (Rao, 2002; Rao and Holt, 2005;

Green Jr. et al., 2012; Giovanni, 2012). Giovanni (2012) noted that greening the supply chain should start with an environmental initiative in each organisation as the first step (internal environmental management practices) and environmental management integration with the supply chain members later (external environmental management practices). Firms concerned about environmental issues deliberately implement external environmental initiatives to achieve success in GSCM more than the firms that do not have such an environmental consideration in their criteria.

Moreover, Rao and Holt (2005) and Giovanni (2012) found that when firms consider the green supply chain not only in each firm but also in the whole supply chain, they can improve competitive advantage and ultimately enhance their economic performance. They also found that the environmental initiative in each phase, including greening in production, greening inbound and outbound functions are related to each other, e.g. greening the production phase is linked to greening the outbound phase. They noted that greening in the firm's production which use environmentally friendly raw materials, taking environmental criteria into consideration, considering environmental design, using cleaner technology processes and recycling materials within the production, can lead to greening the outbound phase, including greening marketing, environmentally friendly packaging and also environmental distribution (transportation).

As a result, adopting internal and external environmental initiatives in all production processes within a firm as well as the entire supply chain allows the firm to reduce waste, such as solid waste, waste water and gas emissions. By doing so, the firm will have a better image which leads to competitive advantage and ultimately economic performance (Giovanni, 2012; Rao and Holt, 2005). Therefore, the hypothesis of the relationship between IGSCM practices and EGSCM practices in this research is:

H8: Internal green supply chain management practices are positively related to external green supply chain management practices.

3.9. The Mediating Role of Green Supply Chain Management Practices on the Relationship between Supply Chain Integration and Sustainable Firm Performance

As well as the direct effect of the relationship between SCI, GSCM practices and sustainable performance mentioned previously, the indirect effect should be examined for this research as well. The previous hypotheses posited that supply chain integration directly and positively impacts both environmental performance (H1) and economic performance (H2). In addition, the supply chain integration has direct and positive links to green supply chain management (IGSCM and EGSCM) practices (H5 and H6) and green supply chain management (IGSCM and EGSCM) practices; they are directly and positively linked to environmental (H3a and H3b) and economic performance (H4a and H4b), so if they are taken together, it can be argued that supply chain integration will indirectly relate to sustainable performance by having GSCM practices, including IGSCM and EGSCM practices as mediating variables. Thus, the positive relation between supply chain integration and sustainable firm performance is mediated by green supply chain management practices, which are IGSCM and EGSCM practices.

By reviewing supply chain integration literature, it emerges that, although a business which integrates within a firm and/or with its suppliers or customers can improve firm performance, such a firm’s performance may not relate to environmental and economic outcomes at the same time. Because supply chain integration alone, without considering the environmental initiative, may improve only operational performance, not specific environmental performance and/or economic performance. Thus, the environmental initiative seems to be based on the efforts of each firm to represent that firm and minimise its environmental impacts. Also, an environmental initiative leads to enhanced environmental performance (Zhu and Sarkis, 2004; Zhu et al., 2005) and economic performance (Zhu and Sarkis, 2004; Zhu et al., 2005; Rao and Holt, 2005). Environmental activities or green supply chain management practices are a part of the environmental initiatives of each firm. Therefore, if a business has GSCM practices in its operation and its production processes, the business can demonstrate better environmental and/or economic performance than other businesses which do not have GSCM practices.

According to Vachon and Klassen (2008), inter-organisational interactions between supply chain members facilitate environmental collaborative activities, which is called environmental collaboration, and these activities can contribute to manufacturing performance, including cost, quality, delivery, flexibility and environmental performance. However, there are some articles that conclude that integration of management systems can directly improve environmental and economic performance, such as the study by Griffith and Bhutto (2008, 2009). They argued that establishing an integrated management system within an organisation can create benefits for the firm, which fall into three categories: economic, organisational and environmental performance, as mentioned in the previous section. However, their findings did not come from testing the hypothesis which considered the connection between integration of management systems and firm performance, so their finding was interesting but lacks a theoretical foundation. As mentioned above, using supply chain integration alone may not improve all dimensions of sustainable firm performance. Thus, in order to enhance environmental and economic outcomes, it is necessary to consider green supply chain management practices as a mediator with supply chain integration. Therefore, testing the relationship between supply chain integration and sustainable performance by having green supply chain management practices as a mediator is an interesting hypothesis to explore the empirical results to be applied further in the business world.

Given the reasons above and the hypotheses stated in the previous section, taking H5 and H3a together and H5 and H4a together, for IGSCM practices as a mediator of the relationships among constructs, it is argued that IGSCM practices mediate the link between SCI and environmental performance and economic performance, respectively. In addition, for EGSCM practices as a mediator, taking H6 and H3b together and H6 and H4b together, it can be inferred that EGSCM practices mediate the link between SCI and environmental and economic performance respectively.

In light of these arguments, the author would like to test if the positive relationship between SCI and firm performance is mediated by GSCM practices. Thus, the next hypotheses are:

H9a: The positive relationship between supply chain integration and environmental performance is mediated by internal green supply chain management practices.

H9b: The positive relationship between supply chain integration and economic performance is mediated by internal green supply chain management practices.

H10a: The positive relationship between supply chain integration and environmental performance is mediated by external green supply chain management practices.

H10b: The positive relationship between supply chain integration and economic performance is mediated by external green supply chain management practices.

3.10. Summary

The theoretical model of this research as shown in Figure 3.1 represents the hypothesized relationship between three main constructs, including supply chain integration (SCI : II, SI and CI), green supply chain management (GSCM) practices (IGSCM and EGSCM practices) and sustainable firm performance (SP : ENP and EP). The summary of the hypotheses of this study is presented in Table 3.1.

Table 3.1 Summary of Hypotheses

Hypotheses	Description
	The relationship between SCI and Sustainable Performance
H1	SCI is positively related to the environmental performance of the firms within a supply chain.
H2	SCI is positively related to the economic performance of the firms within a supply chain.
	The relationship between GSCM practices and Sustainable Performance

H3a	IGSCM practices are positively related to environmental performance.
H3b	EGSCM practices are positively related to environmental performance.
H4a	IGSCM practices are positively related to economic performance.
H4b	EGSCM practices are positively related to economic performance.
	The relationship between SCI and GSCM practices
H5	SCI is positively related to IGSCM practices.
H6	SCI is positively related to EGSCM practices.
	The relationship between environmental performance and economic performance
H7	Environmental performance is positively related to economic performance.
	The relationship between internal green supply chain management practices and external green supply chain management practices
H8	IGSCM practices are positively related to EGSCM practices.
	The mediating role of GSCM practices on the relationship between SCI and Sustainable Performance
H9a	The positive relationship between SCI and environmental performance is mediated by IGSCM practices.

H9b	The positive relationship between SCI and economic performance is mediated by IGSCM practices.
H10a	The positive relationship between SCI and environmental performance is mediated by EGSCM practices.
H10b	The positive relationship between SCI and economic performance is mediated by EGSCM practices.

CHAPTER 4: RESEARCH METHODOLOGY

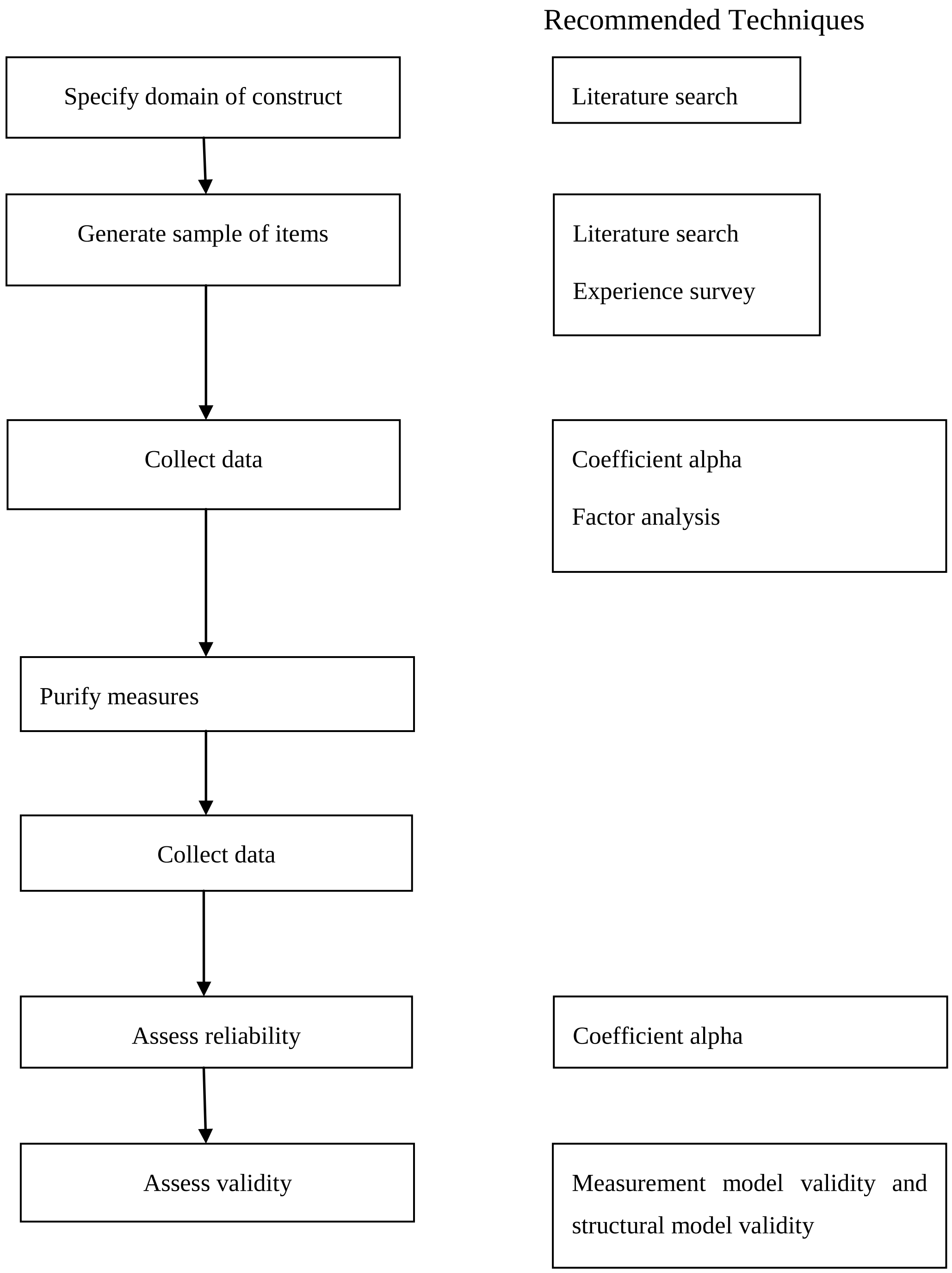
4.1 Introduction

Before the conceptual framework can be validated and the relationship among SCI, GSCM, and sustainable performance, including environmental dimension and economic dimensions, can be tested, a construct measurement needs to be developed. According to Carter and Dresner (2001), most studies adopt case-based methodology to develop the metrics and support the research by adopting survey-based methodology in order to increase the generalisability of the results. Alternatively, one can develop the measurement scales by referring to existing literature, as long as there are already adequate theoretical foundations underpinning each construct. Currently, there is very little empirical research regarding the link between SCI, GSCM practices, and firm performance (Vachon, 2003). Therefore, a review of previous literature on different topics, such as SCI, environmental management and firm performance, was conducted to develop the construct measurement for this research.

4.2 Construct Measurement Development

Construct measurement is an important issue in research. To gain accurate results in a study, it is necessary that a researcher generates valid and reliable measurement items. For socio-economical phenomenon, such as the focus of this study, a single measurement item cannot measure constructs precisely and completely (Spector, 1992). Thus, researchers need to develop multiple measurement items in order to approximate the constructs in their research (Field, 2005). Multi-item measurement is required for capturing the domain of complicated constructs, clarifying the method of construct measurement, and improving the reliability of measurement (Stevens, 1986). As discussed in Chapter 2, the constructs for SCI, GSCM, and the two performance outcomes are multi-faceted in nature. The research follows the construct measurement procedure suggested by Churchill (1979) as shown in the following eight steps in Figure 4.1

Figure 4.1 Construct Measurement Development (adapted from Churchill, 1979)



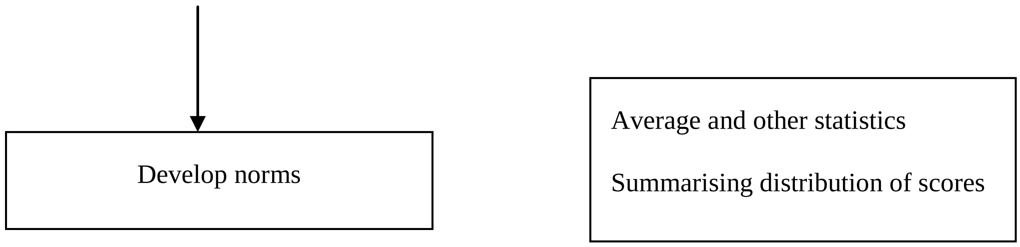


Figure 4.1 shows that the first step of construct measurement development is that of reviewing literature relevant with all constructs of interest, to identify the varying domain. The second step is to develop measurement items by reviewing the literature and/or modifying items from existing scales. Once measurement items are established, validation should be implemented by means of measurement purification (Moore and Benbasat, 1991). Then, these items can be tested in terms of validation and reliability.

4.2.1. Specifying Domain of the Constructs

The first step in developing construct measures for this research it that of specifying the domain of constructs in order to define them clearly. The domains of the constructs in this research were obtained by reviewing relevant literature on logistics and supply chain management and strategic management. The definition of construct is also important for defining the domain. Moreover, before applying the constructs, the validity of the constructs' should be confirmed. In this research, there are three main constructs, SP, GSCM practices, and SCI. SP is further divided into two sub-constructs: environmental performance (ENP) and economic performance (EP). GSCM practices are categorised into two sub-constructs: internal green supply chain management (IGSCM) practices and external green supply chain management (EGSCM) practices. SCI is separated into three sub-constructs: internal integration (II), supplier integration

(SI), and customer integration (CI). All of the constructs' domains are explained in the next section.

4.2.1.1 Sustainable Performance

The first main construct is SP, which consists of ENP and EP. ENP has been previously examined in the operations management and environmental management literature (Clemens and Bakstran, 2010; Shaw et al., 2010; Shi et al., 2012; Zhu and Sarkis, 2004; Zhu et al., 2005; Zhu et al., 2007). ENP is defined as managerial concern about issues ranging from regulations, contractual compliance, to public perception and competitive advantage (Theyel, 2001). Shi et al. (2012) propose that ENP can be separated into three components: environmental impact reduction, environmental cost saving, and related social issues.

Environmental impact reduction mainly includes reduction of greenhouse gas emission such as carbon dioxide (also referred to as reduction of carbon footprint; Shaw et al., 2010), methane, nitrous oxide, hydrofluorocarbons and perfluorocarbons, and sulphur hexafluoride from production, reaction, distribution, and treatment processes (Verfaillie and Bidwell, 2000) and hazardous waste, wastewater, and solid waste disposal. Environmental cost saving refers to the management of cost saving resulting from GSCM practices that consist of procurement of environmentally friendly material or parts, waste management, a 3R programme for close-looped operation, energy use, and risk management; measures for environmental cost saving include green purchasing, environmental technology investment, material recovery, energy saving, and reduction of environmental risk or penalties (Shi et al., 2012).

The last element, social impact, involves health and safety committees and health and safety performance. The Global Reporting Initiative (GRI) is used as a guideline by businesses in this regard. Shi et al. (2012) added social aspects to environmental performance measurement besides environmental issues.

Furthermore, the Department for Environmental, Food and Rural Affairs (Defra) set 22 environmental performance indicators as a guidance for UK businesses to apply in their business processes; the environmental performance measures can be divided into four key elements: emissions to air, water, and land and resource use (Defra, 2013). Zhu and Sarkis (2004) applied these indicators in their research and added consumption of hazardous materials and frequency for environmental accident as well. The validity of ENP has been tested in a many empirical studies (Zhu and Sarkis, 2004; Zhu et al., 2005; 2007; 2008). The existing definition of ENP in Table 4.1 is applied in this research.

EP, in this research, focuses on financial performance and marketing performance as explained in Chapter 2. EP has been previously studied in the strategic management, operations management, and environmental management literatures (Clemens and Bakstran, 2010; Droge et al., 2004; Maydeu–Olivares and Lado, 2003; Rao and Holt, 2005; Shi et al., 2012; Zhu and Sarkis, 2004; Zhu et al., 2005; 2007; 2008). EP also includes various initiatives for reducing the adverse environmental impact of business operations (Rao and Holt, 2005). The financial outcome is affected by environmental performance because waste, both hazardous and non-hazardous, is reduced as part of environmental management, resulting in better usage of resources, improved efficiency and productivity, and reduced operating cost. When environmental performance improves, a firm obtains marketing advantage, leading to improved revenue, increased market share, and ultimately market opportunities (Rao and Holt, 2005). Thus, if financial performance increases, marketing performance improves.

Examples of EP measures include new market opportunities, product price increase, profit margin, sales, and market share (Rao and Holt, 2005), but Zhu and Sarkis (2004) examined the outcomes of environmental management practices implementation, such as decrease in the cost of material purchasing, energy consumption, fee for waste treatment and waste discharge, and fines for environmental accidents and increase in investment, operational cost, training cost, costs for purchasing environmental friendly materials (Zhu and Sarkis, 2004, Zhu et al., 2005; 2007; 2008). The validity of EP has been tested in many empirical studies (Maydeu–Oliverres and Lado, 2003; Rao and Holt, 2005; Zhu and Sarkis, 2004; Zhu et al., 2005; 2007; 2008).

Table 4.1 Definitions of Constructs

Constructs	Definitions
Environmental Performance (ENP)	Environmental performance is defined as the outcomes of an organisation's attempts to establish compatible relationships among various stakeholders who are concerned with environmental issues (Gimenez and Ventura, 2005).
Economic Performance (EP)	Economic performance is defined as the outcomes which include not only financial performance but also a marketing performance components.
Internal Green Supply Chain Management (IGSCM) Practices	Internal green supply chain management practices is defined as environmental practices within a firm, with regard to product design, material sourcing and selection, manufacturing process, delivery of the final product to the consumers and end of life management of the product within a firm (adapted from Srivastava, 2007).

Constructs	Definitions
External Green Supply Chain Management (EGCSM) Practices	External green supply chain management practices is defined as environmental practices within supply chain management, with regard to product design, material sourcing and selection, manufacturing process, delivery of the final product to the consumers as well as end of life management of the product with both suppliers and customers (adapted from Srivastava, 2007).
Internal Integration (II)	Internal integration is defined as the process of inter-departmental interaction and collaboration that brings departments together into a cohesive organisation (Kahn and Mentzer, 1998).
Supplier Integration (SI)	Supplier integration is defined as a process of interaction and collaboration between a focal firm and its suppliers to make sure that it has beneficial information and flow of supplies (Wong and Boon-itt, 2008)
Customer Integration (CI)	Customer integration is defined as a process of interaction and collaboration between a focal firm and its customers to make sure that they have valuable information and flow of supplies (Wong and Boon-itt, 2008).

4.2.1.2. Green Supply Chain Management Practices

The second main construct, GCSM practices: IGSCM practices and EGCSM practices, has been previously examined in the operations management and environmental management literature (Green et al., 2012; Hu and Hsu, 2010; Lee et al., 2012; Srivastava, 2007; Zhu and Sarkis, 2004; Zhu et al., 2005; Zhu et al., 2007). According to Srivastava (2007), GSCM is defined as “integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumer as well as end-of-life management of the product after its useful life”. Unlike Srivastava, Hervani et al. (2005) included reverse logistics in GSCM. Reverse logistics is defined as “the process of planning, implementing and controlling the efficient, cost-effective flow of raw material, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal" (Roger and Tibben–Lembke, 1999). The point of reverse logistics is to eliminate or reduce wastage of energy, emissions, chemical or hazardous and solid waste generation. Lee et al. (2012) also mentioned about GSCM practices involving green purchasing, eco-design, and cooperation with customers, where large manufacturers would need not only good internal environmental management but also external cooperation and coordination with suppliers and customers in their supply chain. Furthermore, Lamming and Hampson, (1996) expand the supply chain to suppliers' supplier, so to implement proactive strategic supply chain management, manufacturers will need to collaborate with both first- and second-tier suppliers to generate green systems and comply with environmental regulation in the production process.

However, the definition of IGSCM practices is inconclusive. Thus, the author adopts the meaning of this construct from the definition of Srivastava (2007) to set out the domain of IGSCM practices for this research. IGSCM practices involve integration of environmental thinking into SCM within an organisation (adapted from Srivastava, 2007). IGSCM practiced include commitment towards GSCM from senior managers to mid-level managers for GSCM, cooperation of cross-functional teams for environmental improvement, total quality environmental management, environmental compliance and auditing, environmental management system, and ISO 14001 certification (Zhu and Sarkis, 2004; Zhu et al., 2005; 2007; 2008). Also, IGSCM practices are related to establishing environmental consciousness in internal groups (e.g. managers and employees) such that they take action to use environment-friendly raw materials, take the environmental criteria of production processes into consideration, optimise processes to reduce solid waste and emission, promote internal recycling of materials within the production phase, and use advanced prevention and safety systems at work (Shi et al., 2012). The validity of IGSCM practices has been tested in many empirical studies (Zhu and Sarkis, 2004; Zhu et al., 2005; 2007; 2008).

For EGSCM practices, the constructs have been previously studied in the operations management and environmental management literatures (Shi et al., 2012; Zhu and Sarkis, 2004; Zhu et al., 2005; 2007; 2008). This domain is adapted from the definition of GSCM practices of Srivastava (2007) as well. Thus, EGSCM refers to integration of environmental thinking into supply chain management with other organisations, including suppliers and customers (adapted from Srivastava, 2007). EGSCM practices involve green purchasing, designing green distribution practices that are built on socially complex resources through collaborations involving trust, and commitment and joint objective setting among multiple supply chain partners (Vachon and Klassen, 2007). Green purchasing is defined as “environmental plans for a firm’s long-term material, component or system requirement” (Sroufe, 2006). Also, Shi et al. (2012) argue that green purchasing is a socially complex resource that requires consensus between supply chain partners (e.g. multiple team and firms). It is necessary that organisations continuously synchronise their communication and operations to make sure a reliable, environment-friendly collaboration is established within the supply chain. Therefore, green purchasing practices involves frequent communication and sharing of information between the organisation and its suppliers and also good cross-functional relationship with top management and environmental experts (Shi et al., 2012).

Elements of green purchasing include holding awareness seminars for suppliers and contractors, guiding suppliers to set up their own environmental programmes, bringing suppliers who are in the same industry together to share know-how and problems, informing suppliers about the benefits of cleaner production and technologies, pressuring supplier to adopt environmental practices, choosing suppliers by environmental criteria, eco-labelling, cooperation with suppliers for environmental objectives, auditing environmental practices of suppliers internal management, encouraging suppliers with ISO 14001 certification, and assessing environment-friendly practices of second-tier suppliers (Rao and Holt, 2005; Zhu and Sarkis, 2004; Zhu et al. 2005; Shi et al., 2012). The validity of EGSCM practices has been tested by a many empirical studies (Zhu and Sarkis, 2004; Zhu et al., 2005; 2007; 2008). The existing definition of EGSCM practices (adapted from Srivastava, 2007 as mentioned above) in Table 4.1 is applied in this study.

4.2.1.3. Supply Chain Integration

In general, SCI is defined as “the degree to which manufacturers strategically coordinate with their supply chain partners and collaboratively manage intra- and inter-organisation processes” (Flynn et al., 2010). The definition highlights the importance of strategic collaboration to meet strategic goals of the firm, e.g. gaining mutual trust, long-term relationship, or repeat contract and efficient conflict resolution and sharing of information, rewards, and risks (Ellam, 1990; Flynn et al., 2010). This definition also focuses on business processes, not only within an organisation but also with other supply chain members, including customers and suppliers. Furthermore, the supply chain literature points out that SCI is important internally within and across departments in the same business and externally with other supply chain partners across customers’ and suppliers' organisation (Frohlich and Westbrook, 2001). Consequently, SCI for this thesis can ultimately be separated into three dimensions: internal integration (II), supplier integration (SI), and customer integration (CI).

Firstly, internal integration has been studied in the operations management, logistics and marketing literatures (Gimenez and Ventura, 2005; Kahn and Mentzer, 1998; Wong and Boon-itt, 2008; Wong et al., 2011). It mainly involves different functions within an organisation, e.g. communicating, interacting, and collaborating towards achievement of a set of common objectives (Morash and Clinton, 1997, Wong and Boon-itt, 2008). So far, the different definitions of II have been rather convergent and II has also been conceptualised as cross-functional integration (Frohlich and Westbrook, 2001), as well as integration between two specific functions, such as logistics-production and logistics-marketing (Gimenez and Ventura, 2005) and integration between supply chain functions, such as manufacturing, purchasing, and logistics (Pagell, 2004). Thus, II involves interaction or integration between different functions, such as procurement, production, logistics, marketing, sales, and distribution (Birou et al., 1998; Morash and Clinton, 1997; Wong and Boon-itt, 2008). The validity of this construct has been tested by many empirical studies (Flynn et al., 2010; Gimenez and Ventura, 2005; Wong and Boon-itt, 2008), and it appears that little concern about its definition and domain has been reported. Thus, the existing definition of internal integration in Table 4.1 is applied in this study.

Secondly, SI has been studied in operations management, logistics, and marketing research studies (Das et al., 2006; Flynn et al., 2010; Lee et al., 2007; Wong and Boon-itt, 2008; Wong et al., 2011). SI involves interaction and collaboration between a focal firm and its suppliers (Wong and Boon-itt, 2008) to assert that a firm is able to access to precise and real-time information from effective ways of communication across the two parties (Das et al., 2006; Ragatz et al., 2002; Koufleros et al., 2005). SI is mainly involved in the design stage of new products, production planning and inventory management, developing a quick response order processing system with suppliers, establishing a supplier network, and exchanging information with suppliers (Lee et al., 2007). SI has also been conceptualised as inter-organisational integration that involves establishing close, interactive relationships with suppliers (Flynn et al., 2010). The validity of this construct has been tested in a large number of empirical studies (Das et al., 2006; Flynn et al., 2010; Lee et al., 2007; Wong and Boon-itt, 2008). The definition and domain of SI appear inconclusive. Thus, the existing definition of supplier integration in Table 4.1 is applied in this study.

Lastly, CI is a construct that has been previously studied in the operations management and supply chain management literature (Lee et al., 2007; Wong and Boon-itt, 2008; Wong et al., 2011). CI involves the interaction and collaboration between an organisation and its customers (Wong and Boon-itt, 2008) as well as communication about delivery of the right products and service to customers locally and globally at the right time, right place, and right quantity with precise invoices (Lee et al., 2007). CI mainly refers to interacting with customers for managing demands, accepting customer orders, sharing product information, receiving an order placing system, sharing order status with customers, and product delivery (Lee et al., 2007). The validity of this construct has been tested in many empirical studies (Flynn et al., 2010; Lee et al., 2007; Wong and Boon-itt, 2008) and there is little concern about the definition and domain of this construct. Thus, the existing definition of customer integration in Table 4.1 is applied in this study.

4.2.2. Generation of Construct Measurement Items

In this study, literature review was used to create and identify measurement items. The identification of measurement items was guided by the definitions in the previous section. The main constructs chosen were sustainable firm performance, GSCM practices, and SCI. These measurement items will be described in the following sections.

4.2.2.1. Sustainable Firm Performance

Sustainable firm performance can be divided into two components which are ENP and EP. ENP is defined as the outcome of the organisation attempts to establish compatible relationships among various stakeholders who are concerned with environmental issues (Gimenez and Ventura, 2005). The measurement items that any organisations need to consider for reduction of environmental impact as a fundamental objective of environmental management are reduction of emission of green greenhouse gases, especially carbon dioxide, also known as carbon emission or carbon footprint (Shaw et al., 2010).

Furthermore, the Defra(2010) considered four main environmental performance indicators: emission into air, water, land, and resource use. Thus, ENP in this thesis is measured in terms of reduction of air emission, reduction of waste water, and reduction of solid waste (Shi et al., 2012; Vachon and Klassen, 2008; Zhu et al., 2005; 2010; Zhu and Sarkis, 2004). Moreover, many environmental regulations prohibit the use of hazardous or toxic substances in products to prevent environmental impact and harm to humans, e.g. the Restriction of Hazardous Substance (RoHS) Directive (Hu and Hsu, 2010). Consequently, ENP also is examined in terms of reduction of consumption of hazardous/harmful/toxic materials.

In addition, firms concerned about environmental issues should ensure reduction of scrap rate, which is the percentage of failed materials that cannot be repaired or restored and are thus discarded (Business dictionary, 2014). Finally, to measure the overall environmental outcome of the firm, organisations need to determine their image or reputation, particularly on environmental issues (Tachizawa et al., 2011), to confirm that if they implement GSCM practices, these activities will improve their environmental reputation.

Therefore, ENP in this thesis was measured in terms of seven items: reduction of air emission, waste water, solid wastes, decrease of consumption of hazardous/harmful/toxic materials, reduction of scrap rate, reduction in frequency of environmental accidents, and improvement of environmental reputation. The seven items were developed using a 5-point Likert scale. The selected respondents were asked to evaluate the environmental performance level in their plant unit using these items.

Table 4.2 Items for Environmental Performance

Constructs	Item No.	Environmental Performance Items	Source
Environmental Performance	ENP1	Reduction of air emission	Zhu and Sarkis,2004 Zhu et al.,2005;2010 Rao, 2002 Vachon and Klassen, 2008 Green Jr. et al., 2012 Perotti et al., 2012
	ENP2	Reduction of water wastes	Zhu and Sarkis,2004 Zhu et al., 2005; 2010

			Shi et al., 2012 Vachon and Klassen, 2008 Green Jr. et al., 2012 Perotti et al., 2012
	ENP3	Reduction of solid wastes	Zhu and Sarkis,2004 Zhu et al., 2005; 2010 Rao, 2002 Shi et al., 2012 Vachon and Klassen, 2008 Green Jr. et al., 2012 Perotti et al., 2012
	ENP4	Decrease in consumption of hazardous/harmful/toxic materials	Zhu and Sarkis,2004 Zhu et al., 2005; 2010 Shi et al., 2012 Green Jr. et al., 2012 Perotti et al., 2012
	ENP5	Reduction of scrap rate	Perotti et al., 2012
	ENP6	Reduced frequency of environmental accidents	Zhu and Sarkis,2004 Zhu et al.,2005; 2010 Green Jr. et al., 2012 Perotti et al., 2012
	ENP7	Improvement of environmental reputation	Tachizawa et al., 2011

The second aspect, EP, is the most essential driver for all businesses to assess profitability of management. For this thesis, EP included not only on financial performance but also marketing performance. According to Jenning (2004), the financial perspective involves the investment ability of a business, as indicated in the annual report. Jenning (2004) suggested that only the financial view is not sufficient for evaluating economic performance of the firm. In practice, when organisations implement environmental management practices, it leads to improve environmental outcomes, marketing advantage, increased revenue, and improved market share (Rao and Holt, 2005). Therefore, EP, involving operational efficiency and profitability of a firm, is measured by average return on investment, average profit, profit growth, and average return on sales over the last three years (Green Jr. et al., 2008; 2012). In addition, from the marketing perspective, EP is examined by average market share growth and average sales volume growth over the last three years to estimate market competitiveness of a firm (Green Jr. et al., 2008; 2012; Droge et al., 2004; Rao, 2002).

From the reasons above, in this thesis, EP included six measurement items: average return on investment, average profit, profit growth, average return on sales, average market share growth, and average sales volume growth over the last three years. The six measurement items were developed using a 5-point Likert scale. The selected respondents were asked to assess the EP in their plant unit using these items.

Table 4.3 Items for Economic Performance

Constructs	Item No.	Economic Performance Items	Source
Economic Performance	EP1	Average return on investment over the last three years	Green Jr. et al., 2008; 2012 Maydeu-Olivares and Lado, 2003 Vickery et al.,2003 Droge et al.,2004
	EP2	Average profit over the last three years	Green Jr. et al., 2008; 2012 Maydeu-Olivares and Lado, 2003 Rao, 2002
	EP3	Profit growth over the last three years	Green Jr. et al., 2008; 2012
	EP4	Average return on sales over the last three years	Green Jr. et al., 2008; 2012 Vickery et al.,2003 Droge et al.,2004
	EP5	Average market share growth over the last three years	Green Jr. et al., 2008; 2012 Maydeu-Olivares and Lado, 2003 Droge et al.,2004 Rao, 2002 Rao and Holt, 2005
	EP6	Average sales volume growth over the last three years	Green Jr. et al., 2008; 2012 Maydeu-Olivares and Lado, 2003 Kim et al.,2006 Droge et al.,2004 Rao, 2002

4.2.2.2. Green Supply Chain Management Practices

GSCM is defined as "integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the customer as well as end-of-life management of the product after its useful life" (Shivastava, 2007) and also reverse logistics (Hervani et al., 2005). For this research, GSCM practices can be divided into IGSCM and EGSCM practices.

Firstly, IGSCM practices focus on integration of environmental thinking within an organisation. The measures for IGSCM practices include support from top-level managers (Hu and Hsu, 2010) and mid-level managers (Carter et al., 1998; Zhu and Sarkis, 2004), which is the most important point for successful adoption of GSCM. Top management can be an internal driver of GSCM policy and strengthen collaborative mechanisms among different departments (Trowbridge, 2001). In addition, after encouragement of top and mid-level managers, environmental policy for GSCM aims to increase the consciousness about environmental issues to employees who are in various functions through environmental education and training (Zhu and Geng, 2001) in order to improve environmental across-functional cooperation. Furthermore, to accomplish continuous environmental improvement, an organisation should provide compliance statements and conduct audits to ensure that all materials and products comply with regulations, particularly environmental regulations (Green Jr. et al., 2012; Lee et al., 2012; Zhu et al., 2005; 2010; Zhu and Sarkis, 2004).

Organisations need to take environmental issues into consideration by incorporating them in new product development plans. The product design process termed as green design or eco-design is being adopted increasingly as a method to reduce environmental impact of products and processes. Organisations are also striving to reduce consumption of materials and energy, reuse, recycle, and recover materials or component parts (Zhu and Sarkis, 2004; Zhu et al., 2005; 2010) as well as avoid the use of hazardous materials in the manufacturing process. Additionally, investment in recovery processes helps lengthen or extend the life of the materials or products by recycling or reprocessing of excess inventories or used materials into other products or parts as well as by sale of excess capital equipment (Shi et al., 2012; Zhu and Sarkis, 2004; Zhu et al., 2005; 2010). From the reasons above, IGSCM practices are measured using 10 items (as presented in Table 4.4): participation of senior managers in GSCM, participation of mid-level managers in GSCM, cross-functional cooperation for environmental improvement, environmental compliance and audit programmes, design of products for reduced consumption of materials/energy, design of products for reuse/recycle, recovery of materials/component parts, recycling of excess inventories/materials, recycling of used materials, and sale of excess capital equipment. The 10 items were developed using a 5-point Likert scale. The selected respondents were asked to evaluate the IGSCM practices in their plant unit using these items.

Table 4.4 Items for Internal Green Supply Chain Management Practices

Constructs	Item No.	Internal green supply chain management practices Items	Source
IGSCM practices	IGP1	Participation of senior managers in green supply chain management	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010 Green Jr. et al., 2012 Lee et al., 2012 Perotti et al., 2012

	IGP2	Participation of mid-level managers in green supply chain management	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010 Green Jr. et al., 2012 Lee et al., 2012 Perotti et al., 2012
	IGP3	Cross-functional cooperation for environmental improvement	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010 Green Jr. et al., 2012 Lee et al., 2012 Perotti et al., 2012
	IGP4	Environmental compliance and auditing programmes	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010 Green Jr. et al., 2012 Lee et al., 2012 Perotti et al., 2012
	IGP5	Design of products for reduced consumption of materials/energy	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010
	IGP6	Design of products for reuse, recycle, recovery of materials, component parts	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010
	IGP7	Design of products and /or the manufacturing process to avoid or reduce use of hazardous products	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010
	IGP8	Recycling of excess inventories/materials	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010
	IGP9	Recycling used materials	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010 Shi et al., 2012 Rao and Holt, 2005

	IGP10	Sale of excess capital equipment	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010

Secondly, EGSCM practices emphasise on integration of environmental thinking with other organisation across supply chain partners, such as suppliers and customers. Currently, there is increased awareness of the impact of pollution on the environment. The RoHS directive forbids the use of hazardous materials, such as lead, cadmium, mercury, and hexavalent chromium in products (Hu and Hsu, 2010). Therefore, to ensure that suppliers meet such regulations or environmental standards and consumers' requirements, organisations need to set environmental objectives with their suppliers, involving a joint commitment on environmental quality improvement, by providing green design specifications for green items and cooperation with suppliers (Zhu and Sarkis, 2004). This helps encourage suppliers be more concerned about their own environmental activities (Lamming and Hampson, 1996).

Furthermore, a firm should audit internal supplier's GSCM practices to ensure that suppliers take environmental awareness into consideration. As suggested by Handfield et al. (2005), GSCM involves collaboration on environmental issues of SCM through audits of suppliers using environmental performance indicators. Organisations that have implemented environmental audits of their suppliers have an opportunity to learn together, resulting in building up of long-term relationships (Hu and Hsu, 2010). Additionally, beyond environmental auditing of suppliers, encouraging or rewarding suppliers for achieving ISO 14001certification can help ensure that a firm receives materials, component, or products which meet the environmental standards and customer requirements. Also, the practices of second-tier suppliers need to be evaluated by using environmental auditing programmes to ensure that environmental regulations are met in the whole supply chain.

Besides the supplier perspective, the customer point of view should also be considered in EGSCM practices (Zhu and Sarkis, 2004). EGSCM practices are known as greening the outbound function because Rao and Holt (2005) suggested that greening the outbound function is about green marketing, environmental-friendly packaging, and environment-friendly distribution which are related to environmental activities with customers (Rao and Holt, 2005). These practices are related to green marketing and environment-friendly packaging and distribution which are all initiatives that help improve the environmental outcome of a firm and the whole supply chain (Rao, 2003). Accordingly, the measurement item for EGSCM practices in terms of the customer's views is cooperation with customers for green design or eco-design. Currently, customers seem to be more concerned about the environment and want to protect the environmental not only for their generation but also for the next generations. As a result, cooperation with customers for eco-design can help organisations meet their expectations or requirements.

Nowadays, many regulatory requirements are pushing organisations to consider environmental issues. The Waste Electrical and Electronic Equipment (WEEE) Directive of the European Union was enforced to ensure that manufacturers and importers to the EU countries used green products and adopted green manufacturing or cleaner production processes (Hu and Hsu, 2010); similarly, the RoHS directive forbids the use of toxic substances in the manufacturing of products. Therefore, cooperation with customers in the area of environment-friendly production is very effective to ensure that every step of manufacturing is green in the entire supply chain and to ensure that environmental regulations and customers' needs are met.

Additionally, most products are packaged for easy handling. Therefore, packaging is an important aspect for a product, so firms should consider adopting environmental packaging or green packaging. Many countries have enforced regulations to reduce the amount of packaging which enters the waste stream, such as the Packaging Directive in the EU. Consequently, packaging is recycled and reused.

Therefore, the dimension of EGSCM practices comprises eight measurement items (as shown in Table 4.5): providing design specification to suppliers that include environmental requirements for purchased item, cooperation with suppliers for meeting environmental objectives, auditing suppliers' internal management, encouraging or rewarding suppliers with ISO 14001 certification, evaluating second-tier supplier's environment-friendly practices, cooperating with customers for eco-design, cooperating with customers for cleaner production, and cooperating with customers for green packaging. The eight items are developed on a 5-point Likert scale. The selected respondents were asked to evaluate the EGSCM practices in their plant unit using these items.

Table 4.5 Items for External Green Supply Chain Management Practices

Constructs	Item No.	External green supply chain management practices items	Source
EGSCM Practices	EGP1	Providing design specification to suppliers that include environmental requirements for purchased items	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010 Perotti et al., 2012
	EGP2	Cooperation with suppliers for environmental objectives	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010 Lee et al., 2012 Shi et al., 2012 Perotti et al., 2012
	EGP3	Environmental audit of suppliers' internal management	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010 Lee et al., 2012 Perotti et al., 2012
	EGP4	Encourage or reward suppliers with ISO 14001 certification	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010 Lee et al., 2012 Shi et al., 2012 Perotti et al., 2012
	EGP5	Evaluation of second-tier supplier's environment-friendly practice	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010 Shi et al., 2012 Perotti et al., 2012
	EGP6	Cooperation with customers for eco-design	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010 Lee et al., 2012

			Perotti et al., 2012
	EGP7	Cooperation with customers for cleaner production	Zhu and Sarkis, 2004 Zhu et al., 2005, 2010 Lee et al., 2012 Perotti et al., 2012
	EGP8	Cooperation with customers for green packaging	Zhu and Sarkis, 2004 Zhu et al., 2005; 2010 Lee et al., 2012 Perotti et al., 2012

4.2.2.3. Supply Chain Integration

In this thesis, SCI was divided into three components: II, SI, and CI.

II is measured by items that are related to interaction or collaboration that helps departments to work together into an efficient and cohesive manner (Kahn and Mentzer, 1998). Thus, II involves interaction across functions within an organisation, from procurement, production, marketing, and sales to distribution (Steven, 1989). For high-level II, the information systems of a firm must be connected to other different departments, so that all departments have access to precise and real-time information (Frohlich and Westbrook, 2001). Therefore, in this thesis, the measurement items for II involve data integration and enterprise application integration (Flynn et al., 2010). Furthermore, real-time information about the level of inventory is very important for making effective decisions (Sadler, 2007). For instance, when the production department a manufacturer has real-time information about the inventory level, it is able to deduce the right time to produce its products.

