

THE UNIVERSITY OF HULL

Investigating the Effect of Environmental Uncertainty on Supply Chain
Collaboration and Operational Performance

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by

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ABSTRACT

Supply chain collaboration is an important strategic consideration for manufacturing firms, which need to effectively manage the globalization of the value chains of manufacturing firms. Like any other manufacturing firms, Korean manufacturing firms in China have to structure a whole new value creation network. Moreover, from the viewpoint of manufacturing firms, the analysis of the market and resources is the basis of formulating strategy. Consequently, this research investigates the impact of environmental uncertainty as an antecedent of supply chain collaboration based upon previous investigations. Because prior literature has indicated that supply chain collaboration could create value and superior performance in a supply chain and perhaps also in newly created supply networks, this research aims to find the reasons behind improved performance. In this regard, there are two aims of this research: 1) to confirm the relationship between supply chain collaboration and operational performance and 2) to verify the roles of environmental uncertainty on the relationship between supply chain collaboration and operational performance.

The thesis refers to prior research and contingency theory, resource-based theory, strategic choice theory, relational view and information processing theory to explain the relationships between the above variables (environmental uncertainty, supply chain collaboration and operational performance). Conceptual and operational definitions of the variables are extracted from prior research and applied to this research. A questionnaire was sent to Korean manufacturing firms in China and 208 data collected by the survey are used in the analysis. To achieve the aims of this research, various analytical methods are used. First, reliability and validity of the questionnaire instrument are verified as follows. The characteristic of the responding firms is proved through descriptive statistics. Content validity is verified by extracting items, verification by experts and the average of items. Estimation and purification of data are carried out. These include data screening, evaluation of assumptions (linearity, homoscedasticity and normality), internal consistency and exploratory factor analysis. Construct validity is tested by convergent validity through confirmatory factor analysis, discriminant validity and multicollinearity analysis. Second, the hypotheses are tested by two analytical methods: an analysis of structural equation modelling and moderating effect analysis.

In this research, contingency theory explains the relationship between environmental uncertainty and supply chain collaboration and resource-based theory, relational view; information processing theory and strategic choice theory explain the relationship between supply chain collaboration and operational performance. These theoretical relationships are verified by empirical tests. The results of the analyses can elucidate various theoretical implications. First, the relationship between supply chain collaboration and operational performance is significantly verified and this means that Korean manufacturing firms reduce costs and improve service through internal collaboration with departments and external collaboration with suppliers and customers. Second, the role of environmental uncertainty on the relationship between supply chain collaboration and operational performance is a moderator and this is explained by contingency theory and fit as moderation. The former is to start from the supposition; that is, there is no organisational structure which satisfies all conditions. From this viewpoint, firms need to find the fittest structure which is equal to the environment which they face and this is connected with high performance. The latter has two viewpoints such as a moderator and a mediator. In this research, environmental uncertainty is the role of a moderator on the relationship between supply chain collaboration and operational performance. When Korean manufacturing firms in China face environmental uncertainty, they acquire high performance through enhancing supply chain collaboration. The results provide managers with managerial implications as follows. First, managers should grasp their present level of supply chain collaboration and formulate supply chain strategy for performance improvement. Second, the analysis of environment is a precondition to perform supply chain strategy, followed by high performance. If managers perform supply chain collaboration on the basis of these implications, they can achieve high cost performance and high service performance.

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THE KEY TO ABBREVIATIONS

Abbreviation	Terminology	Abbreviation	Terminology
AGFI	adjust goodness of fit index	IFI	incremental fit index
ANOVA	analysis of variance	JIT	just-in-time
AVE	average variance extracted	MANOVA	multivariate analysis of variance
BPR	business process reengineering	MNEs	multinational enterprise
CFI	comparative fit index	MRP	material resource planning
C.R.	critical ratio	NFI	normal fit index
CRM	customer relationship management	RMSEA	root mean square error of approximation
DRP	distribution resource planning	R&D	research and development
EDI	electronic data interchange	ROA	return on assets
ERP	enterprise resource planning	ROI	return on investment
ESP	environment, strategy and performance	RQ	research question
FDI	foreign direct investment	SCM	supply chain management
GFI	Goodness of fit index	SEM	structural equation modelling

Supply chain collaboration as terminology is used in this research. In fact, supply chain integration or collaboration is usually used as the same meanings in the research field for SCM but forward integration and backward integration are used in this research. The integration means mergers and acquisitions. For this reason, supply chain collaboration is used in this research to prevent confusion.

Chapter I Introduction

1.1 Background

Prior research investigates supply chain collaboration (and integration) and its performance based on three perspectives: internal collaboration (Gimenez and Ventura, 2005; Daugherty et al., 2009), external collaboration (Bagchi et al., 2005; Chen et al., 2009) and supply chain collaboration as a whole (Boon-itt and Wong, 2011a, b; Iyer, 2011). Most studies have verified that these collaboration practices have a positive effect on performance. In addition, internal collaboration is found to have a positive effect on performance (Ellinger, 2000; Gimenez and Ventura, 2005); supplier collaboration has a positive effect on performance (Scannell et al. 2000; Tsai et al., 2012) and customer collaboration has a positive effect on performance (Stank et al., 2001/2002; Germain and Iyer, 2006). These perspectives remain an unresolved research gap; where researchers focus on either collaboration in each dimension or collaboration as a whole. Besides, prior research is also unsure about the effects of environmental uncertainty (Boon-itt and Wong, 2011b; Paulraj and Chen, 2007b; Rajaguru and Matanda, 2009) on the relationship between supply chain collaboration and performance. Environmental uncertainty is sometimes found to act as an antecedent to supply chain collaboration (and their effects on performance mediated by supply chain collaboration); but, in other circumstances, act as a moderator for the relationship between supply chain collaboration and performance.

Supply chain collaboration research starts from an internal viewpoint of firms and it has now been developed into an inter-firm viewpoint (Stevens, 1989). Prior research explains it in three dimensions: internal collaboration, supplier collaboration and customer collaboration (Flynn et al., 2010; Lee et al., 2007; Wong et al., 2011). Prior research has demonstrated the performance impacts of internal collaboration, external collaboration and supply chain collaboration (Frohlich and Westbrook, 2001;

Gimenez, 2006; Bae, 2012b). The concept of supply chain collaboration and its effect on performance has in general been verified by the majority of prior research but there are still various unsolved issues where the roles of environmental uncertainty in the causal link between supply chain collaboration and operational performance are evident.

Prior research has identified some antecedents of supply chain collaboration. Some researchers have found that environmental uncertainty has a positive effect on supply chain collaboration (Fink et al., 2008; Paulraj and Chen, 2007b). However, others have verified that environmental uncertainty has a moderating effect on the relationship between supply chain collaboration and performance (Boon-itt and Wong, 2011a; Fynes et al., 2004; Liao and Tu, 2008; Wong et al., 2011). Thus, environmental uncertainty has two roles: one is a moderating variable on the relationship between supply chain collaboration and performance and the other is an antecedent of supply chain collaboration. In this regard, the role of environmental uncertainty on the relationship between supply chain collaboration and performance is still unclear. Therefore, this research attempts to ascertain the role of environmental uncertainty in two aspects: 1) a moderator between supply chain collaboration and performance and 2) an antecedent of supply chain collaboration.

1.2 Literature gaps

Although there is a great deal of prior research on the relationship between collaboration and performance, this research identifies six knowledge gaps. The first, the understanding of sub-dimensions of supply chain collaboration is lacking. Supply chain collaboration is extended to inter-corporate relationships as well as inter-departmental relationships. In this regard, prior research explains supply chain collaboration from the various viewpoints (Stevens, 1989; Barratt, 2004; Fawcett and Magnan, 2002; Narasimhan and Kim, 2001; Schoenherr and Swink, 2012). However, the explanation concerned with sub-dimensions of supply chain collaboration and its theoretical basis are

lacking. For example, Stevens (1989) classified the levels into baseline, functional integration, internal integration and external integration. This is unclear because functional integration can be regarded as a part of internal integration. Similarly, Narasimhan and Kim (2001) classified the levels into independent operation, functional integration, internal integration and external integration. This is also unclear because functional integration and internal integration overlap. Frohlich and Westbrook (2001) and Schoenherr and Swink (2012) have the same viewpoint for the levels such as inward-facing pattern, periphery-facing pattern, supplier-facing pattern, customer-facing pattern and outward-facing pattern. However, their criterion for the classification is unclear.

Second, the causal link between supply chain collaboration and operational performance is still undetermined. The positive relationship between collaboration and performance has already been proven by many researchers. Prior research has ascertained that firms which achieve a high level of supply chain collaboration also enjoy high performance (Flynn et al., 2010; Kannan and Tan, 2010; Saeed et al., 2011). However, some results have suggested that the relationship between collaboration and performance is insignificant (Danese and Romano, 2011; Flynn et al., 2010; Sezen, 2008).

Third, the measurement scales (sub-dimensions) of environmental uncertainty are still undetermined. Prior research has classified environmental uncertainty into various sub-dimensions. For example, some researchers have focused on environmental uncertainty itself (Liao and Tu, 2008; Wong et al., 2011) but others have divided it into various dimensions: dynamism, heterogeneity and hostility (Kohn et al., 1990), munificence, instability and complexity (Pagell and Krause, 2004), demand, technology and supply (Fynes et al., 2004), technology uncertainty (Ragatz et al., 2002), technological turbulence and market turbulence (Iyer, 2011) and technological uncertainty and demand uncertainty (Boon-itt and Wong, 2011). The disparity of the sub-dimensions is based on the fact that there is no common viewpoint concerned with it in prior research. Therefore, the different compositions of environmental uncertainty have been used in prior research.

Fourth, the relationship between environmental uncertainty and supply chain collaboration is also

unclear. Some prior research has ascertained the positive relationship between environmental uncertainty and collaboration (Liao and Tu, 2008; Ragatz et al., 2002) but other prior research has not found such positive relationships (Babakus et al., 2006; Paulraj and Chen, 2007b). In this regard, there is a need to verify the causal link between environmental uncertainty and supply chain collaboration. According to ESP (the environment-strategy-performance), the relationship between the environment and performance is moderated by strategy. In other words, if there is high environmental uncertainty, firms focus on external oriented strategy because they need to get opportunities in the market, followed by high performance. From this viewpoint, supply chain collaboration can be regarded as the strategy and environmental uncertainty has a positive effect on supply chain collaboration. However, the results of some prior research did not find the positive effect of environmental uncertainty on supply chain collaboration (Babakus et al., 2006; Paulraj and Chen, 2007b).

Fifth, there is a lack of understanding about the effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance. Some researchers have ascertained the moderating effect of environmental uncertainty on the relationship between collaboration and performance (O'Leary-Kelly and Flores, 2002; Wong et al., 2011). However, the other researchers could not verify the moderating effect on the relationship between the variables. For example, Boon-itt and Wong (2011a) verified that technology uncertainty and demand uncertainty does not enhance the relationship between customer integration and customer delivery performance. Fynes et al. (2004) proved that technological uncertainty does not enhance the relationship between supply chain relationship quality and supply chain performance. In addition, Wong et al. (2011) ascertained that environmental uncertainty does not enhance the relationship between customer integration and delivery. According to Venkatraman (1989), the environment has a role of a moderating variable on the relationship between strategy and performance. From this viewpoint, the higher the environmental uncertainty, the more the positive relationship between supply chain collaboration and operational performance. However, the results of some prior research did not find a

positive relationship (Boon-itt and Wong, 2011a; Fynes et al., 2004; Wong et al., 2011).

Sixth, it is still unsure the roles of environmental uncertainty on operational performance. Prior research confirmed that environmental uncertainty had a positive effect on performance (Agbejule and Burrowes, 2007; Coelho and Easingwood, 2005) but the others proved that environmental uncertainty had a negative effect on performance (Wood, 2008). According to Porter (1980), the environment exists outside of firms and affects them. From this viewpoint, the environment is an important factor to have an influence on performance of firms. However, prior research ascertained that there are two different results on the relationship between the environment and performance: one is the positive relationship and the other is the negative relationship. According to ESP theory, the relationship between the environment and performance is mediated by strategy. This means that the environment does not directly affect performance but indirectly affects performance. Therefore, the relationship between environmental uncertainty and performance is still unclear.

1.3 Research objectives and questions

This research suggests two research questions mainly on the basis of above six knowledge gaps.

Research Question (RQ) 1 -

What is supply chain collaboration and how does supply chain collaboration affect operational performance?

Research Question (RQ) 2 -

What is environmental uncertainty and how does it affect supply chain collaboration and influence the relationship between supply chain collaboration and operational performance?

The first research objective of this research is to understand supply chain collaboration and the relationship between supply chain collaboration and operational performance. This answers RQ 1. The second objective of this research is to understand the role of environmental uncertainty on the relationship between supply chain collaboration and operational performance. This explains RQ 2, which has two aspects: one is the moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance and the other is the direct effect of environmental uncertainty on supply chain collaboration. Thus, this research has three steps: 1) develop measurement scales for environmental uncertainty, supply chain collaboration and operational performance; 2) confirm the effect of supply chain collaboration on operational performance, and 3) verify the roles of environmental uncertainty on the relationship between supply chain collaboration and operational performance.

1.4 Potential contributions

The answer to the first research question potentially contributes to the following: to provide new evidence that firms choose different levels of supply chain collaboration, to provide new evidence that firms with different levels of supply chain collaboration achieve different operational performance, to further verify the positive relationship between supply chain collaboration and operational performance, to provide (test /refine) theoretical and contextual explanations for the above findings and to develop the theoretical model and normative recommendation for the effective management of supply chain collaboration.

The insights generated from answering the second research question potentially aim to: 1) provide new evidence on the roles or effects of environmental uncertainty on supply chain collaboration and the relationship between supply chain collaboration and operational performance and 2) provide theoretical reasons which explain how manufacturing firms should consider environmental

uncertainty when they manage supply chain collaboration.

1.5 Structure of this thesis

This thesis is composed of total eight chapters. The contents are as follows.