In addition, for achieving continuous improvement in internal processes, interdepartmental meetings among different functions within an organisation should be held periodically in order to encourage conflict resolution among functions (Flynn et al., 2010), gain accurate information, and ensure connectivity among all internal functions, ranging from procurement to distribution (Sadler, 2007). Moreover, II enables cross-functional teams to improve product and process designs, in the interest of product quality (Rosenzweig et al., 2003) and production cost (Ettlie and Stoll, 1990). For example, a production department can gain information about customers' actual requirements, particularly product design, from the marketing department which is in direct contact with the customers of the firm.

Therefore, II includes nine measurement items: data integration among internal functions, enterprise application integration among internal functions, integrative inventory management, real-time searching of the level of inventory, real-time searching of the logistics-related operating data, utilisation of periodic interdepartmental meetings among internal functions, use of cross-functional teams in process improvement, use of cross-functional teams in new product improvement, real-time integration and connection among all internal functions from raw material management through to production, shipping and sales. The nine items were developed on a 5-point Likert scale. The selected respondents were asked to assess the II in their plant unit using these items.

Table 4.6 Items for Internal Integration

Constructs	Item No.	Internal Integration Items	Source
Internal Integration	II1	Data integration among internal functions	Flynn et al.,2010 Stank and Keller, 2001 Koufterous et al., 2005
	II2	Enterprise application integration among internal functions	Flynn et al.,2010
	II3	Integrative inventory management	Flynn et al.,2010 Koufterous et al., 2005
	II4	Real-time searching of the level of inventory	Flynn et al.,2010
	II5	Real-time searching of the logistics-related operating data	Flynn et al.,2010
	II6	Utilisation of periodic interdepartmental meetings among internal functions	Flynn et al.,2010
	II7	Use of cross-functional teams in process improvement	Flynn et al.,2010
	II8	Use of cross-functional teams in new product improvement	Flynn et al.,2010 Koufterous et al., 2005
	II9	Real-time integration and connection among all internal functions, from raw material management through to production, shipping and sales	Flynn et al.,2010

The second aspect of SCI, SI, was measured using measurement items that are related to the process of interaction and collaboration between an organisation and its suppliers (Wong and Boon-itt, 2008). To achieve high level of SI, an organisation should have efficient information systems which are linked to its suppliers. In this way, a firm and its suppliers can access valid and real-time information, which is also an effective method of interaction between the two partners (Koufterous et al., 2005). Consequently, the measurement items for SI in this thesis involve information sharing from a firm to major supplier and vice versa through information network and also establishing quick ordering systems to gain real-time information to interact with each other efficiently. Also, a firm is able to make a right decision because of the real-time information (Sadler, 2007). The information that an organisation can share to its suppliers include production plan, demand forecast, and inventory level.

Furthermore, to achieve strategic goals, an organisation and its suppliers should develop a strategic partnership as well as long-term procurement relationships (Wong and Boon-itt, 2008). Additionally, participation of major suppliers is very important not only in the process of procurement and production but also in the design process to improve business processes, product innovation, quality, and profitability of the firm (Koufterous et al., 2005).

Therefore, SI in this thesis consists of 12 items: information exchange with major suppliers through information networks, establishment of quick ordering systems with major suppliers, strategic partnership with major suppliers, long-term procurement relationship with major suppliers, participation of major suppliers in the process of procurement and production, participation of major suppliers in the design stage, major suppliers share their production schedule information with the firm, major suppliers share their production capacity information with the firm, sharing production plans information with major suppliers, sharing demand forecasts with major suppliers, sharing inventory levels with major suppliers to help them improve their process to better meet the firm’s needs. The 12 items were developed using a 5-point Likert scale.

The selected respondents were asked to evaluate SI in their plant units in terms of these items.

Table 4.7 Items for Supplier Integration

Constructs	Item No.	Supplier Integration Items	Source
Supplier Integration	SI1	Information exchange with major suppliers through information networks	Flynn et al.,2010 Swink et al., 2007 Vachon and Klassen, 2007
	SI2	The establishment of quick ordering systems with major suppliers	Flynn et al.,2010
	SI3	Strategic partnership with major suppliers	Flynn et al.,2010
	SI4	Long-term procurement relationship with major suppliers	Flynn et al.,2010
	SI5	Participation of major suppliers in the process of procurement and production	Flynn et al.,2010 Vachon and Klassen, 2007
	SI6	The participation level of major suppliers in the design stage	Flynn et al.,2010 Swink et al., 2007 Vachon and Klassen, 2007 Koufterous et al., 2005 Narasimhan and Das, 2001
	SI7	Major suppliers share their production schedule information with the firm	Flynn et al.,2010 Swink et al., 2007
	SI8	Major suppliers share their production capacity information with the firm	Flynn et al.,2010
	SI9	Sharing production plans information with major suppliers	Flynn et al.,2010 Stank and Keller,2001

	SI10	Sharing demand forecasts with major suppliers	Flynn et al.,2010
	SI11	Sharing inventory levels with major suppliers	Flynn et al.,2010
	SI12	Helping major suppliers to improve their process to better meet the firm's needs	Flynn et al.,2010

The last aspect of SCI, customer integration (CI), is measured using items related to the process of interaction and collaboration between a firm and its customers (Wong and Boon-itt, 2008). To achieve a high level of CI, an organisation has to change from product orientation to customer orientation to penetrate deep into customer's organisation in order to understand its culture, product, and market. To do so, the organisation will know more customers' requirements and achieve their needs easier (Wong and Boon-itt, 2008). Furthermore, information systems which link the customers and their partners can give the firms access to valid and real-time information to help them achieve effective communication (Frochlich and Westbrook, 2001) and make accurate decisions (Sadler, 2007). Additionally, beyond information sharing with each other, following-up customers' for feedback also helps improve business processes.

Therefore, CI included11 items: linkage with major customers through information networks, computerisation for major customer's ordering, sharing of market information with major customers, provide effective communication channels to major customers, establishment of quick ordering systems with major customers, follow-up with major customers for feedback, frequent contact with major customers, major customers share point-of-sales information with the firm, major customers share demand forecast information with the firm, sharing available inventory information with major customers, and sharing production plan with major customers. The items were developed on 5-point Likert scale. The selected respondents were asked to assess the CI in their plant units using these items.

Table 4.8 Items for Customer Integration

Constructs	Item No.	Customer Integration Items	Source
Customer Integration	CI1	Linkage with major customers through information networks	Flynn et al.,2010
	CI2	Computerisation of major customer's ordering	Flynn et al.,2010
	CI3	Sharing of market information with major customers	Flynn et al.,2010 Swink et al., 2007 Vachon and Klassen, 2007 Stank and Keller,2001
	CI4	Provide effective communication channels to major customers	Flynn et al.,2010 Vachon and Klassen, 2007
	CI5	Establishment of quick ordering systems for major customers	Flynn et al.,2010
	CI6	Follow-up with major customers for feedback	Flynn et al.,2010

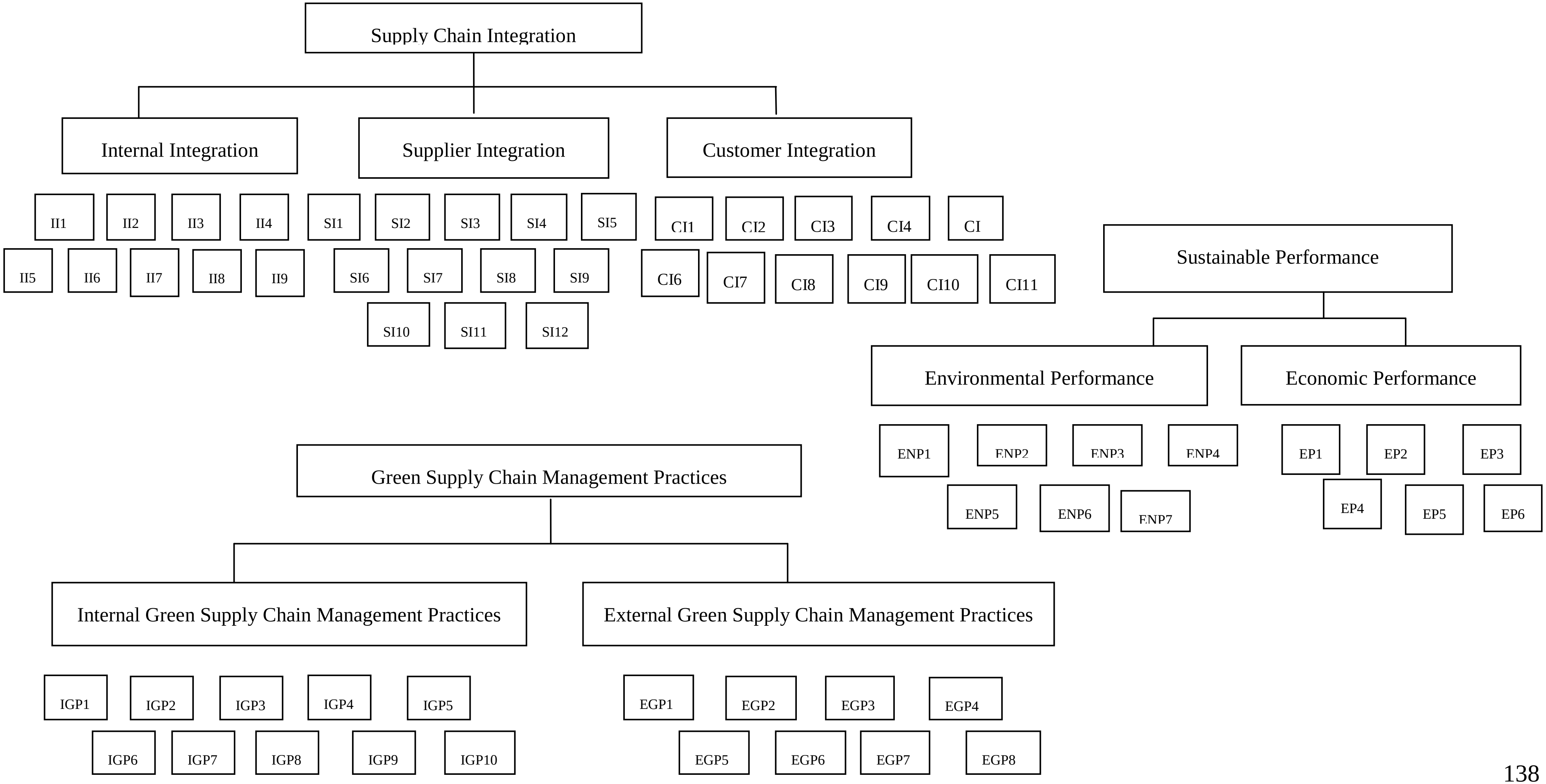
	CI7	Frequent contact with major customers	Flynn et al.,2010
	CI8	Major customers share point-of-sales information with the firm	Flynn et al.,2010
	CI9	Major customer share demand forecast information with the firm	Flynn et al.,2010
	CI10	Sharing available inventory information with major customers	Flynn et al.,2010
	CI11	Sharing production plan with major customers	Flynn et al.,2010

The questionnaire was divided into two parts: company description and background information and SCM information. The questions in the questionnaires were transformed to measurement items (as presented in Figures 4.1–4.8). Each question was accompanied by narrative statements related to the measurement items that were measured under seven constructs: II, SI, CI, IGSCM practices, EGSCM practices, ENP, and EP.

4.3. Unit of analysis

The unit of analysis can be established at the firm (Klassen and McLaughlin, 1996), the divisional or business level (Christmann, 2000) or the plant level (Geffen and Rothenberg, 2000). In this study, the unit of analysis was the plant level. Curkovic et al. (2000)stated that SCI, environmental supply chain practices, and the selection of environmental technologies mostly originate at the plant level. Furthermore, Klassen and Whybark (1999b) stated that environmental technology in some industries was different for various plants of each organisations, especially in the furniture industry. Since the focus of this study is sustainable performance at plant level, using a divisional or business level unit could lead to biased results. Furthermore, many firms have multiple plants and each plant can have different levels of SCI and GSCM practices; thus, a plant level focus is likely to produce more reliable results than a firm level focus.

Figure 4.2 Construct Measurement Items



4.4. Target Respondents

According to a number of empirical studies, various respondents can be used to collect data. In this study, the author focused on the influence of SCI and GSCM practices on a plant's sustainable performance. In order to gather information from all of the constructs, the target respondents were the management staff who had in-depth knowledge about SCI, environmental policy, and firm performance. The respondents needed to know about the manufacturing and supply chain processes in his/her plant very well. Therefore, the respondents targeted in this thesis were logistics or supply chain management managers, environmental managers, manufacturing managers, or plant managers.

Survey data were gathered from Thai manufacturing and processing industries. Target respondents were selected from the database of the Thailand Energy and Environmental Network (TEENET) and the Department of Industrial Works in the Ministry of Industry (Thailand). The target respondents were chosen from multiple industry groups to ensure wider generalisability. Also, respondents were chosen from firms with varying firm size (number of employees) because the databases had limited information on the number of employees and revenue of each firm. The questionnaires were sent to the industrial estates in north, north eastern, eastern, west, central Thailand. Because of the Muslim insurgency problem in the southern part of Thailand, it was not included in this research. However, the firms were selected from industries which had environmental impact, such as automotive, automotive components, electronic components, electrical components, food and beverage, industrial material and machinery, petrochemicals and chemicals, transportation and logistics, textile, clothing including decorating and colouring wool industries.

They were selected because all of them performed manufacturing and supply chain activities that had a direct impact on the environment and the manufacturing processes of these industries might lead to environmental problems within the communities.

4.5. Data Collection

Data can be collected by various methods, in different surrounding, and from different sources. This study adopted the survey to test the theoretical model. According to Forza (2002), survey can provide scientific knowledge in different ways. The main methods in the survey approach are mail survey, personal interview, telephone interviews, and internet survey (Dillman, 2000). Each method has its own advantages and disadvantages. For example, Tse et al. (1995) suggested that mail survey has a higher response rate and is more effective than e-mail survey or web-based survey. Also, Zatz (2000) stated that the risk of non-delivery of surveys is lower in the mail method than in the internet-based method, owing to the fact that people change their email addresses more frequently than their postal addresses. Furthermore, the main problem of using email or web-based survey is that not all have access to the Internet (Dillman, 2000).

This research targeted respondents specifically in the Thai manufacturing industry. Not many Thai organisations prefer using the Internet as a main instrument for their business operations. They tend to use the old-fashioned methods, such as telephone and face-to-face communication. Also, they only consider original, legal documents to confirm that they are dealing with real businesses.

The reason for not using web-based survey is supported by a report from National Statistical Office (NSO) of Thailand regarding the use of ICT among Thai organisations in 2011. It was reported that only 16.6% of Thai firms used the Internet for their business purpose, such as receiving or sending e-mails, purchasing goods/service, interacting with government, etc. Therefore, the web-based method was considered inappropriate for data collection in this case. This research used mail survey as an instrument to collect data, where questionnaires were sent to the target companies by post.

The procedure of mailing questionnaires is cost-effective and the questionnaires can be used to collect the data from respondents. Also, there is no limitation of time. Furthermore, the confidential information of the respondents is protected. This method also decreases interviewer bias (Brown, 2006b), thereby leading to a higher level of generalisability.

The data collection for this research can be separated into three stages: pilot-testing of the questionnaire, the first mailing of the survey to collect data, and the second mailing of the survey to remind or follow-up respondents who did not respond to the first questionnaire. Before sending the questionnaire for the pilot-testing stage, the first draft of the questionnaire was translated from English to Thai by a certified translator in Thailand.

The survey was pilot-tested by sending the pilot questionnaire to four kinds of populations: colleagues, academics, industry experts, and sample respondents. The procedures of the pilot-testing will show in Figure 4.3. Three groups of people (-colleagues, academics and experts) were used to prove the questionnaire before mailing to respondents. The questionnaire (Thai version) was sent to colleagues so that they could ensure that the questions were precise and clear, to academics so that they could examine the technical terms in logistics and supply chain management field, and to experts so that they could evaluate all the contents of the questionnaire on the basis of their knowledge and experience in business processes and supply chain management.

After that, the researcher sent the questionnaire (after translating into Thai version) to three academics in Thailand to check that the wordings and technical terms used were appropriate. Two of them specialised in management, especially supply chain management, and the other specialised in logistics management and marketing. They were sent both the Thai and English versions to clearly understand the wordings and definitions that were used in the questionnaire.

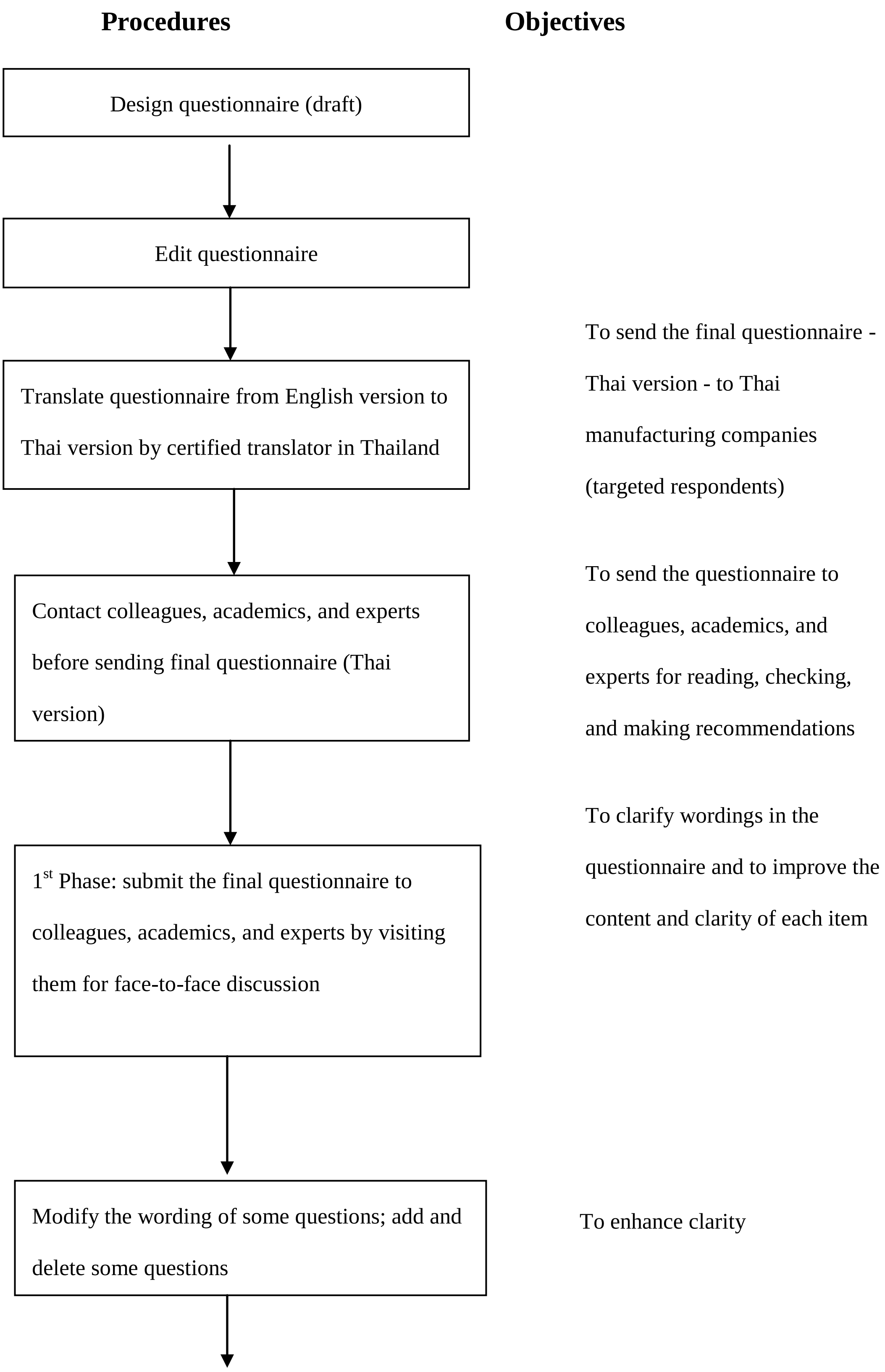
Then, the final questionnaire was sent to the four groups of people as mentioned earlier. After few days, the researcher visited them to discuss the questionnaire. After a face-to-face discussion with all the respondents, the wordings of some questions were modified for accuracy and clarity. The feedback from the colleagues was mainly regarding correction of spellings in the questionnaires. The feedback from the academics was regarding correction of technical terms (from English language to Thai language) in section 2.1.1 (internal integration) – questions 1, 2, 3, 9, in section 2.1.2 (supplier integration) – questions 1 to 12, and in section 2.2.2 – questions 6, 7. The author checked the original meaning in English before making changes according to the academics' suggestions. One academic commented that economic performance should be compared between the firm in question and its competitors. However, this point was argued by an expert that it is difficult to compare economic performance of the firm with other competitors' performance because a manager from one organisation cannot know the profitability or economic performance of the competitors' or the other companies' outcome.

The experts suggested adding more industries, e.g. food and beverage, textile and clothing because all sections would produce environmental impact as well. Thus, three industries were included in section 1 (company description and background) of the questionnaires.

Also, the experts pointed out that the characteristics of the primary product of the plant (question 6 in Part 1) mentioned as “engineered-to-order” was unclear and in Thailand, the normally used term is “made-to-order” production, this revision was made. Furthermore, they suggested that “energy and utilities” industry would be a service industry, not a manufacturing industry; therefore, “energy and utilities” was eliminated from the list of industry groups (question 1 part 1). After questionnaire development, the final questionnaire was sent to 100 selected plants for pilot testing; of which, 15 were returned, but 2 were incomplete, so the researcher received 13 valid questionnaires from the pilot testing.

The second stage of data collection (as shown in Figure 4.4) was mailing the survey to target respondents, which was further divided into two waves: the first wave aimed to collect data and the second wave aimed to increase the response rate. The target respondents were chosen from the database of the Thailand Energy and Environmental Network (TEENET) and the Department of Industrial Works in the Ministry of Industry (Thailand).

Figure 4.3 Pilot-testing



To test that questionnaire is accurate and easily understood by managers

2nd Phase: submit the (modified) questionnaire to sample companies

There are 2,520 companies in different industrial groups, ranging from general industries to exporters. The data came from 30 industrial estates of Thailand, such as the industrial estate of Amata City, Anyanee, Asia, Bangchan, Gateway City, etc. The author selected target companies by checking the industrial groups of each company. The following groups were selected for this study: automotive, automotive components, electronic components, food and beverage, industrial material and machinery, petrochemical and chemical, transportation and logistics, textile, clothing industries.

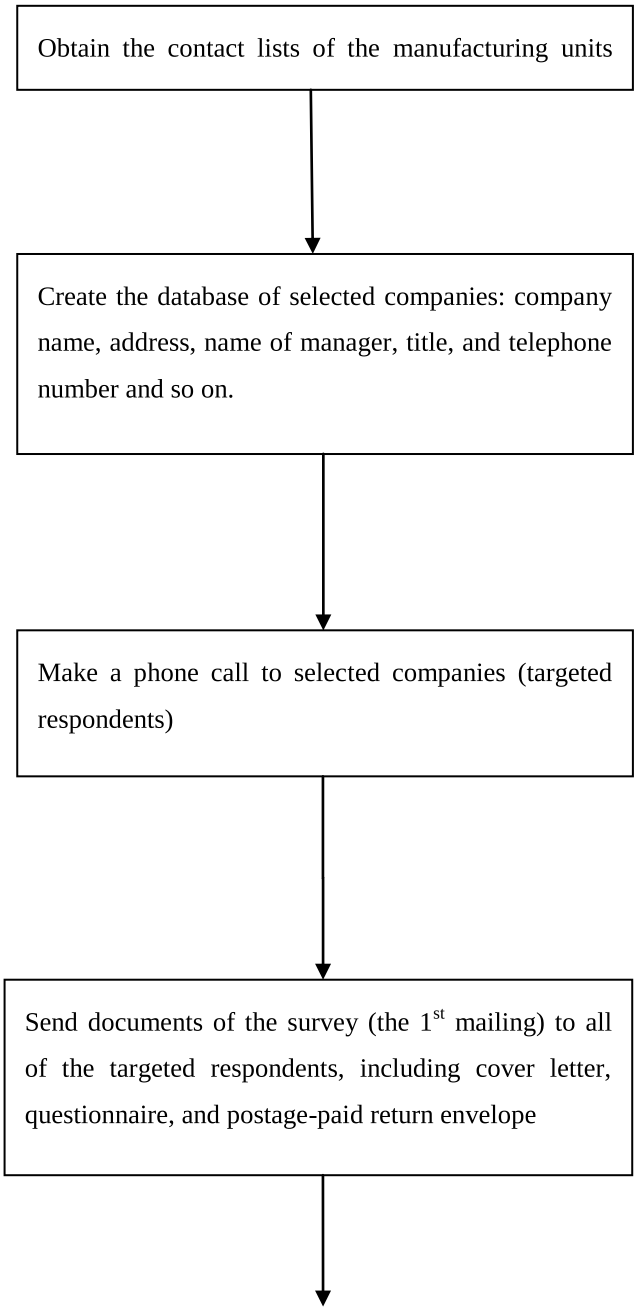
The researcher created a database of the selected companies to record the contact list of the firms. After that, the researcher phoned the firms in order to ask for the names of the managers who were direct responsible for SCM and environmental policy and also explained the objectives of this study and persuaded them to participate in the survey.

After that, the survey questionnaire was mailed to the target respondents. Along with the questionnaire, a cover letter stating the objectives of the research, and a postage-paid return envelope to mail the survey back to the researcher were sent to the respondents. In the first wave, 500 companies were contacted; of which, 257 agreed to participate. In the second wave, a group of research assistants was assigned to collect data to the increase response rate. Thus, 500 companies were contacted, but 322 companies agreed to participate in the survey. For this time, the research assistant directly contacted to these 322 companies by face-to-face method.

The final step of collecting data of each wave was reminding and following-up the target respondents. One week after mailing the questionnaire, the researcher called the respondents to remind them about the survey.

Figure 4.4 Data Collection

Procedures



Objectives

To prepare the list of the companies before sending the questionnaire

To record the information of all selected companies, making it easier to contact them if they do not respond the questionnaire

To contact the companies and ask for the name of the manager who had responsibility of supply chain management or environmental policy in order to send the questionnaire to the right person

To collect data (Targeted respondents: supply chain manager, logistics manager, environmental manager manufacturing or plant manager)

One week after the 1st mailing, make a phone call to remind the respondents	To follow-up and remind the respondents to answer the questionnaire
↓	
Two week after the 1st mailing, check the returned questionnaire against the data base	For the 2nd mailing of the documents to the companies that have not responded the questionnaire
↓	
Two week after the 1st mailing, send the 2ndset of documents to respondents who had not responded to the 1st mailing	To increase the response rate
↓	
If the response rate is low, remind the companies who have not responded the questionnaire and send a 3rdset of documents	To increase the response rate

4.6. Data Analysis

According to Forza (2002), when measurements are unreliable and/or invalid, the analysis can lead to incorrect inferences and misleading conclusions. The measurement instrument development process (Figure 4.1) for this research follows the one developed by Churchill (1979) to ensure the reliability and validity of the measures. The process of measurement development can be divided into eight main steps where each step is evaluated using different techniques.

As shown in Figure 4.1, the main processes and relevant techniques in each process consisted of specifying domains of constructs obtained from literature review on operation management, supply chain management, environmental management and strategic management, testing the validity of each construct, pilot-testing for establishing content validity before collecting the main data from the target respondents, purifying the measure, and assessing the reliability of the measurement model through coefficient alpha and factor analysis. Also, the construct validity was tested by exploratory factor analysis (EFA) and confirmatory factor analysis (CFA).

This section will be separated into six sub-sections: descriptive statistics, factor analysis, reliability analysis, validity analysis, correlation analysis, and hypothesis testing.

4.6.1. Data Preparation

Before data analysis, preparing a data file is an essential process. This process consists of the following steps: preparing a codebook (as presented in Appendix J), setting up the structure of the data file, entering the data which are transformed from raw data to an appropriate form for further analyses, and modifying the data file. In addition, after preparing the data, screening the data is also necessary, which is done by checking for error and correcting the error (Pallant, 2007).

First, the procedure of checking of errors involves searching for variables that fall outside the range of their appropriate values. For example, if a target company was asked whether it is ISO 14001 certified, the answer should be “Yes” or “No”. If the answer is coded as “Yes” = 1 and “No” = 2, the researcher should not find any scores that fall outside of 1 or 2. Second, the stage of finding and correcting the errors involves finding some out-of-range responses in the data file and correcting them by accessing the original questionnaires. In addition, checking for outliers before data analysis is an important step in eliminating or correcting some data (Pallant, 2007). Preliminary analyses also are very important to make sure that there is no violation of the assumptions of normality, homoscedasticity, and multicollinearlity (Hair et al., 2010; Pallant, 2007).

After checking all those processes, the researchers can analyse the data to answer the research questions or determine the outputs of the research by using statistical analysis techniques that are appropriate for the type of variables and research questions (Pallant, 2007).

4.6.2. Preliminary Analyses

4.6.2.1. Normality

Normality refers to the shape of the data distribution for an individual variable and its correspondence to the normal distribution. The shape of the any distribution can be explained by kurtosis and skewness. Kurtosis refers to the flatness of the distribution as compared with the normal distribution, or in other words the height of the distribution, whereas skewness refers to the balance of the distribution. According to Tabachnick and Fidell, (2007), for large samples, skewness will not make a substantive difference in the analysis. Kurtosis leads to underestimation of the variance, but the risk is decreased with a large sample (more than 200 responses or cases). Because of the sensitiveness with large sample, the shape of the distribution should be inspected (e.g. using a histogram) (Hair et al., 2010). Both of these values can be computed using statistical programs such as SPSS.

To examine the normal probability, statistical tests can be used. The statistical value for the skewness is evaluated as follows:

$$Z - skewness = skewness/\sqrt{6/N},$$ N is the sample size.

Also, the z-score for kurtosis can be computed by using the formula:

$$Z - kurtosis = kurtosis/\sqrt{24/N}$$

If the calculated z-score is higher than the specified critical value, then the distribution is non-normal, in terms of the characteristic. The most used critical values are ±2.58 ($p = 0.01$) and ±1.96 ($p = 0.05$).

In addition, the Kolmogorov–Smirnov test is used to assess the normality of the distribution, where a non-significant result ($p > 0.05$) indicates normality. However, for a large sample, the p value is usually equal to 0.00. In case of a large sample, the curve represents normal distribution, if the values are between 0.03 and 0.6 ($p < 0.01$). This value can be evaluated by statistical programmes such as SPSS.

4.6.2.2. Homoscedasticity

Homoscedasticity refers to the assumption that one or more dependent variables represent the same level of variance across a range of indicator(s) or predictor variable(s). Homoscedasticity is related to the dependence relationships between such variables. To have such a relationship fully, the variance of the dependent variable values must be relatively equal for each of the independent variables. If this variance or dispersion is unequal across the independent variables, the relationship is termed as heteroscedastic. To examine the homoscedasticity, graphical tests of equal variance dispersion, such as boxplots and normal probability plot can be used. Furthermore, homoscedasticity can be assessed by using statistical test such as the Levene test. The Levene test is performed to determine whether the variances of a single metric variable are equal across any number of groups.

4.6.2.3. Multicollinearity

Collinearity is an expression of the relationship between two independent variables, and if a correlation occurs between more than two independent variables, it is called multicollinearity (Hair et al., 2010). If the relationships of independent variable have a correlation coefficient of 1, the two variables are said to have complete collinearity. Multicollinearity occurs when any single independent variable or item is very highly related to a set of other independent variables (Hair et al., 2010). The independent variable has high correlation with the others, indicating it is perfectly predicted by one or more than one independent variable.

The most common measures for assessing multicollinearity are tolerance and its inverse, variance inflation factor (VIF). The VIF values indicate whether a predictor has a strong linear regression with the other predictors. In general, no multicollinearity is considered for statistical data analysis. It means that the relationship between one dependent variable and more than two independent variables is not acceptable. A VIF above 10 could be a matter of concern, indicating multicollinearity. Furthermore, tolerance is an indicator which explains how much of the variability of the proposed independent is not explained by the other independent variables in the model. The tolerance (or 1/VIF) for each predictor should not be less than 0.1. If the value is less than 0.1, it indicates that the multiple correlations with other independent variables are high (multicollinearity).

Multicollinearity seems not to exist when the tolerance and VIF values have met the criteria. A VIF ranging between 1.88 and 2.82 (<10), supported by the tolerance ranges between 0.36 and 0.59 (>0.10), indicates that there is no possibility of multicollinearlity among independent constructs or variables.

4.6.3. Descriptive Statistics

The descriptive statistics explained herein are frequency, respondent profile and company profile, demographic differences in firm characteristics, non-response bias, and common method bias. Furthermore, the results about the data related to the questions will be presented as mean and standard deviation values. The questionnaire was divided into two parts: company description and background information and supply chain management information of the firm, consisting of SCI, GSCM practices and SP.

4.6.3.1. Non-response Bias

Non-response bias refers to a situation where respondents refuse to participate in a said study or not be able to provide the necessary information (Agresti and Finlay, 2009). The non-response bias testing in this study was based on the assumption that those who responded late (late respondent) are representative of the non-respondent population (Armstrong and Overton, 1977).

To test the non-response bias, the independent sample *t*-test was employed to compare the responses of those who responded to the questionnaire at the first instance (early respondents) with the responses of those who responded later (late respondents). All of the 63 measurement items for this research were computed by comparing the mean values of two different groups (early and late respondents). A p-value above 0.05 indicates that there is no statistically significant difference in the mean values between the two groups.

4.6.3.2. Common Method Bias

The problem of method bias is a key source of measurement error (Podsakoff et al., 2003). Measurement error can lead to invalid conclusions about the relationship between measurement items and is considered to involve both random and systematic aspects (Bagozzi and Yi, 1991;Spector, 1987). According to Bagozzi and Yi (1991), one of the key sources of systematic measurement error is method variance that emerges from diverse sources. Nevertheless, regardless of its sources, systematic error variance can produce a serious confounding impact on the research results, leading to misleading conclusions (Campbell and Fiske, 1959). Also, Podsakoff et al. (2012)

provided empirical evidence of the effects that method bias has on reliability, validity of items, and covariation between constructs. Therefore, it is important to understand the sources of the common method bias (CMB) and when it is likely to be a problem.

Method bias arises when measurement items have a common source, common measurement context, and common item context or from the characteristics of the measurement items themselves (Podsakoff et al., 2003). Because of these problems, the controlling CMB is very important before analysing data using correlation, factor analysis, or structural equation modelling (SEM). There are two primary ways to control for CMB: the design of the study's procedure and/or statistical controls.

Firstly, the key method to control common method variance (CMV) through procedural remedies involves identifying what the measures of the predictor (independent) and criterion (dependent) variables have in common and delete or minimise this through research design. The main sources of CMV are the measures of both variables, including predictor and criterion variables that are from the same source. The connection between variables may arise from the respondent, contextual cues in the measurement environment or within the questionnaire and the specific wording and format of the questions. There are many ways to control the CMB, e.g. collecting the measures of these variables from different sources that are related to the main constructs (Podsakoff et al., 2003). Improvement of scale items is another way to reduce method bias, by defining the unfamiliar terms and avoiding unclear concepts or providing examples when such concepts are used, keeping questions simple, using specific and concise statements, improving scale items by avoiding the use of bipolar numerical values of scale (e.g. -2 to +2), and providing verbal labels for the midpoints of measures.

CMV can also be controlled by statistical remedies. In the research literature, many statistical remedies were used to control for CMB, such as Harman's single-factor test, measuring of CMV by controlling for the effects of directly measured latent methods factor, and measuring of CMV by controlling for the effects of an unmeasured latent method factor (Meade et al., 2007, Podsakoff et al., 2003).

Harman's single-factor test

In this test, all the items or variables in the study are loaded into EFA (Anderson and Bateman, 1997) and the unrotated factor solution is determined to examine the numbers of factors that are necessary to account for the variance in the items. The basic assumption of the test is that if a substantial amount of CMV exists, either a single factor will arise from the factor analysis or one general factor will account for the majority of the covariance among the measurement items. However, this test has several limitations (Podsakoff et al., 2003). For example, although, the use of this technique may provide an indication of a single factor accounting for variance among the variables, it does nothing to statistically control for method effects and there are no specific guidelines on how much variance of the first factor should be extracted before it is examined as a general factor.

Controlling for the Effects of Directly Measured Latent Methods Factor

The researcher use directly measured items as indicators (Williams and Anderson, 1994, Williams et al., 1996) and then modified the model such that it directly affected all other items administered. In this technique, CMV was controlled by incorporating the effects of a latent method factor on each observed measure.

Controlling for the Effects of an Unmeasured Latent Method Factor

This method uses an unmeasured latent method factor as an indicator (Podsakoff and MacKenzie, 1994, Meade et al., 2007). The benefits of this technique are that no special item needs to be administered and multiple types of effects can be modelled with the latent methods factor at the same time. This model controls for CMV through the factor loading between the methods factor and the measured items or indicators. However, this model has identification problems (Podsakoff et al., 2003)

4.6.3.3. No Significance Difference

The independent sample *t*-test is used to compare between groups of independent and dependent variables. In this research, the author used the independent *t*-test to compare companies with and without ISO 14001 certification to test the differences between the two groups in terms of ISO 14001 certification. The recommended value for equal variance was examined by Levene's test, with a cut-off value of 0.05; if this value was higher than the cut-off of 0.05, it indicated that there is no significant difference in the mean values of the two groups (Hart et al., 2010, Pallant, 2007).

Furthermore, the analysis of variance (ANOVA) was employed when one independent variable had more than 2 levels (Pallant, 2007). ANOVA is used for comparing the variance between the different groups, such as firm size. The value of the F-test can be used to assess the difference between the groups; a large F value indicates that there is more variability between groups than within each group. In addition, the significant value can be examined to test the difference; if the significant value is less than or equal to 0.05, it indicates there is a significant difference among the means of different groups (dependent variables). However, this does not tell the researcher which group is different from the others, so a post-hoc test would be required.

4.6.4. Correlation Analysis

Correlation analysis is used to explain the strength and direction of the linear relationship between two variables, including independent and dependent variables. There are two types of correlations: simple bivariate correlation and partial correlation. The Pearson product-moment coefficient is designed for interval variables, whereas the Spearman rank order correlation is designed for ordinal levels and also is especially useful when the data do not achieve the criteria for Pearson's correlation. For this research, Pearson product-moment coefficient was used to examine the relationship between different variables, II, SI, CI, IGSCM, EGCSM practices, ENP and EP. The author analysed the correlation between measurement items of each construct to determine the correlation coefficient. If the correlation is lower than 0.3, the items are removed because the items have less correlation with other items in the same construct. Also, if the correlation is greater than 0.9, the items are deleted because of multicollinearity (Hair et al., 2010). Cohen (1988) suggests that values ranging between0.10 and0.29 indicate that the correlation between two variables is small, values ranging between 0.30 to 0.49 indicate medium correlation, and those ranging between 0.50 to 1.0 indicate large correlation.

4.6.5. Exploratory Factor Analysis

This section will explain the approaches to factor analysis to understand the basic concept first, prior to addressing factor analysis and hypothesis testing in detail in the next section. Two main procedures are involved in factor analysis: EFA and CFA (Hair et al., 2010; Pallant, 2007;2010). EFA is used to gain information about how many factors are appropriate for representing each factor by using statistical techniques and results (Hair et al., 2010). With EFA, all variables are linked to all the factors by considering the correlation estimate. The relationship between the factors and measured variables is called factor loading. Generally, each measured item will load highly on only one factor and has lower factor loading on other factors (loading lower than 0.3). However, if a measured variable has a loading greater than 0.3 on more than a single factor (cross-loading), this variable is deleted from the factor analysis. After examination of item loading, the factors or constructs that emerge are named on the basis of variables loading highly on each factor. The factor analysis tool in SPSS programme version 19 is used for EFA in this research.

On the other hand, CFA is a more sophisticated procedure for testing the specific hypotheses or confirming the theories underlying the structure in the research. On the basis of literature review and CFA findings, the researcher specified both the number of factors and which factors each variable would load on before computing the statistical results. Therefore, the CFA is a good tool for either confirming or rejecting the proposed theories (Hair et al., 2010). In this research, SEM is used to test the hypotheses that represents the relationship between all constructs, including SCI, GSCM practices, and sustainable performance which from the theoretical model. For this study, the AMOS programme version 19 was used to perform the CFA to test the hypotheses proposed in this research.

The main difference between EFA and CFA is that the factors for EFA are derived from statistical results, not from theory, while the factors for CFA are derived from related theories. CFA will be used to test or confirm whether the hypotheses are supported by the selected theories. EFA and CFA are related because when EFA is examined in the research, EFA will show suitable variables that load on a specific factor. Also, the researcher will know how many factors are appropriate and use these factors as guidelines for factors or constructs in CFA further. In the CFA, the researcher confirms the factors that are extracted in the EFA.

4.6.5.1. Factor Analysis

Factor analysis is a statistical technique for determining the relationship between the variables in the data set. Factor analysis follows an interdependence technique. With this technique, the variables cannot be grouped as either dependent or independent. All variables are analysed simultaneously to find an underlying structure between them (Hair et al., 2010). Factor analysis is not designed to test hypotheses, but it is a data reduction method (Pallant, 2007). It can be used to reduce a large number of related items and summarise them into a smaller number of factors or constructs by grouping the variables that are highly intercorrelated in the same factor or construct before using them in other analyses, such as multiple regression or SEM for testing the hypotheses. The significant factor loading is above 0.3 (Hair et al., 2010); the measured items that show factor loading lower than 0.3 are omitted from the factor analysis. However, according to Hair et al. (2010) and Stevens (2009), the significant factor loading will depend on the sample size, as shown in Table 4.9. However, prior to using factor analysis to find an underlying structure in the set of variables, it is necessary that the dataset meets the conceptual requirements or critical assumptions of factor analysis.

4.6.5.2. The Critical Assumptions of Factor Analysis

The initial steps before computing factor analysis for all variables is checking the critical assumptions for factor analysis which are: (1) sample size,(2) correlation between variables,(3) Bartlett test of sphericity, and (4) Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) (Field, 2009). First, the overall sample size should be greater than 150 (Pallant, 2007) and the common rule about the sample size is that the researcher needs at least 10 to 15 participants for each variable (Field, 2009). Hair et al. (2010) suggested that a researcher needs at least 5 to 10 participants for each variable,up to a total of 300. Additionally, Tabachnick and Fidell (2007) agree that the sample size should have at least 300 cases for factor analysis. Field (2009) suggested that 300 was a good sample size, 100 was poor, and 1000 was excellent for factor analysis.

The intercorrelation between measured variables can be checked by creating a correlation matrix of all variables. The correlation coefficient should be at least 0.3 or greater. If the correlation coefficient of a variable has a value lower than 0.3, the variable is dropped because the relationship between the variables is quite low (Pallant, 2007, Hair et al., 2010, Field, 2009). Furthermore, if a variable has a high correlation (greater than 0.9) with other variables, it shows multicollinearity. The variables that are correlated very highly (correlation value greater than 0.9 (Hair et al., 2010) or greater than 0.8 (Field, 2009a)are eliminated. Therefore, the correlation coefficient should not be lower than 0.3 as well as not higher than 0.9 (Hair et al., 2010).

Third, suitable variables for factor analysis are determined by examining the entire correlation matrix using the Bartlett test of Sphericity for the presence of correlation among the variables. This value indicates whether the correlation matrix is significantly different from an identity matrix (Field, 2009). If the Bartlett test is significantly large, then it indicates that there are some correlations between variables which should be taken into account in the analysis (Bartlett, 1954). In factor analysis, Bartlett's test of

Sphericity should be significant ($p < 0.05$) to represent that correlation between variables are large enough for factor analysis (Tabachnik and Fidell, 2007).

Finally, the measure of sampling adequacy (MSA) is used to examine the degree of intercorrelation between variables. The KMO measure of sampling adequacy was used in this research (Hair et al., 2010). The KMO value usually ranges between 0 and1; if it is closer to 1, it indicates that a variable is perfectly predicted, without error, by the other variables. Kaiser (1974)and Hair et al. (2010) suggested the acceptable values greater than 0.5indicate that the variables have sufficient correlations. If the value is below 0.5, the variable should be dropped from the factor analysis. Moreover, Hair et al.(2010) stated that KMO values between 0.5 and 0.7 were mediocre, those between 0.7 and 0.8 were good, those between 0.8 and 0.9 were great, and those above 0.9 were superb.

In this research, 63 items had to be analysed by using the EFA procedure to find appropriate factors for all variables. Factor analysis is a necessary initial procedure before CFA through SEM. Furthermore, researchers should also address other relevant issues before beginning factor analysis, e.g. factor extraction, number of factors, and factor loading.

4.6.5.3. Other Issues involved in Factor Analysis

4.6.5.3.1. Factor Extraction

Factor extraction involves finding out the appropriate number of factors that can be used to present the correlation among variables in the data set. There are many methods to extract the number of underlying structure or factors. According to Field (2009b), for the first analysis, selecting varimax rotation is a good general approach that makes the interpretation of factors easier. Hence, for this research, EFA with varimax method was chosen to interpret the factors. This method is used to reduce the number of items that have high factor loadings on each factor.

Moreover, the principle component method is used to extract factors which are rotated and loaded by reducing the large set of items to a small set of measures. The principal components analysis attempts to reproduce the variance in the sample data, instead of in the population. However, if the sample reasonably represents the population, the factors that come from the sample data will represent the population factors as well (Thompson, 2008). Therefore, this research employed EFA with varimax rotation and also principal components analysis to identify the factors for SCI, GSCM practices and sustainable firm performance (environmental and economic performance).

4.6.5.3.2. Number of Factors

The number of factors can be extracted by using the scree plots of the data set or considering the eigenvalues which are higher than 1 (Hair et al., 2010). The scree plots test involves plotting each of the eigenvalues of the factors in the research and investigating the plot to check the point at which the shape of the line changes direction and changes into a horizontal line (Pallant, 2007). Thus, this point is the cut-off point to select the appropriate numbers of factor (Pallant, 2007). Furthermore, the eigenvalue is another measure that is determined to find out the possible number of factors. The eigenvalues represent the amount of the total of variation explained by those factors (Pallant, 2007). Only factors that have eigenvalues more than 1 are considered significant; other factors with values lower than 1 are not significant and are ignored. The eigenvalue >1 rule also is called the Kaiser-Guttman rule (Brown, 2006b), Kaiser's criterion (Pallant, 2007), or latent root criterion (Hair et al., 2010).

4.6.5.3.3. Factor Loading

A factor loading represents the correlation between a measured variable and its factor or appropriate construct. The minimal level of factor loading ranges between 0.30 and 0.40; item loadings⩾0.50 are considered significant (Hair et al., 2010). The factor loading that is lower than 0.3 is omitted from the factor analysis. Furthermore, the variable that has factor loading (higher than 0.3) on more than a single factor (indicating that it is cross-loading) is also deleted from the factor analysis. Significant factor loading is dependent on the sample size (Hair et al., 2010; Field, 2009; Steven, 2009). Steven (2009) recommended the guidelines for identifying significant factor loadings based on sample size, as shown in Table 4.9.

Table 4.9 Sample Size and Significant Factor Loading

Sample size	Significant factor loading
50	0.722
100	0.512
200	0.364
300	0.298
600	0.210
1000	0.162

After extracting the factors, the next step is to look at the content of the all items or questions that are related to the same construct and identify common themes that are meaningful to all measures in each factor or construct.

4.6.6. Reliability

Reliability involves dependability, stability, consistency, predictability, and accuracy (Burns, 2000). Construct reliability (CR) represents the degree of intercorrelation between variables measuring a latent construct (Mentzer and Flint, 1997). Reliability analysis commonly uses Cronbach’s alpha to determine the consistency and reliability of each construct (Garver and Mentzer, 1999). In general, good reliability should have coefficient alpha scores 0.7 or higher (Churchill, 1999; Hair et al., 2010). However, Nunnally (1978) suggested that allowable alpha values can be a little lower than 0.70 for newly developed measures. For instance, Van de Venn and Ferry (1980) note that 0.40 can be an acceptable value for widely defined constructs. However, many researchers consider 0.40 too low, and a value of 0.60 is often used as the lower range (Flynn et al., 1994).Furthermore, for obtaining Cronbach’s alpha, it is necessary that each unidimensional construct has a minimum of three variables (Mentzer and Flint, 1997; Garver and Mentzer, 1999).

Cronbach’s alpha has some limitations. For instance, the coefficient may underestimate scale reliability in some cases (Garver and Mentzer, 1999; Hair et al., 2010), but if the scale has a large number of items, it tends to artificially increase (Anderson and Gerbing, 1988). Thus, many researchers wrongly select items to artificially enhance the reliability. Also, traditional reliability defines reliability as consistency. Consistency is quite difficult to assess and achieve(Bollen, 1989). Therefore, the researcher can select different reliability estimates that measure the reliability of each construct, especially with the SEM model, e.g. SEM variable (or item) reliability and CR.

SEM Reliability Measures

To overcome limitations related to coefficient alpha stated earlier, the SEM technique is used to validate variables and determine CR. SEM reliability for variables or items is measured by means of the square of the estimated correlation value (R^2). This value associates the latent construct to its item. However, the measure of reliability works only if the measurement model is specified that the latent construct directly related to the measurement items of each construct (Bollen, 1989).

In addition, SEM techniques exist for assessing CR. SEM computer software, such as AMOS, does not calculate the CR. The values can be computed from the squared sum of factor loading (L) for each construct and the sum of the error variance terms (e) for a construct as follows:

$$\text{Construct Reliability (CR)} = (\sum L)^2/[(\sum L)^2 + \sum e]$$

The CR value is relatively close to Cronbach's alpha, in many cases, and the acceptable value is 0.70 or higher. Furthermore, the average variance extracted (AVE) is an additional measure of CR (Garver and Mentzer, 1999). This value can be calculated as the total of squared standardised factor loading (L) (or squared multiple correlations: R^2) divided by the number of items (n). The acceptable reliability value for AVE is 0.5 or higher (Garver and Mentzer, 1999; Hair et al., 2010). The AVE formula is:

$$\text{Average Variance Extracted (AVE)} = \sum L^2/n$$

According to Baumgarter and Homburg (1996), a researcher should take into account at least one measure of CR, such as composite reliability, AVE. Cronbach's alpha is only value that is lower bound on reliability. However, Garver and Mentzer (1999) recommended that logistics researchers should report coefficient alpha and both SEM CR measures.

4.6.7. Validity Analysis

4.6.7.1. Content Validity

The content validity of a measurement is the extent to which it provides adequate coverage for the construct domain or essence of the domain that is measured (Stevens, 1986). The results of content validity are subjective and cannot be explained by any numerical value (Emory, 1980). To generate the content validity, a researcher has to review existing literature related to the content of his/her research. Moreover, pre-testing the measurement is a method that can be employed to determine content validity. For this dissertation, the developed questionnaire was sent to four groups of relevant people, i.e. colleagues, academics, industry experts, and target respondents. The role of the colleagues was to test whether the questionnaire met the objectives of the research (Dillman, 1978). The role of industry experts was to prevent the inclusion of some obvious questions that might reveal avoidable ignorance of the investigator in some specific area. Finally, the role of target respondents was to provide feedback on any aspect that could affect the responses of the target respondents. The industry experts selected in this study were top managers in logistics and/or supply chain management departments or a person who knew about the process of the plant very well. The process of pre-testing allows researchers to review the questionnaire for readability, ambiguity, and completeness (Dillman, 1978).

4.6.7.2. Construct Validity

Construct validity is the extent to which a set of measured variables reflects the theoretical construct those measured items are designed to measure (Churchill, 1987; Hair et al., 2010). Therefore, construct validity is concerned about the measurement accuracy. If the data set can provide evidence of construct validity, it indicates that variables taken from a sample represent the true score for the population. Construct validity can be separated into two aspects: convergent validity and discriminant validity (Campbell and Fiske, 1959). However, before presenting convergent and discriminant validity, unidimensionality has to be examined as a statistical process to test constructs in the measurement model as well (Churchill, 1979; Garver and Mentzer, 1999).

4.6.7.2.1. Unidimensionality

Unidimensionality refers to the existence of a set of measured variables in a single latent construct. In other words, one measured variable or indicator should load on only one construct. The criterion for evaluating construct unidimensionality in CFA is the overall goodness-of-fit (GOF) of the measurement model and components of the measurement model, e.g. CR, convergent, and discriminant validity (Garver and Mentzer, 1999). Therefore, the constructs that show an acceptable reliability, convergent, and discriminant validity are likely to be unidimensional (Anderson and Gerbing, 1988).

The CFA process should be conducted with each latent construct independently. When each construct in the measurement model is considered a unidimensional construct by itself, then all possible pairs of constructs should be tested unidimensionality. Finally, the overall measurement model should be evaluated for unidimensionality.

4.6.7.2.2. Convergent Validity

Convergent validity measures convergence between the individual items which measure the same construct (Brown, 2006b). According to Hair et al. (2010), convergent validity is the extent to which indicators of a specific construct converge or share a high proportion of variance in common. Convergent validity can be assessed by both EFA (Flynn et al., 1994) and CFA (Ahire et al., 1996). For EFA, convergent validity of the construct can be assessed by considering eigenvalue and factor loadings. A construct has convergent validity if its eigenvalue is greater than 1.0 and all the factor loadings are 0.5 or higher (Hair et al., 2010).

For CFA, convergent validity can be assessed by considering the factor loading, AVE, and CR (Hair et al., 2010). First of all, the size of item loading is an essential point; values that are 0.5 or higher and, ideally, 0.7 or higher are considered acceptable. However, factor loading as low as between 0.4 and 0.5 have been acceptable when checking the theoretical content of a measurement model (Kirchoff, 2011). In addition, all measured item loadings should be statistically significant (Garver and Mentzer, 1999; Hair et al., 2010). In most cases, the researcher interprets standardised loading estimates or factor loading values are limited to range between -1.0 and +1.0. Unstandardised factor loadings represent covariances; therefore, they do not have upper and lower bound values.

The second value, AVE, is a summary indicator of convergence. AVE is computed as the sum of all squared standardised factor loading (R^2) divided by the number of items. A rule of thumb for this value is that it should be equal to 0.5 or higher. If the AVE is less than 0.5, it means more error remains in the measured items than variance explained by the latent construct imposed on the measure. In a measurement model, each latent construct should be computed using an AVE measure to ensure the convergent validity (Hair et al., 2010).

Finally, CR is a convergent validity indicator as well. The CR is computed from the squared sum of standardised factor loading for each construct (R^2) divided by the sum of factor loading and the sum of the error variance terms for a construct. A good reliability should be 0.7 or higher (Garver and Mentzer, 1999), but CR between 0.6 and 0.7 is acceptable (Hair et al., 2010). Thus, the CR values (between 0.6 and 0.7) provided that other estimates of the measurement model validity for each construct is good. High CR means that internal consistency exists or that the measured items constantly represent the same latent construct.

4.6.7.2.3. Discriminant Validity

Discriminant validity measures the extent to which the individual items of a construct are distinctive. It means that individual measured items should represent only single latent constructs. Therefore, a high discriminant validity implies that a construct is unique and captures some aspects that other measured items do not (Hair et al., 2010). Discriminant validity can be evaluated by subjecting the item to CFA. According to Hair et al. (2010), CFA provides two approaches to assess discriminant validity. In the first approach, the correlation between any two constructs is constrained to be specifically equal to one. In the second approach, discriminant validity can be examined by comparing the AVE value for any two constructs with the square of the correlation estimate between these two constructs. The AVE for a construct should be higher than the squared correlation (R^2) between the said construct and other constructs; this means that discriminant validity is supported.

4.6.8. Hypothesis Testing

This research involves the relationship among three main constructs, SCI, GSCM practices, and sustainable performance, including environmental and economic performance. The statistical analysis technique that is used for hypothesis testing in this research is SEM. Normally, there are many statistical techniques to test theoretical hypotheses, such as simple and multiple regression analysis and SEM. SEM is used in this research because SEM has more advantages than multiple regression analysis. Regression analysis is suitable for analysing the relationship between several independent variables and a single dependent variable, while SEM can be used to analyse a series of the relationship between several independent variables and latent constructs and between several latent constructs at the same time (Hair et al., 2010). In this research, two latent constructs needed to be examined, so SEM was more appropriate than multiple regression analysis. Besides, SEM can also evaluate the indirect effect, such as mediation effects. Because all of the constructs can be included in one model, a researcher can examine both the direct and indirect effects of the relationships.

4.6.8.1. Structural Equation Modelling

SEM is a multivariate technique that combines features of both factor analysis and multiple regressions analysis, thereby enabling a researcher to examine a series of interrelated dependence relationships among the measured variables and latent constructs and also between several latent constructs simultaneously (Hair et al., 2010). SEM examines the structure of interrelationship that exists in a series of equations (similar to regression equations from multiple regression analysis). The equations from SEM represent all the relationships among the dependent and independent variables or constructs that are related in the analysis. Latent constructs are as unobservable or latent factor that are represented by several variables (like measurement items or variables that represent a factor in factor analysis). SEM is also termed as covariance structure model analysis (Steven, 2009) and latent variable analysis (Hair et al., 2010).

SEM is used to analyse the relationships between the constructs in two steps; hence, many researchers call SEM "the two-step approach" (Anderson and Gerbing, 1988). The first step is validating the measurement models through CFA. The measurement model represents the theory that shows how measured items come together to represent a construct. After the measurement model is validated, the researcher conducts the second step, i.e. estimating the structural model. The structural model represents how the latent constructs are related to each other with multiple dependence relationships (Brown, 2006). In other words, this step defines the structural model by identifying direct and indirect relationships among the latent constructs. According to Maruyama (1998), the measurement model and structural model should be separated to ensure accurate model identification. If each measurement model for each construct is independently identified, then the structural model will be identified as well.

The model can be drawn as a path diagram including both the measurement model and structural model. A path diagram represents the link between the specific variable and its associated construct as well as the relationship among constructs. The measurement model's validity was assessed to confirm that it fit; then the structural model will be assessed the structural model validity to test the theoretical hypotheses (Hair et al., 2010).

4.6.8.1.1. Measurement Model

CFA was employed to assess the measurement model of the constructs at the first-order factor level for this research. A measurement model is based in a measurement theory that identifies how constructs are operationalised by sets of measured variables (Hair et al., 2010). In a measurement model, the number of factors and the variable loadings on each factor come from the relevant theories that are known before the analysis can be performed. Prior to testing the hypotheses, the researcher must examine unidimensionality by checking whether the measurement model is valid or not. Checking measurement model's validity is a vital step in SEM.

Measurement Model Validity

Measurement model validity shows how measured variables logically and systematically represent a construct that are involved in a theoretical model (Hair et al., 2010). Generally, a researcher has to consider how all individual constructs can come together to establish an overall measurement model. The measurement model of each construct will be validated by evaluating the overall measurement model validity to check whether model validity is an acceptable value or not. Measurement model validity depends on two main aspects: evaluating overall measurement model validity and finding evidence of construct validity (Hair et al., 2010).

The measurement model to be used in this his study was generated, analysed, and revised using the AMOS programme version 19. The measurement model could be separated into three sub-models: the models of SCI, GSCM practices, and sustainable firm performance. SCI comprised three sub-constructs: II, SI, and CI. GSCM practices comprised two sub-constructs: IGSCM and EGSCM practices; sustainable firm performance comprised two sub-constructs: ENP and EP.

To analyse the measurement model's fit, the researcher conduct an SEM analysis that involved assessing and reporting the GOF for the measurement model, i.e. the absolute fit indices and incremental fit indices. Hair et al., 2010 suggest that at least one index from the absolute fit indices and one index from the incremental indices should be presented. However, the basic of GOF, such as χ^2/degree of freedom (df) should be reported with the absolute and incremental fit indices. Thus, this research presents the fundamental measures with both GOF indices mentioned above.

GOF represents how well the model reproduces the observed covariance matrix with the measured variables. There are many alternative GOF measures that a researcher can use to validate the measurement model.

The Basics of Goodness-of-fit

The ***chi square*** (***χ^2***) is a fundamental measure used to examine the differences between the observed and estimated covariance matrices (Hair et al., 2010).The χ^2 is represented mathematically using the following equation:

$$\chi^2 = (N-1)(\text{observed sample covariance matrix} - \text{SEM estimated covariance matrix})$$

N is the overall sample size; χ^2 is sensitive to sample size (Gerging and Anderson, 1985). If a study has a large sample to increase the precision of parameter estimation (N increases), χ^2will increase as well. A χ^2 will almost be significant, implying that the measurement model is a poor fit. Thus, with some consensus in psychometric research, a model is said to represent reasonable fit if the χ^2adjusted by its df does not exceed 3.0 (Kline, 2004).

The ***degree of freedom (df)*** represents the amount of mathematical information required to estimate parameters in the model. The df is calculated as follows:

$$df = \frac{1}{2} [(p)(p+1)] - k$$

where p is the total number of observed variables and k is the number of estimated parameters

The ***normed chi-square (χ^2/df)*** is a simple ratio. In general, a ratio in the order of 3:1 or less indicates better-fitting models. This value is less dependent on the sample size.

Absolute Fit Indices

The ***goodness-of-fit index*** explains how well a researcher's theories fit the sample data. The GOF values range between 0 and 1; higher values indicate better fit. Values that are greater than 0.90 are considered acceptable (Hair et al., 2010). However, others argue that 0.95 should be used as the ideal value (Hu and Bentler, 1999)

The ***root mean square error of approximation (RMSEA)*** represents how well a model fits a population and not only the sample that was used for estimation. It is not affected by sample size. The RMSEA values between 0.05 and 0.08 are considered acceptable (Gerver and Mentzer, 1999). The RMSEA is also called a badness-of-fit index. Lower RMSEA values indicate better fit.

The ***standardised root mean residual (SRMR)*** is a badness-of-fit index (larger values indicate worse fit). The acceptable SRMR values range from 0.00 to 1.0. If SRMR is zero, the model predictions match the data perfectly. The index is increased (lowered) when the measurement item is high loading or clean (Anderson and Gerbing, 1984). An

SRMR value that is lower than 0.09 is considered acceptable (Iacobucci, 2010). SRMR is relatively less sensitive to other issue (e.g. violation of distribution assumption), so it is a pretty good measure.

Incremental Fit Indices

The ***normed fit index (NFI)*** is one of the original incremental fit indices (Hair et al., 2010). The index is the ratio of the difference between the χ^2 value for the fitted model and null model and the χ^2 value for the null model. The NFI value ranges between 0.00 and 1.00.

The ***Tucker-Lewis Index (TLI)*** compares a proposed model's fit to a null model. The TLI also is known as the non-normed fit index (NNFI) (Garver and Mentzer, 1999). The index measures parsimony by evaluating the df of the proposed model against the df of the null model. An acceptable value for TLI is 0.9 or higher (Marsh et al., 1988). The TLI value is similar to the CFI in most situations.

The ***comparative fit index (CFI)*** compares a model to the data; the index takes the fit of one model to the data and compares it to the fit of the same data to another model. Unlike the SRMR and RMSEA, the CFI index ranges between 0 and 1; the acceptable threshold for CFI is 0.9 or higher (Hair et al., 2010).

Table 4.10 Model Fit Indices for the Measurement Model Validity

Types of Model of Fit Indices	Model Fit Indices	Recommended Value	References
Basics of Goodness-of-fit	Chi-square (χ^2)	n/a	
	Degree of freedom (df)	n/a	
	Statistical significance of χ^2	Non-significance	Hair et al., 2010
Absolute Fit Indices	Normed Chi-square or (χ^2/df) or Chi-square ratio	⩽3.00	Hair et al., 2010 Kline, 2004
	Goodness-of-fit Index (GFI)	⩾0.90	Hair et al., 2010
	Root Mean Square Error of Approximation (RMSEA)	⩽0.08 0.05 to 0.08	Browne and Cudeck, 1993 Carter and Jennings, 2004 Garver and Mentzer, 1999
	Standardised Root Mean Residual (SRMR)	⩽0.09	Iacobucci, 2010
Incremental Fit Indices	Normed Fit Index (NFI)	⩾0.90	Hair et al., 2010
	Tucker-Lewis Index (TLI)	⩾0.90	Garver and Mentzer, 1999
	Comparative Fit Index (CFI)	⩾0.90 ⩾0.95	Garver and Mentzer, 1999 Hair et al., 2010 Hu and Bentler, 1999 Iacobucci, 2010

Evaluating overall measurement model validity involves two strategies: selecting model fit indices that can show various groups of fit indices and specifying a rigorous criteria and choosing model fit indices that best illustrate the criteria (Garver and Mentzer, 1999). According to Marsh et al., (1988)the criteria for the ideal model fit indices should be relative independence of sample size, accuracy and consistency in evaluating various models, and easy interpretation by means of a well-defined on a pre-set range (e.g. 0 to 1).

Garver and Mentzert recommended three ideal GOF indices: TLI, CFI, and RMSEA. All of these indices can be interpreted easily and also are relatively independent of sample size (Gerbing and Anderson, 1992).

Furthermore, if the measurement model has an unacceptable model fit when assessing the model fit with the AMOS programme, Garver and Mentzer (1999) and Hair et al. (2010) suggest modifying the measurement model by employing three diagnostics measures from CFA. The diagnostics indicators should contain factor loadings of each measured items, standardised residuals (SRs), and modification index (MI). All of the indicators can help a researcher examine why the measurement model is not fit or unacceptable (Joreskog and Sorbom, 1993). However, theoretical considerations are still important for measurement model modification (Bollen, 1989).

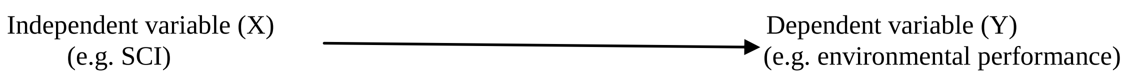
Firstly, factor loadings or items with standardised loading values of 0.5 or greater were considered acceptable values. The items that had values lower than the threshold value were dropped from the dataset. Secondly, the researcher used SR when the measurement model was not fit. To examine SR value, the researcher should consider a large residual value. A large residual value is over 1.96 or 2.576, depending on the alpha level selected by the researchers (e.g. if they choose significant at the 0.05, the considered SR value should be over 1.96).

Lastly, the modification index (MI) is useful for examining how to modify a measurement model. Each MI value represents the expected change in the χ^2value and the expected parameter estimate. A substantial MI value is considered 7.88 and is more likely to be a significant model improvement. The greatest MI represents the largest scope for improvement in fit model. The items that have the largest MI should be considered for modification first (Garver and Mentzer, 1999). The measurement model should be re-calculated after each re-specification.

4.6.8.2. Direct and Indirect Effect

A direct effect is the relationship one that links two main constructs with single arrow that points from an independent variable to a dependent variable (Hair et al., 2010), as presented in Figure 4.5. The direct effect explains whether an independent variable can impact a dependent variable. The direct effect was used to test the theoretical hypothesis of this research. For example, in this research, the author aimed to determine whether SCI had a direct positive impact on sustainable performance, including environmental and economic performance. The direct relationships studied in this research were SCI–sustainable firm performance, GSCM practices–sustainable firm performance, and SCI–GSCM practices relationship.

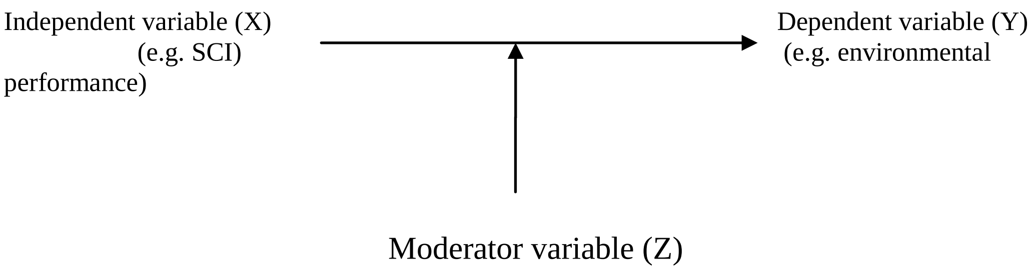
Figure 4.5 Diagram of the Direct Effect



An indirect effect is a relationship that is related to a sequence of relationships with at least an intervening construct involved, such as a mediator variable (Hair et al., 2010). There are two variations of the basic relationships among the main constructs: mediation and moderation.

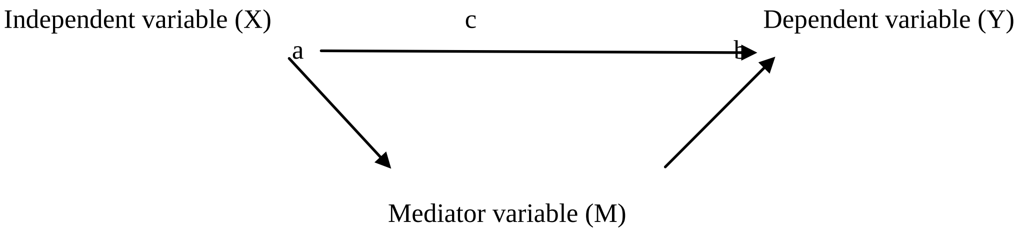
The moderation effect is a relationship between an independent variable and a dependent variable affected by a third variable which termed as a moderator (Hair et al., 2010). According to Baron and Kenny (1986), a moderator is a qualitative or quantitative variable that influences the direction or strength of the relationship between an independent and dependent variable. This moderator variable can change the linkage between two main constructs (the independent and dependent variable). For example, the results between males and females were significantly different, indicating that gender is a moderator because it can change the relationship between two main constructs. Therefore, if a moderator variable affects the relationship, then an interaction between an independent and moderator will exist. Thus, a moderation effect is an interaction effect. The moderation model is presented in Figure 4.6.

Figure 4.6 Diagram of the Moderation Effect



Mediation effect is another type of the relationship among two variables (Hair et al., 2010). As mentioned by Baron and Kenny (1986), mediators can explain how or why the effects occur. The mediation model generally has a three-variable system and two causal paths that point to the dependent or outcome variable. The mediator variable is presumed to cause the dependent variable and not vice versa. The causal paths contain the direct impact of the independent variable to the dependent variable (Path c), a path from the independent variable to the mediator (Path a), and the impact of the mediator to the dependent variable (Path b), as shown in Figure 4.7. In this research, the author aimed to examine whether GSCM practices played the role of a mediator in the relationship between SCI (as an independent variable) and sustainable performance (as a dependent variable).

Figure 4.7 Diagram of the Mediation Effect



The empirical results of this research show that SCI does not directly affect sustainable firm performance. On the other hand, GSCM practices have a direct effect on sustainable firm performance. Both of the internal and external GSCM practices have direct influence on economic performance, but only internal GSCM practices have a direct effect on environmental performance. In addition, integration of business processes had an influence on the relationship between SCI and GSCM practices for both of internal and external GSCM practices. This finding mainly answers research questions RQ1 and RQ2 "Does SCI have a direct positive effect on sustainable firm performance in terms of environmental and economic performance simultaneously? If so, how?" and "Do GSCM practices have a direct positive effect on sustainable firm performance in terms of environmental and economic performance simultaneously? If so, how?" In addition, the results also answer RQ3 and RQ4 "Does environmental performance have a direct positive effect on economic performance? If so, how?" and "Are SCI and GSCM practices related? If so, how do they influence each other?" The mediation effect was used to answer research question RQ5, "What are the combined effects of SCI and GSCM practices on sustainable firm performance in terms of environmental and economic performance?" Both the direct and indirect effects of the relationships between SCI, GSCM practices, and sustainable performance are shown in Figure 3.1.

Testing Mediation Effect

To test for mediation, this research followed the procedures of Baron and Kenny's (1986) and Sobel's test. Baron and Kenny's mediation testing has four steps (Baron and Kenny, 1986; Judd and Kenny, 1981). First, the significant direct effect of the independent variable on the dependent variable (without mediator) is determined (Path c in Figure 4.7). Second, the significant effect of the independent variable on the mediator variable (Path a in Figure 4.7) is determined. Third, the significant effect of the mediator on the dependent variable by controlling the effect of the independent variable on the dependent variable (Path b in Figure 4.7) is determined. Finally, the insignificant effect of the independent variable on the dependent variable when the mediator variable is controlled is determined. If the results present a significant effect for the first three steps and insignificant effect for the last step, the mediator variable is considered a full mediator in the independent variable–dependent variable relationship. On the other hand, if the last step presents a significant effect of the independent variable on the dependent variable with mediator simultaneously, the mediator variable is considered a partial mediator (Baron and Kenny, 1986).

The second assessment for examining the mediation effect, Sobel's test, is a statistical method (Lee et al., 2012a). The method is used to test whether a mediator plays the role of an intervening variable. The result shows that the indirect or mediation effect is significantly different from zero (Sobel, 1982). The calculation tool used to determine the mediation effect is the Sobel test calculator. This tool calculates the z-score (value) as follows:

$$Z\text{-}score = a \times b / \sqrt{(b^2 x S_a^2 + a^2 x S_b^2)}$$

Where a and b are unstandardised regression coefficients and S_a and S_b are the standard errors of the respective paths. The result shows a significant mediation effect when the z-score is greater than 1.96 ($p < 0.05$).

CHAPTER 5: SURVEY DESCRIPTIVE STATISTICS AND FACTOR ANALYSIS

5.1. Introduction

The data and results of the statistical analyses are presented in this chapter. Also, the response rate, response and non-response bias, and sample profile are presented here. In addition, the results of the preliminary analyses are outlined, followed by descriptive correlation analysis of the data in the next section.

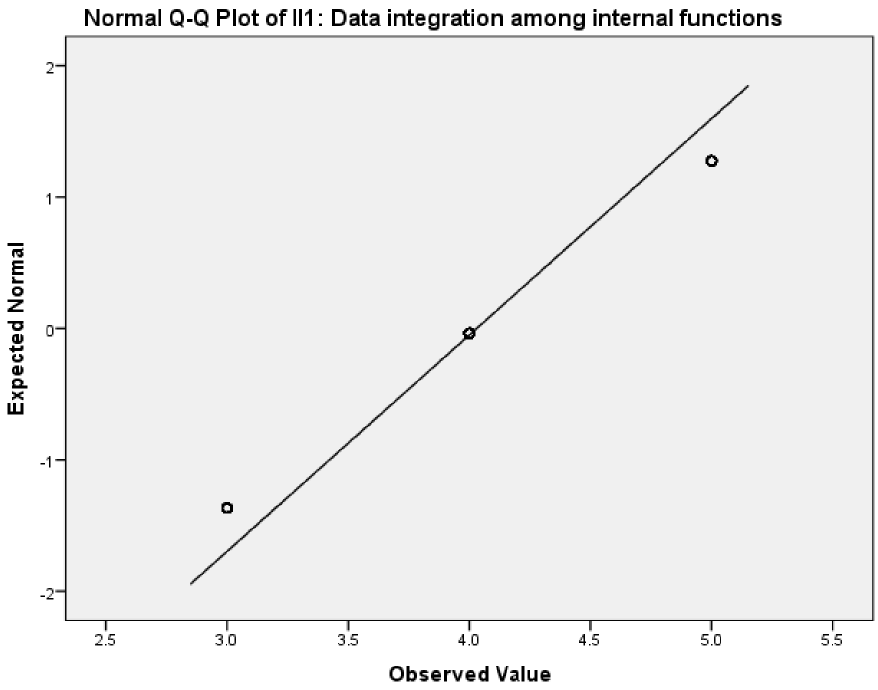
5.2. Preliminary Analyses

Before preliminary analyses using SPSS, the data were screened and cleaned, where necessary, in order to check the error and correct it. To check the error, the author entered the data into SPSS version 19 for Windows and checked if any data fell outside of the appropriate range by checking minimum, maximum, mean, and standard deviation values. Thereafter, the normality and homoscedasticity were assessed.

5.2.1. Normality and Homoscedasticity

The data were assessed for normality first. Normal probability plots were generated for 63 variables which were related to SCI, GSCM practices, and sustainable performance. Normal probability is shown where plots are clustered around a straight line. A reasonably straight line indicates normality (Palant, 2007). Figure 5.1 presents the probability plot for one of the variables. The probability plots (as shown in Normal Q-Q plot in Figure 5.1) for all data were normal, meaning the data could be considered as having normal distribution for statistical data analysis. Furthermore, the scatter plots of data points for two variables (identification number and II1: data integration among internal functions) with normal distribution show equal dispersion across all data values. It indicates that homoscedasticity is supported.

Figure 5.1 Normal Probability Plot



5.3. Response Rate and Non-Response Bias

5.3.1. Response Rate

The target respondents were selected from the database of the Thailand Energy and Environmental Network (TEENET) and the database from the Department of Industrial Works in the Ministry of Industry (Thailand). Both databases were used to find out information about the companies' addresses and other relevant information in order to prepare the contact list.

The data collection for this study can be separated into three stages; pilot-testing, the first wave of mailing the questionnaire to collect data, and the second wave of mailing the questionnaire to increase the response rate. For each wave, there were three sub-stages of data collection:(i) calling the target firms to explain the objectives of the research and confirming the position of the manager who was directly responsible for supply chain management or environmental department, (ii) mailing the questionnaire to collect data, (iii) and following up or reminding the respondents who did not answer the questionnaire.

For the pilot-testing, questionnaires were posted to 100 target companies; 15 were returned of which 2 were incomplete. In the first wave, questionnaires were posted to 500 target companies; 48 were returned of which 6 were incomplete. During the first wave, Thailand experienced a severe natural disaster (flood problem) (October–January 2011); this might have been a reason behind the low response rate. In the second wave, questionnaires were sent to additional 500 target companies. A group of research assistants were assigned to collect data directly to increase the response rate. Eventually, 259 completed questionnaires were collected of which 5 questionnaires were incomplete. Overall, 1,000 questionnaires were sent to target companies; 296 completed questionnaires were returned (excluding the 13 returned from the pilot testing). Subsequently, the response rate was 29.6%. According to Mile and Shevlin (2001), a sample size of 200 is sufficient (predictor or measurement items up to 20 items), if a researcher is expecting a medium effect. Also, Hair et al. (2010) suggest that a minimum sample size should be 100 or greater, so that a researcher can evaluate the data using factor analysis. Thus, 296 completed questionnaires were sufficient for analysing the data by using factor analysis for this study.

5.3.2. Non-Response Bias

Non-response bias is a major issue that a researcher has to deal with when conducting a survey. Non-response bias refers to the fact that the responses of those who return the questionnaire could differ from the responses of those who do not return the questionnaire. For obtaining the non-response bias, the mean scores of two different groups were compared to examine whether the respondents' answers significantly differed from the non-respondents' answers. The non-response bias was assessed assuming that the person who respond later (late respondents) is more likely a representative of the non-respondent (Armstrong and Overton, 1977) and the general population.

The data collection process as divided into two phases: (i) initial data collection, and (ii) data collection for improving response rate. Each phase had three sub-stages: calling, collecting, and reminding. First, the target firms were called to enquire about the position and names of the managers who were responsible for supply chain management and environmental policy. After that, data were collected by mail survey using systematic random sampling. One week after mailing, the next step was reminding the respondents of each selected company by phone (the first call) to answer the questionnaire. Two weeks after mailing the questionnaire, the non-respondents were given a reminder call (the second calling). As a result, the respondents who returned the questionnaires after the second or later call were considered non-respondents.

Therefore, to test non-response bias, this research has compared the answers of the respondents who returned the questionnaires before the second phone call (early respondents)and those who returned the questionnaire after the second phone call (late respondents). The mean values were compared between the two different groups using an independent-sample *t*-test with 63 items, including 32 items for SCI, 18 items for GSCM practices, and 13 items for sustainable firm performance. Overall, values for all items of SCI, GSCM practices, and sustainable performance constructs were above the required cut-off point of 0.05. Therefore, there were no statistically significant differences in the mean values for all items from the three main constructs between the early and late respondents, at 95% confidence interval.

In addition, the characteristics of firms, including firm size (number of employee), annual sales, primary product of the firm and positions of the respondents were also compared between the early and late respondents. No statistically significant differences were found between the groups (for firm size: p-value = 0.08, annual sales: p-value = 0.154, primary product: p-value = 0.074 and respondent's position: p-value = 0.333). Therefore, this dissertation does not have a serious non-response bias problem. The details of the non-response bias test are presented in Appendix C.

5.4. Common Method Bias

Method bias can be problematic because it is one of the key sources of measurement error (Podsakoff et al., 2003) which can produce a wrong conclusion about the relationship between measurement items (Bagozzi and Yi, 1991; Nunnally, 1978; Spector, 1987). For this research, Harman's single-factor test was conducted to ensure that no one general factor accounted for the majority of covariance between the independent variables and dependent variables. To determine the common method bias all 63 items of the research were loaded onto the exploratory factor analysis (Anderson and Bateman, 1997). If the percentage of variance is less than 40%, it means common method bias is not a problem for the findings (Wong et al., 2011).

Factor analysis (as shown in Appendix D) showed 24.387% of total variance. It indicates that no single factor affected the validity of our results, where the independent and dependent variables load on different factors with the first factor accounting for less than 40% of total variance. This indicates there is no common method variance problem in this research.

5.5. Reliability

All 63 measured items were examined for reliability. The cut-off value of reliability for this research was 0.40 (Van de Venn and Ferry, 1980); if the values are lower than 0.40, they were deleted from the dataset before assessing the EFA and CFA. The reliability values for each measured item are demonstrated in Table 5.1. The Cronbach's alpha value for all constructs (II, SI, CI, IGSCM practices, EGSCM practices, ENP, and EP) are very high (>0.80), indicating that all constructs for this research have high reliability.

Table 5.1 Reliability of the Main Constructs

Main Constructs	Sub constructs	Cronbach's alpha
Supply Chain Integration	Internal Integration	0.859
	Supplier Integration	0.887
	Customer Integration	0.840
Green Supply Chain Management Practices	Internal Green Supply Chain Management Practices	0.870
	External Green Supply Chain Management Practices	0.890
Sustainable Performance	Environmental Performance	0.805
	Economic Performance	0.961

5.6. Correlation Analysis

Correlation analysis is conducted to explain the strength and direction of the linear relationship between two variables, including independent and dependent variables. The researcher assessed the correlation between the measured items, i.e. II, SI, CI for SCI, IGSCM and EGSCM practices within GSCM, and ENP and EP of sustainable performance to explain the strength and direction of the linear relationship between two variables. The samples used to detect the relationships among these variables showed a correlation between II and SI, II and CI, II and IGSCM, II and EGSCM, II and ENP, and II and EP. Cohen (1988) suggested that correlation values between 0.10 and 0.29 indicate small, 0.30 to 0.49 indicate medium, and 0.50 to 1.0 indicate large correlation.

For this research, the author used 0.30 as the minimum correlation between two variables (Pallant, 2007). If the correlation value was less than 0.30, then the item was eliminated from the dataset. Table 5.2 presents the correlation among the seven main constructs. It can be seen that almost all constructs have an acceptable correlation, except the relationships between II and ENP, II and EP, SI and ENP, SI and EP, CI and EP, IGSCM practices and EP, EGSCM practices and ENP, and ENP and EP, showing correlation values below 0.30.

The researcher also assessed the correlations between each measured item and the other items to check whether items that are in the same construct are correlated to each other or not. The results of these correlations are presented in Appendices E,F, and G

Based in the results of the correlation between each measured item (e.g. II1) and other measured items that are in the same construct (e.g. II2, II3, II4, II5), 23 items were removed from the dataset because the correlation values were below 0.30, before evaluating EFA and CFA. Also, 3 items were deleted from the dataset because of multi-collinearity (correlation > 0.90, VIF > 10, or tolerance < 0.10) as shown in Tables 5.3 and 5.4.