Chapter I explains the whole flows of this research. In particular, research objectives and questions explain the reasons to perform this research. The background and literature gaps of this research are to suggest the limitations of prior research and research issues. In addition, potential contributions explain latent benefits suggested by the results of this research.

Chapter II explains the background of supply chain collaboration from the theoretical viewpoint. This research explains the importance of supply chain collaboration. Transaction cost theory and internalisation theory are the theories to explain the motives and the processes for internationalisation of MNEs but, in this research, the relationships between supply chain participants and Korean manufacturing firms in China are explained by a couple of theories from the viewpoint of supply chain collaboration. In addition, the relationships between the variables through prior research are explained in this chapter.

Chapter III describes the theoretical background, the definitions of the variables, theoretical explanations on the different levels of supply chain collaboration, research models and research hypotheses. The theories explain the relationship between the variables. In this research, contingency theory explains the relationship between environmental uncertainty, supply chain collaboration and operational performance. Resource-based theory, information processing theory, relational view and strategic choice theory explains the relationship between supply chain collaboration and operational performance. The definitions of the variables come from prior research and the relationships between the variables also come from the same sources. This can be shown in the research model and there are seven research hypotheses, which explain the relationships between the variables.

Chapter IV details the research methodology from two perspectives. One is philosophy of science which explains the role of philosophy in scientific research. The other is concerned with research design: science and scientific research, the process of a quantitative analysis and research methodology. Science and scientific research include the need of scientific research as well as the definitions. The process of a quantitative analysis shows the scientific process for this research. Research methodology explains the methodology used in the research, the conceptual and operational definitions of the variables and the methods for analysing the collected data.

Chapter V shows the results of descriptive statistics and reliability and validity analyses as the results of analysing the collected data. Reliability and validity of the collected data are verified through various procedures in this research. Contents validity is ascertained by extracting items, verification by experts and the average of items. Estimates and purification of data are established by data screening, evaluation of assumptions for multivariate analysis, internal consistency and exploratory factor analysis. In addition, construct validity is identified by convergent validity, discriminant validity and multicollinearity analysis.

Chapter VI explains the results to test the hypotheses as the result of the empirical tests. This research has seven hypotheses. H.1, H.2 and H.3 are the results of confirmatory factor analysis concerned with developing the variables, which are connected with RQ 1. H.4 explains the effect of supply chain collaboration on operational performance concerned with RQ 1. In addition, H.5, H. 6 and H. 7 show the roles of environmental uncertainty between supply chain collaboration and operational performance connected with RQ 2.

Chapter VII shows discussion on above analytical results. The implications of this research derive from comparison of the analytical results on seven hypotheses with the results of prior research and, in addition, it is possible to suggest new implications which evolve from the results. In particular, the roles of environmental uncertainty between supply chain collaboration and operational performance consist of significant implications. In addition, theoretical implications mentioned from the results of

this research are suggested, followed by managerial implications.

Chapter VIII summarizes the whole research. In the contents, main findings are suggested and, in addition, the limitations of this research and future research directions are suggested.

1.6 Summary

This research has two aims: one is to verify the relationship between supply chain collaboration and operational performance and the other is to prove the role of environmental uncertainty on the relationship between supply chain collaboration and operational performance.

Chapter II Literature Review

2.1 Introduction

This literature review first examines the research in supply chain collaboration from the internalisation and transaction cost literature. The modes of entry into the foreign market of firms are explained through internalisation theory. The use of network as supply chain collaboration is explained by transaction cost theory. Next, existing evidence for the performance implications of supply chain collaboration are examined. Then existing literature about the influences of environmental uncertainty on the relationships between supply chain collaboration and performance are reviewed. Finally, global supply chain collaboration of manufacturing firms is shown in this chapter.

2.2 Supply chain collaboration

2.2.1 The value of supply chain collaboration

There are various definitions concerned with supply chain collaboration. In this research, supply chain collaboration is defined as working together among departments within a firm, understanding mutual different viewpoints, sharing resources and information and achieving common goals in supply chains (Ellinger et al., 2000; Stank et al., 2001/2002). In previous research, some researchers use supply chain collaboration (Bagchi et al., 2005; Ellinger, 2000; Kahn and Mentzer, 1998; Stank et al., 2001; Tsai et al., 2012) and the others use supply chain integration (Narasimhan and Kim, 2001; Schoenherr and Swink, 2012; Stevens, 1989; Wong et al., 2011). From the viewpoint of supply chains, integration is extended from functional areas of a firm to participants included in supply chains. It

includes reliance to work together and investment to the relationship and sharing resources is required (Stank et al., 2001). Hence, integration is focused on the processes such as mutual understanding, common visions, shared resources and collective goals. This is connected with a number of boundaries, followed by increased efficiency and productivity. There are three perspectives of integration: interaction, collaboration and a composite of the two (Griffin and Hauser, 1996). Whereas, collaboration is a decision-making process among organisations and the core of collaboration is an inter-organisational scope, a commitment to working together and common bond (Stank et al., 2001). The most important aspect of the similarities between integration and collaboration is the relationships among organisations but the difference is that the former is to focus on the processes among organisations and the latter is to focus on a mind to collaborate among organisations.

Supply chain collaboration has been explained from various theoretical viewpoints. In particular, it is useful to explain supply chain relationships from the viewpoint of value. The relationships are changed by which value firms pursue. If their value is in cost leadership, firms focus on internal efficiency through collaboration between departments, whereas if their value is in differentiation, they focus on external effectiveness through collaboration between supply chain partners. Under the circumstances, value is created by supply chain relationships. The relationships which create value in supply chains are enhanced by the intensity of relationships through collaboration. In other words, supply chain relationships explain that the stronger the supply chain collaboration, the higher the performance in supply chains. In this regard, this research investigates supply chain collaboration on the basis of value of firms from the viewpoint of supply chain relationships. From this viewpoint, supply chain collaboration rather than supply chain intensity is regarded as having an effect on value in supply chains.

From the perspective of supply chain relationships, resources can be obtained through the market as well as hierarchic organisations through vertical integration (O'Donnell et al., 2001). The mechanism of transaction can dominate the market if the market is stable. However, if there is high environmental

uncertainty and transactional cost is required in the market, participants of the market want stable trade through hierarchic organisations. If the position of the market is in the middle, between stability and uncertainty, supply chain relationships can provide value to firms when they operate in supply chain networks.

Supply chain networks are composed of participants and relationships: the former means departments of a focal firm and supply chain partners like suppliers and customers and the latter represents collaboration between supply chain partners as well as departments. Supply chain networks are classified into a vertical network and a horizontal network from the supply chain viewpoint. The former is to mean the network participants from suppliers of raw materials to final customers and supply chain collaboration adjusts the flow of complementary resources. The latter is to include collaborators and competitors (e.g. joint logistics) and supply chain collaboration that adjusts the flow of reciprocal substitute resources (Elg and Johansson, 1996). In this situation, value is created by collaboration (relationships) between supply chain participants.

The basic assumption of a supply chain network is that each firm depends on resources controlled by supply chain partners. An approach to the resources is achieved by collaboration with supply chain participants. The participants invest in relationships with other participants and, consequently, they acquire the information, the knowledge and the skill of the partners. As a result, they structure collaborative supply chain relationships, followed by value creation. Thus, the core of a supply chain network is to create value through achieving supply chain collaboration. To create value, firms enhance supply chain relationships through collaboration from the viewpoint of whole firms. This means that they enhance supply chain relationships through supply chain collaboration and, as a result, they create value in a supply chain network.

The management of relationships in a supply chain network is performed by close collaboration between functional areas and it is also achieved by efficient connection through external operations among supply chain partners. Supply chain collaboration between supply chain partners enhances

their performance and supply chain efficiency is maintained in the best efficient conditions through collaboration between the partners. Relationship-oriented supply chain collaboration becomes an integrated part of relationships for suppliers and customers and it provides firms with opportunities of performance improvement. The collaboration helps to carry out specific requirements such as low cost and high quality goods and services which have an effect on customers' choice because firms recognize the long-term need, expectations and preferences of customers (Lai et al., 2002). Therefore, firms which want to create value through supply chain collaboration focus on internal collaboration and they also respond to customers' expectations very well and achieve customer needs through supplier collaboration.

Supply chain collaboration research starts from the viewpoint of inter-functional areas in a firm and it has been expanded to the aspects of collaboration with customers and suppliers. The collaboration is developed into the efficient relationships between firms (Bowersox and Daugherty, 1995). It can improve efficiency and production as well as cost saving and, consequently, benefits appear as exact plans and forecasts to the market, improved logistics efficiency and enhancement of customer service. Therefore, successful collaboration creates value in supply chain processes and it is connected with operational performance such as cost saving and superior service.

2.2.2 Supply chain collaboration

2.2.2.1 Internalisation theory

Transactions as activities of firms are performed from: 1) external transactions in the market and 2) internal transactions in firms. Firms create stable benefits following value secured by substituting internal transactions for external transactions (Williamson, 1975). For example, it is possible to secure stable value creation when firms directly distribute products in the market through forward integration

as well as directly procuring raw materials and components in the market through backward integration. This means that their tangible and intangible assets (information systems, technology, knowledge etc.) create value by internalisation but not by market transactions. The core factor of internalisation is stable value creation following a high level of control, which focuses on inter-organisational relationships. Therefore, the essence of internalisation is in mutually dependent activities through common ownership and control.

Firms perform transactions through the internal market rather than the external market when a market has imperfections. If a market is stable, there are no benefits of internalisation. However, firms can achieve efficiency if a market is highly imperfect because they can save a transaction cost through internalizing transactions. Coase (1937) suggested four transaction costs concerned with market imperfection: a negotiation cost, a contract cost, uncertainty of contract fulfilment and tax following market transactions (Williamson and Winter, 1993). In contrast, Williamson (1975) suggested the causes of transaction costs as follows. One is human factors: bounded rationality and opportunism. Another is environmental factors: a small number of dealers, concentration of information and uncertainty. The third is transaction-specific assets: physical asset specificity, human asset specificity and location specificity. Firms can save and prevent transaction costs through internalizing transactions. For this reason, the core factor of internalisation is in the degree of internalisation rather than the internalisation itself (Williamson, 1975).

Firms would substitute internalisation for market transactions because of market imperfection (Hymer, 1968). Firms, which have their advantages to create value through internalisation because of market distortion such as the distortion and asymmetry of information, would internalize market transactions for creating more benefits through using information which they have. In addition, they prefer internalisation to market transactions because they are afraid of losing their specific advantages.

Kindleberger (1969) divided market imperfection into four dimensions: imperfection of the market of products, imperfection of the market of factors for production, economy of scale and governmental

regulation. Calvet (1981) also classified market imperfection by a market disequilibrium hypothesis, government-imposed distortions, market structure imperfection and market failure imperfection. From these viewpoints, internalisation is possible if there are high market failure and low organisational failure in the market. Therefore, firms decide internalisation when transaction costs, in a market, are higher than internal organisational costs.

Firms should decide the degree and mode of internalisation if there are the causes of internalisation. Strategy is saving transaction costs through internalisation and a strategic decision should be made by considering internal and external conditions. When firms make decisions, they should consider the degree and the mode of internalisation, economical efficiency of internalisation and influencing factors of internalisation (Kwon, 1996).

First, the degree of internalisation is decided by the degree of control. It can be explained as the dimension of control following the investment of resources; that is, internalisation is higher than contracts in the market compared on the basis of the degree of control and independent subsidiary firms are higher than joint venture firms compared on the basis of the degree of control. The mode of internalisation means that firms decide the market which they would internalise such as product markets, intermediate goods markets, labour markets or capital goods markets. Buckley and Casson (1976) divided the types of internalisation into vertical integration (internalisation of intermediate goods markets), horizontal integration (internalisation of knowledge markets such as technological knowledge) and conglomerate integration (internalisation of international capital markets). The degree and the mode of internalisation are connected with the choice of an entry mode of firms to the market.

Second, firms decide the degree of internalisation and the degree means that marginal benefits are higher than marginal costs compared with costs and benefits following internalisation. Hymer (1968) insisted that the degree of internalisation is decided by achieving economy of scale, marginal benefits and marginal costs. These benefits of internalisation can be explained as four evasions (Casson, 1979): market exchange and settlement costs, contract costs, moving costs of property right and

intervention costs. The first means the avoidance of transaction costs following decentralization of decision-making, negotiation and discriminative price application. The second means the avoidance from non-fulfilment of contracts (the date of delivery, conformity of quality etc.) and the risks by opportunistic behaviour of business partners. The third means the avoidance from the legal guarantee of the right of ownership and the risk of a leakage of secrets. The fourth means the avoidance of governmental regulation such as price control, customs duty, discriminative tax and quota. Therefore, firms enjoy the benefits following internalisation such as saving transaction costs of an external market (negotiating costs, monitoring costs, performing costs, opportunism etc.), control of an external drain to intangible assets and exclusive possession of benefits of firms and a spontaneous response to physical regulations and interference. In addition, internalisation has the contrary relationship between costs and benefits: the relationship between costs and risks and the relationship between control and benefits. The former is that the higher the level of internalisation, the larger investing costs and then followed by the higher risks. The latter is that the higher the level of internalisation, the higher the level of control (knowledge, information and a market) and then followed by the higher benefits.

Third, internalisation is decided by firm-specific factors and location-specific factors. According to Buckley and Casson (1979), the factors which have an influence on internalisation in international commerce are industry-specific factors, region-specific factors, nation-specific factors and firm-specific factors. Internalisation is decided by interaction among them and knowledge as industry-specific factors is the origin of proprietary advantage and the key object of transfer pricing. In addition, Dunning (1988, 1993) insisted that the factors which have an influence on internalisation are political, legal, social, cultural and geographical the environment as external aspects of firms and organisational, managerial, marketing and financial factors as internal aspects of firms. Therefore, firm-specific factors as internal aspects of firms and location-specific factors as external aspects of firms are the basis of deciding internalisation because they have an influence on market imperfection

and transaction costs.