Table 5.2 Correlation Analysis

	II	SI	CI	IGSCM	EGSCM	ENP	EP
II	1						
SI	0.651**	1					
CI	0.447**	0.540**	1				
IGSCM	0.477**	0.420**	0.367**	1			
EGSCM	0.448**	0.469**	0.404**	0.428**	1		
ENP	0.223**	0.153**	0.307**	0.383**	0.284**	1	
EP	0.268**	0.160**	0.165**	0.287**	0.308**	0.139**	1

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

Table 5.3 Deleted Variables (Correlation < 0.3)

Constructs	No.	Items
Internal Integration (II)	II3	Integrative inventory management
	II4	Real-time sharing of the level of inventory
	II5	Real-time sharing of the logistics-related operating data
Supplier Integration (SI)	SI1	Information exchange with major suppliers through information networks
	SI2	Establishment of quick ordering systems with major suppliers
	SI3	Strategic partnership with major suppliers
	SI4	Long-term procurement relationship of major suppliers
	SI5	Participation of major suppliers in the process of procurement and production
	SI6	Participation of major suppliers in the design stage
	SI7	Major suppliers share their production schedule information with the firm
	SI8	Major suppliers share their production capacity information with the firm
Customer Integration (CI)	CI1	Linkage with major customer through information networks
	CI2	Computerisation of major customer's ordering
	CI4	Provide effective communication channels with major customers
	CI6	Follow-up with major customers for feedback
	CI7	Frequent contact with major customers
Internal Green Supply Chain Management	IGP6	Design of products for reuse, recycle, and recovery of materials and components

(IGSCM) practices		
	IGP7	Design of products to avoid or reduce use of hazardous products and/or their manufacturing process
	IGP8	Recycle of excess inventories/materials
	IGP10	Sale of excess capital equipment
Environmental Performance (ENP)	ENP1	Reduction of hazardous gaseous emissions
	ENP2	Reduction of water wastes
	ENP3	Reduction of solid wastes

Table 5.4 Deleted Variables (Multi-collinearityProblem or Correlation >0.9)

Constructs	Item no.	Items
Customer Integration	CI5	The establishment of quick ordering systems with major customers
Internal Green Supply Chain Management Practices	IGP9	Recycle used materials
Economic Performance	EP4	Average return on sales over the last three years

5.7. Sample Profile

Before starting the data analysis, it is necessary to screen the data. The researcher checked for errors and found some errors in the data file. Therefore, the researcher corrected them to eliminate any outlier and incorrect values from the data file. After that, the researcher began to examine the nature of all variables. This section is divided into three parts: sample profile, including company and respondent profile;SCI and GSCM practices of the firm; and performance profile, including descriptive statistics and factor analysis.

5.7.1. Firm Profile

The responses of 296 target companies were analysed using the SPSS version 19 as show in Table 5.5. This table describes the general characteristics, including industrial group, firm size (represented by numbers of employees), ISO 9000 and ISO 14001 certification of the firm, and characteristic of the primary product, and financial profile, including capital, non-current assets, and annual sales.

Table 5.5 Firm Profile

Variables	**Number**	**Percentage**
Industrial group		
Automotive industry	29	9.8
Automotive components industry	28	9.5
Electronic components industry	30	10.1
Food and beverage industry	32	10.8
Industrial material and machinery industry	33	11.1
Petrochemical and chemicals industry	37	12.5

Transportation and logistics industry	24	8.1
Textile industry	25	8.4
Clothing industry including decorating and colouring wool	27	9.1
Other	31	10.5
Number of employees		
Under 50 employee	23	7.8
50 to 100 employees	60	20.3
100 to 200 employees	75	25.3
200 to 300 employees	64	21.6
Over 300 employees	74	25.0
ISO 9000 Certification of the company		
ISO 9000 certified	169	57.3
Not ISO 9000 certified	126	42.7
Missing	1	
ISO 14001 Certification of the company		

ISO 14001 certified	93	31.5
Not ISO 14001 certified	202	68.5
Missing	1	
Main characteristics of the primary product		
Assembled-to-order	180	61.4
Make-to-stock	90	30.7
Make-to-order	23	7.8
Missing	3	
Capital of the company		
Less than 5,000,000 Baht	4	1.4
5,000,000 to 10,000,000 Baht	31	10.5
10,000,000 to 20,000,000 Baht	55	18.6
20,000,000 to 50,000,000 Baht	86	29.1
Over 50,000,000 Baht	120	40.5
Non–current assets		

Less than 50,000,000 Baht	57	19.3
50,000,000 to 100,000,000 Baht	77	26.0
100,000,000 to 200,000,000 Baht	75	25.3
200,000,000 to 500,000,000 Baht	65	22.0
Over 500,000,000 Baht	22	7.4
Total annual sales		
Less than 50,000,000 Baht	47	15.9
50,000,000 to 100,000,000 Baht	99	33.4
100,000,000 to 200,000,000 Baht	76	25.7
200,000,000 to 500,000,000 Baht	50	16.9
Over 500,000,000 Baht	24	8.1

Table 5.5 shows the data related to the Thai manufacturing industries included in this study. The sample industries in this study were automotive (9.8%), automotive components (9.5%), electronic components (10.1%), food and beverage (10.8%), industrial material and machinery (11.1%), petrochemical and chemical (12.5%), transportation and logistics (8.1%), textile (8.4%), clothing (9.1%) and other industries

(10.5%). The firm size was determined in terms of the number of employees: 7.8% of all firms had less than 50 employees, 20.3% of the firms had 50–100 employees, 25.3% of the firms had 100–200 employees, 21.6% of the firms had 200–300 employees, and 25% of the firms had more than 300 employees. Thus, most of the Thai manufacturing industries were large firm size more than small size.

Furthermore, 57.3% of firms and 31.5% of firms received ISO 9000 and ISO 14001 certification, respectively. In general, Thai manufacturing industries have the ISO 9000 certification, but few manufacturers in Thailand have ISO 14001 certification because this environmental management standard is relatively new in this country. Also, the Thai government does not have stringent environmental regulations for the manufacturing industry.

Also, 61.4% of the firms in the sample had assembly-to-order manufacturing as the main characteristic of the primary product, 30.7% of the firms had make-to-stock manufacturing, and 7.8% of the firms had make-to-order manufacturing.

5.7.2. Respondent Profile

Table 5.6 describes the respondent profile. The sample contained top and middle managers who were responsible for SCM and environmental policy of the firm and also knew the business processes very well. For this research, data were collected from the CEO (0.3%), logistics manager (2.4%), supply chain manager (1%), production manager (18.6%), purchasing manager (25%), operating manager (21.6%), plant manager (24.3%), and other positions (6.8%). The results show that the number of logistics and supply chain managers in Thai manufacturing industries is relatively lowerthanthe number of managers in other positions because logistics and SCM issues are still new concepts in Thailand. Thus, almost all Thai manufactures have managers at other positions (e.g. purchasing manager, operation managers, plant manager) who manage the supply chain of their firms.

Table 5.6 Position of the Respondents

	Amount	**Percentage**
CEO	1	3
Logistics Manager	7	2.4
Supply Chain Management Manager	3	1.0
Production Manager	55	18.6
Purchasing Manager	74	25.0
Operation Manager	64	21.6
Plant Manager	72	24.3
Other	20	6.8
Total	296	100.0

5.8. Descriptive Statistics

5.8.1. Mean and Standard Deviation Values for Supply Chain Integration

Tables 5.7, 5.8 and 5.9 show the descriptive statistics for the items of SCI, GSCM practices, and sustainable firm performance constructs. All of them were measured on a 5-point Likert scale, with 1 = not at all, 2 = slight extent, 3= moderate extent, 4= great extent, and 5= very great extent. The mean scores were used to examine the level of SCI, GSCM practices, and sustainable performance in the samples. According to Pallant (2007), a mean score of 1.67 or lower is considered low-level mean value, score ranging between 1.68 and 3.34 is considered moderate-level mean value, whereas a score of 3.35 or greater is considered high-level mean value.

Table 5.7 shows that the mean scores for all items of the SCI were relatively high (3.74 to 4.54) and the standard deviation ranged between 0.50 and 0.85, indicating that all items had high level of SCI for all sub-constructs (II, SI, and CI). Also, the minimum value was 1 for 2 items, but 2 for most of the items, and 3 for certain items. The maximum value was 5 for all items.

5.8.2. Mean and Standard Deviation Values for Green Supply Chain Management Practices

Table 5.8 shows the descriptive statistics of the items for GSCM practices. The mean scores of this construct are relatively high (3.84 to 4.58), and standard deviation for all items of GSCM practices ranged between 0.558 and 0.905, indicating that the samples had high-level GSCM practices. The minimum value was 1 for 3 items, followed by 2 and 3 for most of them. The maximum value was 5 for all items.

5.8.3. Mean and Standard Deviation Values for Sustainable Firm Performance

Table 5.9 represents descriptive statistics for the items of sustainable firm performance. The mean values of sustainable firm performance were relatively high (3.31 to 4.60) and the standard deviation of this construct ranged between 0.591 and 0.888, indicating that the samples had high level of sustainable firm performance. The minimum value was 1 for 3 items, 2 for the most of them, and 3 for 3 items, whereas the maximum value was 5 for the rest of the items.

According to Tables 5.7, 5.8 and 5.9, the standard deviation values for SCI, GSCM practices, and sustainable firm performance, in terms of environmental and economic performance are considered relatively high. These results indicate that the operation level of SCI, GSCM practices, and sustainable firm performance are dispersed from the mean values of each construct, implying that all constructs were involved at high level of operationsin all sample firms. However, only these results are not sufficient for arriving at this conclusion; it is necessary to further analysethe data through other statistical techniques, such as factor analysis and structural equation modelling (SEM).

In conclusion, the mean values for SCI, GSCM practices are all relative high (mean scores of all items for both of constructs are higher than 3.35), but for sustainable firm performance, the mean scores for the four items of economic performance (EP1, EP2, EP3, and EP4) were moderate, ranging between 3.31 and 3.33. However, the items EP5 (average market share growth) and EP6 (average sales volume growth)were higher than the minimum high level of 3.35 (mean scores of 3.47 and 3.37, respectively). In contrast, the mean scores of environmental performance were all relatively high.

The mean score results for all items indicate that SCI, GSCM practices, especially in the context of Thai manufacturing industry are operationalised for all firms and also have high environmental performance, but medium economic performance.

Table 5.7 Mean and Standard Deviation of Supply Chain Integration

Constructs	Items	Mean	Std. Deviation	Minimum	Maximum
Internal Integration	II1: Data integration among internal functions	4.03	0.607	3	5
	II2: Enterprise application integration among internal functions	4.15	0.662	3	5
	II3: Integrative inventory management	4.15	0.712	2	5
	II4: Real-time sharing of the level of inventory	4.10	.656	2	5
	II5: Real-time sharing of the logistics-related operating data	4.03	0.717	2	5
	II6: Periodic interdepartmental meetings among internal functions	4.42	0.627	2	5

	II7: Use of cross-functional teams in process improvement	4.15	0.794	1	5
	II8: Use of cross-functional teams in new product improvement	4.00	0.848	2	5
	II9: Real-time integration and connection among all internal functions, from raw material management through production to shipping and sales	4.14	0.675	2	5
Supplier Integration	SI1: Information exchange with major suppliers through information networks	3.82	0.604	2	5
	SI2: Establishment of quick ordering systems with major suppliers	4.00	0.632	2	5
	SI3: Strategic partnership with major suppliers	3.74	0.516	2	5

	SI4: Long-term procurement relationship with major suppliers	4.03	0.731	2	5
	SI5: Participation of major suppliers in the process of procurement and production	4.02	0.821	1	5
	SI6: Participation of major suppliers in the design stage	3.99	0.858	2	5
	SI7: Major suppliers share their production schedule information with the firm	3.93	.800	2	5
	SI8: Major suppliers share their production capacity information with the firm	3.88	0.704	2	5
	SI9: Sharing production plans information with major suppliers	3.95	0.701	2	5

	SI10: Sharing demand forecasts with major suppliers	3.89	0.694	2	5
	SI11: Sharing inventory levels with major suppliers	3.90	0.725	2	5
	SI12: Helping major suppliers improve their process to better meet the firms' needs	3.94	0.624	2	5
Customer Integration	CI1: Linkage with major customer through information networks	4.20	0.503	3	5
	CI2: Computerisation for major customer's ordering	4.30	0.601	2	5
	CI3: Sharing of market information with major customers	4.31	0.632	3	5
	CI4: Communication with major customers	4.34	0.583	3	5
	CI5: Establishment of quick ordering systems with major	4.29	0.624	3	5

	customers				
	CI6: Follow-up with major customers for feedback	4.46	0.575	3	5
	CI7: Frequency contact with major customers	4.54	0.604	2	5
	CI8: Major customers share Point-of-Sales (POS) information with the firm	4.35	0.663	2	5
	CI9: Major customer share demand forecast with the firm	4.14	0.690	2	5
	CI10: Sharing available inventory with major customers	4.15	0.718	2	5
	CI11: Sharing production plan with major customers	4.14	0.685	2	5

Notes:

Item II1 – II9, SI1 – SI12 and CI1 – CI11: 1= Not at all, 2= Slight extent, 3= Moderate extent, 4= Great extent, 5= Very great extent; n is the number of respondent manufacturing companies

Table 5.8 Mean and Standard Deviation of Green Supply Chain Management Practices

Constructs	Items	Mean	Std. Deviation	Minimum	Maximum
Internal Green Supply Chain Management Practices	IGP1: Participation of senior managers in green supply chain management	4.40	0.603	2	5
	IGP2: Participation of mid-level managers in green supply chain management	4.38	0.648	2	5
	IGP3: Cross-functional cooperation for environmental improvements	4.40	0.585	3	5
	IGP4: Environmental compliance and auditing programmes	4.09	0.558	2	5
	IGP5: Design of products for reduced consumption of	4.22	0.674	2	5

	materials/energy				
	IGP6: Design of products for reuse, recycle, and recovery of materials and components	4.19	0.723	2	5
	IGP7: Design of products to avoid or reduce use of hazardous products and/or manufacturing process	4.58	0.600	2	5
	IGP8: Recycling of excess inventories/materials	4.06	0.661	2	5
	IGP9: Recycling of used materials	4.07	0.665	2	5
	IGP10: Sale of excess capital equipment	4.10	0.624	2	5
External Green Supply Chain Management Practices	EGP1: Providing design specification to suppliers that include environmental requirements for purchased item	3.94	0.582	3	5

	EGP2: Cooperation with suppliers for environmental objectives	3.91	0.621	2	5
	EGP3: Environmental audit of suppliers' internal management	3.89	0.737	1	5
	EGP4: Encourage or reward suppliers' with ISO14001 certification	3.87	0.905	1	5
	EGP5: Second-tier supplier's environment-friendly practice evaluation	3.84	0.804	1	5
	EGP6: Cooperation with customers for eco-design	4.04	0.719	2	5
	EGP7: Cooperation with customers for cleaner production	4.15	0.647	2	5

	EGP8: Cooperation with customers for green packaging	4.15	0.686	3	5

Notes:

Item IGP1 – IGP10 and EGP1 – EGP8: 1= Not at all, 2= Slight extent, 3= Moderate extent, 4= Great extent, 5= Very great extent; n is the number of respondent manufacturing companies

Table 5.9 Mean and Standard Deviation of Sustainable Firm Performance

Constructs	Items	Mean	Std. Deviation	Minimum	Maximum
Environmental Performance	ENP1: Reduction of hazardous gaseous emission	4.49	0.621	2	5
	ENP2: Reduction of water wastes	4.46	0.615	2	5
	ENP3: Reduction of solid wastes	4.42	0.583	3	5
	ENP4: Reduction of consumption of	4.57	0.612	2	5

	hazardous/harmful/toxic materials				
	ENP5: Reduction of scrap rate	4.54	0.631	2	5
	ENP6: Reducing the frequency of environmental accidents	4.60	0.591	3	5
	ENP7: Improvement of environmental reputation	4.55	0.635	3	5
Economic Performance	EP1: Average return on investment	3.33	0.818	1	5
	EP2: Average profit	3.31	0.858	2	5
	EP3: Profit growth	3.32	0.888	1	5
	EP4: Average return on sales	3.31	0.843	1	5

	EP5: Average market share growth	3.47	0.772	2	5
	EP6: Average sales volume growth	3.37	0.767	2	5

Notes:

Item ENP1 – ENP7: 1= Not at all, 2= Slight extent, 3= Moderate extent, 4= Great extent, 5= Very great extent, **Item EP1 – EP6:** 1= much worse than the previous economic performance, 2= worse than the previous economic performance, 3= about the same as the previous economic performance, 4= better than the previous economic performance, 5= much better than the previous economic performance

5.8.4. Test of Differences by Demographics

Test of differences by demographic variables was conducted to understand the variation in companies. An independent samples *t*-test was used to compare the mean score. The mean and standard deviation values for SCI, GSCM practices, and sustainable performance (including ENP and EP) were examined in terms of ISO 14001 certification and firm size. If the p value was greater than 0.05, then there was no significant difference between the two variables, and if the p value was lower than 0.05, there was a significant difference between the two variables (Pallant, 2007).

To explore the impact of ISO 14001 certification on the levels of SCI, GSCM practices and sustainable firm performance, the independent samples *t*-test was conducted. According to the results in Table 5.10, overall there were statistically significant differences for SCI, including II and SI; GSCM practices, including IGSCM and EGCSM practices; and sustainable firm performance, including only economic performance. However, the firms that received ISO 14001 certification had non-significant differences in the mean scores for customer integration (*t* value = 1.412; p value = 0.159) and environmental performance (*t* value = -0.334; p value = 0.739). The results indicates that the firms with and without ISO 14001 certification achieved relatively different levels of SCI and GSCM practices, meaning ISO 14001 certification could be considered a control variable, which can be included in the regression model to double-check its influences on the relationship between two variables (e.g. SCI and GSCM practices).

Table 5.10 Test of Differences by ISO 14001 certification of the firms

Construct	Certification ISO 14001 of the company				
	Items	**Mean**	**Std. Deviation**	***t* value**	**p-value**
Internal Integration (II)	ISO 14001 certified	4.234	0.361	2.950	0.003
	Not ISO 14001 certified	4.079	0.524		
Supplier Integration (SI)	ISO 14001 certified	4.109	0.416	4.853	0.000
	Not ISO 14001 certified	3.841	0.485		
Customer Integration (CI)	ISO 14001 certified	4.315	0.369	1.412	0.159
	Not ISO 14001 certified	4.244	0.419		
Internal Green Supply Chain Management Practices	ISO 14001 certified	4.382	0.374	3.854	0.000
	Not ISO 14001 certified	4.190	0.444		
External Green Supply Chain Management Practices	ISO 14001 certified	4.251	0.404	7.135	0.000
	Not ISO 14001 certified	3.845	0.550		

Environmental performance	ISO 14001 certified	4.522	0.406	-0.334	0.739
	Not ISO 14001 certified	4.540	0.445		
Economic performance	ISO 14001 certified	3.509	0.660	2.535	0.012
	Not ISO 14001 certified	3.286	0.783		

Furthermore, to examine the impact of firm size on the level of SCI, GSCM practices of the firms, and sustainable firm performance, one-way between-group analysis of variance (ANOVA) was conducted. Firm size was divided into five groups according to number of employees (group 1: under 50 employees; group 2: 50 to 100 employees; group 3: 100 to 200 employees; group 4: 200 to 300 employees, and group 5: more than 300 employees). Table 5.11 shows there were statistically significant differences for all of these groups in the levels of SCI, GSCP, and sustainable firm performance. These results indicate that small- and large-sized firms achieve relatively different levels of SCI, GSCM practices, and sustainable firm performance. This result indicates firm size can be considered a control variable, which can be included in the regression model to double-check its influence on the relationship between two variables (e.g. SCI, GSCM practices, and sustainable performance).

Table 5.11 Test of Differences by Firm Size

Construct	F - value	P - value
Internal Integration	10.950	<0.0001
Supplier Integration	7.104	<0.0001
Customer Integration	7.338	<0.0001
Internal Green Supply Chain Management Practices	10.943	<0.0001
External Green Supply Chain Management Practices	10.005	<0.0001
Environmental performance	6.557	<0.0001
Economic performance	8.141	<0.0001

5.9. Factor Analyses

5.9.1. Critical Assumptions for Factor Analysis

In all, 23 items (as shown in Table 5.3) which had correlation coefficients lower than 0.30 with other items in the same factor were dropped. Furthermore, 3 items (CI5, IGP9 and EP4) were eliminated because of multi-collinearity ($r > 0.90$) as shown in Table 5.4. Therefore, for exploratory factor analysis, 32 measurement items were analysed to extract the suitable factors for this research.

According to the factor analysis findings, the value of Kaiser-Meyer-Olkin (KMO) measures of sampling adequacy for all measurement items was 0.834 (as shown in Appendix H). This measure quantifies the degree of intercorrelation among the variables and the appropriateness for factor analysis (Hair et al, 2010). The value can be interpreted using the following guideline: 0.80 or above, meritorious; 0.70 or above, middling; 0.60 or above, mediocre; 0.50 or above, miserable; below 0.50, unacceptable (Hair et al., 2010). Therefore, the KMO values should be above the minimum 0.50 for all variables (Tabachnik and Fidell, 2007). The results of the factor analysis show that the values for all items in this study were above the acceptable value, so the data set used in this research was appropriate for factor analysis.

Bartlett's test of Sphericity is a statistical test for the presence of correlations among the variables. This value provides the statistical significance at which the correlation matrix has significant correlations among at least some of the variables (Hair et al., 2010). From the results, Bartlett's test of Sphericityχ^2value was7282.482($p < 0.0001$); this value indicated that the correlation between items was sufficiently large for factor analysis.

According to the finding of the priori factor analysis, nine factors were extracted as presented in Table 5.12. However, when all measurement items were examined, the problem of cross-loading on some measures occurred. Cross-loading refers to a variable that has factor loadings exceeding the threshold value (> 0.30 for this thesis) on more than a single factor (Hair et al., 2010). The measured items that had the cross-loading aspect were dropped from the dataset and the researcher examined the results of the factor analysis for each modification. Thus, the researcher had to access factor analysis by eliminating any cross-loading items out off the data set one by one, after that run factor analysis again until the result had no cross-loading item in the output.

From the final factor analysis results as shown in Appendix I, the value of KMO measures of sampling adequacy for all measurement items was 0.806. Therefore, The KMO value was greater than the minimum 0.50 for all measured variables (Tabachnik and Fidell, 2007), implying that the data set was used in this research was appropriate for factor analysis.

From the results, Bartlett's test of Sphericityχ^2 value was 5671.285($p < 0.0001$); this value indicated that the correlation between items was sufficiently large for factor analysis. According to the finding of the final factor analysis, seven factors were extracted, as presented in Table 5.13.

5.9.2. Results of Factor analysis

For exploratory factor analysis, after dropping the items that had a correlation lower than 0.3 and multicollinearity, as presented in Table 5.3 and Table 5.4, respectively, 37 remainingitems were used for the exploratory factor analysis. At first, there were nine factors, as shown in Table 5.12. However, some cross-loading items, II6, SI9, SI12, IGP4, IGP5, EGP1, EGP2, EGP3, EGP4, and EGP6, were deleted from the data set one by one for each modification. Seven variables were eliminated from data set, namely IGP4, EGP1, EGP2, EGP3, SI9, II9, and IGP5. Therefore, theremaining 30 items were used with varimax rotation.

The final result of the exploratory factor analysis extracted seven critical factors, with 69.551% of total variance (as shown in Appendix I).

Table 5.12 A-Priori Factor Analysis

Items	Factor								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
EP2	**0.916**	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
EP3	**0.909**	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
EP5	**0.889**	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
EP1	**0.886**	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
EP6	**0.854**	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
EGP7	(-)	**0.770**	(-)	(-)	(-)	(-)	(-)	(-)	(-)
EGP8	(-)	**0.769**	(-)	(-)	(-)	(-)	(-)	(-)	(-)
EGP5	(-)	**0.764**	(-)	(-)	(-)	(-)	(-)	(-)	(-)
EGP6	(-)	**0.750**	(-)	(-)	(-)	(-)	(-)	**0.381**	(-)
EGP4	(-)	**0.658**	(-)	(-)	(-)	(-)	(-)	**0.315**	(-)
II2	(-)	(-)	**0.813**	(-)	(-)	(-)	(-)	(-)	(-)
II1	(-)	(-)	**0.802**	(-)	(-)	(-)	(-)	(-)	(-)
II9	(-)	(-)	**0.714**	(-)	(-)	(-)	(-)	(-)	(-)
II8	(-)	(-)	**0.688**	(-)	(-)	(-)	(-)	(-)	(-)
II7	(-)	(-)	**0.590**	(-)	(-)	(-)	(-)	(-)	(-)
II6	(-)	(-)	**0.539**	(-)	(-)	**0.305**	(-)	(-)	(-)
CI10	(-)	(-)	(-)	**0.848**	(-)	(-)	(-)	(-)	(-)
CI9	(-)	(-)	(-)	**0.787**	(-)	(-)	(-)	(-)	(-)
CI11	(-)	(-)	(-)	**0.715**	(-)	(-)	(-)	(-)	(-)
CI3	(-)	(-)	(-)	**0.619**	(-)	(-)	(-)	(-)	(-)
CI8	(-)	(-)	(-)	**0.561**	(-)	(-)	(-)	(-)	(-)
IGP2	(-)	(-)	(-)	(-)	**0.821**	(-)	(-)	(-)	(-)
IGP1	(-)	(-)	(-)	(-)	**0.775**	(-)	(-)	(-)	(-)
IGP3	(-)	(-)	(-)	(-)	**0.724**	(-)	(-)	(-)	(-)
IGP5	(-)	(-)	(-)	(-)	**0.515**	(-)	(-)	(-)	**0.361**
ENP6	(-)	(-)	(-)	(-)	(-)	**0.849**	(-)	(-)	(-)
ENP7	(-)	(-)	(-)	(-)	(-)	**0.783**	(-)	(-)	(-)
ENP5	(-)	(-)	(-)	(-)	(-)	**0.668**	(-)	(-)	(-)
ENP4	(-)	(-)	(-)	(-)	(-)	**0.659**	(-)	(-)	(-)
SI10	(-)	(-)	(-)	(-)	(-)	(-)	**0.855**	(-)	(-)
SI11	(-)	(-)	(-)	(-)	(-)	(-)	**0.803**	(-)	(-)
SI12	(-)	(-)	(-)	(-)	(-)	(-)	**0.668**	(-)	**0.435**
SI9	(-)	(-)	(-)	**0.360**	(-)	(-)	**0.634**	(-)	(-)
EGP2	(-)	**0.396**	(-)	(-)	(-)	(-)	(-)	**0.713**	(-)
EGP1	(-)	**0.396**	(-)	(-)	(-)	(-)	(-)	**0.538**	(-)
EGP3	(-)	**0.405**	(-)	(-)	(-)	(-)	(-)	**0.493**	(-)
IGP4	(-)	(-)	(-)	(-)	**0.387**	(-)	(-)	(-)	**0.710**

Note: Absolute values less than 0.30 were suppressed (-)

According to Table 5.13, the final factor analysis, for the first factor, five measurement items had eigenvalues greater than 1 (Kaiser's criterion) (detailed output shown in Appendix I). This factor contained average profit, profit growth, average market share growth, average return on investment, and average sales volume growth over the last three years; all of them were compared with the previous firm performance. This factor had factor loading which accounted for 14.247% of the total variance. Furthermore, this factor achieved high reliability, with Cronbach's Alpha of 0.948 (as shown in Table 5.13). All items for factor 1 were related to economic outcome; therefore, this factor was identified as economic performance.

The second factor consisted of five items which had eigenvalues greater than 1 (detailed output, as shown in Appendix I). The five measured items for this factor included encouragement or rewarding of suppliers with ISO 14001 certification; evaluation of the second-tier supplier environment-friendly practices; and cooperation with customers for eco-design, cleaner production, and green packaging. This factor had a factor loading which accounted for 11.15 % of the total variance. Furthermore, this factor achieved high reliability, with Cronbach's Alpha of 0.870 (as shown in Table 5.13). According to the final factor analysis, all of the items in factor 2 were related to GSCM activities of each company; therefore, this factor was labelled external cooperation for GSCM practices.

The third factor consisted of five items: data integration among internal functions, enterprise application integration among internal functions, periodic interdepartmental meetings among internal functions, the use of cross-functional teams in new product, and process improvement, which accounted for 10.084% of the total variance (as shown in Appendix I). Furthermore, this factor achieved high reliability, with Cronbach's Alpha of 0.818 (as shown in Table 5.13). All of the items in factor 3 were related to integrating business's processes within a firm, so this factor was labelled as internal integration.

The fourth factor comprised five measurement items: sharing of market information with major customers, and major customers' share POS information with the company, major customers share demand forecast with the company, sharing available inventory with major customers, and sharing production plan with major customers. This factor accounted for 9.673% of the total variance (as shown in Appendix I). Also, this factor achieved high reliability, with Cronbach's Alpha of 0.806 (as shown in Table 5.13). All the items for factor 4 were related to information sharing, so this factor was identified as information sharing across customers.

The fifth factor contained four items: reduction of consumption of hazardous/harmful/toxic materials, reduction of scrap rate, reduction of the frequency of environmental accidents, and improvement of environmental reputation. Its factor loading accounted for 8.999%of the total variance. In addition, this factor achieved high reliability, with Cronbach's Alpha of 0.783 (as shown in Table 5.13). This factor was labelled as environmental performance.

The sixth factor consisted of three items, including participation of senior managers and mid-level managers in GSCM and cross-functional cooperation for environmental improvement. Its factor loading accounted for 7.851% of the total variance (as shown in Appendix I). Additionally, this factor achieved high reliability, with Cronbach's Alpha of 0.860 (as shown in Table 5.13). This factor was labelled as internal cooperation for GSCM practices.

The last factor contained three items: sharing demand forecast with major suppliers, sharing company's inventory levels with major suppliers, and helping major suppliers to improve their processes to better meet company's needs. This factor accounted for

7.547% of the total variance (as shown in Appendix I). Furthermore, this factor achieved high reliability, with Cronbach's Alpha of 0.814 (as shown in Table 5.13). As all items were related to sharing company information with major suppliers, this factor was labelled information sharing across suppliers.

Table 5.13 Final Factor Analysis (After Deleting Cross-loading Items)

Items	**Factor**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
EP2	**0.914**	(-)	(-)	(-)	(-)	(-)	(-)
EP3	**0.911**	(-)	(-)	(-)	(-)	(-)	(-)
EP5	**0.891**	(-)	(-)	(-)	(-)	(-)	(-)
EP1	**0.891**	(-)	(-)	(-)	(-)	(-)	(-)
EP6	**0.851**	(-)	(-)	(-)	(-)	(-)	(-)
EGP5	(-)	**0.826**	(-)	(-)	(-)	(-)	(-)
EGP8	(-)	**0.786**	(-)	(-)	(-)	(-)	(-)
EGP7	(-)	**0.746**	(-)	(-)	(-)	(-)	(-)
EGP6	(-)	**0.745**	(-)	(-)	(-)	(-)	(-)
EGP4	(-)	**0.741**	(-)	(-)	(-)	(-)	(-)
II2	(-)	(-)	**0.837**	(-)	(-)	(-)	(-)
II1	(-)	(-)	**0.813**	(-)	(-)	(-)	(-)
II8	(-)	(-)	**0.675**	(-)	(-)	(-)	(-)
II7	(-)	(-)	**0.622**	(-)	(-)	(-)	(-)
II6	(-)	(-)	**0.576**	(-)	(-)	(-)	(-)
CI10	(-)	(-)	(-)	**0.862**	(-)	(-)	(-)
CI9	(-)	(-)	(-)	**0.806**	(-)	(-)	(-)
CI11	(-)	(-)	(-)	**0.699**	(-)	(-)	(-)
CI3	(-)	(-)	(-)	**0.621**	(-)	(-)	(-)
CI8	(-)	(-)	(-)	**0.542**	(-)	(-)	(-)
ENP6	(-)	(-)	(-)	(-)	**0.853**	(-)	(-)
ENP7	(-)	(-)	(-)	(-)	**0.755**	(-)	(-)
ENP5	(-)	(-)	(-)	(-)	**0.708**	(-)	(-)
ENP4	(-)	(-)	(-)	(-)	**0.639**	(-)	(-)
IGP2	(-)	(-)	(-)	(-)	(-)	**0.848**	(-)
IGP1	(-)	(-)	(-)	(-)	(-)	**0.812**	(-)
IGP3	(-)	(-)	(-)	(-)	(-)	**0.743**	(-)
SI10	(-)	(-)	(-)	(-)	(-)	(-)	**0.826**
SI11	(-)	(-)	(-)	(-)	(-)	(-)	**0.812**
SI12	(-)	(-)	(-)	(-)	(-)	(-)	**0.796**
Eigenvalue	4.274	3.345	3.025	2.902	2.700	2.355	2.264
Percentage of variance explained	14.247	11.150	10.084	9.673	8.999	7.851	7.547
Cronbach's Alpha	0.948	0.870	0.818	0.806	0.783	0.860	0.814

Note: Absolute value less than 0.30 were suppressed (-)

Details of factor analysis and reliability for each construct are shown in Table 5.17. All the items in each construct were used for further analysis, explained in next chapter.

Table 5.14 Summary of Variables and Reliability Value of Variables

Constructs		**Items**	**Factor loading**	**Cronbach's Alpha**
Supply chain integration				
Internal integration				0.818
	II1	Data integration among internal functions	0.813	0.667
	II2	Enterprise application integration among internal functions	0.837	0.640
	II3	Integrative inventory management	-	Item not included (r < 0.3)
	II4	Real-time searching of the level of inventory	-	Item not included (r < 0.3)
	II5	Real-time searching of the logistics-related operating data	-	Item not included (r < 0.3)

	II6	Utilisation of periodic interdepartmental meetings among internal functions	0.576	0.553
	II7	Use of cross-functional teams in process improvement	0.622	0.619
	II8	Use of cross-functional teams in new product improvement	0.675	0.613
	II9	Real-time integration and connection among all internal functions from raw material management through production to shipping and sales	-	Item not included (cross-loading)
Supplier Integration				0.814
	SI1	Information exchange with major suppliers through information networks	-	Item not included ($r < 0.3$)
	SI2	Establishment of quick ordering systems with major suppliers	-	Item not included ($r < 0.3$)
	SI3	Strategic partnership with major suppliers	-	Item not included
	SI4	Long-term procurement relationship of major suppliers	-	Item not included ($r < 0.3$)

	SI5	Participation of major suppliers in the process of procurement and production	-	Item not included (r < 0.3)
	SI6	Participation of major suppliers in the design stage	-	Item not included (r < 0.3)
	SI7	Major suppliers share their production schedule information with the firm	-	Item not included (r < 0.3)
	SI8	Major suppliers share their production capacity information with the firm	-	Item not included (r < 0.3)
	SI9	Sharing production plans information with major suppliers	-	Item not included (cross-loading)
	SI10	Sharing demand forecasts with major suppliers	0.826	0.649
	SI11	Sharing inventory levels with major suppliers	0.812	0.722
	SI12	Helping major suppliers improve their process to better meet the firm's needs	0.796	0.635
Customer Integration				0.806

	CI1	Linkage with major customer through information networks	-	Item not included (r < 0.3)
	CI2	Computerisation for major customer's ordering	-	Item not included (r < 0.3)
	CI3	Sharing of market information with major customers	0.621	0.504
	CI4	Provide effective communication channels with major customers	-	Item not included (r < 0.3)
	CI5	Establishment of quick ordering systems with major customers	-	Item not included (multi-collinearity)
	CI6	Follow-up with major customers for feedback	-	Item not included (r < 0.3)
	CI7	Frequent contact with major customers	-	Item not included (r < 0.3)
	CI8	Major customers share Point-of-Sales information with the firm	0.542	0.445

	CI9	Major customers share demand forecast information with the firm	0.806	0.687
	CI10	Sharing available inventory information with major customers	0.862	0.699
	CI11	Sharing production plan with major customers	0.699	0.626
Green Supply Chain Management Practices				
Internal Green Supply Chain Management Practices				0.860
	IGP1	Participation of senior managers in green supply chain management	0.812	0.732
	IGP2	Participation of mid-level managers in green supply chain management	0.848	0.783
	IGP3	Cross-functional cooperation for environmental improvements	0.743	0.696
	IGP4	Environmental compliance and auditing programmes	-	Item not included (cross-loading)
	IGP5	Design of products for reduced consumption of materials/energy	-	Item not included (cross-loading)
	IGP6	Design of products for reuse, recycle,	-	Item not included

		recovery of materials and components		(r < 0.3)
	IGP7	Design of products to avoid or reduce use of hazardous productsand/or their manufacturing process	-	Item not included (r < 0.3)
	IGP8	Recycle excess inventories/materials	-	Item not included (r < 0.3)
	IGP9	Recycle used materials	-	Item not included (multi-collinearity)
	IGP10	Sale of excess capital equipment	-	Item not included (r < 0.3)
External Green Supply Chain Management Practices				0.870
	EGP1	Providing design specifications that include environmental requirements for purchased item to suppliers	-	Item not included (cross-loading)
	EGP2	Cooperation with suppliers for meeting environmental objectives	-	Item not included (cross-loading)
	EGP3	Environmental audit of suppliers' internal management	-	Item not included (cross-loading)

	EGP4	Encourage or reward suppliers with ISO 14001 certification	0.741	0.695
	EGP5	Evaluation of second-tier suppliers' environment-friendly practices	0.826	0.775
	EGP6	Cooperation with customers for eco-design	0.745	0.666
	EGP7	Cooperation with customers for cleaner production	0.746	0.674
	EGP8	Cooperation with customers for green packaging	0.786	0.701
Sustainable Firm Performance				
Environmental Performance				0.783
	ENP1	Reduction of air emission	-	Item not included (r < 0.3)
	ENP2	Reduction of water wastes	-	Item not included (r < 0.3)
	ENP3	Reduction of solid wastes	-	Item not included (r < 0.3)

	ENP4	Decrease in consumption of hazardous/harmful/toxic materials	0.639	0.481
	ENP5	Reduction of scrap rate	0.708	0.574
	ENP6	Decrease in frequency of environmental accidents	0.853	0.673
	ENP7	Improvement of environmental reputation	0.755	0.636
Economic Performance				0.948
	EP1	Average return on investment over the last three years	0.891	0.839
	EP2	Average profit over the last three years	0.914	0.903
	EP3	Profit growth over the last three years	0.911	0.871
	EP4	Average return on sales over the last three years	-	Item not included (multi-collinearity)
	EP5	Average market share growth over the last three years	0.891	0.861
	EP6	Average sales volume growth over the	0.851	0.826

		last three years		

5.10 Summary of Constructs

This dissertation considered three main constructs or factors: SCI, GSCM practices, and sustainable firm performance. The main objective of this research was to determine the independent and combined effects of SCI, GSCM practices on sustainable firm performance, in terms of environmental and economic performance.

Two kinds of variables were used in this dissertation. First, the independent variables of used were SCI and GSCM practices (for the effect of SCI and GSCM practices on sustainable firm performance). For the first construct, SCI, three sub-dimensions were extracted by factor analysis from the SPSS programme version 19:II, ISS, and ISC. For the second construct, GSCM practices, two sub-dimensions were extracted by factor analysis, including ICGSCM and ECGSCM practices. However, according to the theoretical hypothesis of this thesis, GSCM practices can be both dependent and independent variable at the same time. Second, sustainable firm performance and GSCM practices were the dependent variables (for the relationship between SCI and GSCM practices). For the sustainable firm performance construct, two sub-dimensions were extracted from factor analysis: environmental and economic performance. The details of all factors will be explained in the next section.

Seven constructs were extracted from factor analysis: II, ISS, ISC for the SCI factor; internal and external cooperation for the GSCM practices factor; and environmental and economic performance for sustainable firm performance factor.

First, SCI, one of the main constructs, refers to the degree to which manufacturers strategically collaborate with their supply chain partners and collaboratively manage both intra- and inter-organisation processes (Flynn et al., 2010).The factor analysis results for the SCI construct were consistent with those of previous studies (Wong and Boon-itt, 2008; Wong et al., 2011). It indicates that the finding can confirm the component of SCI that include all three sub-factors, including II, SI and CI, especially for the context of Thai manufacturing industry. Factor 1, II, contains five measurement items: data integration, enterprise application integration, and utilisation of periodic interdepartmental meetings among internal functions, and use of cross-functional teams in both process improvement and new product improvement. Factor 2,ISS, comprises three measurement items: sharing inventory level, sharing demand forecast with major suppliers of the firm, and helping firm's suppliers improve their business processes to better meet company's requirements. Factor 3, ISC, contains five measurement items: sharing information of market, production plan, inventory, and Point-of-Sale and sharing of demand forecasts from major customer of the firm.

Second, GSCM practices, the next construct in this study, refers to integrating environmental thinking with SCM which comprises product design, material sourcing and selection, manufacturing process, delivery of the final product to the customers, and also end-of-life management of the product after its useful life (Srivastava, 2007). GSCM is concerned with the environment along the entire supply chain and required strategic collaborations among the supply chain members, e.g. suppliers, manufacturers, customers and so on. According to the findings of the factor analysis, GSCM practices are one of the critical constructs in this dissertation. The construct can be separated into two sub-dimensions: internal and external cooperation for GSCM practices, consistent with several previous such as those of Zhu and Sarkis (2004), Zhu et al. (2005), Giovanni (2012), and Shi (2012).ICGSCM practices contained three measurement items: participation of senior and mid-level managers in GSCM and cross-functional cooperation for environmental improvement. The second component, ECGSCM practices, included five measurement items: encouraging or rewarding suppliers with ISO 14001 certification and evaluation of second-tier supplier's environment-friendly practice and cooperation with customers for green packaging, cleaner production, and eco-design.

The last construct in this research was sustainable firm performance. The factor analysis findings showed that this construct had two sub-dimensions: economic and environmental performance. The results of the factor analysis of sustainable firm performance construct were consistent with the previous literature (Zhu and Sarkis, 2004; Zhu et al., 2005; Zhu et al., 2007). It indicates that the finding can confirm the component of the construct that include all two sub-factors, including economic and environmental outcomes, particularly for the context of Thai manufacturing industry. The first factor of the construct, economic performance, had are five measurement items: average profit, profit growth, average market share growth, average return on investment, and average sales volume growth for the last three years. The last factor of the construct, environmental performance, consisted of four measurement items: reduction of consumption of hazardous/harmful/toxic materials, reduction of scrap rate, reduction of the frequency of environmental accidents, and improvement of environmental reputation.