2.2.2.2 Supply chain collaboration in internalisation theory

Internalisation is not performing transaction in the market but internally performing transaction through vertical integration. Firms create value through internal organisations because of acquiring tangible and intangible assets such as technology and knowledge through vertical integration in the whole process. Therefore, the nature of internalisation is in reciprocal dependent activities under control structure of common ownership and the degree of internalisation (supply chain collaboration with partners) is decided in the point between market and hierarchy.

Table 2-1 Market, network and hierarchy (Kwon, 2001)

Supply Chain Partners	Market	Network	Hierarchy
competitors	Licensing	Alliance	Independent subsidiary firm
suppliers	Short-term contract (outsourcing)	Long-term subcontract (collaboration)	Backward integration (direct supply)
distributors	Short-term contract	Long-term sales contract (agent, dealer)	Forward integration (direct sales)

The quasi-hierarchy as an intermediate form between market and hierarchy is possible in the control dimension of transactions. Network is regarded as the independent form of the quasi-hierarchy (Dunning, 1993). It has reciprocal orientation, enhanced by unity through investment and relationships, and it has a mutual dependent character (Powell, 1990). As shown in Table 2-1, network can be divided into the alliance with competitors, suppliers and distributors. Joint venture is a representative form of alliance between competitors; that is, they create an independent firm through joint investment. The relationship between manufacturers and suppliers can be classified into outsourcing as a transaction in a market (a short-term contract), direct supply as hierarchy (backward integration) and collaborators as a network (a long-term subcontract). In addition, the relationships

between manufacturers and distributors are sales agents as transactions in a market (a short-term contract), direct sales as hierarchy (forward integration) and agents and dealers as a network (a long-term sales contract) (Kwon, 2001). In this regard, alliances with competitors, long-term subcontracts with suppliers and long-term sales contracts with distributors in network are regarded as supply chain collaboration. According to a network viewpoint, alliances are regarded as internalising value of processes through collaboration with competitors (i.e. joint logistics) and service providers (i.e. logistics service providers and information system providers) from the viewpoint of horizontal collaboration. In addition, long-term subcontracts are regarded as internalising the value through upstream collaboration with suppliers from the viewpoint of vertical collaboration and long-term sales contracts are regarded as internalising the value through downstream collaboration with customers (agents and dealers) from the viewpoint of vertical collaboration.

2.2.2.3 Transaction cost theory

The concept of network in transaction cost theory originally came from the work of O'Donnell et al. (2001) and Elg and Johansson (1996) explained network between buyers and sellers. In addition, Stock et al. (2000) ascertained the relationship between supply chain structure and performance on the basis of transaction cost theory. The theory has prerequisites; that is, if firms transact in a market, they should pay transaction costs because of assets specificity, environmental uncertainty and behaviour uncertainty. In this regard, firms would transact in an internal market rather than an external market to reduce transaction costs coming from market imperfection (Williamson, 1975). Transaction costs mean the costs needed to negotiate a transaction between traders, monitor contracts to follow the transaction and enforce the contracts. Transaction costs appear because of the difficulty of transactions when there is high environmental uncertainty. The factors which make the difficulty are classified into the characteristics which humans have and the characteristics which transactions have: the former

means bounded rationality and opportunism and the latter means asset specificity, uncertainty and frequency (Williamson, 1975). Therefore, transaction cost theory explains that firms internalise transactions to reduce transaction costs appearing from the market imperfection.

Transaction cost theory supposes market failure. One of the determinant factors concerned with market failure is the existence of specialised assets (Williamson, 1975). Firms would internalise transactions because the assets do not fit in a market transaction because of difficulty of contracts and the character of public goods (Buckley and Casson, 1976). For example, differentiated goods, accumulated technology or knowledge has high uncertainty when firms transact them in a market and, consequently, high transaction costs exist in the market. In this situation, firms can avoid the uncertainty through internalisation. Therefore, uncertainty following market transactions is a determinant factor of internalisation and firms acquire the stocks of a subsidiary firm from the viewpoint of the lowest transaction costs.

The cause of market failure is transaction costs; whereas, the cause of organisational failure is internal organisational costs such as employing and managing employees, collecting and applying information and monitoring performance (Hennart, 1991). Bureaucratic costs as representative internal organisational costs mean the costs expended in structuring regulations or rules for controlling opportunistic behaviour and performance of organisational members (Jones and Hill, 1988). In this situation, organisational failure is due to internal organisational costs, resource risk and demand uncertainty (Kwon, 2001).

First, if there are gaps in the business the environment between nations like high bureaucratic costs in the market, firms can suffer high internal organisational costs. Firms can suffer the internal organisational costs of subsidiary firms as follows: difficulty of monitoring subsidiary firms, difficulty for control caused by gaps in the business the environment, difficulty for adjustment following the rapid change of the environment, difficulty for quick response caused by geographical distance and the cost of socialisation to employees. In addition, the causes of organisational failure are suggested as

competitive barriers, political barriers (regulations, restrictions etc.) and consumers' barriers. These barriers are the causes of internal organisational costs because of increasing foreignness costs to internal organisations and functioning as psychological distance to interrupt the smooth flow of information and knowledge between firms and the market (Johanson and Vahlne, 1977).

Second, resource risk is another cause of organisational failure. It is the risk which occurs when firms require the resources which they have not or cannot acquire such as technology, human resources and capital. Firms would consider the external dependence of the resources as a solution because of these limitations of resources when they perform strategy. Under the circumstance, alliances are regarded as sharing risks and costs through procuring the resources from external partners. Therefore, if there are complementary resources among partners, the risk of organisational failure decreases.

Third, demand uncertainty is another cause of organisational failure. It can be measured by the scale of the market and the variance of the product life cycle. For instance, if the scale is small and the variance is quick, demand uncertainty is increased. Under the circumstance, transactions in a market are stable but alliance is flexible in entry and withdrawal to a market compared with independent subsidiary firms. In addition, if the risk of organisational failure is high due to demand uncertainty, an alliance (network) is more efficient than independent subsidiary firms (hierarchy) but it is less efficient than licensing (market). Though, if the risk of market failure is high due to demand uncertainty, alliance (network) is more efficient than licensing (market) but it is less efficient than independent subsidiary firms (hierarchy). Therefore, when firms select an entry mode to a market, they should consider organisational failure as well as market failure.

According to transaction cost theory, managerial structure of firms can be divided into market and hierarchy. Williamson (1975) explained the relationship between organisations as quasi-hierarchy, which is an intermediate form between market and hierarchy. In this situation, the structure of the relationships between firms is partnerships and it is acquired by contracts. The objective of the

contracts is to create a joint surplus through collaboration and the surplus is possessed by the parties of the contracts. Under the circumstances, the aim of collaboration is combinations of a competitive advantage which the parties have. The competitive advantage can be produced by organisational capability and knowledge generated from resource-based view and knowledge-based view.

A contractual approach is focused on transaction cost or the right of ownership of immobile assets, whereas a knowledge-based approach is focused on the role of firm-specific routine, capability, learning and tacit knowledge which are rare and difficult to imitate and they have an influence on the creation and continuance of a joint surplus through partnerships. When firms choose either market or hierarchy, the choice depends on a level of control. Hierarchy (vertical integration) is chosen when there are high uncertainty and complexity following opportunism in the market, there are a small number of trading partners in the market with high asset specificity and firms cannot rely on partners (it is similar to the oligopolistic or duopolistic market). When market (licensing) is chosen, there is low uncertainty and complexity in the market; and while there are a great number of trading partners in the market, there is no requirement for transaction-specific investment (it is similar to perfectly competitive market). In this regard, the lower the transaction cost is, the more firms prefer market to hierarchy, whereas the higher the transaction cost is, the more firms prefer hierarchy to market. Therefore, firms can choose an intermediate form (network like supply chain collaboration) between market and hierarchy (Stock et al., 2000) for control of transaction costs and internal organisational costs.

2.2.2.4 Supply chain collaboration in transaction cost theory

Williamson (1991) suggested three entry modes to the market concerned with the interaction of market failure and organisational failure: network (long-term relationship), hierarchy (vertical integration) and market (a short-term contract). Compared on the basis of transaction costs and

internal organisational costs, firms prefer a hierarchy which decreases transaction costs if there are the high risks of market failure and the low risks of organisational failure in the market. Compared on the basis of transaction costs and internal organisational costs, market is more preferential than hierarchy if there are the high risks of organisational failure and the low risks of market failure in a market because it can reduce internal organisational costs. However, firms would select an intermediate form rather than selecting one of them if there are the high risks of or the low risks of the two failures. Therefore, firms would choose network (alliance like supply chain collaboration) which can control market failure and organisational failure.

Figure 2-1 The relationship between organisations following market failure and organisation failure (Kwon, 2001)

		market failure	
		high	low
organisational failure	high	(network) Long-term relationship	(market) Short-term contract
	low	(hierarchy) Vertical integration	(network) Long-term relationship

As shown in Figure 2-1, the inter-organisational relationship following market failure and organisational failure can be applied to the relationship between manufacturers, suppliers and distributors for SCM. The relationship between manufacturers and suppliers can be divided into three aspects: one is a short-term contract as market (licensing), another is direct supply as hierarchy (backward integration) and the third is a long-term relationship as network (supply chain collaboration). Firms would choose the lowest risks as direct procurement through hierarchy

(backward integration) rather than procurement in the market when the risk of market failure is high and the risk of organisational failure is low in the relationship between manufacturers and suppliers. The risk of organisational failure is high and the risk of market failure is low as the transaction in the market rather than hierarchy is the lowest risk-taking method. However, firms can control or adjust the risks of market failure and organisational failure through network (long-term subcontract like supply chain collaboration) which is in the middle area between market and hierarchy when there are the high or the low risks of both market failure and organisational failure (Kwon, 2001).

The relationship between manufacturers and distributors can be also classified into three aspects: one is a short-term contract as market, another is direct sales as hierarchy (forward integration) and the third is a long-term sales contract as network (long-term sales contract like supply chain collaboration). Firms would choose direct sales as hierarchy rather than transaction in the market if there are the high risks of market failure because of transaction costs. However, transaction in the market rather than hierarchy is the method of the lowest risk-taking if there are the high risks of organisational failure. However, if both market failure and organisational failure are high or low, firms would control or adjust the risks of market failure and organisational failure through network (supply chain collaboration) as long-term contractual sales by agents and dealers.

The viewpoint of network can be applied to the relationships between manufacturing firms and their partners as suppliers and distributors. In particular, Korean manufacturing firms in China need to make long-term relationships with their local suppliers and customers. In this regard, this research suggests the methods of value creation through ascertaining supply chain collaboration as the methods of managing the relationships between Korean manufacturing firms in China and their local suppliers and distributors.

2.3 Prior research

2.3.1 The performance implication of supply chain collaboration

As summarized in appendix 1, 2 and 3, research on the relationship between supply chain collaboration and performance can be divided into three perspectives. First, research from the viewpoint of internal collaboration is as follows. Kahn and Mentzer (1998) investigated 514 US electronics firms through multiple regression analysis and, consequently, ascertained that collaboration between marketing, manufacturing and R&D has a positive effect on the performance in department, company, productive development and product management and satisfaction in working with other departments. Gimenez and Ventura (2005) analysed 64 Spanish manufacturing firms through multiple regression analysis and, consequently, found that collaboration between logistics and production has a positive effect on logistics performance. In addition, Stank et al. (1999b) investigated 309 U.S. manufacturing firms through multiple regression analysis. They found that working together as a team has a positive influence on overall relative performance and, in addition, achieving goals collectively, working together as a team and conducting joint planning to anticipate and resolve operational problems has a positive effect on overall marketing and logistics effectiveness. Mollenkopf et al. (2000) analysed 186 New Zealand firms including manufacturers, wholesalers and retailers to use multiple regression analysis and they found that inter-departmental connectivity has a positive influence on dissemination of information and coordination of activity as integration. Ellinger et al. (2000) investigated 309 U.S. manufacturing firms through multiple regression analysis and, consequently, they found that collaboration has a positive influence on the perceived effectiveness of a relationship, which has a positive influence on distribution service performance. In addition, Ellinger (2000) found that cross-functional collaboration has a positive effect on effective relations, which has a positive effect on logistics performance. Daugherty et al. (2009) analysed 125 U.S. firms

through an analysis of structural equation modelling and they ascertained that marketing and logistics relationship effectiveness has a positive influence on firm-wide integration, which has a positive influence on logistics performance.

Similarly, researchers have ascertained that internal collaboration yields various performances. This can be explained as follows. Larson (1994) investigated 532 US manufacturing firms through an analysis of structural equation modelling and, consequently, proved that inter-organisational functional integration has a negative effect on total cost, which means that total cost is decreased. Stank et al. (2001) analysed 306 US manufacturing firms to use an analysis of structural equation modelling and they proved the positive effect of internal collaboration on logistical service performance. In addition, Stank et al. (2001/2002) found that internal integration has a positive influence on logistics cost, delivery dependability, order fill capability and inventory turnover as overall logistics performance. Droge et al. (2004) investigated 57 car companies in North America through multiple regression analysis and, consequently, they found the positive effect of internal integration on financial performance. Simatupang and Sridharan (2005) analysed 76 New Zealand manufacturing firms using multiple regression analysis and they verified that information sharing, decision synchronization and incentive alignment as collaborative practices have a positive influence on fulfilment, inventory and responsiveness as operational performance excluding the effect of information sharing on responsiveness. Lee et al. (2007) analysed 122 U.S. manufacturing firms through multiple regression analysis and they proved that internal linkage has a positive influence on cost-containment and performance reliability as supply chain performance. Liao and Tu (2008) investigated 303 U.S. manufacturing firms through multiple regression analysis and they found that manufacturing system integration has a positive effect on manufacturing performance in a high level of uncertainty. Braunscheidel and Suresh (2009) analysed 218 firms in various industries to use an analysis of structural equation modelling and they ascertained that internal integration has a positive effect on a firm's supply chain agility. Daugherty et al. (2009) used an analysis of structural equation

modelling and, consequently, they verified the positive effect of firm-wide integration on logistics performance. Flynn et al. (2010) investigated 617 Chinese manufacturing companies through multiple regression analysis and the result is that internal integration has a positive effect on operational performance and business performance. Boon-itt and Wong (2011a) investigated 151 Thai automotive firms through multiple regression analysis and, consequently, they ascertained the positive effect of internal integration on customer delivery performance. Boon-itt and Wong (2011b) confirmed that internal integration has a positive effect on delivery, production costs and product quality as operational performance. Wong et al. (2011) found the positive effect of internal integration on performance such as delivery, production costs, product quality and production flexibility using an analysis of structural equation modelling. Bae (2012a) investigated 163 Korean shipping firms by applying an analysis of structural equation modelling and he found the positive effect of internal integration on customer service performance. In addition, Schoenherr and Swink (2012) investigated 403 firms in various industries through multiple regression analysis and they found that internal integration has a positive influence on quality performance, delivery performance, flexibility performance and cost performance.