CHAPTER 6: CONSTRUCT VALIDATION AND HYPOTHESIS TESTING

6.1. Introduction

Before testing the research hypotheses as shown in Figure 4.8, the construct validity has to be evaluated first. Construct validity represents the degree to which a scale measures what it intends to measure (Churchill, 1979). Construct validity is composed of several sub-dimensions, including content validity, unidimensionality, reliability, and convergent and discriminant validity (Mentzer and Flint, 1997; Garver and Mentzer, 1999). Therefore, this chapter is dedicated to explaining the construct validity.

6.2. Content Validity

Content validity is the extent to which the measurement instrument provides adequate convergence for the construct domain or essence of the domain that it measures (Churchill, 1972). For this dissertation, to generate the content validity, the researcher reviewed previous and recent literatures related to this research. Furthermore, the measure was pilot-tested to improve content validity. The process of pre-testing for this research involved submitting the questionnaires to three types of people: academics, industry experts, and target respondents. From the pilot-testing, the issues related to the readability, ambiguity, and completeness of the contents in the questionnaire could be determined (Dillman, 1978).

6.3. Unidimensionality

Unidimensionality is defined as the existence of a single construct underlying a set of items (Anderson et al., 1987; Garver and Mentzer, 1999). Therefore, unidimensionality is the degree to which measures represent one and only one underlying latent construct. To evaluate construct unidimensionality, the researcher assessed the overall goodness-of-fit for the measurement model and the components of the model e.g. factor loading, and standardised residual and modification index (Garver and Mentzer, 1999). Beyond that, reliability and validity (convergent and discriminant validity) were also measured for assessing unidimensionality. Therefore, the constructs that met an acceptable reliability, convergent, and discriminant validity were likely to be unidimensional (Anderson and Gerbing, 1988). For this dissertation, the overall model-fit indices were evaluated using three components: the basics of goodness-of-fit, absolute fit indices, and incremental fit indices. Firstly, the researcher represented the measurement model validity measures through χ^2, degree of freedom (df), and statistical significance of χ^2. Secondly, the absolute fit indices were measured by the normed chi-square (or ratio of χ^2 to degrees of freedom), the goodness-of-fit index (GFI), and the root mean square error of approximation (RMSEA). For the normed χ^2, the acceptable value was less than 5.0 (Marsch and Hocevar, 1985); however, in most current studies, a value of less than 3.0 is considered an indication of a good fit (Hair et al., 2010). For GFI measure, values greater than 0.9 represented acceptable fit (Schumacker and Lomax, 1996). For the RMSEA test, values less than 0.08 were considered acceptable fit (Byrne, 1998). Finally, the incremental fit indices were assessed through the Tucker-Lewis index (TLI), the comparative fit index (CFI) and normed fit index (NFI). For TLI, CFI, and NFI, the values $\geq$0.9 were considered reasonable fit (Byrne, 1998; Hair et al., 2010) although a CFI value greater than 0.8 is accepted (Zhang et al., 2002).

Furthermore, if the measurement model had an unacceptable model fit when assessing the model fit with the AMOS programme, Garver and Mentzer (1999) and Hair et al. (2010) suggest modifying the measurement model through three diagnostics measures from confirmatory factor analysis. The diagnostics indicators contain path estimates or factor loadings for each measured item: standardised residuals (SRs) and modification index (MI). All of the indicators can assist the researcher examine why the measurement model is not fit or unacceptable (Joreskog and Sorbom, 1993). However, theoretical considerations are still the most important criteria for measurement model modification (Bollen, 1989).

For the first diagnostics indicators, the researcher employed factor loadings or standardised regression loadings (in AMOS outputs) with values ≥0.5 as acceptable. The items that had values lower than the threshold value were dropped from the dataset. For the second diagnostics measure, the researcher used SRs when the measurement model was not fit. To examine SR value, the researcher considered a large residual value. A large residual value is greater than 2 or 2.58, depending on the significance level selected by the researcher (Gerver and Mentzer, 1999). Thereafter, the modification index was examined further. For the last diagnostics measure, modification indices (MI) were used to modify the measurement model. The modification index value considered for this research was over 7.88, which is a significant model development value (Joreskog and Sorbom, 1993; Garver and Mentzer, 1999). A large MI shows that the considered item needs to be modifiedto fit the model. Then, the items that had large SR and MI values were eliminated to improve the model fit. Thus, both SR and MI values should be examined simultaneously. The measurement model was re-specified and re-evaluated to determine the goodness-of-fit indices after each modification.

6.4. Reliability

Reliability refers to the interval consistency of a scale in measuring a latent construct (Churchill and Peter, 1984). For this dissertation, the reliability was evaluated through the Cronbach's alpha (Nunnally, 1978; Cronbach, 1951). This acceptable value was ≥0.70 (Nunnally, 1978). Many researchers choose a Cronbach's alpha value of 0.6 as the practical measure and lower bound to evaluate reliability (Flynn et al., 1994). However, this value could underestimate reliability (Garver and Mentzer, 1999; Hair et al., 2010). Therefore, other reliability measures were used in this study, such as composite reliability and average variance extracted (AVE). Composite reliability is computed from the squared sum of factor loading for each construct and the sum of the error variance terms for a construct. The construct reliability value of ≥0.70 represented an acceptable fit (Nunnally, 1978; Garver and Mentzer, 1999; Hair et al., 2010). The last measure, AVE, was an additional value used to represent the construct reliability. The AVE value is calculated from the sum of squared standardised factor loading (R^2) divided by the number of items. The acceptable value for AVE was ≥0.50 (Garver and Mentzer, 1999; Hair et al., 2010).

6.5. Convergent and Discriminant Validity

Convergent validity measures convergence between the individual items which measure the same construct (Brown, 2006). Convergent validity is tested by examining whether the variables in a data set converge or load together on only one construct in the measurement model (Garver and Mentzer, 1999). Convergent validity is evaluated by considering factor loading and the statistical significance of factor loading (Hair et al., 2010). For the first measure, reasonable factor loadings or standardised regression loadings should be ≥0.50 to be considered reasonable (Hair et al., 2010). However, factor loadings as low as 0.40 can be considered acceptable (Kirchoff, 2011). In addition, the factor loading of each item has to be statistically significant. The measured items with non-significant factor loadings were dropped from the dataset.

Discriminant validity refers to variables that are created to measure different constructs (Garver and Mentzer, 1999). In other words, discriminant validity determines how well a measure item is associated with its hypothesised construct versus other constructs in the model (Kerlinger, 1973). This measure can be evaluated by using two approaches. First, the χ^2 values of the constrained and unconstrained models were employed to assess discriminant validity. The χ^2 value for the constrained model should be lower than the χ^2value for the unconstrained model (Giovanni, 2012). In addition, the AVE value and the squared correlation between the said construct and other constructs can be compared to evaluate discriminant validity. If a construct has an AVE value higher than the squared correlation between the said construct and other constructs, it means discriminant validity is supported (Hair et al., 2010).

The details of all construct validations assessed through unidimensionality, reliability, and convergent and discriminant validity are explained in the next sections.

6.6. Construct Validation

This section will explain the procedures of construct validation. The construct validity assessment was divided into three sub-stages as follows:

Step 1: A confirmatory factor analysis (CFA) was conducted to evaluate unidimensionality through the overall goodness-of-fit for the measurement model, including the basics of goodness-of-fit (e.g. χ^2, degree of freedom), absolute fit indices (e.g. normed χ^2, GFI, RMSEA), incremental fit indices (e.g. CFI, TLI, and NFI) and adjusted goodness-of-fit index (e.g. AGFI). In addition, components of measurement model, including standardised factor loading, SRs, and MI were assessed to modify the model in cases where the values were unacceptable.

Step 2: The construct reliability was computed through Cronbach's alpha, composite reliability, and AVE. The acceptable values for Cronbach's alpha and composite reliability were ≥0.7, while those for AVE were ≥0.5.

Step 3: Using the results of the CFA, convergent validity was assessed through standardised factor loading of 0.5 or greater, and the factor loading had to be statistically significant. In addition, discriminant validity was evaluated by comparing the AVE value with the squared correlation between the said construct and other constructs.

6.6.1. Supply Chain Integration

SCI was categorised into three sub-components: internal integration (II), information sharing with suppliers (ISS), and information sharing with customers (ISC). For II, five items were selected in the CFA, including II1, II2, II6, II7, and II8. For ISS, only three items were used, SI10, SI11, and SI12. For ISC, five items were selected, including CI3, CI8, CI9, CI10, and CI11. Figure 6.1 represents the path diagram of the measurement model of SCI using the SEM techniques with AMOS programme. The results of CFA for SCI are shown in Table 6.1 below. Additionally, SCI construct validation is illustrated by evaluating unidimensionality, reliability, and convergent and discriminant validity.

Step 1: Evaluating Unidimensionality

Table 6.1 shows the CFA results for SCI. Almost all factor loadings for the measured items were above the acceptable value of 0.5 and also statistically significant with critical ratio or had *t*-value above 6.00. Only one measured item (CI8: Major customers share POS information with the firm) had factor loading lower than 0.5, but further analysis showed that, even after removing the weak item (CI8) from the CFA, the measurement model fit indices did not significantly improve. The CFA results that included CI8 in the model hadχ^2: 169.028; df: 58; normed χ^2: 2.914; GFI: 0.922; CFI: 0.929; TLI: 0.905; AGFI: 0.878, and RMSEA: 0.081, while the results that excluded CI8 hadχ^2: 142.528,df: 47, normed χ^2: 3.033, GFI: 0.929, CFI: 0.936, TLI: 0.911, AGFI: 0.881,and RMSEA: 0.083. From the model fit indices above, the former model, especially the normed Chi-square and RMSEA,fit better than the latter. Thus, this item (CI8) was retained in the model.

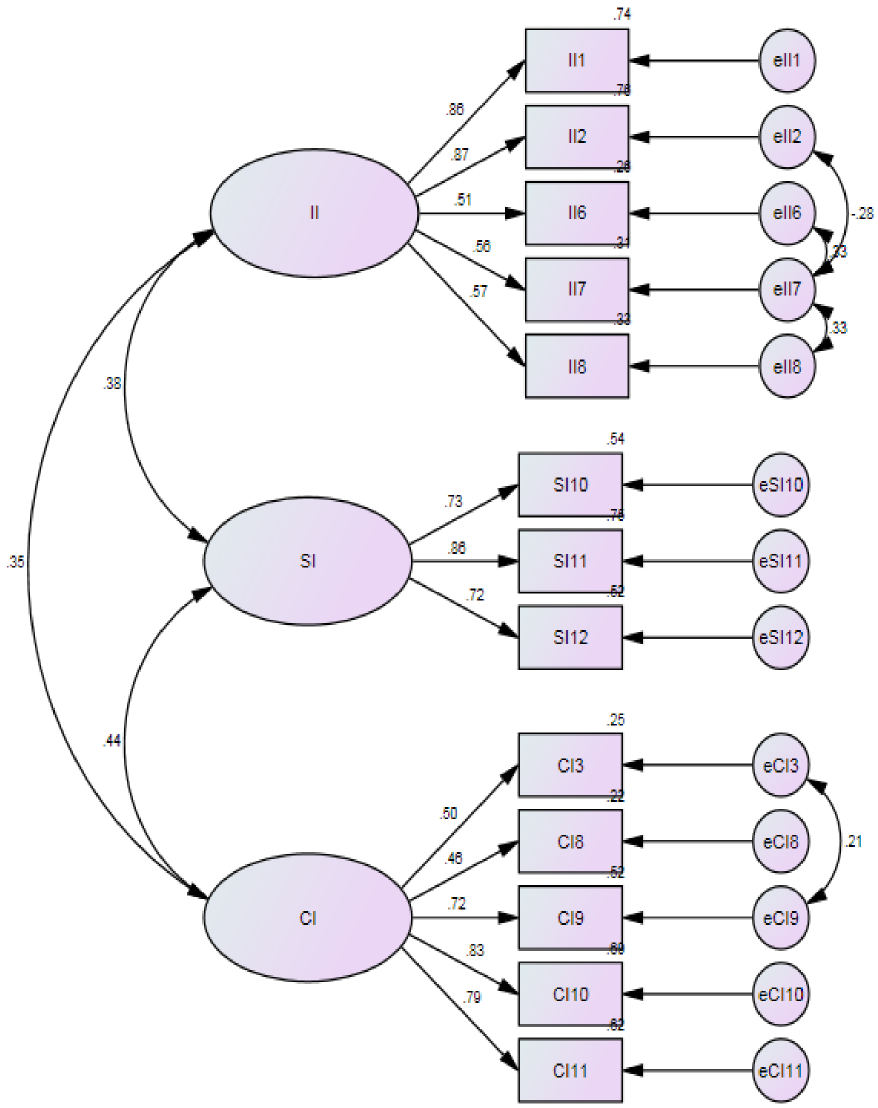
Furthermore, to improve the measurement model fit, SRs and MI were determined to modify the model. Linking the covariance of error terms within the same construct is the first method for examining the largest MI (MI > 7.88) and large SR (SR > 1.96). For the modification, covariance of error terms of II8 and II7 (MI = 37.196 and SR = 3.424), covariance of error terms of II7 and II6 (MI = 39.517 and SR = 4.479), and covariance of error terms of II2 and II7 (MI = 10.701 and SR = -.947) were added. After modification of the model, as mentioned above, the results of CFA for SCI are shown in Table 6.1.

According to Table 6.1, the measurement model fit indices represented a good model fit. The normed χ^2, for example, is lower than 3.0, an acceptable level; GFI, CFI, and TLI were all greater the recommended value of 0.9 and AGFI was greater than 0.80.

Also, RMSEA value was equal to 0.080. Thus, all indices represented a good measurement model fit for the SCI construct.

Furthermore, Garver and Mentzer (1999) suggested that research conducting SEM for evaluating construct validity should concentrate on indices that are independent of sample size. The model indices that were recommended are TLI, CFI, and RMSEA. As a result, with these indices, the measurement model fit was considered acceptable.

Figure 6.1 Path Diagram Representing the Measurement Model of Supply Chain Integration



Step 2: Evaluating Reliability

The Cronbach's alpha for all 5 items of II was equal to 0.818, 0.814 for all 3 items of ISS, and 0.806 for all 5 items of ISC. In addition, the composite reliability for the items of II, SI, and CI were 0.803, 0.819, and 0.765, respectively. The results of the CFA are shown in Table 6.1. For three constructs, Cronbach's alpha and composite reliability were all above the acceptable value of 0.7, indicating that the reliability of each construct is acceptable.

In addition, the AVE values, as represented in Table 6.1, were 0.466, 0.602, and 0.458 for II, SI and CI, respectively. The AVE values for II and CI were lower than the acceptable value of 0.5. In Vachon's (2003) study, the AVE was lower than 0.5 for SCI with suppliers and customers; therefore, as this research is based on a similar context of the construct and also the unit of analysis in his research was similar to that used in this research, the AVE being lower than 0.5 should be acceptable. Furthermore, Cronbach's alpha and composite reliability were all above the threshold value. Therefore, the reliabilities of II, SI, and CI are acceptable.

Table 6.1 Confirmatory Factor Analysis for Supply Chain Integration

Items	Standardised Loadings			Critical Ratio
	II	SI	CI	
II1: Data integration among internal functions	0.861			-[1]
II2: Enterprise application integration among internal functions	0.873			15.117
II6: Utilisation of periodic interdepartmental meetings among internal functions	0.505			8.668
II7: Use of cross-functional teams in process improvement	0.557			8.938
II8: Use of cross-functional teams in new product improvement	0.571			9.975
SI10: Sharing demand forecasts with major suppliers		0.733		-[1]
SI11: Sharing inventory levels with major suppliers		0.863		12.023

SI12: Helping major suppliers to improve their process		0.724		11.275
CI3: Sharing market information with major customers			0.500	-[1]
CI8: Major customers share Point-of-Sales information with the firm			0.465	6.038
CI9: Major customer share demand forecast with the firm			0.723	8.628
CI10: Sharing available inventory with major customers			0.832	8.087
CI11: Sharing production plan with major customers			0.787	7.990
Cronbach's alpha	0.818	0.814	0.806	
Composite reliability	0.803	0.819	0.765	
Average variance extracted	0.466	0.602	0.458	
Measurement Model Indices	Model Fit	Recommended values		
Chi-square	169.028	-		

Degree of freedom	58	-		
Normed Chi-square	2.914	< 3.00		
p-value	0.000			
Goodness-of-fit index	0.922	> 0.90		
Comparative-fit index	0.929	> 0.90		
Tucker-Lewis index	0.905	> 0.90		
Normed fit index	0.898	> 0.90		
Adjust goodness-of-fit index	0.878	> 0.80		
Root Mean Square Error of Approximation	0.080	< 0.05 to 0.08		

-[1] critical values for these parameters were not available because they were fixed for scaling purpose.

Step 3: Convergent and Discriminant Validity

The results of the CFA for the SCI construct shows that almost all factor loadings of measure items were above the acceptable limit of 0.5, but all of them were statistically significant with critical ratio over 6.8 at 0.01 critical value. Only one item (II7) had item loading below 0.5, but with a high critical ratio (8.42). However, when it was removed from the model, the overall measurement model fit was not significantly improved. The factor loading values and significance of these values as represented in Table 6.1 support the convergent validity.

Moreover, discriminant validity was evaluated by comparing AVE values with the squared correlation between the said construct and other constructs. According to results shown in Table 6.1 and 6.2, the AVE values of II, SI, and CI were 0.466, 0.602 and 0.458, respectively, all higher than the squared correlation of the relation between all of these constructs. Therefore, the results represent that the dataset was well within the acceptable range, indicating that discriminant validity is supported.

Table 6.2 AVE and Squared Correlation Values

Constructs	**AVE**	**II**	**SI**	**CI**	**ICGSCM**	**ECGSCM**	**ENP**	**EP**
II	0.466	0.524						
ISS	0.602	0.144	0.602					
ISC	0.458	0.070	0.131	0.458				
ICGSCM	0.678	0.182	0.066	0.089	0.677			
ECGSCM	0.495	0.192	0.081	0.154	0.181	0.496		
ENP	0.481	0.015	0.000	0.092	0.138	0.076	0.480	
EP	0.767	0.056	0.001	0.006	0.116	0.102	0.023	0.767

6.6.2. Green Supply Chain Management Practices

GSCM practices can be categorised into two sub-categories: ICGSCM and ECGSCM practices. For ICGSCM practices, three measure items were chosen in the model, IGP1, IGP2, and IGP3. For ECGSCM practices, five items were used in the model, EGP4, EGP5, EGP6, EGP7, and EGP8. Figure 6.2 shows the measurement model of GSCM practices using the AMOS programme version 19. The results of the CFA of GSCM practices are presented in Table 6.3 below. Furthermore, the procedure of GSCM practices construct validation consisted of three steps: evaluating unidimensionality, reliability, convergent and discriminant validity.

Step 1: Evaluating Unidimensionality

As per Table 6.3, almost all factor loadings for the measure items were above the acceptable value of 0.5 and also statistically significant, with critical ratio being above 10.60.

In addition, the SRs and MI were examined to improve the measurement model fit. Linking the covariance of error terms within the same construct was the first step to modify the model by examining the largest MI and large SRs. From the CFA results, the researcher added covariance of error terms of EGP4 and EGP5 (MI = 29.785 and SR = 1.149). After modification of the model as mentioned above, the results of the CFA for GSCM practices are shown in Table 6.3.

From Table 6.3, it can be seen that the measurement model fit indices for the GSCM practices construct represent a good model fit. The normed χ^2 was lower than the acceptable value of 3.0. Also, the GFI, CFI, TLI, NFI, and AGFI were all greater than recommended 0.9. The RMSEA value was within the acceptable range of 0.05 to 0.08.

Therefore, all model indices represented a good model fit for the GSCM practices construct.

Step 2: Evaluating Reliability

The Cronbach's alpha was equal to 0.860 and 0.881 for ICGSCM and ECGSCM practices, respectively. Furthermore, the composite reliability for the measured items of ICGSCM and ECGSCM practices were 0.863 and 0.870, respectively. All CFA results for GSCM practices are presented in Table 6.3. From the results shown in the table, Cronbach's alpha and composite reliability were all above the acceptable threshold value of 0.7. Moreover, AVE values for ICGSCM and ECGSCM practices were 0.678 and 0.504. For GSCM practices, the values of both constructs (ICGSCM and ECGSCM practices) were higher than the acceptable threshold value. Therefore, the Cronbach's alpha, composite reliability, and AVE values for both of ICGSCM and ECGSCM practices were all acceptable, indicating that these values were well within acceptable limits of reliability.

Step 3: Assessing Convergent and Discriminant Validity

Table 6.3 shows the results of CFA for GSCM practices, including ICGSCM and ECGSCM practices. All factor loadings of the measure items of each construct were above the acceptable threshold of 0.5 and also statistically significant, thereby providing provide evidence of convergent validity.

Figure 6.2 Path Diagram Representing the Measurement Model of Green Supply Chain Management Practices

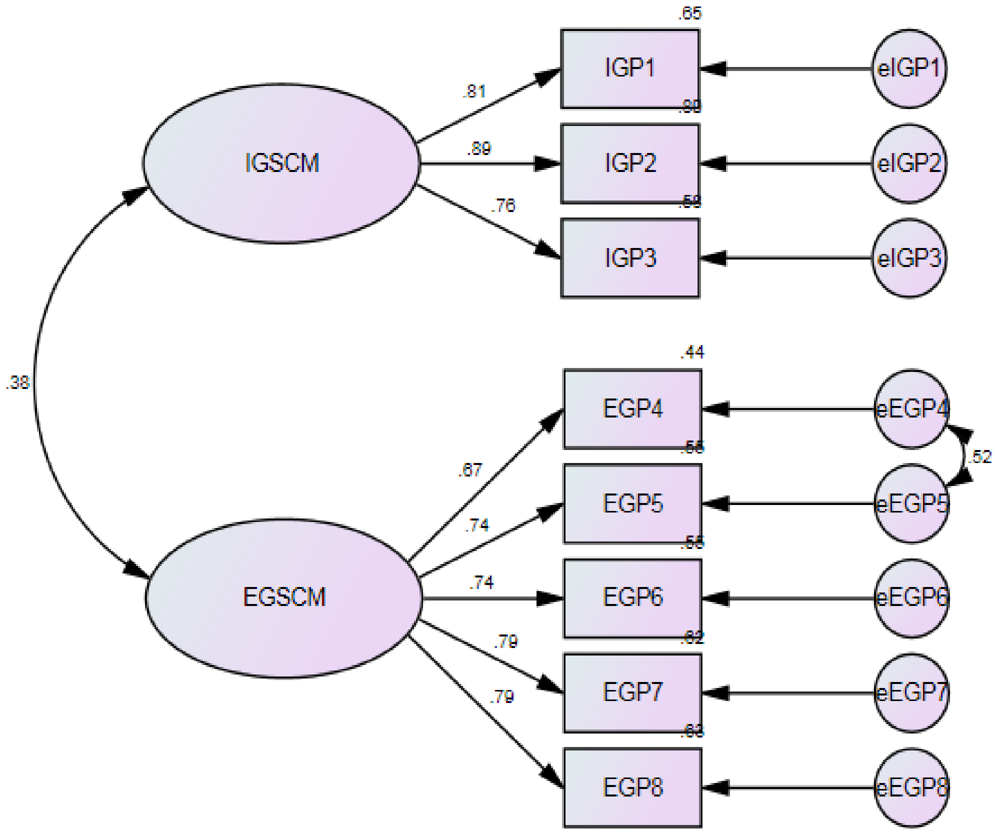


Table 6.3 Confirmatory Factor Analysis for Green Supply Chain Management Practices

	Standardised Loading		Critical Ratio
	ICGSCM	ECGSCM	
IGP1: Participation of senior managers in green supply chain management	0.807		-1
IGP2: Participation of mid-level managers in green supply chain management	0.894		15.076
IGP3: Cross-functional cooperation for environmental improvements	0.763		13.763
EGP4: Encouraging or rewarding suppliers with ISO14001 certification		0.666	-1
EGP5: Evaluation of second-tier suppliers' environment-friendly practice		0.745	15.464
EGP6: Cooperation with customers for eco-design		0.744	10.633
EGP7: Cooperation with customers for cleaner production		0.787	11.058
EGP8: Cooperation with customers for		0.793	11.112

green packaging			
Cronbach's alpha	0.860	0.870	
Composite reliability	0.863	0.870	
Average variance extracted	0.678	0.504	
Measurement Model Fit	GSCM Model	Recommended values	
Chi-square	50.754		
Degree of freedom	18		
p-value	0.000		
Normed chi-square	2.820	< 3.00	
Goodness-of-fit index	0.958	> 0.90	
Comparative-fit index	0.973	> 0.90	
Tucker-Lewis index	0.958	> 0.90	
Normed fit index	0.959	> 0.90	
Adjust goodness-of-fit index	0.916	> 0.80	

Root Mean Square Error of Approximation	0.079	< 0.05 to 0.08	

-[1] critical values for these parameters were not available because they were fixed for scaling purpose.

Discriminant validity of the GSCM construct was assessed by comparing the AVE values with the squared correlation of ICGSCM and ECGSCM practices. For instance, discriminant validity was evaluated by comparing the AVE value of IGSCM practices and squared correlation of the relationship between ICGSCM and ECGSCM practices. According to Table 6.3, AVE values of ICGSCM and ECGSCM practices were 0.678 and 0.504; these were compared with the squared correlation of the relationship between ICGSCM and ECGSCM practices (R^2= 0.181). On comparing all of these values, it was found that the AVE values for ICGSCM and ECGSCM practices were all higher than the squared correlation of ICGSCM and ECGSCM practices. Thus, discriminant validity was supported by all the evidences.

6.6.3. Sustainable Firm Performance

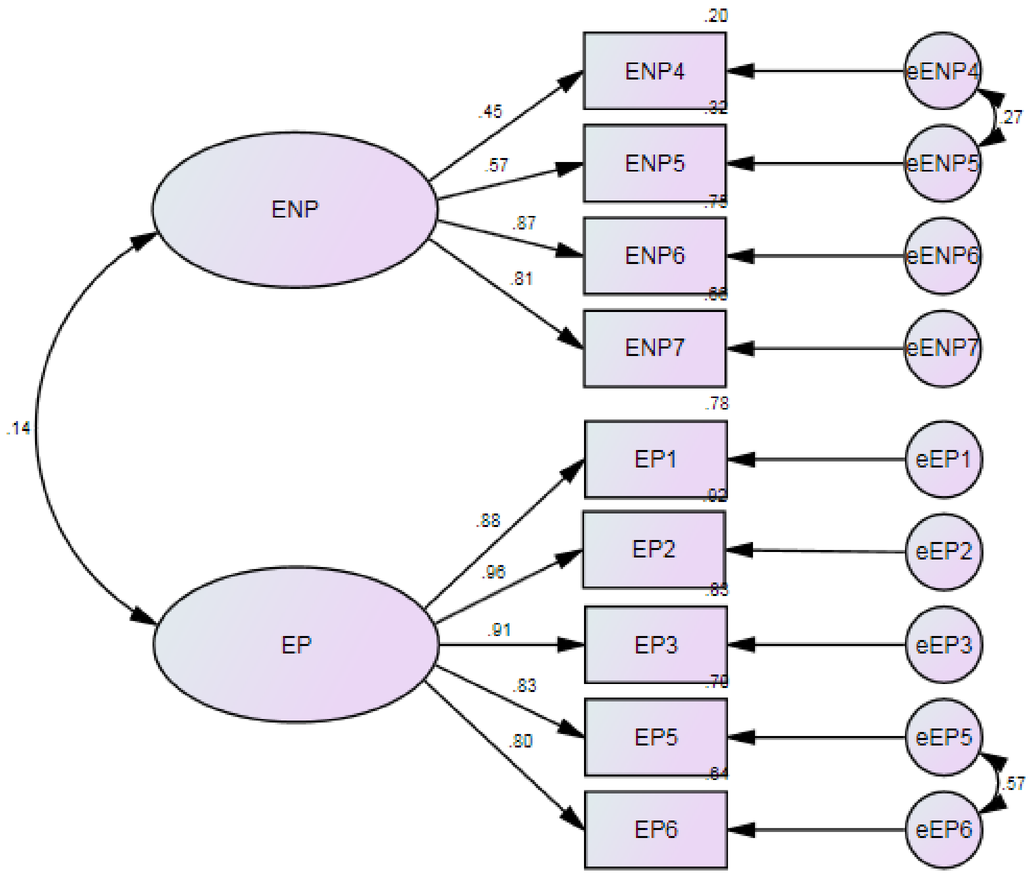
Sustainable firm performance in this dissertation was separated into two sub-dimensions: environmental performance (ENP) and economic performance (EP). For ENP, 4 items were selected in the measurement model: ENP4, ENP5, ENP6, and ENP7. For EP, 5 items were used in the model: EP1, EP2, EP3, EP5, and EP6.

Figure 6.3 shows the path diagram for the measurement model of sustainable firm performance using the AMOS programme. The results of CFA for sustainable firm performance are presented in Table 6.4. Furthermore, the procedure for construct validation involved three steps: evaluating unidimensionality, reliability, convergent and discriminant validity.

Step 1: Evaluating Unidimensionality

Table 6.4 shows the CFA results for sustainable firm performance. Almost all factor loadings for the items were above the acceptable value of 0.5 and also statistically significant, with critical ratio being above 7.18. Only one measured item (ENP4) had factor loading lower than the acceptable threshold of 0.5,but further analysis suggested that, even after removing the weak item (ENP4) from the CFA, the measurement model fit was not significantly improved.

Figure 6.3 Path Diagram representing the Measurement Model of Sustainable Firm Performance



The CFA results show that results when ENP4 was included and excluded; the model that included ENP4 hadχ^2: 68.56, df: 24, normed χ^2: 2.857, GFI: 0.952, CFI: 0.977, TLI: 0.966, AGFI: 0.911, and RMSEA: 0.079, while the model that excluded ENP4 had χ^2: 57.654,df: 18, normed χ^2: 3.203, GFI: 0.954, CFI: 0.979, TLI: 0.967, AGFI: 0.907, and RMSEA: 0.086. From the model fit indices above, model fit for the former was better than that for the latter. Therefore, this item still was used in the model.

In addition, the SRs and MI were determined to improve the measurement model fit. From the CFA results, the researcher added covariance of error terms of EP5 and EP6 (MI = 84.325 and SR = 1.799) and covariance of error terms of ENP5 and ENP4 (MI = 18.410 and SR = 2.707). After modification of the model mentioned above, the results of CFA for sustainable firm performance are shown in Table 6.4.

Table 6.4 shows that the model fit indices for the sustainable firm performance construct represent a good model fit. The normed χ^2 is lower than the acceptable value of 3.0. In addition, the GFI, CFI, TLI, and NFI were all greater than recommended 0.9 and AGFI was greater than 0.8. Also, the RMSEA value was within the acceptable range of 0.05 to 0.08. Therefore, all model indices represented a good model fit for the sustainable firm performance construct.

Table 6.4 Confirmatory Factor Analysis for Sustainable Firm Performance

	Standardised Loading		Critical Ratio
	Environmental Performance	Economic Performance	
ENP4: Reduction of consumption of hazardous/harmful/toxic materials	0.447		-1
ENP5: Reduction of scrap rate	0.566		7.352
ENP6: Reducing the frequency of environmental accidents	0.865		7.107
ENP7: Improvement in environmental reputation	0.811		7.181
EP1: Average return on investment		0.881	-1
EP2: Average profit		0.957	26.318
EP3: Profit growth		0.912	23.687
EP5: Average market share growth		0.834	19.550
EP6: Average sales volume growth		0.801	18.134

Cronbach's alpha	0.783	0.948	
Composite reliability	0.777	0.942	
Variance extracted	0.481	0.767	
Measurement Model Fit	Sustainable Performance Model	Recommended values	
Chi-square	68.560		
Degree of freedom	24		
p-value	0.000		
Normed chi-square	2.857	<3.00	
GFI	0.952	>0.90	
Comparative-fit index	0.977	>0.90	
Tucker-Lewis index	0.966	>0.90	
Normed fit index	0.966	>0.90	
Adjust goodness-of-fit index	0.911	>0.80	
Root Mean Square Error of	0.079	<0.05 to 0.08	

Approximation			

-[1] critical values for these parameters were not available because they were fixed for scaling purpose.

Step 2: Evaluating Reliability

For ENP and the Cronbach's alpha was 0.783 and 0.948, respectively. In addition, composite reliability values for all four measure items of ENP and EP were 0.777 and 0.942, respectively. The results of CFA for sustainable firm performance are shown in Table 6.4. According to the results, the Cronbach's alpha and composite reliability are all above the acceptable threshold level of 0.7. Furthermore, the AVE values of ENP and EP were 0.481 and 0.767. The value for ENP was lower than the acceptable value of 0.5, while the AVE value of EP was acceptable (0.767).

However, according to O'Leary-Kelly and Vokurka (1998) and Swafford et al. (2006), Cronbach's alpha and composite reliability are typically considered when assessing the reliability of the constructs. Thus, all of these measures were well within acceptable limits, supporting reasonable reliability.

Step 3: Assessing Convergent and Discriminant Validity

Table 6.4 shows that almost all standardised factor loadings for the items of ENP and EP were statistically significant. To consider significance of each item at 0.01 critical level, the critical ratio or *t*-value has to be greater than 2.576. Only one item (ENP4) had a low factor loading that was lower than the acceptable value of 0.5. However, when the researcher removed this item from the model, the results were not significantly improved as explained in step 1 (evaluating unidimensionality). Therefore, ENP4 was still used in the model to assess convergent and discriminant validity. On examining the standardised factor loading limits and statistical significance of each variable, it was found that convergent validity was supported.

Discriminant validity was determined through the AVE values and the squared correlation of the relationship between ENP and EP. Table 6.4 shows that the AVE values of ENP and EP were 0.481 and 0.767, respectively. The squared correlation among these constructs was 0.023 (as shown in Table 6.2). Therefore, the AVE values were all greater than the squared correlation of the relation between both constructs, indicating that discriminant validity was supported.

6.7. Structural Model

The structural model for sustainable firm performance is presented using a path diagram in Figure 4.8. To evaluate the hypothesised model for sustainable firm performance, the researcher set up SCI, containing II, ISS, and ISC, as the exogenous variable, whereas sustainable firm performance, comprising ENP and EP, as the endogenous variable. However, GSCM practices, comprising ICGSCM and ECGSCM practices could be considered an exogenous variable as well as endogenous variable simultaneously because ICGSCM and ECGSCM practices can lead to sustainable performance and simultaneously impact SCI.

The structural model was assessed through SEM techniques with AMOS programme, version 19 after the measurement models of all constructs were acceptable. For this research, all measurement models for SCI, GSCM practices, and sustainable firm performance were acceptable, as shown in Tables 6.1, 6.2, and 6.3, respectively. Thus, the structural model fit could be used to test the research hypotheses as mentioned in Chapter 3.

From the path diagram in Figure 6.7, the structural equations parameters represent the paths from the exogenous to endogenous variables and vice versa. The exogenous variables, II, ISS, and ISC, are located on the left side of the figure; the endogenous variables, ICGSCM and ECGSCM practices, are located in the middle of the figure; while ENP and EP are located on the right side of the figure.

To evaluate the structural model fit for all correlations among constructs, the values of each structural model fit were examined to assess the measurement model fit of each construct. For instance, the normed χ^2 value should be less than 3.0, the GFI, CFI, and TLI values should be $\geq$0.9, or RMSEA value should be less than 0.08 to indicate that the structural model has an acceptable fit. Furthermore, the factor loading of each path has to be significant, as determined by the critical ratio or *t*-value of each path, i.e.>2.576, indicating the path is statistically significant at 0.01 critical value.

Before testing all the research hypotheses, it was necessary to determine whether the structural model was an acceptable fit. At first, the a priori model (as shown in Appendix K) was evaluated in AMOS by combining all measurement models of the latent constructs, including SCI, GSCM practices, and sustainable firm performance. This assessment was conducted to obtain the baseline for all measurement model indices. The model fit for the a priori model was not acceptable (χ^2: 1225.314, df: 389, normed χ^2: 3.150, GFI: 0.788, CFI: 0.847, TLI: 0.828, NFI: 0.792, AGFI: 0.747, and RMSEA: 0.085). Therefore, the a priori model needed to be modified to improve the model fit. The researcher improved the model fit indices to be acceptable as per the threshold values by determining which items had large MI and SR. If any measured item had a large MI (MI > 7.88) and large SR (SR > 1.96) simultaneously, it was eliminated from the model. Furthermore, the model was re-evaluated after each re-specification.

Seven measure items were eliminated from the model; all of the deleted items are shown in Table 6.6. The structural model was re-specified and re-assessed at each modification. An SR of 2 was considered large, while an MI of 7.88 was considered large (Garver and Mentzer, 1999). The item with the largest MI represents the scope for the largest improvement in model fit and this item should be examined for modification first.

Table 6.6 Deleted Items for Model Modification

Items	Descriptions of Items	MI and SR
EP6	Average sales volume growth over the last three years	MI = 33.846 SR = 4.912
ENP6	Reduced frequency of environmental accidents	MI = 28.566 SR = -2.810
EGP6	Cooperation with customers for eco-design	MI = 21.524 SR = 2.787-

EGP4	Encourage or reward suppliers' ISO 14001 certification	MI = 20.944 SR = 2.968
II7	The use of cross-functional teams in process improvement	MI = 18.544 SR = 4.434
II6	Utilisation of periodic interdepartmental meetings among internal functions	MI = 22.825 SR = 4.849
CI10	Sharing production plan with major customers	MI = 17.943 SR = -2.392

6.7.1. Structural Model Validity

After modifying the model fit as mentioned above, the results of the structural model fit are shown in Table 6.7. They indicate that the structural model has a good fit (χ^2: 493.164, df: 217, χ^2/df: 2.273, CFI: 0.920, GFI: 0.875, NFI: 0.867, TLI: 0.907, RMSEA: 0.066, and AGFI: 0.841). The normed χ^2 was well within the acceptable range (less than 3.0) and the CFI and TLI values were both greater than the acceptable threshold of 0.90. The AGFI was 0.80, and the RMSEA index was within the recommended range of 0.05 to 0.08. While, GFI and NFI were marginally acceptable – the values were lower than the recommended 0.9, but above 0.80, as suggested in the literature (Vachon, 2003). Therefore, the structural model fit indices were all acceptable.

6.7.2. Hypothesis Testing

6.7.2.1. Direct Effects

Table 6.7 shows that the path estimate values or factor loadings and critical ratio (or *t*-value) for the structural model, the relationship between SCI and sustainable firm performance, including both environmental and economic performance were not significant for both H1 and H2.

The relationship between ICGSCM practices and ENP was positively significant, so H3a was supported. On the other hand, EGSCM practices and ENP were not significant, so H3b was not supported.

On the other hand, the relationship between ICGSCM and ECGSCM practices and EP were positively significant for both. Hence, H4a and H4b were supported. Moreover, the relationship between SCI (II, ISS, and ISC) and GSCM practices (ICGSCM and ECGSCM practices) were positively significant (H5 and H6). However, the relationship between ENP and EP and the relationship between ICGSCM and ECGSCM practices were not significant for both (H7 and H8), indicating that H7 and H8 were not supported.

Table 6.7 Structural Model Fit

Path	Hypotheses	Standardised Loadings	Critical Ratio	P-value	Results
SCI →ENP	H1	-0.001	-0.009	0.993	Not supported
SCI →EP	H2	-0.170	-1.512	0.131	Not supported
ICGSCP →ENP	H3a	0.418***	3.897	<0.001	Supported
ECGSCP →ENP	H3b	0.297**	3.002	0.003	Supported
ICGSCP →EP	H4a	0.363***	3.861	<0.001	Supported
ECGSCP →EP	H4b	0.334***	3.808	<.001	Supported
SCI →ICGSCP	H5	0.542***	5.251	<.001	Supported
SCI →ECGSCP	H6	0.464***	3.910	<0.001	Supported
ENP →EP	H7	-0.094	- 0.976	0.329	Not supported
ICGSCP →ECGSCP	H8	0.091	1.011	0.312	Not supported
Structural Model Indices		Model Fit	Recommended values		
Chi-square		493.164			

Degree of freedom		217			
P- value		0.000			
Normed chi-square		2.273	<3.00		
Goodness-of-fit index		0.875	>0.90		
Comparative-fit index		0.920	>0.90		
Tucker-Lewis index		0.907	>0.90		
Normed fit index		0.867	>0.90		
Adjust goodness-of-fit index		0.841	>0.80		
Root Mean Square Error of Approximation		0.066	<0.05 to 0.08		

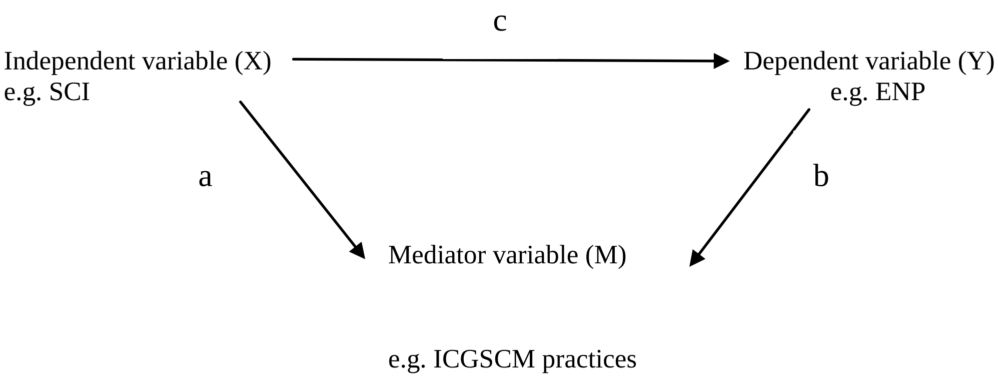
***p<0.001, ** p<0.01, *p<0.05

6.7.2.2. Mediation Effects

The mediation effect is generated when a third construct intervenes between two other related constructs and can be an independent variable or dependent variable (Hair et al., 2010). The diagram of the mediator effect is presented in Figure 6.4.

For this research, H9a–H9b and H10a–H10b were tested using the mediating effect; the researcher followed the procedures of Baron and Kenny's (1986) to test for the mediation effect. Baron and Kenny's (1986) mediating test includes four steps:

Figure 6.4 Diagram of the Mediation Effect



Step 1: The direct effect of the independent variable on the dependent variable without the mediator.