To sum up, the existing literature largely shows that internal collaboration has a positive influence on performance. Only few studies could not find significant influence. For example, Stank et al. (1999b) verified that informally working together has no effect on overall relative performance. Droge et al. (2004) found that internal integration has no effect on market share performance. Rodrigues et al. (2004) analysed 284 US manufacturing firms to use an analysis of structural equation modelling and they proved that integrated internal operations have no effect on logistics performance. Babakus et al. (2006) analysed 257 manufacturing firms to use an analysis of structural equation modelling and they found that domestic networking activities have no effect on export performance. Boon-itt and Wong (2011b) ascertained that internal integration has no effect on production flexibility.

The second perspective is concerned with external collaboration, which normally includes supplier

and customer collaboration. Researchers have confirmed that supplier collaboration has a positive influence on various performances. This can be explained as follows. Scannell et al. (2000) investigated 57 US manufacturing firms. Through multiple regression analysis and their use of upstream SCM practice such as supplier development, supplier partnering and JIT (Just-In-Time) purchase, they ascertained that 1) supplier development has a positive influence on flexibility, innovation and cost, 2) supplier partnering has a positive influence on flexibility and cost, and 3) JIT purchase has a positive influence on flexibility, quality and cost. Ragatz et al. (2002) analysed 83 US manufacturing firms to use an analysis of structural equation modelling and they verified that supplier integration strategies have a positive effect on new product development such as cycle time results, quality results and cost results. Bagchi et al. (2005) analysed 149 multinational data using multiple regression analysis and, consequently, they found that 1) collaboration with suppliers in inventory control has a positive influence on total logistics cost, 2) collaboration with suppliers on R&D has a positive influence on return processing cost and inventory turnover, 3) collaboration with suppliers in inventory control has a positive influence on inventory turnover, 4) collaboration with suppliers in software implementation has a positive influence on inventory turnover and 5) collaboration with suppliers in R&D has a positive influence on rate of return. Lee et al. (2007) ascertained that supplier linkage has a positive effect on cost-containment and performance reliability as supply chain performance. Paulraj and Chen (2007b) analysed 211 US manufacturing firms with an analysis of structural equation modelling and they proved the effect of strategic supply management on buyer performance and supplier performance. So and Sun (2010) investigated 558 manufacturing firms in 17 countries through multiple regression analysis and they propagated that e-business supported supplier integration, information sharing in supplier integration and policy-based supplier selection has a positive influence on regular use of lean manufacturing. Boon-itt and Wong (2011a) verified the positive effect of supplier integration on customer delivery performance.

Other researchers have verified that customer collaboration has a positive effect on various

performances. This can be interpreted as follows. Stank et al. (2001/2002) investigated 306 U.S. manufacturing firms through multiple regression analysis and they found that customer integration has a positive effect on customer satisfaction, product customization, delivery speed, responsiveness, order flexibility and delivery flexibility as supply chain logistics competency. Lee et al. (2007) verified the positive effect of customer linkage on performance reliability as supply chain performance. Germain and Iyer (2006) investigated 152 U.S. manufacturing firms through an analysis of structural equation modelling and they verified the positive effect of demand integration on logistical performance. Flynn et al. (2010) ascertained the positive effect of customer integration on operational performance. Iyer (2011) investigated 152 US manufacturing firms through multiple regression analysis and found the positive effect of demand chain collaboration on operational performance.

In addition, researchers have ascertained that supplier collaboration and customer collaboration simultaneously produce a positive effect on various performances. For example, Salvador et al. (2001) analysed 164 manufacturing firms to use multiple regression analysis and they proclaimed the positive effect of interaction for quality management and for flow management with suppliers and customers on punctuality of delivery and operations speed. Droge et al. (2004) found the positive effect of external integration on product development time, product cycle time and responsiveness. Gimenez and Ventura (2005) confirmed the positive effect of external integration on absolute performance. Paulraj and Chen (2007a) analysed 221 U.S. manufacturing firms and used an analysis of structural equation modelling to find out that there was a positive effect of external logistics integration on agility performance. Braunscheidel and Suresh (2009) found that external integration has a positive influence on firm's supply chain agility. Singh and Power (2009) analysed 418 Australian manufacturing firms by using multiple regression analysis and they ascertained that customer relationship and supplier involvement have a positive influence on a firm's performance. Rajaguru and Matanda (2009) investigated 231 Australian food and hardware retailing firms through an analysis

of structural equation modelling and they verified that inter-organisational information systems integration and inter-organisational activity integration have a positive influence on supply chain organisational performance and financial performance. Zacharia et al. (2009) analysed 342 US firms included various industries to use an analysis of structural equation modelling and they confirmed that the positive effect of an inter-firm collaboration level on operation outcomes and rational outcomes. Wong et al. (2011) analysed 151 Thai automotive firms to use an analysis of structural equation modelling and they found that supplier and customer integration have a positive influence on delivery, production cost, product quality and production flexibility as performance. Boon-itt and Wong (2011b) proved the positive effect of external integration on delivery, production cost, product quality and production flexibility as operational performance. In addition, Schoenherr and Swink (2012) ascertained that external integration has a positive effect on quality performance, delivery performance, flexibility performance and cost performance.

In summary, the existing literature largely establishes that external collaboration has a positive influence on performance. Only few studies could not find significant influence. For instance, Stank et al (1999a) investigated 47 US food firms through multiple regression analysis and they found that partnering as inter-firm supply chain coordinating processes has no effect on performance in delivery relative to competitors. Stank et al. (2001) established that external collaboration has no effect on logistical service performance. Stank et al. (2001/2002) confirmed that customer integration has no effect on logistics cost, delivery dependability, information systems support, order fill capability, advanced ship notification, inventory turnover and return on asset (ROA) and that supplier integration has no effect on customer satisfaction, product customization, delivery speed, logistics cost, delivery dependability, order flexibility, delivery flexibility, information system support, order fill capability, advanced ship notification, inventory turnover and ROA as supply chain logistics. Droge et al. (2004) verified that external integration has no effect on financial performance. Rodrigues et al. (2004) verified that integrated external operations have no effect on logistics performance. Lee et al. (2007)

confirmed that customer linkage has no effect on cost-containment as supply chain performance. Rajaguru and Matanda (2009) proved that inter-organisational information systems and inter-organisational activity have no effect on customer responsiveness. Flynn et al. (2010) ascertained that customer integration has no influence on business performance and supplier integration has no influence on operational performance and business performance. Boon-itt and Wong (2011a) found that customer integration has no effect on customer delivery performance. Danese and Romano (2011) proved that customer integration has no effect on efficiency as a result of analysing 200 manufacturing firms through multiple regression analysis. Bae (2012a) established that external integration has no effect on customer service performance.

The third perspective is connected with supply chain collaboration, normally as a combination of internal and external collaboration. Researchers have confirmed that supply chain collaboration has a positive influence on various performances. This can be explained as follows. Stank et al. (1999a) found that effective communication, information exchange, partnering and performance monitoring as inter-firm supply chain coordinating have a positive influence on absolute performance in delivery service. Stank et al. (2001/2002) verified that internal integration has a positive effect on logistics cost, delivery dependability, order fill capability and inventory turnover and customer integration has a positive effect on customer satisfaction, product customization, delivery speed, responsiveness, order flexibility and delivery flexibility. Rosenzweig et al. (2003) analysed 238 manufacturing firms through the use of multiple regression analysis and they found that supply chain integration intensity has a positive effect on product quality, delivery reliability, process flexibility and cost leadership as competitive capabilities and revenue from new products and ROA as business performance. Droge et al. (2004) established that internal integration has a positive influence on product development time, product cycle time, responsiveness and financial performance and external integration has a positive influence on product development time, product cycle time, responsiveness and market share performance. Fynes et al. (2004) investigated 200 manufacturing firms in various countries using an

analysis of structural equation modelling and they ascertained that supply chain relationship quality has a positive effect on supply chain performance. Rodrigues et al. (2004) found the positive effect of composition of integrated internal operations and integrated external operations on logistics performance. Fynes et al. (2005) verified that customer cooperation has a positive influence on adaptation. Rai et al. (2006) analysed 432 manufacturing and retail organisations to use an analysis of structural equation modelling and they found that supply chain process integration has a positive influence on firm performance. Germain and Iyer (2006) established that internal integration and downstream integration have a positive effect on logistical performance and the interaction between internal integration and downstream integration has a positive effect on logistical performance. Lee et al. (2007) found that a strong linkage with customers, suppliers and functions has a positive effect on supply chain performance, customer linkage has a positive effect on performance reliability, supplier linkage has a positive effect on cost-containment and performance reliability and internal linkage have a positive effect on cost-containment and performance reliability. Aryee et al. (2008) analysed 29 UK manufacturing firms using multiple regression analysis and they verified that supply chain process integration has a positive influence on organisational performance and supply chain collaborative strategies have a positive influence on operational performance. Braunscheidel and Suresh (2009) ascertained that internal integration and external integration have a positive influence on firm's supply chain agility. Richey et al. (2009) investigated 581 U.S. manufacturing firms through multiple regression analysis and, consequently, they ascertained that orientation on continuous improvement of the processing supply chain integration and levels of environmental driver of supply chain integration have a positive effect on firm performance. Flynn et al. (2010) ascertained that internal integration has a positive effect on operational performance and business performance and customer integration has a positive effect on operational performance. Richey et al. (2010) analysed 254 U.S. manufacturing firms through an analysis of structural equation modelling and they confirmed the negative effect of barrier to integration on supply chain performance and the positive effect of facilitators to integration

on supply chain performance. Boon-itt and Wong (2011a) found the positive effect of internal integration, supplier integration and customer integration on customer delivery performance. In addition, Boon-itt and Wong (2011b) confirmed that internal integration has a positive influence on delivery, production cost and product quality, external integration has a positive influence on delivery, production cost, product quality and production flexibility as operational performance and the moderating effect of internal integration and external integration has a positive effect on just production cost and production quality. Similarly, Wong et al. (2011) found that internal integration, supplier integration and customer integration have a positive effect on delivery, production cost, product quality and production flexibility. In addition, Schoenherr and Swink (2012) established that internal integration and external integration have a positive influence on performance such as quality performance, delivery performance, flexibility performance and cost performance.

In short, the existing literature largely ascertains that supply chain collaboration has a positive influence on performance. Only few studies could not find significant influence. For example, Stank et al. (2001/2002) found that supplier integration has a negative effect on responsiveness. Droge et al. (2004) found that internal integration has no effect on market share performance and external integration has no effect on financial performance. Resenzweig et al. (2003) found that supply chain integration intensity has no effect on customer satisfaction and sales growth. Rodrigues et al. (2004) established that integrated internal operations and integrated external operations have no effect on logistics performance. In addition, Sezen (2008) analysed 196 Turkish manufacturing firms to use multiple regression analysis and, consequently, stated that supply chain integration has no effect on supply chain performance such as flexibility performance, resource performance and output performance.

The relationship between internal collaboration and performance could be understood by resource-based theory (Green et al., 2012; Rungtusanatham et al., 2003). Resources of firms can be classified into human resources, physical resources and organisational resources (Barney, 1991; Grant, 1991;

Peteraf, 1993; Wernerfelt, 1984). Inter-departmental collaborative culture, collaborative problem-solving capability and flexible information sharing between functions as resources of firms are characteristics of internal collaboration, which are a form of organisational resources (Stank et al., 1999a). These kinds of resources can increase communication between functions, making it possible to achieve collaborative goals and remove overlaps and inefficiency in inter-departmental works. As a result, firms can structure efficient processes and attain high performance. Prior research has suggested that contingency theory also explains the contingency effects of environmental effects on relationship between collaboration and performance (Ettlie and Reza, 1992; Flynn et al., 2010; Tsai et al., 2012; Wong et al., 2011). The theory in general explains that there is no the best organisational structure which can be fit in all contexts (Lawrence and Lorsch, 1967; Miller, 1987; Thompson, 1967). Firms can be influenced by the environment and, as a result, the relationship between the environment and performance is mediated by strategy (like collaboration). From this viewpoint, there is a dimension in the relationship between the environment, strategy and performance and how firms focus on strategy (like collaboration) on the basis of recognition on the environment which they face and this is connected with superior performance. These theories are the basis of the positive relationship between internal collaboration and performance suggested by the prior research. Next, the relationship between external collaboration and performance has been explained by the information processing theory (Galbraith, 1973; Thompson, 1967; Wong et al., 2011). It argues that the efforts in external collaboration help firms to obtain valuable information from external sources, which, if used effectively in planning and coordination of supply chain decisions, may have a direct influence on performance. This theory explains the positive relationship between external collaboration and performance reported by the prior research. In addition, relational view explains the relationship between external collaboration and performance. The important resources of firms are put in inter-firm activities and this has a positive influence on inter-firm routines and processes. From this viewpoint, external collaboration enhances performance through the inter-organisational rent-

generating process such as learning, lower transaction costs and pooling of resources (Dyer and Singh, 1998).

In addition, some researchers have found that the interaction between internal collaboration and external collaboration has a positive effect on performance and the other researchers have verified that the interaction between supplier collaboration and customer collaboration has a positive effect on performance. For example, Droge et al. (2004) established that the interaction between internal integration and external integration has a positive effect on market share performance and financial performance. Germain and Iyer (2006) ascertained that the interaction between internal integration and downstream integration has a positive influence on logistical performance. Boon-itt and Wong (2011b) found that the interaction between internal integration and external integration has a positive influence on production cost and product quality as operational performance. Schoenherr and Swink (2012) verified that the interaction between internal integration and external integration has a positive influence on delivery performance and flexibility performance. Similarly, Flynn et al. (2010) established that the interaction between customer integration and supplier integration has a positive influence on operational performance. In addition, Danese and Romano (2011) found that the interaction between customer integration and supplier integration has a positive effect on efficiency.

The results have been partly explained by contingency theory. The theory argues for the importance of the fit (as moderation) between strategy and the environment (Venkatraman, 1989), and such a fit (in this case, fit between internal and external collaboration) has a positive effect on performance. In this regard, firms need to find strategy (like collaboration) with respect to the environment for maximizing performance. From this viewpoint, suppliers and customers can be regarded as environmental factors (Flynn et al., 2010). This explains that firms maximize performance through interaction with the environment (using external collaboration).

In addition, the effect of the dimensions of collaboration on performance can be explained by the information processing theory. The theory explains that when managers change internal processes

through understanding of the variation of the market and customer needs, performance can be improved. From this viewpoint, there are various dimensions of supply chain collaboration in prior research and these have a positive influence on performance (Bae, 2012b; Kannan and Tan, 2010; Narasimhan and Kim, 2001). The clear classification of the dimensions is perhaps useful in explaining the relationship between the dimensions and performance found in the prior research. For instance, Daugherty et al. (1996) investigated 127 manufacturing firms (66.7%), retailers (11.8%), wholesalers (11.8%) and mixed firms in the type of business (9.5%) through a t-test and they found that integrated firms enjoy high performance compared with non-integrated firms. Stank and Larkey (1997) analysed 51 firms in various countries using a t-test and they found that high levels of functional integrative firms have high performance compared with low levels of functional integrative firms in estimated percent of on-time deliveries of shipments to customers, high levels of information-integrative firms have high performance compared with low levels of information-integrative firms in estimated percentage of on-time deliveries of shipments to customers and high levels of supplier-relative firms have high performance compared with low levels of supplier-relative firms in estimated percent of on-time deliveries of shipments to customers. Stank et al. (1999b) used a t-test and they established that there are gaps in performance between a high integrated group and a low integrated group. Frohlich and Westbrook (2001) investigated 322 firms concerned with the manufacture of fabricated metal products, machinery and equipment to use discriminant analysis and analysis of variance (ANOVA) and they divided arc of integration into inward-facing, periphery-facing, supplier-facing, customer-facing and outward-facing. As a consequence, they found that the greater the arcs of supplier integration and customer integration, the larger the rates of performance improvement in areas such as marketplace, productivity and non-productivity. Narasimhan and Kim (2001) analysed 244 manufacturing firms to use correlation analysis and they divided supply chain integration into independent operation of each function, functional integration, internal integration and external integration. Accordingly, they verified that there are gaps in information systems for value creation

management, information systems for logistical operations and information systems for infrastructural support between the level of cost reduction and the level of differentiation of supply chain integration. Gimenez and Ventura (2005) used a t-test which is divided into most collaborative relationship and least collaborative relationship on the basis of internal integration such as logistics/productivity and logistics/marketing and external integration and an analysis of structural equation modelling to verify that internal integration between logistics and productivity has a positive influence on performance in a least collaborative relationship and external integration has a positive influence on performance in both of the relationships. Gimenez (2006) investigated 51 food manufacturers through cluster analysis and ANOVA and they divided integration into external and internal clusters which have logistics/production parts and logistics/marketing parts . In consequence, they proved that a cluster of high internal integration achieves high external integration, a cluster of medium internal integration achieves high and medium external integration and a cluster of low internal integration achieves low external integration. Kim (2006) analysed 623 firms in consumer product industry to use hierarchy regression analysis and divided integration into independent operation, internal integration and external integration. Therefore, he found that performance of a group of external integration is higher than performance of a group of internal integration, which is higher than performance of a group of independent operation. Liao and Tu (2008) divided manufacturing system integration into a high group and a low group. They verified that manufacturing system integration has a positive effect on manufacturing performance in just a group of high manufacturing system integration. Flynn et al. (2010) used cluster analysis and ANOVA and they confirmed that there are gaps in operational performance and business performance among clusters of supply chain integration such as low uniform, medium uniform, high uniform, medium customer learning and high customer learning. Kannan and Tan (2010) analysed 321 data coming from managers in U.S. and Europe. They used t-tests to analyse the data and divided integration into customer focus, supplier focus, supply chain focus and information focus. In consequence, they proved that span of integration is shown in

difference between broad span of integration and narrow span of integration and there are gaps in relationship performance such as sales improvement, quality improvement and new product development time reduction between broad span of integration and narrow span of integration. Saeed et al. (2011) analysed 50 firms using cluster analysis, ANOVA and post hoc analysis (Turkey test) and they divided supply chain integration into a high group, a medium group and a low group. In consequence, they ascertained that there are gaps in strategic integration, operational integration and functional integration between high and low groups, high and medium groups, and medium and low groups. Bae (2012b) analysed 275 forwarders using cluster analysis, ANOVA and post hoc analysis (Duncan test) and proved that there are gaps in performance among development stages of integration in SCM such as independent operation, internal integration, external integration and supply chain integration. The understanding of this phenomenon can be the basis for the relationship between supply chain collaboration and operational performance. Managers could choose to achieve a different level of supply chain collaboration, such as internal collaboration, external collaboration or supply chain collaboration, based on the priority of the business, the perceptions of the need for collaboration, the ability to integrate and perhaps on the influence of environmental uncertainty, and with the new insights they can explain the relationship between supply chain collaboration as a whole and performance.

2.3.2 The impacts of environmental uncertainty

The environment is defined as overall factors having potential and substantial effects on firms and is the source of some uncertainty. Prior research divides approaching methods to the environment into an approach to components and into an approach to characteristics. The former classifies it into composite factors and the factors have an influence on firms' performance. It is classified into the task environment and the general environment. The latter classifies it into various characteristics and the

characteristics are grouped in several dimensions like munificence, dynamism, heterogeneity and hostility (Bae, 2011; McGinnis and Kohn, 1993). In this regard, environmental uncertainty is defined as a degree of difficulty of prediction to outcomes or the future (Chow et al., 1995) and this research divided environmental uncertainty into munificence defined as a degree of continuous growth of a market caused by environmental variance (Clinton, 1997; McGinnis and Kohn, 1993), dynamism defined as the difficulty of predicting a change in the market (Clinton, 1997; McGinnis and Kohn, 1993), heterogeneity defined as the change of competitive methods of competitors and customers' preferences and expectations (Clinton, 1997; McGinnis and Kohn, 1993) and hostility defined as the degree of competition and regulations of the government in the market (Clinton, 1997; McGinnis and Kohn, 1993).

In terms of the roles and impacts of environmental uncertainty, prior research is dominated by two viewpoints. The first viewpoint regards environmental uncertainty as an antecedent of supply chain collaboration, or a driver for the need of supply chain collaboration. Some researchers found that environmental uncertainty has a positive influence on collaborative strategies. Paulraj and Chen (2007b) verified that supply uncertainty and technology uncertainty have a positive effect on strategic supply management. In addition, Ragatz et al. (2002) verified that technology uncertainty has a positive effect on integrative strategies with suppliers. The results support that environmental uncertainty has a positive effect on various strategies. These results can be explained as follows. Celho and Easingwood (2005) investigated 62 UK financial service firms through an analysis of structural equation modelling and they found that environmental volatility, environmental heterogeneity and environmental conflict have a positive effect on utilization of multiple channels of distribution. Agbejule and Burrowes (2007) analysed 78 Finland manufacturing firms using multiple regression analysis and they established the positive effect of perceived environmental uncertainty on supplier development. Fink et al. (2008) investigated 372 U.S. manufacturing firms through an analysis of structural equation modelling and they confirmed that technology uncertainty and resource

availability as environmental uncertainty have a positive effect on increased customer purchases from suppliers over duration of the relationship in short term and long term. Hsu and Wang (2008) analysed 130 Taiwanese firms to use multiple regression analysis and they ascertained the positive effect of perceived environmental uncertainty on knowledge sharing policies and practices. Ryu (2008) investigated 135 US manufacturing firms to use multiple regression analysis and they found that environmental uncertainty has a positive effect on a manufacturer's propensity for vertical control over its supplier's decision. Jokipii (2010) investigated 741 Finnish firms through an analysis of structural equation modelling and found the positive effect of high perceived environmental uncertainty on an internal control structure. In addition, Ragatz et al. (2002) investigated 83 US manufacturing firms through an analysis of structural equation modelling and they found the positive effect of technology uncertainty on integrative strategies with suppliers. Paulraj and Chen (2007b) analysed 221 US manufacturing firms using an analysis of structural equation modelling and they implied that supply uncertainty and technology uncertainty have a positive influence on strategy supply management. These results reflect the factors as follows. Environmental uncertainty means that there are opportunities in the market because the environment is changed. From the viewpoint, firms can seize the opportunities through their strategies. This is explained by the relationship between the environment and strategy and proved from the viewpoint of contingency theory.

Some of these studies have also found that the impacts of environmental uncertainty on performance can be mediated by supply chain collaboration. This can be explained as follows. Ragatz et al. (2002) established that technology uncertainty has a positive effect on integrative strategies with suppliers, which has a negative effect on cost results which means cost saving. In addition, Paulraj and Chen (2007b) used structural equation modelling and they found that supply uncertainty and technology uncertainty have a positive effect on strategic supply management, which has a positive effect on buyer performance.

There are other studies which could not find the effect of environmental uncertainty on various collaborative strategies. For example, Paulraj and Chen (2007b) ascertained that demand uncertainty has no effect on strategic supply management. Pagell and Krause (2004) analysed 168 US manufacturing firms using structural equation modelling and they found that perceived environmental uncertainty such as munificence, instability and complexity has no effect on manufacturing flexibility. Babakus et al. (2006) investigated 257 manufacturing firms through an analysis of structural equation modelling and they demonstrated that environmental uncertainty such as labour market, supplier market, customer market and capital market has no effect on networking such as domestic networking activities and foreign networking activities. Fink et al. (2008) analysed 372 US manufacturing firms using an analysis of structural equation modelling and they confirmed that environmental uncertainty such as technological uncertainty and resource uncertainty has no effect on increased customer purchases from suppliers over duration of the relationship in intermediate term. Wood (2008) investigated 153 US firms through an analysis of structural equation modelling and ascertained that perceptions of external environmental uncertainty have no effect on perception of the availability of alternatives. Similarly, Paulraj and Chen (2007b) using structural equation modelling, they ascertained that demand uncertainty has no effect on strategic supply management. It is still unclear exactly why the collaborative strategies of the samples in these studies are not affected by environmental uncertainty.

The above two conflicting sets of results show that the relationship between environmental uncertainty and supply chain collaboration is still debatable. In this situation, because supply chain collaboration can be regarded as a crucial strategy, more research is needed to verify the relationships between environmental uncertainty, supply chain collaboration and operational performance. According to the existing literature, the relationship between these variables can perhaps be explained as contingency theory, when environmental uncertainty is considered an antecedent or driver of supply chain collaboration (fit as mediation, see Venkatraman, 1989). This contingency theory

explains that firms are affected by the environment and, therefore, need to develop organisation structures and processes to align or fit with the environment (Lawrence and Lorsch, 1967; Miller, 1987; Thompson, 1967; Venkatraman, 1989).

The second viewpoint regards environmental uncertainty as an exogenous (contingency) factor which moderates the relationship between supply chain collaboration and performance (fit as moderation, see Venkatraman, 1989). Prior research verified that firms could improve performance through supply chain collaboration when there is high environmental uncertainty. For example, Dess et al. (1997) investigated 96 firms through multiple regression analysis and they ascertained that the interaction between environmental uncertainty, cost leadership and entrepreneurship has a positive effect on profitability and sales growth, the interaction between environmental uncertainty, marketing differentiation and entrepreneurship has a positive effect on sales growth, the interaction between environmental heterogeneity, marketing differentiation and entrepreneurship has a positive effect on sales growth. Sahadev (2008) investigated 101 firms using moderating regression analysis and they found that the interaction between environmental uncertainty and economic satisfaction has a positive effect on relationship commitment. Similarly, Iyer (2011) established that the interaction between technological turbulence as environmental uncertainty and information technology analytical capability has a positive effect on demand chain collaboration.

In addition, some researchers have found that environmental uncertainty moderates the relationship between collaboration and performance. For instance, Liao and Tu (2008) also found that manufacturing system integration can improve manufacturing performance when there is high environmental uncertainty. O'Leary-Kelly and Flores (2002) investigated 121 manufacturing firms in various industries using multiple regression analysis and they found that demand uncertainty moderates the relationship between marketing/sales planning decision integration and perceived profitability. Narasimhan and Kim (2002) analysed 623 manufacturing firms through moderated regression analysis and they verified that international market diversification moderates the

relationship between company's integration with suppliers and profitability and the relationship between company's integration with customers and profitability. In addition, they found that product diversification moderates the relationship between internal integration and profitability. Fynes et al. (2004) established that demand uncertainty and supply uncertainty moderates the relationship between supply chain relationship quality and supply chain performance. Liao and Tu (2008) found that manufacturing system integration has a positive influence on manufacturing performance when there is high environmental uncertainty. Boon-itt and Wong (2011a) confirmed that technological uncertainty moderates the relationship between internal integration and customer delivery performance and the relationship between supplier integration and customer delivery performance and demand uncertainty moderates the relationship between internal integration and customer delivery performance and the relationship between supplier integration and customer delivery performance. Similarly, Wong et al. (2011) found that environmental uncertainty moderates the relationship between internal integration and performance such as delivery, production cost, product quality and production flexibility, the relationship between supplier integration and performance such as delivery, production cost, product quality and production flexibility and the relationship between customer integration and performance such as production cost, product quality and production flexibility.