Step 2: The significant effect of the independent variable on the mediator variable (Path a).

Step 3: The significant effect of the mediator on the dependent variable (Path b).

Step 4: The insignificant effect of the independent variable on the dependent variable when the mediator is controlled (Path c).

If the results present a significant effect for all first three steps and insignificant effect for the last step, the mediator variable is considered a full mediator in the independent variable–dependent variable relationship. On the other hand, if the last step presents a significant effect of the independent variable on the dependent variable with the mediator, the mediator variable is considered a partial mediator (Baron and Kenny, 1986).

From the results shown in Tables 6.8, 6.9, 6.10, and 6.11, the relationship between SCI and ENP is mediated by ICGSCM practices.

From the results in Table 6.8, because paths a and b are significant but path c is not, H9a is supported. According to the results, ICGSCM practice is a full mediator of the relationship between SCI and ENP.

According to Table 6.9, paths a and b are significant, but path c is insignificant, so H9b is supported. The result indicates that ICGSCM practice is a full mediator of the association between SCI and EP.

From the result in Table 6.10, path a, path b and path c are significant, so H10a is supported. Also, the result indicates that ECGSCM practice is a full mediator of the relationship between SCI and ENP.

From the result in Table 6.11, path a, path b, and path c are significant, so H10b is supported. The finding indicates that ECGSCM is a full mediator of the relationship between SCI and EP.

Table 6.8 Result of Testing for Mediating Effects of ICGSCM Practices on the SCI-ENP Relationship

Step	The relationships	Standardised loadings	Critical value	P-value	Result
Step 1	SCI →ENP (without IGSCM)	0.402	3.383	<0.001	Sig.
Step 2	SCI →ICGSCM practices	0.559	5.406	<0.001	Sig.
Step 3	ICGSCM practices →ENP	0.524	5.042	<0.001	Sig.
Step 4	SCI →ENP (with IGSCM)	.095	0.829	0.407	Not sig.

Table 6.9 Result of Testing for Mediating Effects of ICGSCM Practices on the SCI-EP Relationship

Step	The relationships	Standardised loadings	Critical value	P-value	Result
Step 1	SCI →EP (without IGSCM)	0.160	2.001	0.045	Sig.
Step 2	SCI →IGSCM practices	0.552	5.362	<0.001	Sig.
Step 3	IGSCM practices →EP	0.336	5.341	<0.001	Sig.
Step 4	SCI →EP (with IGSCM)	-0.016	-0.167	0.867	Not sig.

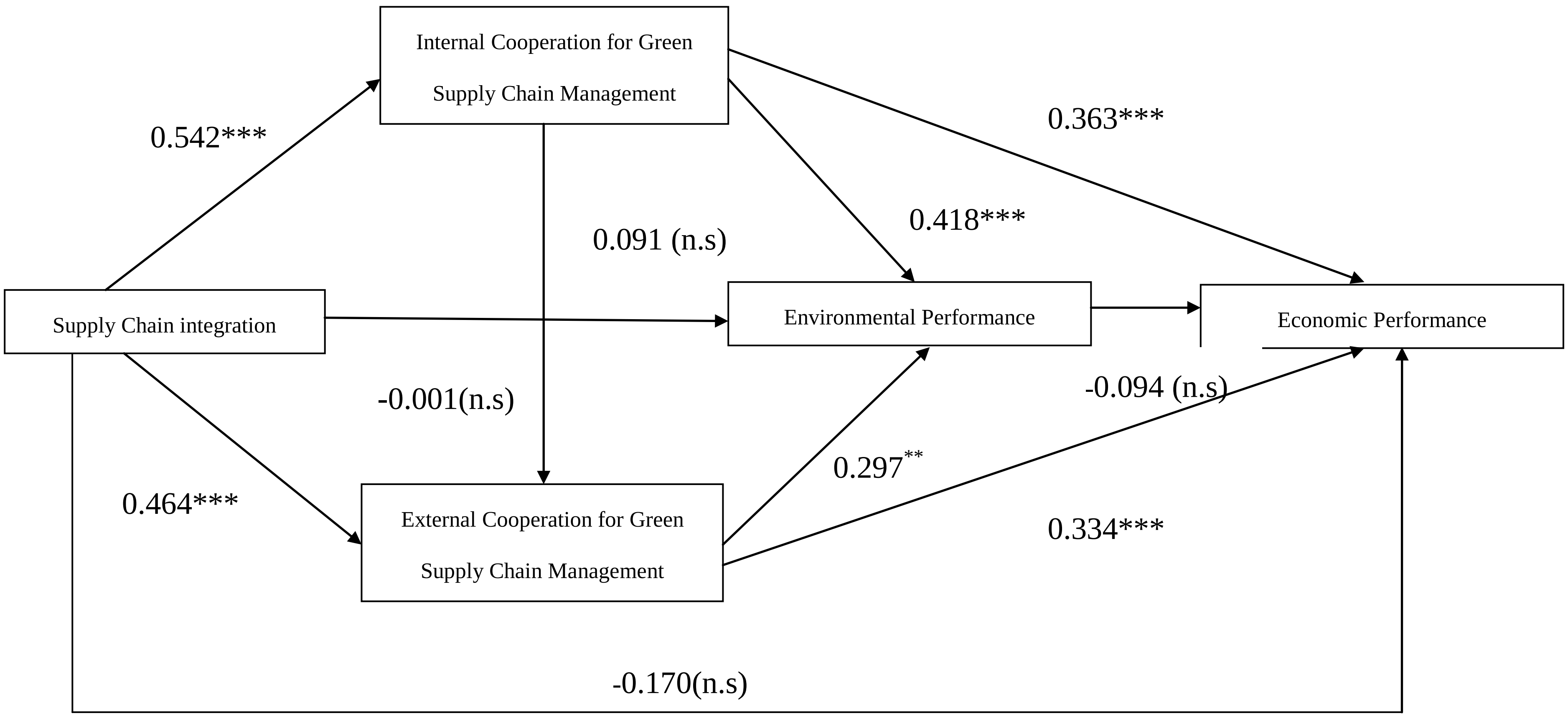
Table 6.10 Result of Testing for Mediating Effects of ECGSCM Practices on the SCI-ENP Relationship

Step	The relationships	Standardised loadings	Critical value	P-value	Result
Step 1	SCI →ENP (without EGSCM)	0.402	3.383	<0.001	Sig.
Step 2	SCI →EGSCM practices	0.527	4.950	<0.001	Sig.
Step 3	EGSCM practices →ENP	0.452	4.778	<0.001	Sig.
Step 4	SCI →ENP (with EGSCM)	0.249	2.149	0.032	Sig.

Table 6.11 Result of Testing for Mediating Effects of ECGSCM Practices on the SCI-EP Relationship

Step	The relationships	Standardised loadings	Critical value	P-value	Result
Step 1	SCI →EP (without EGSCM)	0.160	2.001	0.045	Sig.
Step 2	SCI →EGSCM practices	0.512	4.886	<0.001	Sig.
Step 3	EGSCM practices →EP	0.329	5.153	<0.001	Sig.
Step 4	SCI →EP (with EGSCM)	-0.021	-0.225	0.822	Not sig.

Figure 6.5 Path Diagram representing the Structural Model – Direct Effect



***p<0.001, ** p<0.01, *p<0.05

CHAPTER 7: DISCUSSION OF RESULTS

7.1 Introduction

This chapter discusses the research findings and the statistical analyses that were conducted and in Chapters 5 and 6. All of these discussions will answer the research questions (RQ1 to RQ5), address the research objectives, and fill the gaps in the knowledge that were discussed in Chapter 1.

These discussions are supported by relevant theories and findings in the literature. One of the main research objectives is to understand the relationship between SCI, GSCM practices, and sustainable firm performance, which are the main constructs of this dissertation. Thus, this chapter answers the research questions by discussing the effect of the three main constructs: the influence of SCI and GSCM practices on sustainable firm performance (RQ1 and RQ2), the influence of environmental performance on economic performance (RQ3), the influence of SCI on GSCM practices (RQ4), and, finally, the mediation effect of GSCM practices on the relationship between SCI and sustainable firm performance (RQ5). Therefore, this chapter will be separated into five sections.

7.2. The impact of Supply Chain Integration on Sustainable Firm Performance

This section will answer the research question about the impact of SCI on environmental and economic performance. First, this section will discuss the results of the factor analyses to better understand the components of SCI and sustainable firm performance that were employed in this research.

The SCI construct was divided into three dimensions: II, SI, and CI. The result showed that the SCI construct is a multidimensional construct, consistent with previous studies (Zailani and Rajagopal, 2005; Boon-itt and Paul, 2006; Kim, 2006; 2009; Wong and Boon-itt, 2008; Flynn et al., 2010; Wong et al., 2011). However, the results of the factor analysis are different from those of other studies in terms of the scope of integration in Thai manufacturing industries.

Firstly, II in Thai manufacturing industries involves integration of data and enterprise application in internal departments within organisations and using the benefits of periodic meetings between internal departments on work systems and business activities. Furthermore, an organisation uses cross-functional teams to improve processes and develop new products. The scope of this construct was found to be rather narrow when compared with that in other studies. Flynn et al. (2010) investigated the manufacturing industries in China which is a developing country as Thailand. They suggested that in the context of China, II has wider scope than it does in Thai industries, as it also involved integrative inventory management, real-time searching of level of inventory and logistics-related operating data, and real-time integration and connection among all of the internal functions, ranging from raw material management through production, shipping, and sales to customer. Thus, although both China and Thailand are developing countries, they have different scopes of II in their processing industries. Therefore, these research findings are a novel contribution in the context of Thai manufacturing industries.

Secondly, SI in the context of manufacturers in Thailand includes information sharing on demand forecasts, inventory levels with main suppliers, and also assisting main suppliers improve their processes to meet company requirements. The scope of SI in

Thai manufacturing industries' context is relatively narrow when compared to that in the findings of other studies. For example, Boon-itt and Wong (2011) examined the moderating effects of technological and demand uncertainty on the association between SCI and customer delivery performance in the Thai automotive industry. They found that SI included information sharing with suppliers through information technologies, a high degree of strategic partnership, and joint planning with suppliers to create quick responding ordering processes; also, suppliers provided production plan information for the production and procurement processes and were involved in company's product development processes. Therefore, the differences between the findings of this research and those of Boon-it and Wong show that SI among Thai manufacturers can be different. This could be attributed to the fact that they studied only the Thai automotive just-in-time environmental industries, while this research investigated manufacturing processes in multiple industries.

Lastly, CI in processing industries, especially in Thailand involves sharing of market information, inventory information, and production plan with major customers of the firm and also main customers share information about demand forecast, Point-of-Sale (POS) information, and production plan with the firm. This construct is quite different from that in other developed countries. For example, Zailani and Rajagopal (2005) investigated the relationship between SCI and performance in Japan, Taiwan, Korea, and the USA. In terms of the scope of CI, they found that CI in these developed countries referred to the organisation working closely with customer, the degree of influence and involvement customers have in the firm' decision, and the degree of follow-up with the customers for feedback which consisted of customersproviding feedback to the organisation according to the output delivered or to be delivered. The scope of CI in Zailani and Rajagopal's (2005) literature is different from that in this research because they found CI was extended to customers' feedback.

The findings of this research extend the SCI literature by presenting the aspects of SCI in Thai manufacturing industries. Managers can take this result and apply II, SI, and CI in their business activities.

The results regarding the association between SCI and sustainable firm performance in terms of both environmental and economic outcomes are inconsistent with those in previous studies (Germain and Iyer, 2006; Griffith and Bhutto, 2008; 2009).

The scope of environmental performance will be discussed first to understand the relationship between constructs in this study and other studies. According to factor analysis results of this research, this research measured reduction in consumption of hazardous/harmful/toxic materials, reduction in scrap rate, reduction in frequency of environmental accidents, and improvement in environmental reputation. The scope of this construct is quite dissimilar to that in other studies focusing on developed and developing countries (Griffith and Bhutto, 2008; 2009; Zhu and Sarkis, 2004; Zhu et al., 2005)

For instance, in Griffith and Bhutto'sstudy (2008; 2009), the environmental aspect included reduction in the impact on the natural environment (e.g. land use, ground, water pollution and air), natural resources that are non-renewable and non-sustainable resources (e.g. oil and fuels), and communities (e.g. disruption and distraction to neighbourhoods and local environment); lower environmental cost; reduced environmental risk; and increased reputation and green credentials. Their findings of the scope of environmental performance are dissimilar to this those of this research; this could be attributed to the characteristics of the context each country (developed and developing countries). Also, Zhu and Sarkis (2004) measured environmental performance of Chinese manufacturers in terms of reduction in emission of pollutants, waste water, and solid waste. Nevertheless, this finding is a novel contribution for Thai manufacturing industries.

Therefore, this research found that there is no direct and positive relationship between SCI and environmental performance, inconsistent with some previous studies (Griffith and Bhutto, 2008; 2009). Griffith and Bhutto (2008; 2009) investigated how integrated management systems contribute to environmental performance improvement, using the triangulation approach, including questionnaire survey, interviews, and case studies in UK. They found that integration of management system could improve environmental performance of the organisations. Thus, this result is inconsistent with that of Griffith and Bhutto (2008). Their studies collected data from the UK, which is a developed country that has many stringent regulations on environmental issues; such regulations may have caused many UK organisations to improve their business activities and focus on green business activities. In contrast, Thailand is a developing country which is less likely to be concerned about environmental impact than developed countries. In addition, all of the target respondents from their case studies were certified by ISO 14001, so these factors could have led to results different from those of this research. Furthermore, Griffith and Bhutto (2008; 2009) examined the relationship between integration of management systems and environmental outcome; they found that integrated management system positively impacts to environmental performance.

Moreover, SCI has been traditionally conceptualised as a strategic collaboration with a focus on improving operational performance, such as cost, delivery, quality, and flexibility (Wong et al, 2011). Thus, it is less likely to improve environmental performance. However, environmental performance could be improved by the mediating effect of GSCM practices, as shown by the empirical results of this research.

In terms of economic performance, in this study, financial performance was seen as encompassing the average return on investment, average profit, profit growth over the last three years, and marketing performance, including average market share growth and average sales volume growth over the last three years. The scope of this construct found in this study was not similar to that in other studies. For example, Germain and Iyer (2006) suggested that the financial performance involved average return on investment, average profit, and profit growth. Therefore, the result of this research on financial performance is similar to their result, but this research measured the marketing performance, making this study broader than their study. However, this finding is a novel contribution to manufacturers in Thailand.

This research found that SCI is not directly and positively related to economic performance. This finding is inconsistent with that of previous studies. For example, Germain and Iyer (2006) found an indirect and positive relationship between II, downstream integration, and logistical performance, ultimately leading to improved financial performance. They hypothesised that there was a direct and positive influence of internal and downstream integration on logistics performance and that there was a direct and positive impact of logistical performance on financial performance. They found that all their hypotheses were supported, suggesting that SCI indirectly effected financial performance, consistent with the current finding. However, this research found no direct and positive relationship between SCI and economic performance.

In addition, Rosenzweig et al. (2003) investigated the direct and indirect positive effect of the relationship between SCI intensity, competitive capabilities, and business performance, in terms of return on assets, sales growth, customer satisfaction, and percentage of revenue from new products. They examined both direct and indirect effects of the relationships between constructs. However, their study used hierarchical regression analysis to test the theoretical hypotheses regarding both direct and indirect effects, for this research, the SEM was used to test the theoretical hypotheses. The use of SEM allowed the researcher to clarify the total effects and direct and indirect effects while considering all other constructs simultaneously, so this research accurately presented the actual effects of SCI when GSCM practices are considered.

7.3 The Impact of Green Supply Chain Management Practices on Sustainable Firm Performance

This section will answer RQ2 about the positive relationship between GSCM practices, including ICGSCM and ECGSCM practices and sustainable firm performance, in terms of environmental and economic performance. Furthermore, this section will discuss the factor analyses results for GSCM practices and compare them with the results of previous to understand the aspects of GSCM practices in Thai manufacturing industries that can be applied in developing countries, which are similar to Thailand.

From the factor analyses results for the GSCM practices construct, which was as independent and dependent variable of this research, GSCM practices consisted of two components: ICGSCM and ECGSCM practices. This finding implies that both ICGSCM and ECGSCM practices should be applied as the main constructs for GSCM practices, especially by the manufacturing industry in Thailand and other countries that are similar to Thailand. However, the scopes of ICGSCM and ECGSCM practices are different from those in other studies (Zhu and Sarkis, 2004; Zhu et al., 2005; Giovanni, 2012; Shi et al., 2012).

The factor analysis result of this research showed that ICGSCM practices in Thai manufacturing industries included participation of senior and mid-level managers in GSCM and cooperation between cross-functions for environmental improvements. For example, Zhu and Sarkis (2004) found that ICGSCM practices of manufacturing enterprises in China featured commitment to GSCM from senior managers, support for GSCM from mid-level managers, cross-functional cooperation for environmental improvement, total quality environmental management, environmental compliance and auditing, ISO 14001 certification, and environmental management systems. On comparing their results with the current findings, it can be seen that the scope of ICGSCM practices in Thai processing industries is rather narrow. This is a novel contribution for Thai manufacturers.

This research found that the ECGSCM practices of the firms consisted of encouraging or rewarding suppliers' ISO 14001 certification and evaluating second-tier suppliers' environment-friendly practice and ECGSCM practices with customers, including cooperation with customers for eco-design, cleaner production, and green packaging. Nevertheless, this result is not similar to that of other studies (Zhu and Sarkis, 2004; Zhu et al., 2005; Giovanni, 2012; Shi et al., 2012). For example, Giovanni (2012) found that external environmental management activities included guiding suppliers to adopt the companies' own environmental programmes, choosing suppliers according to environmental criteria, achieving environmental goals collectively, developing a mutual understanding of responsibilities regarding environmental performance, working together to reduce environmental impact of the supply chain, and conducting joint planning to anticipate and resolve environmental-related problems. The finding of this research is that the scope of ECGSCM practices in Thai manufacturing industries is broader than that suggested by Giovanni (2012) because in this research measured GSCM in terms of the customers' perspective, which was not considered by Giovanni. The finding about the scopes of ICGSCM and ECGSCM practices is a novel contribution to manufacturing industries in Thailand.

The SEM analysis showed that there is a direct and positive impact of ICGSCM and ECGSCM practices on economic performance (H4a and H4b) and also in terms of environmental performance, so both ICGSCM and ECGSCM practices have a positive influence on environmental performance (H3a and H3b). The findings of a direct and positive influence of ICGSCM and ECGSCM practices on environmental and economic outcomes are as expected.

Currently, the natural environment has become a key resource and capability that impacts management activities, in turn leading to sustainable competitive benefits (Harts, 1991). Not only ICGSCM practices but also ECGSCM practices can increase economic outcomes, consistent with the N-RBV perspective. Environmental collaboration involves interaction between firms and other supply chain members (e.g. supplier and customers) in order to plan and share information, knowledge, or know-how on environmental issues.

Greening supply chain can be used as a potential resource by a firm for differentiating itself from the others. Accordingly, GSCM practices can create competitive advantage and lead to increased economic performance (Zhu and Sarkis, 2004; Zhu et al., 2005). Zhu and Sarkis (2004) concluded that internal environmental management practices had a positive relationship with economic performance (e.g. reduction in cost of material purchasing, energy consumption, waste treatment, and waste discharge, and reductions in environmental accidents) and negative relationship with economic performance (e.g. increased investment, operational cost, training cost, and costs for purchasing environment-friendly materials), as per hierarchical regression analysis. The finding of this research is similar to the finding of Zhu and Sarkis (2004). On the other hand, this research finding was examined using SEM which allowed the researcher to clarify the total effects and direct and indirect effects while determining all other variables at the same time; thus, although this finding and Zhu and Sarkis' (2004) results are the same, the findings of this research are more likely to accurately represent the actual effects of ICGSCM and ECGSCM practices on environmental and economic performance.

This research showed that both ICGSCM and ECGSCM practices have a positive influence on environmental performance. These findings are consistent with those of previous studies, in terms of the relationship between GSCM (including ICGSCM and ECGSCM practices) and environmental performance (Zhu and Sarkis, 2004; Giovanni, 2012), inconsistent with the findings of some other studies (Lee et al., 2012).

Lee et al. (2012) found no statistical significant link between implementation of GSCM practices and business performance (stronger competitive position, improved profitability and overall improved organisational performance), as per the SEM findings, but found a significantly indirect effect on the relationship between GSCM practices and business performance through the mediating variables of operational and relational efficiency.

Lee et al. (2012) use GSCM implementation as the first-order factor for this construct, while this research finding used ICGSCM and ECGSCM practices as the first-order factor. Their results showed no direct link between GSCM implementation and business performance because GSCM in their study combined the variables internal environmental management, green purchasing, cooperation with customers, and eco-design in one construct, but business performance was not considered as an environmental outcome in their study. Thus, business performance in Lee et al.'s (2012) study may not conform to the antecedent variable (GSCM implement) which involves the environmental perspective for all items. Therefore, the results show that there is no direct link between GSCM implementation and business performance.

The results of this research show that both ICGSCM and ECGSCM practices are associated with economic performance (Zhu and Sarkis, 2004). This finding is not consistent with Giovanni's (2012) findings; Giovanni (2012) found that ICGSCM and ECGSCM practices are not directly and positively related to economic performance.

Moreover, this research shows that there is no direct and positive effect of ICGSCM practiced on ECGSCM practices. This result was unexpected.

To ensure that a supply chain is green, an organisation needs to consider environmental initiatives and internal activities first, followed by integration and collaboration with other supply chain partners (Giovanni, 2012). Internal environmental management affects all business activities that are adopted to green a single firm, such as consideration of environmental criteria, use of green materials or components and cleaner technologies, and reduction of waste and hazardous gaseous emissions. However, the implementation of environmental management in only internal environmental strategy, reduced the degree of its adoption in the supply chain overall (Giovanni, 2012).

ICGSCM practices are not directly and positively linked to ECGSCM practices. Considering the mean scores of ICGSCM and ECGSCM practices in Chapter 5, EGSCM practices seems to be less developed than ICGSCM practices. According to Giovanni (2012), adopting internal environmental management practices is the first step to greening the process of a firm before initiating environmental management integration with the supply chain members. Also, Rao and Holt empirically showed that greening the production leads to greening of outbound logistics, resulting in improved competitive advantage. Therefore, ICGSCM practices are not as developed as ECGCSM practices. Thus, at this stage, manufacturing industries in Thailand are focusing on ICGSCM practices and gradually exploring ways to implement ECGSCM practices, so the effect of ICGSCM practices on ECGSCM practices might still be ineffective.

In addition, the findings of this dissertation fill the gap in the knowledge on GSCM by providing empirical evidence to support previous studies that present only the conceptual model about the impact of organisational environmental practices on firm performance, such as the study of Shi et al. (2012). Shi et al. (2012) conceptualised a structural model by applying the N-RBV of the firm to the GSCM concept and also to its link between intra- and inter-organisational environmental practices and business performance, including environmental, operational, and financial performance. Their proposed hypotheses have not been tested. Thus, the empirical findings of this research provide new evidences for their proposed theoretical hypotheses. Therefore, the findings of the structural model used in this dissertation can be used as empirical evidence to confirm the argument that GSCM practices are positively related to sustainable firm performance, in terms of environmental and economic outcomes.

7.4 The Impact of Environmental Performance on Economic Performance

The third research question aimed to understand the direct and positive association of environmental performance with economic performance. The research finding shows that environmental performance has no direct and positive influence on economic performance. This finding was unexpected. In general, environmental initiatives improve environmental performance (Rao, 2002). When organisations consider environmental criteria, they can minimise the environmental impact of a firm's activities and achieve improved economic outcomes (Zhu et al., 2005); many studies have shown a positive relationship between environmental performance and economic performance (Alverez Gil et al., 2001; Green Jr. et al., 2012; Moneva and Ortas, 2010; Giovanni, 2012). However, the association between environmentally friendly behaviour of the organisation and economic performance is inconclusive (Wagner et al., 2001).

In practice, organisations which implement a proactive approach indicate that they consider pollution prevention as their criteria (Shi et al., 2012). They can create resources or capabilities, which become their knowledge or know-how, thereby obtaining unique resources. Such resources will be valuable and difficult to imitate, resulting in increased competitive advantage and ultimately improved profitability (Barney, 1991). Organisations that have a proactive environmental policy redesign their operational activities including not only production processes but also service delivery processes (Russo and Fouts, 1997). Such a preventative environmental strategy allows businesses to enhance their internal processes for reduction of waste and efficiency of operations and energy use (Shi et al., 2012; Russo and Fouts, 1997). When internal routines work and know-how is developed, organisations achieve competitive benefits, in turn leading to improved environmental, operational, and financial performance (Shi et al., 2012). Many studies showed that better pollution control helped improve profitability (Alverez Gil et al., 2001; Green Jr. et al., 2012; Moneva and Ortas, 2010; De Giovanni, 2012).

Alternatively, some companies adopt a reactive approach merely to meet the minimum level of governmental regulations or customer requirements (Handfield et al., 2002). Reactive businesses are more likely to implement end-of-pipe solutions, which are likely to hinder environmental performance (Klassen and Whybark, 1999). End-of-pipe policies impact only the physical resources (e.g. hardware, equipment, plant) used in the firm. They primarily need to employ such resources to control pollution. They do not want to develop their skills into capabilities. Therefore, such companies tend to have a bad environmental reputation, leading to loss of competitive advantage and finally reduced environmental performance.

In addition, pollution control is very expensive and a firm has to pay more for greening its operation and production processes. Therefore, although organisations improve their environmental performance, they achieve reduced economic performance. The empirical results of this research confirm that environmental performance does not positively impact economic performance. Many other studies also supported this argument, such as Rao (2002); Aragon–Correa and Rubio–Lopez (2007). Furthermore, these results support the proposed theoretical structural model of Shi et al. (2012), as empirical findings on the link between environmental outcomes and economic benefits. Consequently, the research findings indicate that better environmental performance does not necessarily influence economic performance, in terms of ROI, profit, market share and market volume growth, especially in the manufacturing industry of Thailand.

7.5 The Impact of Supply Chain Integration on Green Supply Chain Management Practices

The fourth research question aimed to determine the relationship between SCI and GSCM practices, including ICGSCM and ECGSCM practices. According to the research findings from hypothesis testing (H5: SCI -> ICGSCM practices and H6: SCI -> ECGSCM practices), the empirical evidence shows that SCI as an antecedent to GSCM practices (ICGSCM and ECGSCM practices) has a direct and positive effect. The findings related to the relationship between SCI and GSCM practices are not surprising.

Previous studies suggest that SCI directly and positively affects green supply chain practices (Vachon and Klassen, 2006; Carter and Carter, 1998; Bowen et al., 2001; Canning and Hanmer Lloyd, 2001; Roy et al, 2001).

At present, environmental issues are gaining attracting much attention. Thus, the natural environment has become one factor of environmental changes (Canning and Hanmer Lloyd, 2001). Such changes influence environmental adaptations and management activities, especially environmental management activities. For example, changes in product and packaging designs are a result of the restrictions on the use of hazardous components and increasing demand for reusable and recyclable materials, parts, and products (Walton et al. 1998; Cramer and Schot, 1993). Also, environmental adaptations and activities lead to develop reverse logistics by considering on packaging and product return system (Canning et al., 2001) and improve technical solution on environmental issues.

Therefore, changes can motivate organisations to take action on their work process, not only in terms of operational processes but also production processes and expand those changes to the whole supply chain.

Environmental adaptations push businesses to try and improve their activities in order to obtain core competence or achieve the environmental outcome criteria. Adaptation leads to innovation and continuous improvement (Kikbakhsh, 2009). In addition, environmental commitment is often related to management activities. If a company has a good relationship with both internal (e.g. employee) and external stakeholders (e.g. suppliers and customers), it facilitates adaptation of organisational practices. Customer requirements also play a vital role in product design (Nikbakhsh, 2009). As mentioned above, organisations have to address environmental requirements by integrating environmental issues into their business strategy/policy and activities.

Consequently, the empirical findings of this research confirm a direct and positive relationship between SCI and GSCM practices, indicating that the SCI of a firm is more likely to increase green supply chain practices. This finding can be extended to green SCI. This study provides the first empirical evidence which support the suggestions of many related studies (Vachon and Klassen, 2006; Carter and Carter, 1998; Bowen et al., 2001; Canning and Hanmer Lloyd, 2001; Roy et al, 2001).

7.6 The Mediating role of Green Supply Chain Management Practices on the Relationship between Supply Chain Integration and Sustainable Firm Performance

The last research question aimed to determine the effect of SCI and GSCM practices on sustainable firm performance. In this research, GSCM practices consisted of ICGSCM and ECGSCM practices as mediators of the link between SCI and sustainable performance, including environmental and economic performance (H9a–H9b and H10a–H10b). It was found that SCI is indirectly and positively related to sustainable firm performance, in terms of both environmental and economic performance, with ICGSCM practices as a mediating variable. In addition, ECGCSM practices mediated the positive relationship between SCI and sustainable performance.

This study was similar to a few other studies, e.g. Vachon's (2003) study. He considered the same main constructs that were used in this thesis, but not the same measurement items or variables. He focused on SCI (technological and logistical integration), green operations management (green supply chain practices and environmental technology forms), and operational performance (cost, quality, delivery, flexibility, and environmental performance). Additionally, he hypothesised about the association between all of these constructs, but found only a direct and positive relationship between SCI and green supply chain practices relationship and between green supply chain practices and operational performance relationship. Also, in his dissertation, there was no focus on green supply chain practice as a mediator. Therefore, this study is more likely to present the first empirical results about the mediation role of GSCM practices on the relationship between SCI and sustainable performance. Such a finding about the mediation role can be further studied by other researchers who are in supply chain management and environmental management literature.

The findings of this research, especially in the context of Thai manufacturing industry indicate that GSCM practices, both ICGSCM and ECGSCM practices, can be mediators of the relationship between SCI and sustainable performance, including environmental and economic performance. It implies that firms aiming to implement SCI need to improve their environmental reputation, ultimately leading to improvement in the firms' image and enhanced competitive advantage over competitors; they should be concerned about environmental management and transform environmental strategies and objectives into practice and routines in their business processes, not only within the organisation but also in other organisations which are part of the supply chain.

The empirical evidence shows that ICGSCM practices fully mediate the relationship between SCI and sustainable firm performance, implying that firms should consider environment-friendly products and implement green supply chain management in the business strategy and policy to improve environmental performance and economic performance. Ensuring participation of both top and mid-level managers is the first step in adopting green activities (Rao, 2002; Rao and Holt, 2005; Giovanni, 2012). Then, other departments should cooperate with each other through information sharing to ensure continuous communication and development, thereby improving operation cost and time. Improving internal environmental management practices is the first step in greening the whole supply chain (Giovanni, 2012) before improving external environmental management practices. Organisations that are environmental conscious are willing to adopt environmental initiatives to generate an environmental supply chain management or GSCM. ICGSCM practices facilitate the interaction with all supply chain members because if internal stakeholders (e.g. managers, employees) take the environmental criteria into consideration, then they work jointly to reduce the environmental impact, not only in the organisation but also in supply chain activities. Therefore, IGSCM practices can facilitate SCI within a firm, as internal environment initiatives are conducted better than external ones (Giovanni, 2012).

Firms should also take into account EGSCM in business operations and the whole supply chain, meaning managers need to cooperate with not only other departments in the same organisation (IGSCM practices) but also with other organisations in order to establish commitment, long-term relationships, and trust. Further, interaction between supply chain members, such as suppliers and customers, is able to make the work flow more effective and improve communication. For this purpose, a business needs to collaborate with suppliers and also suppliers' suppliers and persuade them to be concerned about environmental issues and evaluate their environment-friendly practices, encourage suppliers to receive ISO 14001 certification, and provide design specifications on environmental requirements. Furthermore, a firm must cooperate with its customers by taking into account issues such as eco-design, cleaner production, and environment-friendly packaging.

7.7 Summary

This chapter discussed the main findings of this dissertation. All of these discussions answered the research questions (RQ1 to RQ5), accomplished the research objectives, and filled the gaps in the knowledge that were pointed out in Chapter 1.This research found that SCI has no direct and positive impact on sustainable firm performance, in terms of environmental and economic performance. In contrast, GSCM practices have a direct and positive impact on sustainable firm performance. ICGSCM and ECGSCM practices are directly and positively related to both environmental and economic performance. Additionally, there was a direct and positive relationship between SCI and GSCM practices, including both ICGSCM and ECGSCM practices.

It was found that ICGSCM practices fully mediated the relationship between SCI and sustainable firm performance, in terms of both environmental and economic performance. In addition, ECGSCM practices fully mediated the relationship between SCI and sustainable performance as well. Therefore, firms should concentrate on implementing and developing GSCM or environmental management to achieve sustainable competitive advantage, ultimately leading to superior firm performance.

The contributions of this dissertation to theory and practice, limitations of the research, and suggestions for future research are discussed in the next chapter.

CHAPTER 8: CONCLUSION

8.1 Introduction

This chapter presents the summary of the main findings, contributions to theory and practice, empirical evidence, and limitations and recommendations for future research.

8.2 Summary of the Main Findings

To assess the measurement and structural models used in this research, confirmatory factor analysis (CFA) and structural equation modelling (SEM) were employed, following a two-step approach of Anderson and Gerbing (1988). This approach used the measurement model to determine the reliability and validity of the constructs and structural model for testing the theoretical hypotheses of this research. The measurement model results possessed three main constructs, separated into 30 measured items or variables that were unidimensional, reliable, convergent and discriminant validity. All of the goodness-of-fit indices were acceptable in the structural model (as shown in Chapter 6). There were main five research findings on the relationship among three main constructs, including SCI, GSCM, practices and sustainable firm performance. The findings of the research contain both the direct and indirect (mediating) effects which include the direct effect on the SCI-sustainable firm performance relationship, GSCM practices (ICGSCM and ECGSCM practices)-sustainable firm performance relationship, SCI-GSCM practices relationship, environmental performance and economic performance relationship, and the indirect effects of the mediation effect of GSCM practices on the SCI-sustainable firm performance relationship. All the findings will be outlined in the next section.

According to the results, there is no direct impact of SCI on sustainable firm performance, in terms of both environmental and economic performance. Second, the findings about the relationship between GSCM practices and sustainable firm performance could be separated into two dimensions, i.e. ICGSCM and ECGSCM practices. There is a directly positive impact of both ICGSCM and ECGSCM practices on environmental performance. In addition, ICGSCM and ECGSCM practices directly affected economic performance. Third, SCI is directly related to GSCM practices, including both ICGSCM and ECGSCM practices. Fourth, environmental performance is not directly related to economic performance. Finally, with regard to the indirect (mediating) effect, the relationship between SCI and sustainable performance is mediated by GSCM practices (ICGSCM and ECGSCM practices). Both of ICGSCM and ECGSCM practices mediated the relationship between SCI and sustainable performance, in terms of both environmental and economic performance.

In conclusion, this dissertation shows different empirical findings regarding the direct and indirect effect relationships between SCI, GSCM practices, and sustainable firm performance. All the findings of this research are useful for both academic and business areas. In the next section, the contributions of this dissertation that can be applied in the theoretical and managerial areas will be outlined.

8.3 Contributions to Theory and Practice

8.3.1 Contributions to Theory

8.3.1.1 Construct Development and Measurement

This section presents the implications and contributions of the findings of this dissertation to SCI and GSCM literature. The first implication is about the development and conceptualisation of the constructs, i.e. SCI, GSCM practices, and sustainable firm performance. From the factor analysis results, this thesis examined the construct development and conceptualization by considering all constructs as multidimensional constructs. The first construct, SCI was a multidimensional construct; the SCI construct was divided into three sub-dimensions: internal integration, supplier integration, and customer integration. The result is similar to the results of previous studies, e.g. Flynn et al. (2010), Koufteros et al. (2005), Wong and Boon-itt (2008) and Wong et al. (2011).The second construct, GSCM practices, was also examined as a multidimensional construct. The factor analysis showed that the GSCM practices construct was divided into two sub-dimensions: internal and external GSCM practices. The result obtained was similar to that obtained in previous studies, e.g. Zhu and Sarkis (2004), Zhu et al., (2005, 2010), Giovanni (2012), and Shi et al. (2012). The last construct, sustainable performance, was based on the sustainability concept. This construct involved two dimensions: environmental outcome and economic perspective. This finding is consistent with many other earlier studies (Zhu and Sarkis, 2004; Zhu et al., 2005).

However, some previous studies examined SCI, GSCM practices as unidimensional or single-dimension constructs, e.g. Stank et al. (1999) and Rosenzweig et al. (2003)

represented SCI as unidimensional construct in their research. Although unidimensional constructs are generally easier to understand, many measurement constructs cannot be measured by only one dimension. The use of multidimensional constructs can help develop a better comprehensive understanding of SCI and GSCM practices. For example, this research separated GSCM practices into two sub-components, so the relationship between GSCM practices, especially ICGSCM or ECGSCM practices, and firm performance could be determined. Thus, researchers, practitioners and managers not only in the academic area but also in the business area can deeply understand the conceptual model of this study that present the relationship between the main constructs, including SCI, GSCM practices, and sustainable firm performance by separating the main constructs into sub-dimensions.

8.3.1.2 Contribution to Existing Theory

From a theoretical perspective, it is important to consider the findings of this research in light of earlier studies to strengthen the theoretical implications, ultimately leading to systematic development in practice. Nowadays, environmental issues are gaining increasing interest because of the impact of business activities on the natural environmental. Many organisations are concerned about these matters; therefore, they are attempting to take remedial action to achieve competitive benefits. N-RBV of the firm (Hart, 1995) suggests that the natural environment is an important organisational resource that an organisation acquires through collaboration with supply chain partners. Environmental collaboration demands capabilities and know-how or knowledge of integrating and sharing resources (Vachon and Klassen, 2008). Therefore, organisations can develop their knowledge-sharing routines and also the capability to integrate or combine resources of other firms in the supply chain which is known as relational view.

Thus, resource combination can help a company gain competitive advantage, resulting in increased logistic performance (Karia, 2011; Karia and Wong, 2013; Wong and Karia, 2010) or increased environmental and economic performance (Zhu and Sarkis, 2004; Zhu et al., 2005). For this research, the findings show that a combination of ICGSCM and ECGSCM practices can help an organisation enhance both environmental and economic performance. Thus, this research confirms the findings of previous studies (Hart, 1995; Carter et al., 1998; Zhu and Sarkis, 2004; Zhu et al., 2005).

This thesis also provides an empirical study on the GSCM model posited by Shi et al. (2012). In their study, they proposed a theoretical hypothesis, based on the N-RBV, on the association of organisational environmental practices with performance measures, in terms of environmental, operational, and financial performance. However, they did not test the hypotheses. Thus, the findings of this research can confirm the conceptualisation of environmental management in an empirical perspective. The conceptualisation is known as natural resource-based GSCM (N-RBV GSCM) (Shi et al., 2012).

However, profitability and environmental outcome can be increased by implementing GSC activities as a mediator in a firm’s business operation and production. This is a novel contribution to existing SCI and environmental management literature. This finding suggests that the traditional SCM concept can be broadened to GSCM concept by integrating SCI and GSCM into GSCM integration for conducting research on this issue.

8.3.2 Empirical Evidence

This dissertation provides empirical evidence about the link between SCI, GSCM practices, and sustainable firm performance. This dissertation used factor analysis and SEM analysis to develop the constructs and measurement scale for all mentioned constructs and to investigate the relationship between them. This research presents empirical evidence on the direct and indirect effects are relationships between the main constructs in this study. The direct effects results are the direct and positive relationship between SCI, GSCM practices, and sustainable firm performance, while the indirect effects are the mediating effects of GSCM practices on the relationship between SCI and sustainable firm performance. The empirical evidence and novel findings and contributions for SCM and environmental management literature are presented below.

1. SCI does not directly impact environmental performance or economic performance. These findings are inconsistent with those of many studies on environmental performance (Griffith and Bhutto, 2008; 2009; Kim; 2009). However, these findings are consistent with those of Vickery et al.'s (2003) study, in term of finance performance.
2. SCI is not directly related to sustainable firm performance and environmental and economic outcomes. This finding is inconsistent with previous findings (RBV of the firm; Barney, 1991; Germain and Iyer, 2006; Griffith and Bhutto, 2008; 2009; Karia, 2011). To the best of our knowledge, this is the first study showing such empirical findings.
3. Both ICGCSM and ECGSCM practices have a direct effect on environmental performance. The finding is similar to those of previous studies (Zhu and Sarkis, 2004; Giovanni, 2012). However, the target respondents of this research were

those from Thai manufacturing units different from those selected in previous studies. To the best of our knowledge, this is a novel empirical result.

4. Both ICGSCM and ECGSCM practices are directly and positively associated with economic performance. The empirical evidence confirms the conceptualisation in previous research, e.g. Shi et al (2012). Shi and his co-authors created a structural model of N-RBV GSCM and its relationship with relevant performance measures (in term of operational, environmental, and financial performance) and drivers. Their model was purely conceptual and relationships between intra- and inter-organisational environmental practices, performance measures, and institutional drivers were proposed, but they did not empirically test their proposed hypotheses. Therefore, the hypotheses need to be tested empirically. The findings of this dissertation however provide empirical support for Shi et al.'s hypotheses about the association between ICGSCM practices, ECGSCM practices, and business performance, in terms of environmental benefits and economic outcome.
5. This research shows empirical evidence that SCI has no direct effect on sustainable firm performance. Nevertheless, if the firms have adopted ICGSCM and ECGSCM practices, or using them as significant mediators on the relationship between SCI and sustainable firm performance, they can improve firm performance, particularly environmental and economic performance. Therefore, internal and external environmental management is an important operation that firms should focus on. To the best of our knowledge, this is the first study on GSCM practices (including ICGSCM and ECGSCM practice) as mediators of the relationship between SCI and firm performance.

6. The indirect or mediation effects were investigated among the constructs (SCI, GCSM practices and sustainable performance) as well. The findings of this research show that GSCM practices could mediate the SCI-sustainable firm performance relationship. When separated into sub-dimensions, IGSCM practices dimension mediates the association between SCI and sustainable firm performance, in terms of both environmental and economic performance, and ECGSCM practices mediates of the association between SCI and sustainable performance. Such mediating effects have never been studied empirically before.