Other researchers could not prove firm performance being enhanced by the interaction between the environment and collaboration. For example, Iyer (2011) could not prove that market turbulence moderates the relationship between information technology (IT) analytic capability and demand chain collaboration. Dess (1997) analysed 96 data from 32 U.S. firms and, by using multiple regression analysis, they found that environmental uncertainty and environmental heterogeneity could not moderate the relationship between entrepreneurship and profitability, sales growth and overall performance; environmental uncertainty could not moderate the relationship between entrepreneurship and cost leadership and overall performance; environmental heterogeneity could not moderate the relationship between entrepreneurship and cost leadership and profitability, sales growth

and overall performance; environmental uncertainty could not moderate the relationship between entrepreneurship and marketing differentiation and profitability; and overall performance, environmental heterogeneity could not moderate the relationship between entrepreneurship and marketing differentiation and profitability; environmental uncertainty could not moderate the relationship between entrepreneurship and innovative differentiation and sales growth; environmental heterogeneity could not moderate the relationship between entrepreneurship and innovative differentiation and profitability and sales growth. Fynes et al. (2004) could not verify the moderating effect of technological uncertainty on the relationship between supply chain relationship quality and supply chain performance. Boon-itt and Wong (2011a) could not ascertain the moderating effect of technological uncertainty on the relationship between customer integration and customer delivery performance and the moderating effect of demand uncertainty on the relationship between customer integration and customer delivery performance. Similarly, Wong et al. (2011) could not find the moderating effect of environmental uncertainty on the relationship between customer integration and delivery. This suggests that the moderating effect of environmental uncertainty on the relationship between supply chain collaboration and performance is still unclear.

The moderating effect of environmental uncertainty on the relationship between supply chain collaboration and performance has also been explained by contingency theory which shows that firms can improve performance through changing strategy in conformity with environmental variance. Venkatraman (1989) insisted that fit as moderation between the environment and strategy could enhance performance in a contingency perspective. The perspective explains that corporate strategic behaviours like collaboration yields better performance through interaction with environmental conditions (Atuahene-Gima and Murray, 2004). This means that the interaction between environmental uncertainty and supply chain collaboration enhances performance, according to the contingency theory put forward by Wong et al. (2011).

In addition, some researchers have ascertained that environmental uncertainty has a negative effect

on performance but the others have found that environmental uncertainty has a positive effect on performance. First, there is a negative effect on the relationship between environmental uncertainty and service performance (Wood, 2008) as well as a manufacturer's satisfaction with the perceived supplier performance (Ryu et al., 2008). In addition, Ryu et al. (2008) investigated 135 US manufacturing firms and, through multiple regression analysis, they confirmed that environmental uncertainty has a negative influence on a manufacturer's satisfaction with the perceived supplier performance. Similarly, Wood (2008) analysed 153 US firms using an analysis of structural equation modelling and ascertained that perceptions of external environmental uncertainty have a negative effect on service performance. Second, there is a positive effect on the relationship between environmental uncertainty and service performance. For instance, Dess et al. (1997) analysed 96 firms through multiple regression analysis and they ascertained that the interaction between environmental heterogeneity, marketing differentiation and entrepreneurship has a positive effect on overall performance; the interaction between environmental uncertainty, innovation differentiation and entrepreneurship has a positive effect on overall performance and the interaction between environmental heterogeneity, innovation differentiation and entrepreneurship has a positive effect on overall performance. Moreover, there is no effect of environmental uncertainty on performance. For example, Babakus et al. (2006) investigated 257 manufacturing firms through an analysis of structural equation modelling and they found that environmental uncertainty such as labour market, supplier market, customer market and capital market has no effect on export performance. Wood (2008) analysed 153 U.S. firms to use an analysis of structural equation modelling and verified that perceptions of external environmental uncertainty have no effect on perceived alternatives. These results show that the relationship between environmental uncertainty and performance is not clear. This means that the relationship between the environment and performance can be explained by contingency theory. The theory explains that the environment exists outside firms and is affected by them. From this viewpoint, if there is high environmental uncertainty, firms need to acquire market

information and customer needs and they should make an effort to get information from the market because of a lack of existing information. Hence, high environmental uncertainty has a negative effect on performance. However, extant research shows contradictory results. This is based on analysing the relationship between environmental uncertainty and operational performance.

2.3.3 Global supply chain collaboration of manufacturing firms

Supply chain collaboration plays an important role in global SCM of Korean manufacturing firms. They engage in foreign investment to buy raw materials, manufacture products and sell the products overseas. They need to manage the relationships between functions and the relationships between suppliers and customers in order to achieve efficiency and effectiveness. These capabilities to manage supply chain relationships have received recognition as core competence in conformity with the globalisation of value chain in manufacturing firms (Hocker, 2007; Ireland, 2005). In addition, supply chain collaboration is being recognized as a core driver of supply chain relationships; meaning manufacturing firms can improve supply chain relationships by developing supply chain collaboration. In this regard, research on supply chain collaboration is surely important from the viewpoint of global SCM.

From the viewpoint of global SCM, Korean manufacturing firms in China have different goals from Korean based firms. According to prior research, the goals can be divided into resource-seeking, market-seeking and efficiency-seeking (Buckley and Casson, 1976). They would use various advantages (e.g., OLI paradigm: ownership, location and internalization) as well as collaboration with suppliers and customers for survival in the foreign market and, consequently, they could achieve their goals. A detailed search of the existing literature which confirms positive links between supply chain collaboration and performance reveals that some of the survey samples include foreign investment firms. For instance, Stank and Larkey (1997) investigated firms on location at their parent company's

main headquarters in North America, Western Europe and Pacific Rim and ascertained negative correlation between integration and performance. Frohlich and Westbrook (2001) divided samples by region into Asia/Pacific, Europe, North America and South America and confirmed that arcs of external integration enjoy the largest rate of performance improvement. Salvador et al. (2001) gathered data records from firms which have various nationalities such as German, Japanese, UK and US and confirmed that interaction for flow management and interaction for quality management has a positive influence on punctuality of delivery in interactions with customers and suppliers and operational speed in interactions with customers and suppliers. Spina and Zotteri (2001) gathered 218 data records from firms which are located in ten countries in Europe and America such as Italy, Spain, UK, the Netherlands, Denmark, Norway, Sweden, US, Argentina and Brazil. They found high correlation between operations integration among suppliers and customers and purchasing costs. Narasimhan and Kim (2002) confirmed the relationship between integration, diversification and performance when comparing 244 Korean firms and 379 Japanese firms from a total of 623 manufacturing organizations. They found that supplier integration and customer integration had a positive effect on performance such as sales growth, market share growth and profitability by way of international market diversification and internal integration has also a positive effect on performance by way of product diversification. Similarly, Kim (2006) gathered 623 data records and ascertained that a group with external integration had the highest performance compared with one of a group of internal integration and one of a group of independent operations for each function. Rosenzweig et al. (2003) gathered information on 238 manufacturing firms in various regions such as North America (45%), Europe (30.2%), Asia-Pacific (14.3%) and Latin America (10.5%) and established that supply chain integration intensity had a positive effect on revenue from a new product and ROA. Fynes et al. (2004) gathered data on 200 manufacturing firms such as Irish (52%), UK (2.5%), other European (14.5%), US (25%), Japan (2%) and others (3.5%) and confirmed that supply chain relationship quality had a positive influence on supply chain performance. Bagchi et al. (2005) divided regions of

respondent firms into Denmark (27 firms), Finland (14 firms), Norway (12 firms), Sweden (19 firms), Austria (7 firms), Germany (27 firms), Netherlands (7 firms) and UK (36 firms) in total, 149 firms, and verified that inventory turnover ratio in large firms is higher than that of small firms after supply chain integration. Fynes et al. (2005) also classified 200 manufacturing firms such as 55% in Irish, 5% in UK, 14% in other EU, 20.5% in US, 2% in Japan and 3.5% in others and found that customer cooperation has a positive influence on relationship adaptation with customers. Babakus et al. (2006), in research concerned with small and medium size enterprises in Finland (75 firms), Sweden (111 firms) and Norway (71 firms) in total 257 firms, found that foreign networking activities have a positive effect on export performance. Cagliano et al. (2006) gathered data records from firms located in various countries such as Belgium (14 firms), Denmark (30 firms), Germany (23 firms), Hungary (30 firms), Ireland (25 firms), Italy (53 firms), Norway (39 firms), Netherlands (12 firms), Spain (15 firms), Sweden (19 firms) and UK (37 firms) in total 297 firms and ascertained that integration of information flows with suppliers and integration of physical flows with suppliers are affirmatively affected by lean production. So and Sun (2010) gathered 558 data records from firms located in 17 countries such as Argentina (14 firms), Australia (40 firms), Belgium (19 firms), Brazil (35 firms), China (30 firms), Croatia (35 firms), Denmark (38 firms), Germany (32 firms), Hungary (58 firms), Ireland (32 firms), Italy (60 firms), the Netherlands (14 firms), Norway (51 firms), Spain (20 firms), Sweden (19 firms), UK (47 firms) and US (14 firms) and found that supplier integration had a positive influence on lean manufacturing. Thun (2010) gathered 238 data records from firms in Austria (8.8%), Finland (12.6%), Germany (17.2%), Italy (11.4%), Japan (14.7%), Korea (13.0%), Sweden (10.1%) and US (12.2%) and confirmed that supply chain integration and IT integration are positively connected with arcs of supply chain integration. Boon-itt and Wong (2011b) also divided ownership of respondents into Thai owned (48%), Thai-foreign joint ventures (34%) and foreign owned (18%) in total 151 Thai automotive firms and verified that internal integration and external integration have a positive influence on operational performance and external integration enhances the

relationship between internal integration and production cost as well as product quality. Gimenez et al. (2012) collected 145 data records from the Netherlands (80 firms) and Spain (65 firms) and established that cooperative behaviour, structural communication, delivery integration and joint improvement have a positive effect on cost and service. These studies provide us with some initial clues to the value of supply chain collaboration for manufacturing firms which invest in a foreign market.

Even though manufacturing firms investing in foreign markets form part of the samples for these studies, to the author's knowledge, none of the above studies attempt to examine whether the performance implications of supply chain collaboration for manufacturing firms investing in foreign markets are different from other types of firms. As a result, they did not reflect how they perform in terms of supply chain collaboration. On the one hand, one might expect manufacturing firms from advanced countries to perform better than local firms from the low-cost countries. Contrarily, they might not be able to simply bring or replicate the existing integrated supply chain when they invest in another country. They might need to establish a new supply chain and customer base and start building up collaborative relationships with new suppliers and customers in the new country, meaning they may go through different levels of supply chain collaboration. Thus, verifying the effect of supply chain collaboration on performance of Korean manufacturing firms in China is connected with verifying the degree of collaboration with their suppliers and customers. This new insight can perhaps be related to the needs for manufacturing firms investing in foreign markets to achieve their goals such as resource-seeking, market-seeking or efficiency-seeking. Without such new insight it is hard to explain to Korean manufacturing firms in China how they may manage their supply chain collaboration efforts to achieve a desirable performance.

2.4 Summary

The research on the relationship between firms was started by Coase (1937). Coase (1937) suggested the concepts of market and hierarchy and, later, Hymer (1968) explained the relationship between firms as a degree of control. On the basis of their works, Williamson (1975) explained the network as an intermediate form between market and hierarchy (Stock et al., 2000). According to Williamson (1975), on the basis of a high or low level of market failure and organisational failure, firms would select long-term contractual relationships like alliance rather than choosing either a market like licensing or hierarchy like vertical integration. Therefore, this research classifies the relationships between firms as market (licensing), network (supply chain collaboration) and hierarchy (independent subsidiary firms) by a degree of control and explains supply chain collaboration from the viewpoint of market failure and organisational failure.

Firms maintain the relationship between organisations through vertical integration because of transaction costs in the market which have a high risk of market failure. This is regarded as internalising transactions, which have a high possibility of benefits compared with transactions in the market but presents difficulty for entry and withdrawal. If firms maintain the relationship between organisations through transaction (licensing) in the market which has a high risk of organisational failure, this has not only an advantage of convenience to entry and withdrawal in the market but also a disadvantage of low benefits following a low level of control. Therefore, firms continuously maintain the relationship between firms through an alliance or a long-term contractual relationship in the market when both market failure and organisational failure are high or low. If the risks of market failure and organisational failure are low in the market, firms can acquire high benefits through the network because of a high level of control compared with market. Against which, they can enjoy easy entry and withdrawal through the network because of a low level of control compared with hierarchy, if the risks of market failure and organisational failure are high in the market. Under the

circumstances, Korean manufacturing firms in China should maintain the relationship with partners through supply chain collaboration such as an alliance or a long-term contractual relationship. Therefore, this research investigates supply chain collaboration between suppliers and customers on the basis of Korean manufacturing firms in China.

Research concerned with supply chain collaboration is performed in this chapter. The first is the performance implication of supply chain collaboration. Prior research has proved that supply chain collaboration as internal collaboration, supplier collaboration and customer collaboration has a positive influence on performance. The second is the impact of environmental uncertainty as an antecedent of supply chain collaboration and a moderating factor on the relationship between supply chain collaboration and performance. Prior research has ascertained the positive effect of environmental uncertainty on supply chain collaboration and the moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance. The third is the impact of environmental uncertainty on performance. Prior research has verified the negative effect of environmental uncertainty on performance and this provides justification to this research. However, some research papers have shown different results from the above. These results explain that the relationships between the variables are still undetermined. In particular, the role of environmental uncertainty between supply chain collaboration and operational performance is still unclear, either as an antecedent or as a moderator. Therefore, this forms the basis of this research. The last is supply chain collaboration concerning manufacturing firms investing in foreign markets. Following the theoretical explanations of prior research concerned with supply chain collaboration that have been discussed, the frameworks connected with the theoretical background provide the variables used in this research, the research models and the hypotheses.

Chapter III Theoretical Framework

3.1 Introduction

Theories governing the development of the theoretical framework are first presented in this chapter. Definitions of variables from prior research are presented. Conceptual definitions and theoretical explanations on different levels of supply chain collaboration are represented next. Then, research models and hypotheses are developed. Finally, a summary of this chapter follows.