8.3.3 Contributions to Practice

The findings of this research provide significant practical implications for managers, especially supply chain managers, plant or production managers, purchasing managers, and operation managers, particularly in the context of Thai manufacturing industries. Thailand is one of the developing countries in South East Asia. Thailand will become a member of the ASEAN Economic Community (AEC) in the next two years. Consequently, it is very important for Thai organisations to adapt their strategic management practices to achieve competitive advantage, especially when a firm encounters potential competitors from other countries in the same area, such as Singapore, Malaysia and Indonesia.

1. Managers should concentrate on the environmental management policy of the firm, in terms of GSCM practices, if they would like to improve environmental outcomes and profitability. Because the sample respondents of this research were various manufacturers in Thailand, the results can be applied to the Thai

manufacturing industry as well as other developing countries, such as the Philippines, Indonesia, Malaysia, and Singapore which have similar contexts, cultures, and markets as Thailand.

2. Integration of GSCM in the context of Thai manufacturing industries can enhance firm performance, especially economic performance. The results imply that if such manufacturers are concerned about environmental management to support their corporate social responsibility objectives and meet customers' expectations, they will achieve a better business image and reputation in terms of corporate social responsibility, ultimately leading to increased competitive advantage and sustainable profitability. However, organisations should consider both internal and external environmental practices in order to improve profitability. Moreover, Rao and Holt (2005) found that only internal GSCM (greening inbound) had a positive relationship with economic performance, while this dissertation found that IGSCM and EGSCM practices equally enhanced economic performance.
3. Furthermore, this research found that firms adopted only ICGSCM practices to improve environmental performance or be greener. Although, external environmental management practices are unable to directly improve environmental outcomes of firms, they could help improve environmental performance of other parts of the supply chain members. Therefore, this dissertation recommends that managers consider the value of IGSCM and EGSCM practices at the same time.
4. Additionally, GSCM or environmental management practices will be critical issues in South East Asia in the coming decade owing to a major part of the manufacturing industry in this area. Rao's (2002) study involved developing

countries, such as the Philippines, Indonesia, Malaysia, Thailand, and Singapore and found that they had similar markets and cultures in terms of GSCM practices. Thus, organisations in these countries can also learn from the relationships identified in this research. Moreover, Thailand will be part of the ASEAN Economic Community (AEC) in 2015; therefore, it is necessary that organisations in the manufacturing industry prepare their business operations and productions under the conditions and regulations of the AEC, especially in terms of environmental matters.

8.4 Limitations and Recommendations

8.4.1 Limitations of this Research

No research is a perfect study. This dissertation also has some limitations. First, the main limitation of his study was its generalisability. Normally, to improve generalisability, researchers collect data on large populations. For example, the data may come from different target respondents or different places. A large sample population indicates that the results can be more generalised. For this study, the data came from multiple industries, such as automotive, automotive components, electronic components, chemical and petrochemical, textile, clothing, etc., but this study collected data from manufacturing industries in Thailand only. Although a survey involving multiple industries has many advantages, data collection from a sample from only one country may decrease the generalisability of the results. Thailand represents a developing country. Also, the dataset has a local context, so the results of this dissertation cannot be generalised to different countries, such as developed countries, industrialised, or newly industrialised countries.

Second, the target respondents were top or middle managers from each firm, such as supply chain management managers, production managers, purchasing managers, operation or plant managers. However, in practice, only one person may not know and understand all of the business processes and supply chain activities. Therefore, recruiting only one respondent from one department of the firms can be considered a limitation of this dissertation. Furthermore, the target respondents were only manufacturing companies, but the whole supply chain contains many other aspects besides manufacturers, such as suppliers, customers, competitors, and other relevant members. Consequently, the information from only manufacturers cannot cover all the business processes and supply chain.

Third, this dissertation used a cross-sectional survey in order to collect data from Thai manufacturing industries. A single cross-section survey is not able to capture long-term effects of changes. Normally, changes emerge all the time. Therefore, a longitudinal research can solve this limitation by separating data collection into several phrases to investigate the phenomenal changes.

The Likert-scale type survey can also be considered a limitation of this research because the data collection following the measurement items that show in the questionnaires only; it means the findings will relate to only the questions or the researcher can measure only all variables in the questionnaires. The survey methodology is used to gain data related to items of a latent construct. The options for Likert-type questions are captured from managers' responses. Therefore, any additional information that relates to another phenomenon under investigation cannot be highlighted.

The selection of measurement items of each construct can be a limitation of this research. Very few variables are used in this study for SCI (e.g. three items to measure SI) and GSCM practices (e.g. three variables to measure IGSCM practices). This could be problematic for the reliability and validity of each construct.

This research did not take a firm size and ISO 14001 certification of the respondents as control variables to test the research hypotheses. This limitation could affect the results of this research.

Lastly, sustainable development, especially in supply chain management, is a topic gaining increasing importance but was not considered in this study. It involves three dimensions: environmental performance, economic performance, and social performance (Carter and Roger, 2008). Future studies should consider the social perspective of sustainable development.

8.4.2 Recommendations for Future Research

Future studies can consider improving on the limitations of this dissertation and involve different industries and different countries, select multiple target respondents from different departments and other supply chain members, and use longitudinal research methods to capture phenomenal changes.

First, owing to the fact that the study sample included manufacturing industries in Thailand, the study was limited because of the local context and by fact that it involved only a developing country. Future studies on SCI and GSCM should expand to other countries in order to gain an understanding and compare such issues with other countries. Furthermore, although the data from this research come from multiple industries (automotive, automotive components, electronic components, chemical and petrochemical, textile, clothing, etc.), there are other industries that affect the environment and cause severe environmental pollution problems as well. Therefore, future research could possibly add other industries not included in this study.

Second, this dissertation involved only a single respondent in each firm, but only one person would not be able to know the details of all business processes and other information. For example, a manufacturing or plant manager will know the details of the production processes but will not know about firm performance (e.g. profit, ROI, market share of the firm) in detail. Also, this study focused only on manufacturers, but suppliers and customers or suppliers' suppliers and customers' customers are also important aspects of a supply chain. Therefore, future studies should target other supply chain members to gain information about them and deeply understand their attitudes about business operations and environmental issues of those firms.

Third, a cross-sectional research design was employed in this dissertation. This research design collects data at one point in time (Mathews and Ross, 2010). However, in the real world, the information can change over time. A longitudinal study enables the researchers to collect data from the same person or same situation at key points in time and examine how the changes affect different groups of people. In addition, a longitudinal study can lead practitioners and businesses to understand the casual relationship between SCI, GSCM practices, and sustainable firm performance. Moreover, this research design sheds light on the changes in such issues of the businesses over time that relate to firm performance, especially environmental and economic performance. To capture changes in situations for a longitudinal research design, the sources that can be used to collect data are secondary sources, such as annual reports, corporate environmental reports, corporate sustainability reports, and other public information.

Fourth, this research focused on SCI, GSCM practices, and sustainable performance, including environmental performance and economic performance. Further research can extend the scope of this research to other perspectives in order to develop a new concept and theory. Furthermore, new issues can expand from the findings of this research, regarding not only integrating business activities but also extending firm performance issue. For example, further research may consider not only social activities but also social outcomes that enable firms to achieve competitive benefits and ultimately obtain sustainable competitive performance.

8.5 Summary

The findings of this research, both direct and indirect effect results are worthwhile and have important implications in theory. Importantly, this research presents the first empirical evidence of the mediating effects of GSCM practices, including ICGSCM and ECGSCM practices. Moreover, the results of the structural model that proposed in this research can encourage not only academics but also practitioners also to pay attention to GSCM practices as important resources of a firm. In the academic area, the results of this research can help increase the knowledge on SCI, GSCM, and firm performance as well as future studies. In managerial practices, practitioners or managers can apply the framework proposed in this study to their business operation. In addition, they should concentrate on GSCM practices as resources of the firm, instead of SCI only, to achieve improved sustainable firm performance.

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APPENDICES

Appendix A: Cover letter

A survey of Green Supply Chain Management

in Thai Manufacturing Industry

By Rachata Suansawat

University of Hull, UK

and Udon Thani Rajabhat University

Objectives

In the recent years Thai manufacturing firms have been asked by customers to comply with various environmental regulations. Consequently, there is a need to learn how to manage green supply chain more effective. This survey aims to uncover best practices of green supply chain management within the Thai manufacturing industries. By participating in this survey, you contribute to the PHD study of Ms. Rachata Suansawat as well as Thai manufacturing industries as a whole. Thank you in advance for your cooperation.

Questionnaire Directions

Please answer each question carefully and appropriately. Your answers should be based on your opinion and perception as a knowledgeable manager about your plant's information that are important. Your specific plant information will be kept strictly confidential. Only aggregate information will be reported.

Please send the questionnaire back to the address that mentioned below before 10 November 2011.

Thank you for your participation. Results and finding will be sent to all participants as soon as they are available.

If you have any question about this survey, please contact:

Ms. Rachata Suansawat

Udon Thani Rajabhat University

Management Science Faculty

Accounting Programe

Udon Thani 41000

Telephone Number: 042 211 040 ext 415

Mobile Phone Number: 08- 0613-2969

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Appendix B: Questionnaire

Questionnaire Directions

This questionnaire is divided into 2 main parts: part 1- description and background information of your company and part 2 – specific information of your company about supply chain integration, green supply chain management practices and firm performance.

Part 1: Company Description and Background information

This part is about the description and background information of your company. Please tick the correct symbol (√) in the box or fill in the blank to best describe your company's information.

What is the industrial group of your business?

Automotive industry.. □

Automotive components industry……………………..…□

Electronic components industry.................................... □

Food and beverage industry...□

Industrial material and machinery industry....................□

Petrochemical and chemicals industry...........................□

Transportation and logistics industry.............................□

Textile industry………………………………………...□

Clothing industry including decorating

And colouring wool……………………………………□

Other (please identify)... □

As of the beginning of January 2011, how many employees (full – time equivalent) work at your company?

Under 50 employees.. □

Over 50 to 100 employees.. □

Over 100 to 200 employees.. □

Over 200 to 300 employees.. □

Over 300 employees... □

Is your company ISO 9000 certified?

Yes □ since when (year): .... No □

Is your company ISO 14001 certified?

Yes □ since when (year): ....No □

Please indicate the best description of the below information about your company:

Capital

Less than 5,000,000 Baht..□

Over 5,000,000 Baht to 10,000,000 Baht...........................□

Over 10,000,000 Baht to 20,000,000 Baht.........................□

Over 20,000,000 Baht to 50,000,000 Baht.........................□

Over 50,000,000 Baht..□

Please identify...

<u>Non - current Assets</u> (as of the beginning of January 2011)

Less than 50,000,000 Baht..□

Over 50,000,000 Baht to 100,000,000 Baht.........................□

Over 100,000,001 Baht to 200,000,000 Baht.......................□

Over 200,000,001 Baht to 500,000,000 Baht.......................□

Over 500,000,000 Baht..□

Please identify...

<u>Total annual sales</u> (as of the beginning of January 2011)

Less than 50,000,000 Baht..□

Over 50,000,000 Baht to 100,000,000 Baht.........................□

Over 100,000,001 Baht to 200,000,000 Baht.......................□

Over 200,000,001 Baht to 500,000,000 Baht.......................□

Over 500,000,000 Baht..□

Please identify...

What is the main characteristic of the primary product of your manufacturing plant?

Assembled – to – order...□

Made – to – stock..□

Make-to-order..□

Other (please identify) ....□

What is your current position?

CEO...□

Logistics Manager...□

Supply Chain Management Manager..................................□

Production Manager..□

Purchasing Manager..□

Operation Manager..□

Plant Manager……………………………………………..□

Other (please identify) ....□

Part 2: Supply Chain Management information

Please mark the correct symbol (√) at the most appropriate number that describes your company's supply chain.

2.1. Supply Chain Integration

2.1.1. The following statements relate to supply chain integration within your company. Please indicate the extent of integration or information sharing between your department and other departments in the following areas (1= not at all; 5= great extent).

	Statements	Not at all		Moderately	Great extent	
		1	2	3	4	5
1	Our company integrates data among internal					

	functions.					
2	Our company integrates enterprise application among internal functions.					
3	Our company manages integrative inventory information.					
4	Our company shares the level of inventory from one department to other departments.					
5	Our company shares the logistics-related operating data from one department to other departments.					
6	Our company utilizes periodic interdepartmental meeting among internal functions.					
7	Our company uses cross functional teams in process improvement.					
8	Our company uses cross functional teams in new product improvement.					
9	Our company integrates and connect all internal functions from raw material management through production, shipping and sales.					

2.1.2. The following statements relate to supply chain integration of your company with other companies. Please indicate the extent of integration or information sharing between your organisation and **major suppliers** in the following areas (1= not at all; 5= great extent).

	Statements	Not at all		Moderately	Great extent	
		1	2	3	4	5
1	Our company exchanges information with our major suppliers through information networks.					
2	Our company establishes quick ordering					

	systems with our major suppliers.					
3	Our company establishes strategic partnership with major suppliers.					
4	Our company has long-term procurement relationship with our major suppliers.					
5	Our company involves with major suppliers in the process of procurement and production.					
6	Our company involves with major suppliers in the design stage.					
7	Major suppliers share their production schedule information with our company.					
8	Major suppliers share their production capacity information with our company.					
9	Our company shares production plan information with major suppliers.					
10	Our company shares demand forecast information with major suppliers.					
11	Our company shares inventory level information with major suppliers.					
12	Our company helps major suppliers to improve their process to better meet our needs.					

2.1.3. The following statements relate to supply chain integration of your company with your customers. Please indicate the extent of integration or information sharing between your organisation and **major customers** in the following areas (1= not at all; 5= great extent).

	Statements	Not at all		Moderately	Great extent	
		1	2	3	4	5
1	Our company connects to major customers through information networks.					
2	Our company has computerization for major customer's ordering.					
3	Our major customers share market information with our company.					
4	Our company provides effective communication channels to major customers.					
5	Our company establishes quick ordering systems with major customers					
6	Our company follows up feedback from our major customers.					
7	Our company has frequent contacts with major customers.					
8	Major customers share Point of Sales (POS) information with our company.					
9	Major customers share demand forecast information with our company.					
10	Our company shares inventory availability information with major customers.					
11	Our company shares production plan with major customers.					

2.2. Green Supply Chain Management Practices

2.2.1. Please indicate the environmental policy of your company in the following areas (1= not at all; 5= great extent).

	Statements	Not at all		Moderately	Great extent	
		1	2	3	4	5
1	Senior managers of our company participate in environmental initiatives.					
2	Mid-level managers of our company participate in environmental initiatives.					
3	Our company uses cross- functional cooperation for environmental improvement.					
4	Our company has environmental compliance and audit programs.					
5	Our company designs products which reduce consumption of materials and energy.					
6	Our company designs products for reuse, recycle, recovery of materials/ parts.					
7	Our company designs products to avoid or reduce use of hazardous products and/or their manufacturing process					
8	Our company recycles excess inventories/materials					
9	Our company recycles used materials.					
10	Our company sells excess capital equipments.					

2.2.2. Please indicate the environmental policy of your company with your suppliers and customers in the following areas (1= not at all; 5= great extent).

	Statements	Not at all		Moderately	Great extent	
		1	2	3	4	5
1	Our company provides design specification to suppliers that include environmental requirements for purchased item.					
2	Our company cooperates with suppliers to achieve environmental objectives.					
3	Our company uses environmental audit for assessing suppliers' environmental management.					
4	Our company encourages or rewards suppliers' ISO 14001 certification.					
5	Our company evaluates second-tier supplier environmentally friendly practice					
6	Our company cooperates with customers in eco-design.					
7	Our company cooperates with customers in cleaner production.					
8	Our company cooperates with customers in green packaging.					

2.3. Sustainable Firm Performance

2.3.1. This section examines the environmental performance of your company. Please indicate your company's performance in the following areas relative to your major competitors (1= not at all; 5= great extent).

	Statements	Not at all		Moderately	Great extent	
		1	2	3	4	5
1	Reduction of air emission					
2	Reduction of waste water					
3	Reduction of solid wastes					
4	Reduction of consumption of hazardous/harmful/ toxic materials					
5	Reduction of scrap rate					
6	Reducing the frequency of environmental accidents					
7	Improvement of environmental reputation					

2.3.2. Please evaluates your company's performance over the past three years in the following areas relative to your previous firm performance and your major competitors (1 = much worse than previous firm performance; 5 = much better than previous firm performance

	Statements	Compare with the previous firm performance				
		1	2	3	4	5
1	Average return on investment					
2	Average profit					
3	Profit growth					
4	Average return on sales					
5	Average market share growth					

6	Average sales volume growth					

Additional comments

Are there any important issues that you would like to add more information about your company? If so, please comment here or on the separate information sheet.

Please write here:

....

....

....

Consents from the participants

I (name)..of (company name)......................................

....

Hereby agree to participate in this study to be undertaken by Ms.Rachata Suansawat and allow the researcher to use the above data for the research.

Signature:...

Thank you for your participation. Results and finding will be sent to all participants as soon as they are available.

Appendix C: Non-response bias

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Industrial Group of the company/plant	Equal variances assumed	9.562	.003	12.064	58	.000	5.500	.456	4.587	6.413
	Equal variances not assumed			12.064	46.997	.000	5.500	.456	4.583	6.417
Number of employees in the company	Equal variances assumed	.431	.514	-1.785	58	.080	-.600	.336	-1.273	.073
	Equal variances not assumed			-1.785	57.884	.080	-.600	.336	-1.273	.073
Certification ISO 9000 of the company	Equal variances assumed	2.220	.142	-1.034	58	.305	-.133	.129	-.391	.125
	Equal variances not assumed			-1.034	57.921	.305	-.133	.129	-.391	.125

Certification ISO 14001 of the company	Equal variances assumed	12.915	.001	-1.768	58	.082	-.200	.113	-.426	.026
	Equal variances not assumed			-1.768	54.550	.083	-.200	.113	-.427	.027
Capital of the company	Equal variances assumed	1.352	.250	-1.617	58	.111	-.533	.330	-1.194	.127
	Equal variances not assumed			-1.617	56.916	.111	-.533	.330	-1.194	.127
Non-current assets of the company	Equal variances assumed	1.456	.232	-1.703	58	.094	-.600	.352	-1.305	.105
	Equal variances not assumed			-1.703	54.819	.094	-.600	.352	-1.306	.106
Total annual sales of the company	Equal variances assumed	4.277	.043	-1.446	58	.154	-.433	.300	-1.033	.167
	Equal variances not assumed			-1.446	53.897	.154	-.433	.300	-1.034	.168
The main characteristic of the primary product of your manufacturing plant	Equal variances assumed	4.770	.033	1.820	58	.074	.300	.165	-.030	.630
	Equal variances not assumed			1.820	54.152	.074	.300	.165	-.030	.630

The current position of the respondent	Equal variances assumed	.663	.419	.975	58	.333	.400	.410	-.421	1.221
	Equal variances not assumed			.975	57.281	.334	.400	.410	-.421	1.221
II1	Equal variances assumed	.037	.849	-1.000	58	.321	-.167	.167	-.500	.167
	Equal variances not assumed			-1.000	56.577	.322	-.167	.167	-.500	.167
II2	Equal variances assumed	.109	.743	.179	58	.859	.033	.186	-.339	.406
	Equal variances not assumed			.179	57.963	.859	.033	.186	-.339	.406
II3	Equal variances assumed	.002	.965	-2.936	58	.005	-.600	.204	-1.009	-.191
	Equal variances not assumed			-2.936	57.748	.005	-.600	.204	-1.009	-.191
II4	Equal variances assumed	1.801	.185	-.837	58	.406	-.133	.159	-.452	.185
	Equal variances not assumed			-.837	52.232	.406	-.133	.159	-.453	.186

II5	Equal variances assumed	.028	.868	.379	58	.706	.067	.176	-.285	.418
	Equal variances not assumed			.379	57.489	.706	.067	.176	-.285	.418
II6	Equal variances assumed	.160	.690	-1.263	58	.211	-.200	.158	-.517	.117
	Equal variances not assumed			-1.263	57.059	.212	-.200	.158	-.517	.117
II7	Equal variances assumed	4.019	.050	1.224	58	.226	.300	.245	-.191	.791
	Equal variances not assumed			1.224	45.294	.227	.300	.245	-.194	.794
II8	Equal variances assumed	10.049	.002	.942	58	.350	.233	.248	-.262	.729
	Equal variances not assumed			.942	52.446	.350	.233	.248	-.264	.730
II9	Equal variances assumed	.042	.838	1.708	58	.093	.300	.176	-.052	.652
	Equal variances not assumed			1.708	57.236	.093	.300	.176	-.052	.652

SI1	Equal variances assumed	1.753	.191	-.742	58	.461	-.133	.180	-.493	.226
	Equal variances not assumed			-.742	52.225	.461	-.133	.180	-.494	.227
SI2	Equal variances assumed	.048	.827	.421	58	.676	.067	.159	-.251	.384
	Equal variances not assumed			.421	57.453	.676	.067	.159	-.251	.384
SI3	Equal variances assumed	1.603	.210	1.425	58	.159	.200	.140	-.081	.481
	Equal variances not assumed			1.425	57.874	.159	.200	.140	-.081	.481
SI4	Equal variances assumed	.838	.364	1.270	58	.209	.233	.184	-.134	.601
	Equal variances not assumed			1.270	57.875	.209	.233	.184	-.134	.601
SI5	Equal variances assumed	.871	.355	.441	58	.661	.100	.227	-.354	.554
	Equal variances not assumed			.441	54.516	.661	.100	.227	-.354	.554

SI6	Equal variances assumed	3.788	.056	.478	58	.634	.100	.209	-.319	.519
	Equal variances not assumed			.478	54.037	.634	.100	.209	-.319	.519
SI7	Equal variances assumed	1.791	.186	.000	58	1.000	.000	.214	-.428	.428
	Equal variances not assumed			.000	55.740	1.000	.000	.214	-.428	.428
SI8	Equal variances assumed	1.143	.289	1.478	58	.145	.267	.180	-.095	.628
	Equal variances not assumed			1.478	57.587	.145	.267	.180	-.095	.628
SI9	Equal variances assumed	.101	.752	.389	58	.699	.067	.171	-.276	.410
	Equal variances not assumed			.389	57.311	.699	.067	.171	-.276	.410
SI10	Equal variances assumed	.051	.822	1.008	58	.317	.167	.165	-.164	.498
	Equal variances not assumed			1.008	54.342	.318	.167	.165	-.165	.498

SI11	Equal variances assumed	.541	.465	.878	58	.384	.133	.152	-.171	.437
	Equal variances not assumed			.878	54.173	.384	.133	.152	-.171	.438
SI12	Equal variances assumed	2.922	.093	-.249	58	.804	-.033	.134	-.302	.235
	Equal variances not assumed			-.249	53.192	.805	-.033	.134	-.302	.236
CI1	Equal variances assumed	.892	.349	-1.592	58	.117	-.200	.126	-.451	.051
	Equal variances not assumed			-1.592	56.795	.117	-.200	.126	-.452	.052
CI2	Equal variances assumed	.050	.824	-1.489	58	.142	-.233	.157	-.547	.080
	Equal variances not assumed			-1.489	52.427	.143	-.233	.157	-.548	.081
CI3	Equal variances assumed	.358	.552	.000	58	1.000	.000	.161	-.323	.323
	Equal variances not assumed			.000	57.549	1.000	.000	.161	-.323	.323

CI4	Equal variances assumed	.508	.479	-.924	58	.360	-.133	.144	-.422	.156
	Equal variances not assumed			-.924	56.248	.360	-.133	.144	-.423	.156
CI5	Equal variances assumed	.154	.696	-.642	58	.523	-.100	.156	-.412	.212
	Equal variances not assumed			-.642	57.967	.523	-.100	.156	-.412	.212
CI6	Equal variances assumed	4.408	.040	-4.535	58	.000	-.633	.140	-.913	-.354
	Equal variances not assumed			-4.535	48.800	.000	-.633	.140	-.914	-.353
CI7	Equal variances assumed	7.271	.009	-2.740	58	.008	-.433	.158	-.750	-.117
	Equal variances not assumed			-2.740	50.843	.008	-.433	.158	-.751	-.116
CI8	Equal variances assumed	2.558	.115	-2.959	58	.004	-.500	.169	-.838	-.162
	Equal variances not assumed			-2.959	53.152	.005	-.500	.169	-.839	-.161

CI9	Equal variances assumed	5.633	.021	.000	58	1.000	.000	.177	-.355	.355
	Equal variances not assumed			.000	51.183	1.000	.000	.177	-.356	.356
CI10	Equal variances assumed	.008	.927	-.368	58	.714	-.067	.181	-.429	.296
	Equal variances not assumed			-.368	57.954	.714	-.067	.181	-.429	.296
CI11	Equal variances assumed	2.691	.106	1.185	58	.241	.200	.169	-.138	.538
	Equal variances not assumed			1.185	57.940	.241	.200	.169	-.138	.538
IGP1	Equal variances assumed	2.882	.095	.592	58	.556	.100	.169	-.238	.438
	Equal variances not assumed			.592	53.843	.556	.100	.169	-.239	.439
IGP2	Equal variances assumed	1.543	.219	1.941	58	.057	.333	.172	-.010	.677
	Equal variances not assumed			1.941	49.458	.058	.333	.172	-.012	.678

IGP3	Equal variances assumed	1.923	.171	-.408	58	.685	-.067	.164	-.394	.261
	Equal variances not assumed			-.408	55.105	.685	-.067	.164	-.394	.261
IGP4	Equal variances assumed	.307	.582	-.991	58	.326	-.133	.134	-.403	.136
	Equal variances not assumed			-.991	54.479	.326	-.133	.134	-.403	.136
IGP5	Equal variances assumed	.539	.466	.222	58	.825	.033	.150	-.267	.334
	Equal variances not assumed			.222	56.406	.825	.033	.150	-.268	.334
IGP6	Equal variances assumed	.506	.480	-2.153	58	.035	-.367	.170	-.708	-.026
	Equal variances not assumed			-2.153	57.436	.036	-.367	.170	-.708	-.026
IGP7	Equal variances assumed	.502	.481	-1.378	58	.174	-.200	.145	-.491	.091
	Equal variances not assumed			-1.378	57.972	.174	-.200	.145	-.491	.091

IGP8	Equal variances assumed	.434	.513	-.680	58	.499	-.100	.147	-.395	.195
	Equal variances not assumed			-.680	56.470	.499	-.100	.147	-.395	.195
IGP9	Equal variances assumed	1.442	.235	-.215	58	.830	-.033	.155	-.343	.276
	Equal variances not assumed			-.215	54.721	.830	-.033	.155	-.343	.277
IGP10	Equal variances assumed	.355	.553	.000	58	1.000	.000	.133	-.266	.266
	Equal variances not assumed			.000	57.038	1.000	.000	.133	-.266	.266
EGP1	Equal variances assumed	.078	.780	-.426	58	.672	-.067	.157	-.380	.247
	Equal variances not assumed			-.426	57.275	.672	-.067	.157	-.380	.247
EGP2	Equal variances assumed	.009	.926	.219	58	.827	.033	.152	-.271	.338
	Equal variances not assumed			.219	57.784	.827	.033	.152	-.271	.338

EGP3	Equal variances assumed	.760	.387	-.357	58	.722	-.067	.187	-.440	.307
	Equal variances not assumed			-.357	57.972	.722	-.067	.187	-.440	.307
EGP4	Equal variances assumed	1.297	.259	1.144	58	.257	.267	.233	-.200	.733
	Equal variances not assumed			1.144	53.725	.258	.267	.233	-.201	.734
EGP5	Equal variances assumed	.355	.554	.627	58	.533	.133	.213	-.292	.559
	Equal variances not assumed			.627	57.994	.533	.133	.213	-.292	.559
EGP6	Equal variances assumed	.639	.427	-.177	58	.860	-.033	.189	-.411	.344
	Equal variances not assumed			-.177	57.473	.860	-.033	.189	-.411	.344
EGP7	Equal variances assumed	2.851	.097	.000	58	1.000	.000	.165	-.330	.330
	Equal variances not assumed			.000	54.479	1.000	.000	.165	-.330	.330

EGP8	Equal variances assumed	1.996	.163	-.851	58	.398	-.133	.157	-.447	.180
	Equal variances not assumed			-.851	57.275	.398	-.133	.157	-.447	.180
ENP1	Equal variances assumed	.105	.747	.979	58	.332	.167	.170	-.174	.508
	Equal variances not assumed			.979	57.436	.332	.167	.170	-.174	.508
ENP2	Equal variances assumed	6.660	.012	.553	58	.582	.100	.181	-.262	.462
	Equal variances not assumed			.553	52.176	.583	.100	.181	-.263	.463
ENP3	Equal variances assumed	2.231	.141	-.795	58	.430	-.133	.168	-.469	.202
	Equal variances not assumed			-.795	55.242	.430	-.133	.168	-.469	.203
ENP4	Equal variances assumed	2.124	.150	-1.679	58	.098	-.267	.159	-.584	.051
	Equal variances not assumed			-1.679	56.133	.099	-.267	.159	-.585	.051

ENP5	Equal variances assumed	.212	.647	.000	58	1.000	.000	.170	-.339	.339
	Equal variances not assumed			.000	57.631	1.000	.000	.170	-.339	.339
ENP6	Equal variances assumed	8.962	.004	-1.747	58	.086	-.267	.153	-.572	.039
	Equal variances not assumed			-1.747	52.337	.086	-.267	.153	-.573	.040
ENP7	Equal variances assumed	.707	.404	-.636	58	.527	-.100	.157	-.415	.215
	Equal variances not assumed			-.636	57.899	.527	-.100	.157	-.415	.215
EP1	Equal variances assumed	3.944	.052	-1.001	58	.321	-.200	.200	-.600	.200
	Equal variances not assumed			-1.001	55.078	.321	-.200	.200	-.600	.200
EP2	Equal variances assumed	1.885	.175	-1.320	58	.192	-.267	.202	-.671	.138
	Equal variances not assumed			-1.320	54.648	.193	-.267	.202	-.672	.138

EP3	Equal variances assumed	4.700	.034	-1.713	58	.092	-.333	.195	-.723	.056
	Equal variances not assumed			-1.713	53.104	.092	-.333	.195	-.724	.057
EP4	Equal variances assumed	3.125	.082	-1.526	58	.132	-.300	.197	-.694	.094
	Equal variances not assumed			-1.526	52.669	.133	-.300	.197	-.694	.094
EP5	Equal variances assumed	.522	.473	-.173	58	.863	-.033	.192	-.418	.352
	Equal variances not assumed			-.173	57.722	.863	-.033	.192	-.418	.352
EP6	Equal variances assumed	2.244	.140	-.328	58	.744	-.067	.203	-.473	.340
	Equal variances not assumed			-.328	56.137	.744	-.067	.203	-.473	.340

Appendix D: Common Method Bias – Harman's single factor Test

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	15.364	24.387	24.387	15.364	24.387	24.387
2	5.442	8.638	33.024			
3	4.029	6.396	39.420			
4	3.587	5.693	45.113			
5	2.734	4.339	49.452			
6	2.270	3.604	53.056			
7	1.937	3.074	56.130			
8	1.914	3.039	59.169			
9	1.744	2.769	61.937			
10	1.559	2.475	64.412			
11	1.459	2.315	66.728			
12	1.361	2.160	68.887			
13	1.171	1.859	70.747			
14	1.123	1.783	72.530			
15	1.089	1.729	74.258			
16	.942	1.496	75.754			
17	.911	1.446	77.200			
18	.852	1.353	78.552			
19	.816	1.296	79.848			
20	.796	1.263	81.111			
21	.729	1.157	82.269			
22	.704	1.117	83.386			
23	.670	1.063	84.449			
24	.616	.978	85.427			
25	.601	.954	86.381			
26	.568	.902	87.284			

27	.509	.808	88.092			
28	.500	.794	88.887			
29	.457	.726	89.612			
30	.437	.694	90.306			
31	.421	.668	90.974			
32	.390	.619	91.593			
33	.357	.566	92.159			
34	.345	.548	92.708			
35	.336	.534	93.241			
36	.323	.513	93.754			
37	.313	.497	94.251			
38	.280	.444	94.695			
39	.268	.426	95.121			
40	.251	.398	95.519			
41	.244	.388	95.907			
42	.231	.367	96.274			
43	.225	.357	96.631			
44	.220	.349	96.980			
45	.196	.311	97.291			
46	.188	.298	97.589			
47	.176	.280	97.869			
48	.164	.260	98.128			
49	.156	.248	98.377			
50	.134	.212	98.589			
51	.118	.188	98.777			
52	.113	.179	98.956			
53	.107	.170	99.126			
54	.098	.155	99.281			
55	.090	.143	99.424			
56	.085	.134	99.558			
57	.081	.128	99.686			

58	.065	.103	99.789			
59	.056	.088	99.877			
60	.040	.064	99.942			
61	.022	.035	99.977			
62	.009	.014	99.991			
63	.006	.009	100.000			

Extraction Method: Principal Component Analysis.

APPENDIX E: Correlation for Supply Chain Integration

1. Supply Chain Integration

1.1. Internal Integration

Correlations

	II1	II2	II3	II4	II5	II6	II7	II8	II9
II1: Data integration among internal functions	1	.764**	.633**	.299**	.309**	.403**	.447**	.474**	.527**
II2: Enterprise application integration among internal functions	.764**	1	.578**	.386**	.263**	.439**	.363**	.483**	.493**
II3: Integrative inventory management	.633**	.578**	1	.389**	.198**	.378**	.284**	.382**	.452**
II4: Real-time sharing of the level of inventory	.299**	.386**	.389**	1	.362**	.351**	.211**	.280**	.229**
II5: Real-time sharing of the logistics-related operating data	.309**	.263**	.198**	.362**	1	.390**	.344**	.307**	.307**
II6: The utilization of periodic interdepartmental meetings among internal functions	.403**	.439**	.378**	.351**	.390**	1	.540**	.376**	.435**
II7: The use of cross functional teams in process improvement	.447**	.363**	.284**	.211**	.344**	.540**	1	.569**	.499**

II8: The use of cross functional teams in new product improvement	.474**	.483**	.382**	.280**	.307**	.376**	.569**	1	.645**
II9: Real-time integration and connection among all internal functions from raw material management through production, shipping and sales	.527**	.493**	.452**	.229**	.307**	.435**	.499**	.645**	1

**. Correlation is significant at the 0.01 level (2-tailed).

1.2. Supplier Integration

Correlations

	SI1	SI2	SI3	SI4	SI5	SI6	SI7	SI8	SI9	SI10	SI11	SI12
SI1: Information exchange with major suppliers through information networks	1	.613**	.625**	.464**	.540**	.448**	.389**	.170**	.297**	.193**	.299**	.214**
SI2: The establishment of quick ordering systems with major suppliers	.613**	1	.696**	.594**	.379**	.287**	.255**	.167**	.306**	.247**	.296**	.275**
SI3: Strategic partnership with major suppliers	.625**	.696**	1	.791**	.611**	.508**	.459**	.303**	.421**	.220**	.356**	.320**
SI4: Long - term procurement relationship of major suppliers	.464**	.594**	.791**	1	.603**	.492**	.426**	.329**	.498**	.247**	.389**	.353**
SI5: Participation of major suppliers in the process of procurement and production	.540**	.379**	.611**	.603**	1	.621**	.456**	.297**	.361**	.235**	.345**	.234**
SI6: The participation level of major suppliers in the design stage	.448**	.287**	.508**	.492**	.621**	1	.681**	.402**	.326**	.271**	.429**	.316**
SI7: Major suppliers share their production schedule information with us	.389**	.255**	.459**	.426**	.456**	.681**	1	.533**	.326**	.242**	.368**	.304**

SI8: Major suppliers share their production capacity information with us	.170**	.167**	.303**	.329**	.297**	.402**	.533**	1	.446**	.428**	.387**	.299**
SI9: Sharing production plans information with major suppliers	.297**	.306**	.421**	.498**	.361**	.326**	.326**	.446**	1	.586**	.509**	.341**
SI10: Sharing demand forecasts with major suppliers	.193**	.247**	.220**	.247**	.235**	.271**	.242**	.428**	.586**	1	.637**	.524**
SI11: Sharing our inventory levels with major suppliers	.299**	.296**	.356**	.389**	.345**	.429**	.368**	.387**	.509**	.637**	1	.623**
SI12: Helping major suppliers to improve their process to better meet our needs	.214**	.275**	.320**	.353**	.234**	.316**	.304**	.299**	.341**	.524**	.623**	1

**. Correlation is significant at the 0.01 level (2-tailed).

1.3. Customer Integration

Correlations

	CI1	CI2	CI3	CI4	CI5	CI6	CI7	CI8	CI9	CI10	CI11
CI1: Linkage with major customer through information networks	1	.665**	.307**	.213**	.325**	.189**	.277**	.238**	.119*	.161**	.247**
CI2: Computerization for major customer's ordering	.665**	1	.417**	.112	.414**	.297**	.305**	.154**	.236**	.285**	.311**
CI3: Sharing of market information from major customers	.307**	.417**	1	.374**	.971**	.270**	.169**	.324**	.485**	.402**	.371**
CI4: Communication with major customers	.213**	.112	.374**	1	.381**	.311**	.176**	.145*	.232**	.266**	.233**
CI5: The establishment of quick ordering systems with major customers	.325**	.414**	.971**	.381**	1	.294**	.169**	.315**	.491**	.408**	.375**
CI6: Follow-up with major customers for feedback	.189**	.297**	.270**	.311**	.294**	1	.414**	.270**	.260**	.354**	.374**
CI7: The frequency of period contacts with major customers	.277**	.305**	.169**	.176**	.169**	.414**	1	.251**	.061	.069	.209**
CI8: Major customers share Point of Sales (POS) information with us	.238**	.154**	.324**	.145*	.315**	.270**	.251**	1	.398**	.377**	.319**

CI9: Major customer share demand forecast with us	.119*	.236**	.485**	.232**	.491**	.260**	.061	.398**	1	.628**	.534**
CI10: Sharing available inventory with major customers	.161**	.285**	.402**	.266**	.408**	.354**	.069	.377**	.628**	1	.661**
CI11: Sharing production plan with major customers	.247**	.311**	.371**	.233**	.375**	.374**	.209**	.319**	.534**	.661**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix F: Correlation for Green Supply Chain Management Practices

2.1. IGSCM practices

Correlations

	IGP1	IGP2	IGP3	IGP4	IGP5	IGP6	IGP7	IGP8	IGP9	IGP10
IGP1: Participation of senior managers in green supply chain management	1	.725**	.611**	.318**	.353**	.281**	.218**	.211**	.213**	.270**
IGP2: Participation of mid-level managers in green supply chain management	.725**	1	.679**	.357**	.400**	.349**	.172**	.207**	.209**	.298**
IGP3: Cross-functional cooperation for environmental improvements	.611**	.679**	1	.526**	.451**	.395**	.249**	.288**	.281**	.381**
IGP4: Environmental compliance and auditing programs	.318**	.357**	.526**	1	.580**	.370**	.202**	.363**	.348**	.500**
IGP5: Design of products for reduced consumption of materials/energy	.353**	.400**	.451**	.580**	1	.673**	.226**	.503**	.501**	.568**
IGP6: Design of products for reuse, recycle, recovery of materials, component parts	.281**	.349**	.395**	.370**	.673**	1	.243**	.593**	.591**	.550**

IGP7: Design of products to aviod or reduce use of hazadous products and/or manufacturing process	.218**	.172**	.249**	.202**	.226**	.243**	1	.116*	.113	.078
IGP8: Recycle of excess inventories/materials	.211**	.207**	.288**	.363**	.503**	.593**	.116*	1	.985**	.691**
IGP9: Recycle used materials	.213**	.209**	.281**	.348**	.501**	.591**	.113	.985**	1	.684**
IGP10: Sale of excess capital equipment	.270**	.298**	.381**	.500**	.568**	.550**	.078	.691**	.684**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

2.2. EGSCM practices

Correlations

	EGP1	EGP2	EGP3	EGP4	EGP5	EGP6	EGP7	EGP8
EGP1: Providing design specification to suppliers that include environmental requirements for purchased item	1	.586**	.451**	.545**	.495**	.377**	.374**	.471**
EGP2: Cooperation with suppliers for environmental objectives	.586**	1	.586**	.534**	.475**	.372**	.345**	.468**
EGP3: Environmental audit for suppliers' internal management	.451**	.586**	1	.597**	.490**	.373**	.392**	.389**
EGP4: Encourage or reward suppliers' ISO14001 certification	.545**	.534**	.597**	1	.754**	.507**	.485**	.533**
EGP5: Second-tier supplier environmentally friendly practice evaluation	.495**	.475**	.490**	.754**	1	.584**	.540**	.606**
EGP6: Cooperation with customers for eco-design	.377**	.372**	.373**	.507**	.584**	1	.600**	.553**
EGP7: Cooperation with customers for cleaner production	.374**	.345**	.392**	.485**	.540**	.600**	1	.654**
EGP8: Cooperation with customers for green packaging	.471**	.468**	.389**	.533**	.606**	.553**	.654**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix G: Correlation for Sustainable firm performance

3.1. Environmental performance

Correlations

	ENP1	ENP2	ENP3	ENP4	ENP5	ENP6	ENP7
ENP1: Reduction of air emission	1	.562**	.320**	.328**	.364**	.276**	.328**
ENP2: Reduction of waste water	.562**	1	.369**	.189**	.367**	.226**	.288**
ENP3: Reduction of solid wastes	.320**	.369**	1	.320**	.225**	.337**	.437**
ENP4: Reduction of consumption of hazardous/harmful/toxic materials	.328**	.189**	.320**	1	.453**	.383**	.369**
ENP5: Reduction of scrap rate	.364**	.367**	.225**	.453**	1	.493**	.451**
ENP6: Reducing the frequency of environmental accidents	.276**	.226**	.337**	.383**	.493**	1	.703**
ENP7: Improvement of environmental reputation	.328**	.288**	.437**	.369**	.451**	.703**	1

**. Correlation is significant at the 0.01 level (2-tailed).

3.2. Economic performance

Correlations

	EP1	EP2	EP3	EP4	EP5	EP6
EP1: Average return on investment	1	.849**	.789**	.836**	.735**	.712**
EP2: Average profit	.849**	1	.874**	.874**	.783**	.765**
EP3: Profit growth	.789**	.874**	1	.918**	.790**	.729**
EP4: Average return on sales	.836**	.874**	.918**	1	.814**	.764**
EP5: Average market share growth	.735**	.783**	.790**	.814**	1	.855**
EP6: Average sales volume growth	.712**	.765**	.729**	.764**	.855**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix H: Priori Factor Analysis

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.834
	Approx. Chi-Square	7282.482
Bartlett's Test of Sphericity	df	666
	Sig.	.000

Communalities

	Initial	Extraction
II1: Data integration among internal functions	1.000	.736
II2: Enterprise application integration among internal functions	1.000	.830
II6: The utilization of periodic interdepartmental meetings among internal functions	1.000	.543
II7: The use of cross functional teams in process improvement	1.000	.681
II8: The use of cross functional teams in new product improvement	1.000	.639
II9: Real-time integration and connection among all internal functions from raw material management through production, shipping and sales	1.000	.721
SI9: Sharing production plans information with major suppliers	1.000	.721
SI10: Sharing demand forecasts with major suppliers	1.000	.780
SI11: Sharing our inventory levels with major suppliers	1.000	.765
SI12: Helping major suppliers to improve their process to better meet our needs	1.000	.732
CI3: Sharing of market information from major customers	1.000	.489
CI8: Major customers share Point of Sales (POS) information with us	1.000	.493
CI9: Major customer share demand forecast with us	1.000	.715
CI10: Sharing available inventory with major customers	1.000	.772
CI11: Sharing production plan with major customers	1.000	.698
IGP1: Participation of senior managers in green supply chain management	1.000	.743
IGP2: Participation of mid-level managers in green supply chain management	1.000	.799
IGP3: Cross-functional cooperation for environmental improvements	1.000	.728
IGP4: Environmental compliance and auditing programs	1.000	.791
IGP5: Design of products for reduced consumption of materials/energy	1.000	.558

EGP1: Providing design specification to suppliers that include environmental requirements for purchased item	1.000	.642
EGP2: Cooperation with suppliers for environmental objectives	1.000	.745
EGP3: Environmental audit for suppliers' internal management	1.000	.628
EGP4: Encourage or reward suppliers' ISO14001 certification	1.000	.726
EGP5: Second-tier supplier environmentally friendly practice evaluation	1.000	.750
EGP6: Cooperation with customers for eco-design	1.000	.677
EGP7: Cooperation with customers for cleaner production	1.000	.720
EGP8: Cooperation with customers for green packaging	1.000	.721
ENP4: Reduction of consumption of hazardous/harmful/toxic materials	1.000	.495
ENP5: Reduction of scrap rate	1.000	.573
ENP6: Reducing the frequency of environmental accidents	1.000	.798
ENP7: Improvement of environmental reputation	1.000	.689
EP1: Average return on investment	1.000	.813
EP2: Average profit	1.000	.891
EP3: Profit growth	1.000	.864
EP5: Average market share growth	1.000	.841
EP6: Average sales volume growth	1.000	.847

Extraction Method: Principal Component Analysis.