3.2 Theoretical background

3.2.1 Contingency theory

Contingency theory explains that it is possible for successful organisations to have a different structure and strategy and this depends on their recognition of the environment. In other words, firms achieve high performance through a different structure and strategy in a different environment. In this regard, the theory stresses a fit between the environment and the organisation and it has a direct influence on performance (Venkatraman, 1989). Research on contingency theory was started by Chandler (1962) and Woodward (1965) and it was developed by Lawrence and Lorsch (1967) and Thompson (1967). The theory explains the relationship between contingency factors (the environment, technology and scale) as independent variables, organisational factors (structure and strategy) as internal characteristics and performances as organisational efficiency. It also explains that there is no perfect organisational structure to fit in all environmental contexts through denying universality of organisation and, as a result, organisational structure should be changed by environmental variance. It preserves dynamic balance to lead the variance of organisations following environmental variance.

Therefore, organisations can grasp the root of organisational fit in conformity with environmental variance and the theory explains the reason of differences in performance between organisations.

The basic model of contingency theory has been used to understand the relationship between the environment, the organisation and performance (Chandler, 1962; Lawrence and Lorsch, 1967; Thompson, 1967; Venkatraman, 1989; Woodward, 1965). The environment means variables which have an effect on organisations and which exist outside of the organisations such as environmental uncertainty. For example, the classification of the environment is divided into an approach to components and an approach to characteristics. The former is to explain that environmental factors have a bigger influence on the behaviour and performance of firms compared with others. This can be classified into the task environment and the general environment. The latter is that the first grasps the characteristics of environmental factors in a complex viewpoint and, secondly, the characteristics are clearly explained by using several dimensions. It can be divided into characteristics of the environment like dynamism, hostility, heterogeneity and munificence (Bae, 2011; McGinnis and Kohn, 1993).

Organisational variables can be explained as structure and strategy. The variables are internal factors of firms and contingency theory explains achievement of fit between the environment and organisation through the variance of internal resources and management following environmental variance, followed by high performance. Structure stipulates the methods of classification on tasks and harmonization between tasks. It can be divided into complexity, formalization and centralization. Strategy can be explained as fitting firms following environmental variance for achieving their goals. It is performed by decision-making of a chief executive officer and it can be classified into corporate strategy, business unit strategy and functional strategy. Performance is concerned with a degree of achieving goals of firms and it can be divided into efficiency and effectiveness.

The fit between the environment and strategy had been investigated by Venkatraman (1989). Venkatraman (1989) stressed the role of the environment on the relationship between strategy and

performance. He suggested six distinct perspectives of the fit from the viewpoints of specificity and anchoring. This research explains the fit as moderation and the fit as mediation because both of them focus on the role of the environment (environmental uncertainty) on the relationship between strategy (supply chain collaboration) and performance (operational performance). First of all, the fit as moderation explains the interaction between the environment and strategy. From this viewpoint, the environment has an influence on strength or direction of the relationship between strategy and performance. To explain the moderation perspective, Venkatraman (1989) suggested four issues: “the distinction between form and strength of moderation, the role and impact of multicollinearity, the comparison of main versus interaction effects and the requirement of partialling out quadratic effects for testing the moderating effects” (p. 426). The first issue is concerned with analytical methodology. He insisted that researchers should clear up the concept of moderation and choose the analytical method which ensures correspondence between theory and verification, either moderated regression analysis or subgroup analysis. The second issue is concerned with multicollinearity. The core of an interaction effect or a moderating effect is to verify the effect of the additional variable consisted of multiplying an independent variable by a moderating variable on a dependent variable. In this regard, the additional variable must have high multicollinearity with the independent variable and the moderating variable. However, results can be trusted because the method does not change a variable itself. In addition, results have significant meanings enough to offset distortion of results by multicollinearity. Venkatraman (1989), as the third issue, suggested that there is no meaning to compare main effects with interaction effects because standardized coefficients have no meanings. The fourth issue is concerned with curvilinearity but he insisted that it has no effect on the interpretation of results.

The fit as mediation explains the intervening effect of strategy (supply chain collaboration) on the relationship between the environment (environmental uncertainty) and performance (operational performance). In other words, there is a direct effect between the environment and performance and

an indirect effect (intervention) of strategy on the relationship between the environment and performance (Venkatraman, 1989). The fit as mediation has an advantage to verify the effect of various variables on dependent variables. This viewpoint provides measuring structure to prove the relationship between the environment, strategy and performance (ESP).

Contingency theory explains organisations through understanding organisations in a systemic viewpoint and carrying out tasks of organisations in a practical viewpoint. However, there are three limitations: the first does not consider the internal environment such as employees, organisational culture and learning because of excessive emphasis on the external environment. The second is a lack of cognition on the process of organisational variance following environmental variance. The third is that political interaction could hinder communication on the contrary.

Contingency theory explains efforts of firms wanting to achieve high performance through internal reaction of organisations following environmental variances. In this situation, a core factor of the theory is to achieve the fit between the environment and the organisations. Firms would change the organisations in conformity with external environmental variances, followed by achieving value of them. In other words, the focus of the organisations is in the internal aspects when the environment is stable; whereas, when there is high environmental uncertainty, the focus moves on external aspects. In this regard, firms would acquire high value through organisational variances caused by environmental variances. The value can be explained by firm performance and it can be achieved by internal collaboration and external collaboration under the supply chain environment (Bae, 2012a).

Environmental uncertainty means a degree of difficulty in prediction of outcomes or the future (Chow et al., 1995). Firms should acquire the ability to provide customers with superior customer service and cooperate beyond functional areas for achieving a competitive advantage. Collaboration is extended from inter-functional relationships to inter-firm relationships including suppliers and customers (Ellinger, 2000). Firms focus on SCM for attaining customer needs and enhancing profits in the supply chain environment. SCM stands for the need of collaboration of firms' activities for

improving the relationships between firms as well as the relationships between departments and, consequently, they can enjoy sustainable competitive advantages in the market. From this viewpoint, this relationship between environmental uncertainty, supply chain collaboration and operational performance can be explained by contingency theory.

3.2.2 Resource-based theory

Resource-based theory explains competitive advantages of firms like unique resources and capability, which have an influence on performance and, from this viewpoint, firms focus on internal resources rather than the external environment for achieving competitive advantages (Barney, 1991; Peteraf, 1993). The theory has two important factors to grasp resources: heterogeneity and imperfect imitation (Barney, 1991). The former means that firms have unique resources and discriminative using capability on the resources. The resources and the capability are the cause of gaps in performance among firms and, as a result of superior resources and capability, firms can achieve competitive advantages. However, if competitors can imitate the resources and the capability in a short period of time, the competitive advantage is not continued, even though firms have these discriminative resources and capability. According to Barney (1991), there are conditions which resources should have for achieving continuous competitive advantages such as a historical condition, causal ambiguity and social complexity and firms want the resources, which are the basis of a sustainable competitive advantage in the market. Therefore, the non-movement of resources means that the unique resources and capability of firms cannot be moved or if it is possible, they could be imperfectly moved.

In resource-based theory, resources have an effect on structure and strategy which improve efficiency and effectiveness of firms and these resources mean assets, capability, organisational processes, characteristics, information, knowledge, know-how and others which are controlled by

firms (Barney, 1991). In this regard, the theory explains characteristics, types and scales concerned with resources and capability of the firms as decisive factors of benefits. For this reason, resources in the theory do not mean all resources of firms. According to the theory, resources mean the strategic resources and assets to contribute to acquisition of profits and competitive advantages of firms (Markides and Williamson, 1996). These resources 1) should be usefulness and a value which can avoid threat and acquire opportunity in the environment, 2) should be rareness which is not easily acquired by competitors, 3) should be not perfectly imitated by competitors and 4) should not exist strategically as the same substitute (Amit and Schoemaker, 1993). Firm's specific strategic resources which have these characteristics are important factors to determine a competitive advantage among firms. Firms which have these resources enjoy a sustainable competitive advantage in the market and the resources are a cause for making gaps in performance among firms.

An approach to resources can be explained by various methods. The simplest approach is that it can be divided into tangible resources and intangible resources (Grant, 1991; Allee, 2009). The former means tangible assets such as financial and physical assets and the latter means intangible assets such as reputation and technology. Tangible assets are efficient in a stable environment and intangible assets are effective in an uncertain environment. Therefore, intangible assets as strategic resources for ensuring competitive advantages of firms are more important than tangible assets in environmental uncertainty.

According to Miller and Shamsie (1996), resources can be divided into property-based resources and knowledge-based resources. The former can be explained as resources that mean legal property that firms possess such as financial, physical and human resources. These resources cannot be used by other firms if they do not get permission from owners of the resources because the owners dominate these resources. For this reason, the resources are protected by legal rights such as patents, contracts or property. Knowledge-based resources mean intangible knowledge and technology of firms. The resources could not be easily imitated or copied by competitors because of barriers of information and

knowledge. The reason is that it is difficult for competitors to correctly grasp the knowledge and technology and it is not easy to find the causal relationship between the resources and performance. Therefore, knowledge-based resources include resources which are not protected by patents such as knowledge, technology and technological and managerial capability (Hall, 1992).

An analysis on internal resources of firms is to grasp strength and weakness of resources through estimating firms' resources which are the source of competitive advantages. Internal resources of firms mean assets, capability, knowledge, information and so on. The resources should be useful when they devise and practise strategies. The resources have four characteristics: valuable, rare, imperfectly imitable and non-substitutable. In this regard, firms should look for methods to create value for customers through a combination of resources, core competence, organisational capability and administrative heritage. Under the circumstances, core competence means integration of skills, technologies and knowledge streams. It is the assets of organisations and the collection of organisations' learning which can be obtained from personal and organisational levels. In addition, it should be unique and discriminative and it is not easily imitated by competitors as superior internal competence which specific firms have. Competence, which necessarily required in an industry, is not core competence and it is also not core competence that competitors have already had or can easily imitate.

Core competence should have four conditions: value creation, distinctive and superior, leverage to other businesses and scarce and difficult to imitate (Parry et al., 2010). Value creation means that core competence should have superior efficiency when it is concerned with the process which delivers or enhances the value to customers. Distinctive and superior means competitive superior competency compared with competitors rather than general superior skills of firms. Leverage represents that core competence can be applied to other business units. Scarce and difficult to imitate means that core competence cannot be easily imitated by competitors because it is complexly composed by business resources and organisational capability and is learnt as a group.

According to resource-based theory, firms are treated as a unique aggregate of tangible and intangible resources and firms acquire competitive advantages on the basis of discriminative competence of resources and capability. The core factors of the theory are as follows. First, firms which have resources to obtain high efficiency can create windfall profits. Second, efficient firms can maintain sustainable competitive advantages when other firms find it difficult to imitate the resources which they have or there is limited supply of the resources. There are two strategic meanings of the theory. The first is to complement the problems of industrial organisation theory which explains the windfall profits of firms under external factors. The second is to explain gaps in performance among firms which are in the same industry (i.e. source, creation and continuance of competitive advantages).

Resource-based theory explains differences in performance among firms through core competence concerned with unique resources of firms. In other words, core competence of firms can be explained as unique resources which they have. Core competence plays an important role in achieving high profits. This means that firms can create value, which is connected with high benefits, because they attain to customer needs through core competence. From the viewpoint of SCM, customer needs are grasped by ascertaining market information and then the collaborative response of supply chain partners to the information provides the basis of achieving efficiency of a supply chain process. The partners should connect core competence through construction of superior IS and then they can create value through sharing information with suppliers and customers.

Many researchers insisted the importance of internal resources for SCM (Bowersox et al., 2002; Narasimhan and Kim, 2001; Stank et al., 2001; Subramani, 2004). Firms have need of collaboration with supply chain partners for improving their performance in supply chains. Transparency and quality of information are conditions precedent for developing supply chains but intermediation of information could make for two problems as follows. The first, intermediation of information is the cause of imbalance and conflicts of information and this is also the potential barrier to transparency of information in supply chains. The second, because it must incur cost, it is the cause of activity not to

add value (Barratt, 2004). However, intermediating activity to provide abundant information through sharing market information is required in supply chain processes. All partners should pursue a sequent supply chain to integrate the processes and to share necessary information.

Supply chain collaboration for sharing capability among partners has a direct influence on the ability of firms to respond to customer needs beyond efficient customer management and point of sale which acquire data concerned with demand. The collaboration for information sharing among partners promotes communication and they can structure virtual supply chains through information sharing. The virtual supply chains are based on flows of information rather than flows of goods in practice (Christopher and Towell, 2002).

Supply chain collaboration makes possible integration of processes in a supply chain and then firms can improve capability for performance improvement. Firms should make synergy effects following collaboration in supply chains and this is represented as efficient management of a supply chain process because they focus on core competence and other functions depend on outsourcing to external experts. From this viewpoint, the collaboration is directly connected with performance improvement. The collaboration makes it possible for information sharing among suppliers' suppliers and customers' customers as well as suppliers and customers and then firms collaborate with whole supply chain partners through sharing information (Daugherty et al., 1996).

Supply chain collaboration provides firms with the achievement of low cost, high production and efficiency of processes among suppliers and customers and firms enjoy competitive advantages through collaboration in supply chains (Williams et al., 1997). It promotes efficient information exchange among supply chain partners as well as functional areas in all processes. In this regard, supply chain collaboration provides competitive advantages for all supply chain partners. Through the collaboration, firms remove overlaps and inefficiency in a whole supply chain process and, as a result, they achieve a high level of performance.

3.2.3 Relational view

Unlike the industry structure theory, researchers have insisted that gaps in performance among firms are based on heterogeneity of resources among firms rather than industry structure from the viewpoint of resource-based theory (Barney, 1991; Wernerfelt, 1984). However, the viewpoint overlooks the viewpoint of the relationship between firms. From the viewpoint of supply chains, the collaborative relationship between firms is the basis of structuring effective supply chain processes through sharing mutual capability among firms. This explains that they put their resources and capability into core competence and the core competence is the basis of inter-firm collaboration. In this regard, idiosyncratic inter-firm linkages are the source of relational rents and competitive advantages and this is connected with an inter-organisational rent-generating processes. Hence, this research suggests four resources to achieve competitive advantages among firms: relation-specific assets, knowledge-sharing routines, complementary resources/capabilities and effective governance (Dyer and Singh, 1998).