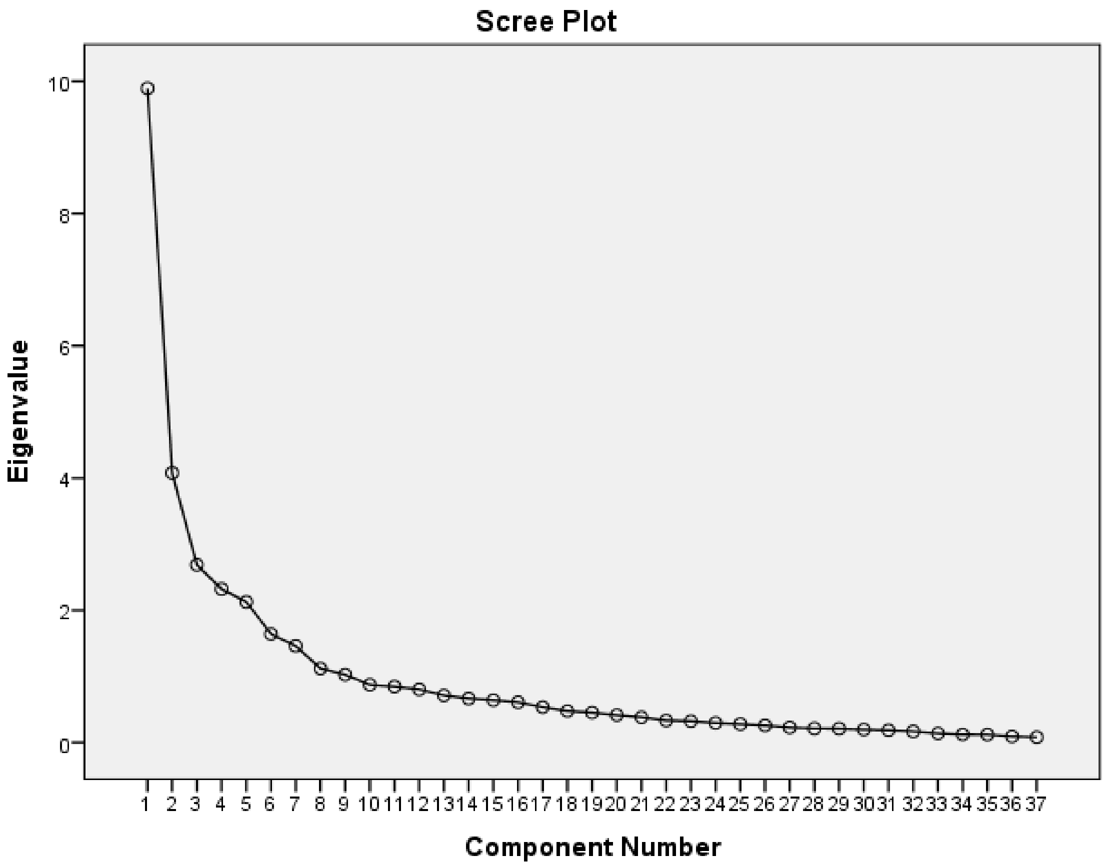
Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.893	26.738	26.738	9.893	26.738	26.738	4.420	11.947	11.947
2	4.077	11.020	37.758	4.077	11.020	37.758	3.815	10.311	22.258
3	2.687	7.262	45.020	2.687	7.262	45.020	3.571	9.652	31.910
4	2.321	6.274	51.294	2.321	6.274	51.294	3.076	8.313	40.223
5	2.126	5.746	57.040	2.126	5.746	57.040	2.880	7.782	48.006
6	1.642	4.437	61.477	1.642	4.437	61.477	2.749	7.430	55.435
7	1.460	3.947	65.424	1.460	3.947	65.424	2.666	7.205	62.640
8	1.120	3.027	68.451	1.120	3.027	68.451	1.810	4.892	67.532
9	1.025	2.771	71.222	1.025	2.771	71.222	1.365	3.690	71.222
10	.873	2.360	73.582						
11	.847	2.288	75.871						
12	.803	2.171	78.041						
13	.713	1.928	79.970						

14	.665	1.797	81.767						
15	.642	1.735	83.502						
16	.608	1.644	85.146						
17	.536	1.448	86.594						
18	.476	1.287	87.881						
19	.452	1.223	89.104						
20	.415	1.122	90.226						
21	.381	1.030	91.256						
22	.333	.899	92.155						
23	.323	.872	93.027						
24	.296	.801	93.828						
25	.278	.751	94.578						
26	.258	.698	95.276						
27	.227	.615	95.891						
28	.212	.573	96.464						
29	.210	.566	97.030						
30	.196	.530	97.560						
31	.186	.502	98.062						
32	.167	.452	98.515						

33	.138	.374	98.888						
34	.122	.330	99.218						
35	.120	.324	99.542						
36	.091	.247	99.789						
37	.078	.211	100.000						

Extraction Method: Principal Component Analysis.



Scree Plot
10
8
6
4
2
0
Eigenvalue
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37
Component Number

Rotated Component Matrix[a]

	Component								
	1	2	3	4	5	6	7	8	9
EP2: Average profit	.916								
EP3: Profit growth	.909								
EP5: Average market share growth	.889								
EP1: Average return on investment	.886								
EP6: Average sales volume growth	.854								
EGP7: Cooperation with customers for cleaner production		.770							
EGP8: Cooperation with customers for green packaging		.769							
EGP5: Second-tier supplier environmentally friendly practice evaluation		.764							
EGP6: Cooperation with customers for eco-design		.750							
EGP4: Encourage or reward suppliers' ISO14001 certification		.658						.381	

II2: Enterprise application integration among internal functions			.813					.315	
II1: Data integration among internal functions			.802						
II9: Real-time integration and connection among all internal functions from raw material management through production, shipping and sales			.714						
II8: The use of cross functional teams in new product improvement			.688						
II7: The use of cross functional teams in process improvement			.590						
II6: The utilization of periodic interdepartmental meetings among internal functions			.539			.305			
CI10: Sharing available inventory with major customers				.848					
CI9: Major customer share demand forecast with us				.787					
CI11: Sharing production plan with major customers				.715					

CI3: Sharing of market information from major customers				.619					
CI8: Major customers share Point of Sales (POS) information with us				.561					
IGP2: Participation of mid-level managers in green supply chain management					.821				
IGP1: Participation of senior managers in green supply chain management					.775				
IGP3: Cross-functional cooperation for environmental improvements					.724				
IGP5: Design of products for reduced consumption of materials/energy					.515				.361
ENP6: Reducing the frequency of environmental accidents						.849			
ENP7: Improvement of environmental reputation						.783			
ENP5: Reduction of scrap rate						.668			
ENP4: Reduction of consumption of hazardous/harmful/toxic materials						.659			
SI10: Sharing demand forecasts with major suppliers							.855		

SI11: Sharing our inventory levels with major suppliers							.803		
SI12: Helping major suppliers to improve their process to better meet our needs							.668		.435
SI9: Sharing production plans information with major suppliers				.360			.634		
EGP2: Cooperation with suppliers for environmental objectives		.396						.713	
EGP1: Providing design specification to suppliers that include environmental requirements for purchased item		.396						.538	
EGP3: Environmental audit for suppliers' internal management		.405						.493	
IGP4: Environmental compliance and auditing programs					.387				.710

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

Appendix I: Final Factor Analysis (after deleting cross-loading items)

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.806
Bartlett's Test of Sphericity	Approx. Chi-Square	5671.285
	df	435
	Sig.	.000

Communalities

	Initial	Extraction
II1: Data integration among internal functions	1.000	.727
II2: Enterprise application integration among internal functions	1.000	.760
II6: The utilization of periodic interdepartmental meetings among internal functions	1.000	.529
II7: The use of cross functional teams in process improvement	1.000	.550
II8: The use of cross functional teams in new product improvement	1.000	.586
SI10: Sharing demand forecasts with major suppliers	1.000	.723
SI11: Sharing our inventory levels with major suppliers	1.000	.763
SI12: Helping major suppliers to improve their process to better meet our needs	1.000	.700
CI3: Sharing of market information from major customers	1.000	.487
CI8: Major customers share Point of Sales (POS) information with us	1.000	.406
CI9: Major customer share demand forecast with us	1.000	.709
CI10: Sharing available inventory with major customers	1.000	.767
CI11: Sharing production plan with major customers	1.000	.652
IGP1: Participation of senior managers in green supply chain management	1.000	.791
IGP2: Participation of mid-level managers in green supply chain management	1.000	.839
IGP3: Cross-functional cooperation for environmental improvements	1.000	.725
EGP4: Encourage or reward suppliers' ISO14001 certification	1.000	.716
EGP5: Second-tier supplier environmentally friendly practice evaluation	1.000	.765
EGP6: Cooperation with customers for eco-design	1.000	.647
EGP7: Cooperation with customers for cleaner production	1.000	.667

EGP8: Cooperation with customers for green packaging	1.000	.720
ENP4: Reduction of consumption of hazardous/harmful/toxic materials	1.000	.449
ENP5: Reduction of scrap rate	1.000	.564
ENP6: Reducing the frequency of environmental accidents	1.000	.749
ENP7: Improvement of environmental reputation	1.000	.665
EP1: Average return on investment	1.000	.821
EP2: Average profit	1.000	.882
EP3: Profit growth	1.000	.854
EP5: Average market share growth	1.000	.842
EP6: Average sales volume growth	1.000	.811

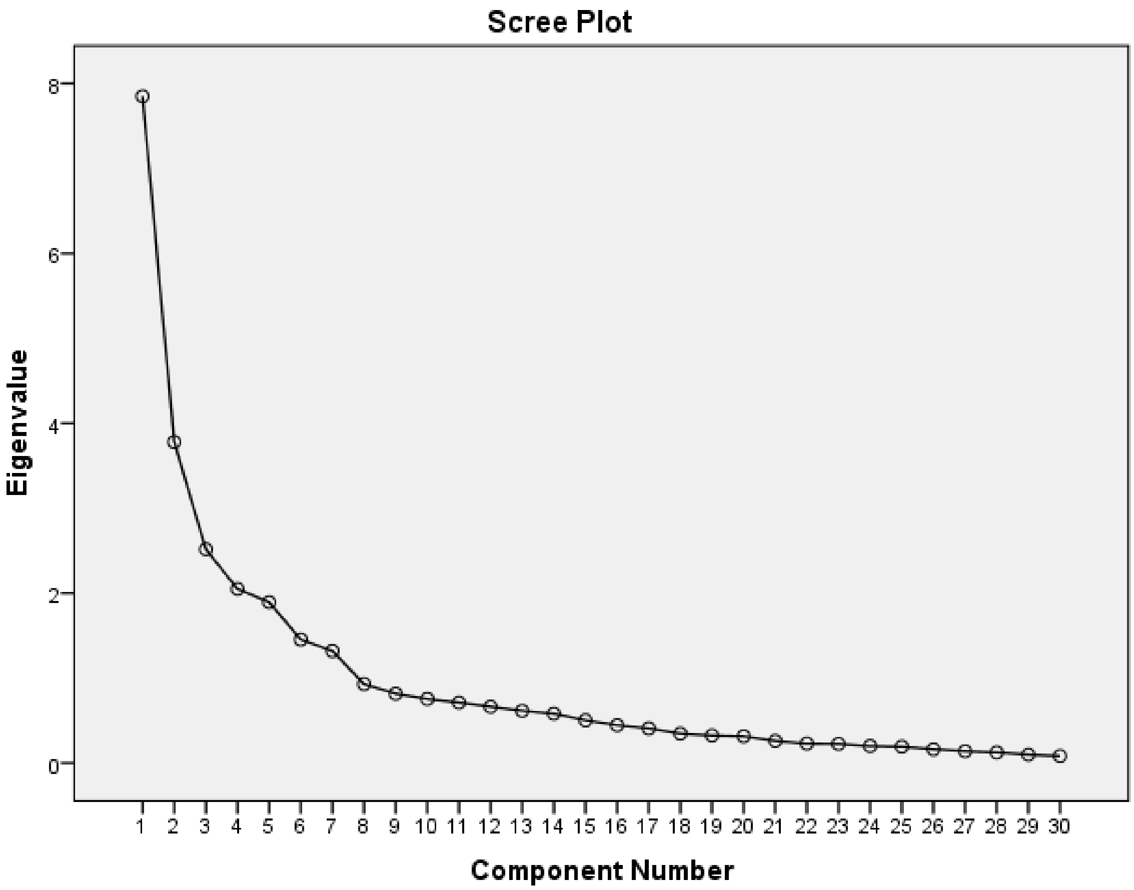
Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.850	26.167	26.167	7.850	26.167	26.167	4.274	14.247	14.247
2	3.780	12.600	38.767	3.780	12.600	38.767	3.345	11.150	25.397
3	2.517	8.390	47.158	2.517	8.390	47.158	3.025	10.084	35.481
4	2.049	6.831	53.989	2.049	6.831	53.989	2.902	9.673	45.154
5	1.894	6.312	60.301	1.894	6.312	60.301	2.700	8.999	54.153
6	1.454	4.848	65.149	1.454	4.848	65.149	2.355	7.851	62.004
7	1.321	4.402	69.551	1.321	4.402	69.551	2.264	7.547	69.551
8	.930	3.098	72.649						
9	.817	2.723	75.372						
10	.755	2.516	77.889						
11	.712	2.372	80.261						
12	.663	2.210	82.471						
13	.615	2.049	84.520						
14	.581	1.938	86.457						
15	.503	1.677	88.134						
16	.445	1.484	89.618						
17	.408	1.360	90.978						
18	.347	1.156	92.134						
19	.324	1.079	93.213						
20	.315	1.050	94.263						
21	.262	.872	95.135						
22	.229	.765	95.900						
23	.225	.751	96.651						
24	.201	.668	97.319						
25	.193	.643	97.963						

26	.163	.543	98.506						
27	.141	.469	98.975						
28	.125	.418	99.393						
29	.099	.332	99.725						
30	.083	.275	100.000						

Extraction Method: Principal Component Analysis.



Rotated Component Matrix[a]

	Component						
	1	2	3	4	5	6	7
EP2: Average profit	.914						
EP3: Profit growth	.911						
EP5: Average market share growth	.891						
EP1: Average return on investment	.891						
EP6: Average sales volume growth	.851						
EGP5: Second-tier supplier environmentally friendly practice evaluation		.826					
EGP8: Cooperation with customers for green packaging		.786					
EGP7: Cooperation with customers for cleaner production		.746					
EGP6: Cooperation with customers for eco-design		.745					
EGP4: Encourage or reward suppliers' ISO14001 certification		.741					
II2: Enterprise application integration among internal functions			.837				

II1: Data integration among internal functions			.813				
II8: The use of cross functional teams in new product improvement			.675				
II7: The use of cross functional teams in process improvement			.622				
II6: The utilization of periodic interdepartmental meetings among internal functions			.576				
CI10: Sharing available inventory with major customers				.862			
CI9: Major customer share demand forecast with us				.806			
CI11: Sharing production plan with major customers				.699			
CI3: Sharing of market information from major customers				.621			
CI8: Major customers share Point of Sales (POS) information with us				.542			
ENP6: Reducing the frequency of environmental accidents					.853		
ENP7: Improvement of environmental reputation					.755		
ENP5: Reduction of scrap rate					.708		
ENP4: Reduction of consumption of hazardous/harmful/toxic materials					.639		

IGP2: Participation of mid-level managers in green supply chain management						.848	
IGP1: Participation of senior managers in green supply chain management						.812	
IGP3: Cross-functional cooperation for environmental improvements						.743	
SI10: Sharing demand forecasts with major suppliers							.826
SI11: Sharing our inventory levels with major suppliers							.812
SI12: Helping major suppliers to improve their process to better meet our needs							.796

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

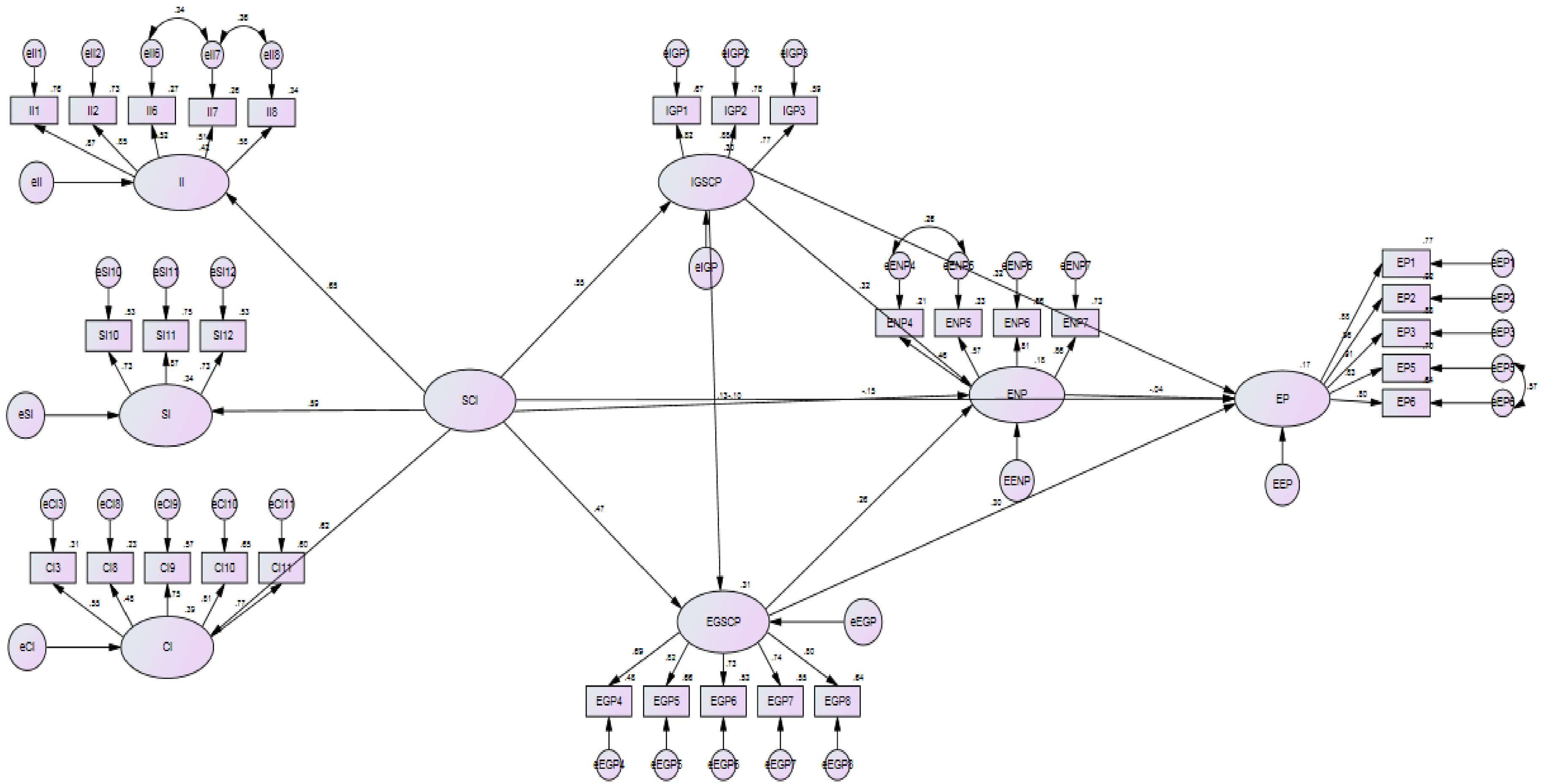
Appendix J: Codebook

Variable (Questions about….)	SPSS Variable name	Coding instructions
Identification Number	ID	Number assigned to each survey
Industial Group	Industrial_Group	Industrial Group of each business
		1 = Automotive industry
		2 = Automotive components industry
		3 = Electronic components industry
		4 = Food and beverage industry
		5 = Energy and utilities industry
		6 = Industrial material and machinery industry
		7 = Petrochemical and chemicals industry
		8 = Transportation and logistics industry
		9 = Textile industry
		10 = Clothing industry including decorating and colouring wool
		11 = Other
	other_ group	other industrial group that not identify above
Numbers of employees	No_of_employee	Number of employee (full – time equivalent)
		1 = Under 50 employees
		2 = Over 50 to 100 employees
		3 = Over 100 to 200 employees
		4 = Over 200 to 300 employees
		5 = Over 300 employees
ISO 9000	ISO_9000	Is the company ISO 9000 certified?
		1 = Yes
		2 = No
	Year_ISO9000	
ISO 14001	ISO_14001	Is the company ISO 14001 certified?
		1 = Yes
		2 = No
	Year_ISO14001	
Capital	Capital	Capital of each company
		1 = Less than 5,000,000 Baht
		2 = Over 5,000,000 Baht to 10,000,000 Baht
		3 = Over 10,000,000 Baht to 20,000,000 Baht
		4 = Over 20,000,000 Baht to 50,000,000 Baht
		5 = Over 50,000,000 Baht
Non-current Assets	Asset	Non-current assets of each company
		1 = Less than 50,000,000 Baht
		2 = Over 50,000,000 Baht to 100,000,000 Baht
		3 = Over 100,000,001 Baht to 200,000,000 Baht
		4 = Over 200,000,001 Baht to 500,000,000 Baht
		5 = Over 500,000,000 Baht
Total Annual Sales	Sale	Total annual sales of each company
		1 = Less than 50,000,000 Baht
		2 = Over 50,000,000 Baht to 100,000,000 Baht
		3 = Over 100,000,001 Baht to 200,000,000 Baht
		4 = Over 200,000,001 Baht to 500,000,000 Baht
		5 = Over 500,000,000 Baht
The main characteristic of the primary product	Main_product	The main characteristics of the primary product of the manufacturing plant
		1 = Assembled – to – order
		2 = Made – to – stock
		3 = Other

	other_product	
Current position	Position	The current position of the respondent
		1 = CEO
		2 = Vice President
		3 = Logistics Manager
		4 = Supply Chain Management Manager
		5 = Production Manager
		6 = Purchasing Manager
		7 = Operation Manager
		8 = Plant Manager
		9 = Other
	Other_position	
Supply Chain Integration		
Internal Integration	II1-II9	1 = Not at all
		2 = Slight extent
		3 = Moderate extent
		4 = Great extent
		5 = Very great extent
Supplier Integration	SI1-SI12	1 = Not at all
		2 = Slight extent
		3 = Moderate extent
		4 = Great extent
		5 = Very great extent
Customer Integration	CI1-CI11	1 = Not at all
		2 = Slight extent
		3 = Moderate extent
		4 = Great extent
		5 = Very great extent
GSCM practices		
IGSCM practices	IGP1-IGP10	1 = Not at all
		2 = Slight extent
		3 = Moderate extent
		4 = Great extent
		5 = Very great extent
EGSCM practices	EGP1-EGP8	1 = Not at all
		2 = Slight extent
		3 = Moderate extent
		4 = Great extent
		5 = Very great extent
Sustainable Firm Performance		
Environmental Performance	ENP1-ENP7	1 = Not at all
		2 = Slight extent
		3 = Moderate extent
		4 = Great extent
		5 = Very great extent
Economic Performance	EP1-EP6	1 = much worse than the previous firm performance
		2 = worse than the previous firm performance
		3 = about the same as the previous firm performance
		4 = better than the previous firm performance

		5 = much better than the previous firm performance
Additional Comments	Comment	Additional comments
Name of participant	Name_of_participant	Name of the manager who participate this survey
Name of Company	Name_of_company	Name of the company

Appendix K: A Priori Structural Model



Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
IGSCP	<---	SCI	.788	.143	5.502	***	par_18
EGSCP	<---	SCI	.795	.196	4.068	***	par_19
EGSCP	<---	IGSCP	.155	.104	1.499	.134	par_32
ENP	<---	SCI	-.084	.098	-.864	.388	par_20
ENP	<---	IGSCP	.183	.055	3.354	***	par_21
ENP	<---	EGSCP	.124	.044	2.829	.005	par_22
II	<---	SCI	1.000				
SI	<---	SCI	.859	.151	5.671	***	par_16
CI	<---	SCI	.633	.117	5.395	***	par_17
EP	<---	ENP	-.090	.178	-.504	.614	par_23
EP	<---	IGSCP	.469	.128	3.662	***	par_24
EP	<---	EGSCP	.367	.104	3.530	***	par_25
EP	<---	SCI	-.316	.239	-1.324	.186	par_26
II1	<---	II	1.000				
II2	<---	II	1.070	.070	15.388	***	par_1
II6	<---	II	.613	.069	8.904	***	par_2
II7	<---	II	.760	.087	8.745	***	par_3
SI10	<---	SI	1.000				
SI11	<---	SI	1.242	.104	11.943	***	par_4
SI12	<---	SI	.897	.080	11.248	***	par_5
IGP1	<---	IGSCP	1.000				
IGP2	<---	IGSCP	1.160	.074	15.717	***	par_6
IGP3	<---	IGSCP	.915	.065	14.064	***	par_7
EP1	<---	EP	1.000				
EP2	<---	EP	1.145	.044	26.254	***	par_8
EP3	<---	EP	1.126	.048	23.529	***	par_9
EP5	<---	EP	.895	.046	19.491	***	par_10
ENP4	<---	ENP	1.000				
ENP5	<---	ENP	1.288	.172	7.482	***	par_11
ENP6	<---	ENP	1.715	.233	7.365	***	par_12

			Estimate	S.E.	C.R.	P	Label
CI3	<---	CI	1.000				
CI8	<---	CI	.908	.138	6.604	***	par_13
CI9	<---	CI	1.486	.168	8.870	***	par_14
CI10	<---	CI	1.663	.181	9.169	***	par_15
II8	<---	II	.936	.091	10.259	***	par_27
EP6	<---	EP	.856	.047	18.123	***	par_28
ENP7	<---	ENP	1.944	.264	7.351	***	par_29
CI11	<---	CI	1.519	.169	8.997	***	par_35
EGP8	<---	EGSCP	1.000				
EGP7	<---	EGSCP	.825	.057	14.398	***	par_36
EGP6	<---	EGSCP	.898	.064	13.976	***	par_37
EGP5	<---	EGSCP	1.126	.069	16.402	***	par_38
EGP4	<---	EGSCP	1.000				

Standardized Regression Weights: (Group number 1 - Default model)

			Estimate
IGSCP	<---	SCI	.551
EGSCP	<---	SCI	.470
EGSCP	<---	IGSCP	.131
ENP	<---	SCI	-.104
ENP	<---	IGSCP	.322
ENP	<---	EGSCP	.258
II	<---	SCI	.651
SI	<---	SCI	.585
CI	<---	SCI	.624
EP	<---	ENP	-.035
EP	<---	IGSCP	.321
EP	<---	EGSCP	.297
EP	<---	SCI	-.151
II1	<---	II	.870
II2	<---	II	.854

			Estimate
II6	<---	II	.517
II7	<---	II	.510
SI10	<---	SI	.728
SI11	<---	SI	.866
SI12	<---	SI	.726
IGP1	<---	IGSCP	.816
IGP2	<---	IGSCP	.881
IGP3	<---	IGSCP	.769
EP1	<---	EP	.879
EP2	<---	EP	.958
EP3	<---	EP	.912
EP5	<---	EP	.834
ENP4	<---	ENP	.457
ENP5	<---	ENP	.571
ENP6	<---	ENP	.812
CI3	<---	CI	.553
CI8	<---	CI	.478
CI9	<---	CI	.752
CI10	<---	CI	.809
II8	<---	II	.584
EP6	<---	EP	.802
ENP7	<---	ENP	.856
CI11	<---	CI	.774
EGP8	<---	EGSCP	.803
EGP7	<---	EGSCP	.743
EGP6	<---	EGSCP	.727
EGP5	<---	EGSCP	.815
EGP4	<---	EGSCP	.692

Covariances: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
eEP5	<-->	eEP6	.110	.015	7.464	***	par_30
eII6	<-->	eII7	.124	.022	5.677	***	par_31
eII7	<-->	eII8	.167	.029	5.766	***	par_33
eENP4	<-->	eENP5	.074	.019	3.980	***	par_34

Correlations: (Group number 1 - Default model)

			Estimate
eEP5	<-->	eEP6	.565
eII6	<-->	eII7	.344
eII7	<-->	eII8	.359
eENP4	<-->	eENP5	.263

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	76	1225.314	389	.000	3.150
Saturated model	465	.000	0		
Independence model	30	5887.493	435	.000	13.534

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.044	.788	.747	.659
Saturated model	.000	1.000		
Independence model	.145	.303	.255	.284

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.792	.767	.848	.828	.847

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.894	.708	.757
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	836.314	734.456	945.768
Saturated model	.000	.000	.000
Independence model	5452.493	5208.012	5703.415

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	4.154	2.835	2.490	3.206
Saturated model	.000	.000	.000	.000
Independence model	19.958	18.483	17.654	19.334

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.085	.080	.091	.000
Independence model	.206	.201	.211	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	1377.314	1395.163	1657.782	1733.782
Saturated model	930.000	1039.205	2646.017	3111.017

Model	AIC	BCC	BIC	CAIC
Independence model	5947.493	5954.538	6058.203	6088.203

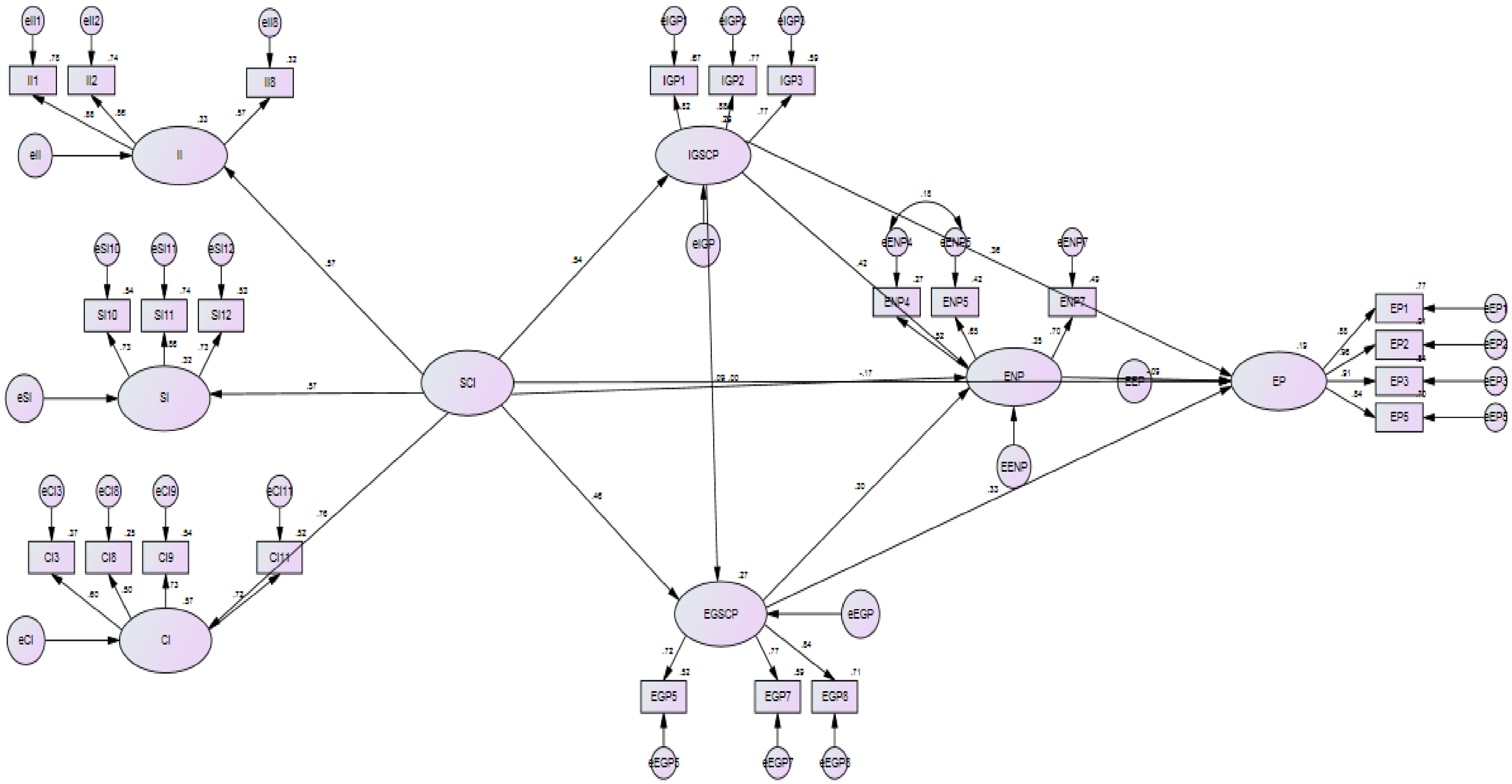
ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	4.669	4.324	5.040	4.729
Saturated model	3.153	3.153	3.153	3.523
Independence model	20.161	19.332	21.012	20.185

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	105	110
Independence model	25	26

Appendix L: Final Refined Structural Model



Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
IGSCP	<---	SCI	.874	.166	5.251	***	par_11
EGSCP	<---	SCI	.877	.224	3.910	***	par_12
EGSCP	<---	IGSCP	.107	.105	1.011	.312	par_22
ENP	<---	SCI	-.001	.130	-.009	.993	par_13
ENP	<---	IGSCP	.270	.069	3.897	***	par_14
ENP	<---	EGSCP	.164	.055	3.002	.003	par_15
II	<---	SCI	1.000				
SI	<---	SCI	.943	.177	5.315	***	par_9
CI	<---	SCI	.947	.175	5.426	***	par_10
EP	<---	ENP	-.212	.217	-.976	.329	par_16
EP	<---	IGSCP	.530	.137	3.861	***	par_17
EP	<---	EGSCP	.415	.109	3.808	***	par_18
EP	<---	SCI	-.399	.264	-1.512	.131	par_19
II1	<---	II	1.000				
II2	<---	II	1.061	.076	13.929	***	par_1
SI10	<---	SI	1.000				
SI11	<---	SI	1.223	.102	11.959	***	par_2
SI12	<---	SI	.892	.079	11.293	***	par_3
IGP1	<---	IGSCP	1.000				
IGP2	<---	IGSCP	1.157	.073	15.786	***	par_4
IGP3	<---	IGSCP	.914	.065	14.088	***	par_5
ENP4	<---	ENP	1.000				
ENP5	<---	ENP	1.283	.180	7.139	***	par_6
CI3	<---	CI	1.000				
CI8	<---	CI	.862	.128	6.733	***	par_7
CI9	<---	CI	1.324	.152	8.684	***	par_8
II8	<---	II	.897	.092	9.780	***	par_20
ENP7	<---	ENP	1.401	.252	5.562	***	par_21
CI11	<---	CI	1.292	.150	8.625	***	par_24

			Estimate	S.E.	C.R.	P	Label
EGP8	<---	EGSCP	1.000				
EGP7	<---	EGSCP	.861	.061	14.075	***	par_25
EGP5	<---	EGSCP	1.000				
EP1	<---	EP	1.000				
EP2	<---	EP	1.143	.044	25.968	***	par_26
EP3	<---	EP	1.131	.048	23.633	***	par_27
EP5	<---	EP	.898	.046	19.516	***	par_28

Standardized Regression Weights: (Group number 1 - Default model)

			Estimate
IGSCP	<---	SCI	.542
EGSCP	<---	SCI	.464
EGSCP	<---	IGSCP	.091
ENP	<---	SCI	-.001
ENP	<---	IGSCP	.418
ENP	<---	EGSCP	.297
II	<---	SCI	.570
SI	<---	SCI	.566
CI	<---	SCI	.757
EP	<---	ENP	-.094
EP	<---	IGSCP	.363
EP	<---	EGSCP	.334
EP	<---	SCI	-.170
II1	<---	II	.882
II2	<---	II	.858
SI10	<---	SI	.734
SI11	<---	SI	.859
SI12	<---	SI	.728
IGP1	<---	IGSCP	.817
IGP2	<---	IGSCP	.880
IGP3	<---	IGSCP	.769

			Estimate
ENP4	<---	ENP	.520
ENP5	<---	ENP	.646
CI3	<---	CI	.605
CI8	<---	CI	.497
CI9	<---	CI	.733
II8	<---	II	.567
ENP7	<---	ENP	.701
CI11	<---	CI	.720
EGP8	<---	EGSCP	.841
EGP7	<---	EGSCP	.769
EGP5	<---	EGSCP	.720
EP1	<---	EP	.878
EP2	<---	EP	.956
EP3	<---	EP	.915
EP5	<---	EP	.835

Covariances: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
eENP4	<-->	eENP5	.045	.024	1.895	.058	par_23

Correlations: (Group number 1 - Default model)

			Estimate
eENP4	<-->	eENP5	.180

Variances: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
SCI	.093	.024	3.812	***	par_29
eIGP	.171	.025	6.801	***	par_30
eEGP	.243	.032	7.603	***	par_31
EENP	.066	.020	3.357	***	par_32
EEP	.417	.046	8.973	***	par_33

	Estimate	S.E.	C.R.	P	Label
eII	.193	.028	6.903	***	par_34
eSI	.176	.030	5.859	***	par_35
eCI	.062	.018	3.488	***	par_36
eII1	.081	.018	4.578	***	par_37
eII2	.116	.021	5.542	***	par_38
eSI10	.222	.024	9.048	***	par_39
eSI11	.137	.026	5.246	***	par_40
eSI12	.183	.020	9.175	***	par_41
eIGP1	.120	.014	8.386	***	par_42
eIGP2	.095	.016	6.073	***	par_43
eIGP3	.139	.015	9.549	***	par_44
eENP4	.273	.029	9.292	***	par_45
eENP5	.231	.031	7.367	***	par_46
eCI3	.252	.025	10.156	***	par_47
eCI8	.330	.030	11.030	***	par_48
eCI9	.220	.027	8.064	***	par_49
eII8	.486	.043	11.300	***	par_50
eENP7	.204	.032	6.313	***	par_51
eCI11	.225	.027	8.344	***	par_52
eEGP8	.138	.020	6.813	***	par_53
eEGP7	.170	.020	8.473	***	par_54
eEGP5	.309	.031	9.959	***	par_55
eEP1	.152	.015	10.082	***	par_56
eEP2	.063	.011	5.780	***	par_57
eEP3	.128	.015	8.830	***	par_58
eEP5	.179	.017	10.773	***	par_59

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	59	493.164	217	.000	2.273
Saturated model	276	.000	0		
Independence model	23	3704.330	253	.000	14.642

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.033	.875	.841	.688
Saturated model	.000	1.000		
Independence model	.136	.378	.321	.346

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.867	.845	.921	.907	.920
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.858	.744	.789
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	276.164	215.467	344.584
Saturated model	.000	.000	.000
Independence model	3451.330	3258.145	3651.834

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	1.672	.936	.730	1.168
Saturated model	.000	.000	.000	.000
Independence model	12.557	11.699	11.045	12.379

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.066	.058	.073	.001
Independence model	.215	.209	.221	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	611.164	621.614	828.895	887.895
Saturated model	552.000	600.886	1570.539	1846.539
Independence model	3750.330	3754.404	3835.209	3858.209

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	2.072	1.866	2.304	2.107
Saturated model	1.871	1.871	1.871	2.037
Independence model	12.713	12.058	13.393	12.727

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	151	161
Independence model	24	25