First, from the perspective of relation-specific assets, the length of the safeguard and the volume of transaction are the two key sub-processes to have an effect on partners' capability which creates relational rents because the assets are a necessary condition for the rents and firms should have relation-specific assets for developing competitive advantages (Amit and Schoemaker, 1993). They can create competitive advantages through connecting the assets of supply chain partners.

Second, inter-firm knowledge-sharing routines can be approached to inter-organisational learning (Dyer and Singh, 1998). Innovation is the basis of collaboration between supply chain participants and learning to innovation among the participants is the source of inter-firm knowledge-sharing routines. The inter-firm collaboration is the most important basis of new ideas and information and this is connected with high performance. Moreover, inter-firm collaboration creates relational rents through developing superior inter-firm knowledge-sharing routines. From this angle, firms' absorptive

capability is the core competence of learning in collaboration among firms. In addition, learning is regarded as core competence in inter-firm knowledge-sharing routines. Therefore, inter-firm knowledge-sharing routines can create inter-firm competitive advantages.

Third, complementary resource endowments are another way to generate relational rents among supply chain participants. A firm can share mutual resources through collaboration with supply chain partners and this is the most efficient method to acquire complementary resources which firms do not possess. Supply chain participants can create better relational rents through collaboration. Therefore, complementary resources which each firm have in supply chains is the basis of creating relational rents through collaboration and this is connected with high supply chain efficiency.

Fourth, effective governance (trust) is a key factor of creating relational rents because it has an effect on transaction costs and value-creative processes among supply chain participants. The participants generate relational rents because of investments in relation-specific assets but value is decreased when resources are specialised because specialised resources include opportunism. In this regard, the participants should select a governance structure which minimises transaction costs (Dyer and Singh, 1998). Thus, effective governance is one of the important factors to create relational rents and it is the basis of the creation of inter-firm competitive advantage.

Relational rents are one of the benefits created by collaboration between participants in supply chains and it is the foundation of a competitive advantage. Trust with partners and partner-specific absorptive capability are the causes of causal ambiguity and time compression diseconomies (Arrow, 1974; Butler, 1991). In this case, relational rents have four dimensions: inter-organisational asset inter-connectedness, partner scarcity, resource and indivisibility and the institutional environment (Dyer and Singh, 1998). Connection of inter-firm assets is concerned with acquisition of a cumulative effect through relation-specific investments among supply chain partners. Partner scarcity is concerned with finding supply chain partners which have complementary strategic resources and relational capability. In this regard, collaborative intention is the key factor in partner scarcity.

Resource indivisibility is concerned with combining resources and developing capabilities among supply chain partners. The institutional environment which is the cause on building trust among supply chain participants is the basis of relational rents.

The relational view explains how supply chain participants create relational rents through collaboration of complementary resources and this is that basis of competitive advantages. It complements the lack of resource-based theory and there are gaps between the relational view and resource-based theory such as the analytical unit of inter-firm relationships, the source of rents and control and ownership of the rent-generating resources. Therefore, the relational view explains performance improvement through inter-firm collaboration in supply chains.

3.2.4 Information processing theory

Information processing theory gives an explanation of fundamental roles of corporate strategy through theoretically explaining the effect of the environment on organisations (Cohen et al., 1972). The theory is focused on using the possibility of information from managers to improve performance. In addition, the theory treats organisations as mutual connected structure of decision-making systems. Information is inputted, processed and outputted in the systems. Managers face various problems when they carry out corporate strategy, business unit strategy and functional strategy. To solve the problems, managers learn and apply external information and, consequently, performance can be enhanced. The basis of external information is regarded as the market or the environment. The environment reflects all factors existing in the outside firms and the market can be treated as a part of the environment. Suppliers and customers can be treated as important environmental factors from the viewpoint of focal firms (Flynn et al., 2010). Information acquired from them is learnt by managers, disseminated to all departments and applied to firms through proper processing. As a result, firms improve processes and solve problems, followed by improved performance (Tuggle and Gerwin,

1980).

From the viewpoint of information processing theory, internal collaboration is regarded as the process of absorbing and applying information acquired from suppliers and customers in internal processes. Galbraith (1973), Thompson (1967) and Tushman and Nadler (1977) ascertained that corporate information processing capability has a positive influence on performance. Similarly, Burns and Wholey (1993) insisted that information processing theory explains the behaviour of organisations which generate, adjust and translate information in decision-making processes. Because organisations cannot possess complete knowledge when they make a decision, the behaviour of organisations means learning by managers of information acquired from external sources such as suppliers and customers is necessary for advanced decision making. For better decision-making, managers should secure, absorb and apply the more detailed and correct information in order to connect with better performance.

Galbraith (1973) suggested the structure of information processing theory on the basis of the relationship between the environment and strategy from the viewpoint of information processing suggested by Cohen et al. (1972). Various research projects were performed on the basis of the perspective of Galbraith (1973). Tuggle and Gerwin (1980) applied strategy to information processing theory. From the internal viewpoint of firms, Gattiker and Goodhue (2004) stressed the role of ERP (enterprise resource planning) on the basis of information processing theory and, from the external viewpoint of firms, Stock and Tatikonda (2004) stressed the importance of external technology integration on performance on the basis of information processing theory. In addition, Premkumar et al. (2005) analysed the relationships between organisations from the viewpoint of information processing theory and Trkman et al. (2010) explained the moderating effect of information systems support on the relationships between a business analysis and supply chain performance from the viewpoint of information processing theory. Wong et al. (2011) explained the moderating effect of environmental uncertainty on the relationships between integration and performance from the

viewpoint of information processing theory and Schoenherr and Swink (2012) analysed the relationships between internal integration and external integration from the viewpoint of information processing theory. From these viewpoints, information processing theory explains that the interaction between internal collaboration and external information enhances performance.

Prior research has verified that internal collaboration has a positive influence on performance (Hult et al., 2004; Resenzweig et al., 2003; Swink et al., 2007; Wong et al., 2011). In addition, Schoenherr and Swink (2012) insisted that information processing capability generated by internal collaboration enhances absorptive capability on external information. Internal collaboration can be strengthened by IS for improving external relationships. This means that IS can help to absorb into the inside information generated from the outside (Zhao et al., 2011). Cohen and Levinthal (1990) defined absorptive capability as firms' capability to recognize, absorb and apply value of external information. They insisted that knowledge learnt from the outside plays an important role in improving performance. The generating capability of external knowledge (external collaboration) is one of important factors for improving performance. The ability to absorb and apply external knowledge (internal collaboration) is based on established knowledge and firms absorb, disseminate and apply new knowledge through absorptive capability, followed by improving performance. The absorptive capability is treated as a by-product of R&D or a by-product of manufacturing operations (Conen and Levinthal, 1990). From this viewpoint, absorptive capability is regarded as the basis of internal collaboration between functions. Firms, through internal collaboration, can learn and apply new information generated from the external market and this is the basis of improving performance. From this viewpoint, absorptive capability (internal collaboration) plays a role of mediation to connect new information with performance. Therefore, internal collaboration is regarded as the source of effective absorptive capability on structured information through external collaboration.

Firms which have superior internal collaboration can better develop and apply new knowledge as well as established knowledge through external collaboration because internal members effectively

share and easily approach information through internal collaborative processes. Hult et al. (2004) verified that information sharing by internal integration has a positive effect on performance from the viewpoint of information processing theory. In addition, Hillebrand and Biemans (2003) ascertained that internal cooperation needs for effective learning on information acquired by external cooperation. Information generated by external partners can be delivered to the most proper internal members as the most efficient and effective methods through superior internal collaboration (Swink et al., 2007). This transmission of information can be supported by IS like ERP and EDI (Gattiker and Goodhue, 2004). The IS can create the superior basis to create an infrastructure of internal collaboration and to absorb new information acquired by external collaboration. Therefore, internal collaboration can create superior performance through recognizing, disseminating and applying information created by external collaboration to internal processes.

3.2.5 Strategic choice theory

Strategic choice theory takes the viewpoint of complementing contingency theory. Contingency theory has a deterministic viewpoint that contextual variables such as the environment, technology or the scale of operation decide structure, whereas strategic choice theory stresses the importance of strategic decision-making. Organisations can evolve and develop through the relationship with the environment (Sadler and Barry, 1970). To achieve high performance, organisations should change organisational structure in conformity with the variance of the environment. The recognition of decision-makers on environmental uncertainty is an important factor for organisations because it is the basis of changing organisational operations. This explains how decision-makers mediate the relationship between the environment and organisations and, as a result, they lead proper variance of organisations following variance of the environment, followed by high performance. From this viewpoint, Child (1997) insisted that strategic choice theory is non-deterministic.

Strategic choice theory is based on strategy theory by Chandler (1962). Chandler (1962) did not agree that organisations are changed by only one factor, either the environment or strategy. Decision-makers should consider environmental and organisational viewpoints simultaneously when they change organisations. From this viewpoint, contingency theory and strategic choice theory are complementary to each other. In addition, Child (1972) criticized contingency theory from the viewpoint of the environment and organisations. From the viewpoint that if contexts are changed, organisations can be changed following the change, Child (1972) insisted that the relationship between the environment and organisations should be interactive. If organisations do not change in conformity with contexts, they lose opportunities and their survival is threatened. To overcome this, organisations need to connect the environment with strategy through managers. In this regard, managers use different strategies following their recognition of the variance of the environment and, consequently, they might achieve different performance. Therefore, performance can be decided by managers' recognition of it rather than the environment itself.

Child (1972) stressed the autonomy of decision-makers, control on the environment and the role of decision-makers on the relationship between the environment and organisations. From this viewpoint, strategic choice theory emphasizes proper performance rather than the best performance and proper control rather than unconditional adaptation to the environment. In addition, decision-makers make strategic choice following their recognition of the environment, which is connected with performance.

Child (1997) stressed a network of internal and external relationships for strategic choice, which is shown as pre-action or re-action. This means the importance of managers. They can suggest proper strategy through learning external environmental factors and analysing internal organisational factors and this is connected with high performance. This perspective can be also applied to the relationship between supply chain collaboration and operational performance. Managers can decide a level of supply chain collaboration on the basis of their recognition of the environment and an analysis on internal resources and, as a result, they can enjoy high performance following the decision.

3.3 Definitions of variables

3.3.1 Environmental uncertainty

The external environment of firms can be defined as overall factors which have potential and substantial influence on organisations and these are beyond their control (Porter, 1980). Firms could understand characteristics of the factors through an analysis of the environment, decrease uncertainty through the understanding and acquire useful information to create strategy (Sun et al., 2009).

An approach to the environment can be classified into two groups: approach to components and approach to characteristics. The former is to ascertain that the environment can be separated into composite factors and this can explain how the factors have an effect on behaviour and performance of firms. For example, the environment can be divided into the task environment and the general environment. The task environment has a direct effect on decision-making for making and achieving goals of firms and because firms make a different decision on the basis of the task environment which they face, it has a different effect on each firm. The general environment has the same or similar influence on all firms and it means the legal, economic, social, cultural and systematic environment. The latter is to grasp various characteristics of environmental factors from complex viewpoints first and, then, to simplify them, grouping them into several dimensions. These kinds of environmental factors are often used to analyse the environment of firms (Buchko, 1994; Damanpour, 1996; Dess and Beard, 1984; Freel, 2005; Lumpkin and Gregory, 2001; Milliken, 1987). From this viewpoint, the environment can be divided into four dimensions: munificence, dynamism, heterogeneity and hostility. According to McGinnis and Kohn (1993), the first is the extent to which the environment can support sustained growth; the second is the extent of unpredictability and change of customers' tastes, technology and modes of competition; the third is differences in competitive tactics, customers' tastes,

product lines and channels of distribution; and the fourth is the level of competition, severity of regulation restrictions and unfavourable demographic trends.

The external environment means all things which affect firms and it exists on the exterior of firms. The definition of the environment can be classified in various methods. First of all, the majority of researchers have conceptualised the environment from the uncertainty point of view. In addition, some researchers insisted that the environment exists outside of firms and the internal environment is also important (Newkirk and Lederer, 2007; Pawlraj and Chen, 2007b; Wood, 2008). Perceived environmental uncertainty was also treated by researchers as one of the important factors (Babakus et al., 2006; Jokipii, 2010; Prado, 2006). These multidimensional viewpoints on the environment are very useful to understand whether each environmental factor has an influence on supply chain collaboration. Therefore, this research divides the environment into four dimensions such as munificence, dynamism, heterogeneity and hostility in conformity with the approach to characteristics (Dess and Beard, 1984; Miller and Friesen, 1978; McGinnis and Kohn, 1993) and this research will ascertain the roles of the factors on the relationship between supply chain collaboration and operational performance.

Environmental uncertainty means the degree of impossibility of prediction of outcomes or the future (Chow et al., 1995; Lee et al., 2007; McGinnis and Kohn, 1993). It can be divided into four sub-variables: munificence, dynamism, heterogeneity and hostility. Munificence appears as the degree of continuous growth of a market caused by environmental variance. Dynamism means the difficulty of predicting a change in the market. Heterogeneity can be explained as the change of competitive methods of competitors and customers' preference and expectations. Hostility can be expounded as the degree of competition and regulations of the government in the market. These are the most comprehensive definitions concerned with environmental uncertainty and they are used in this research.

3.3.2 Supply chain collaboration

Firms make an effort to integrate activities in their internal functional areas such as procurement, manufacturing, marketing and logistics (Gernain et al., 1994; Mollenkopf et al., 2000; O’Leary-Kelly and Flores, 2002; Rodrigues et al., 2004; Verma et al., 2001) and the activities are important in inter-firm aspects as well as intra-firm aspects. In particular, collaboration from the viewpoint of supply chains is focused on the relationships between suppliers and customers through treating inter-functional and inter-corporate aspects at the same time (Barratt and Oliveira, 2001). In other words, manufacturing plans should be connected with the supplying plans of suppliers from the viewpoint of procurement and, simultaneously, manufacturing plans should be connected with sales plans of wholesalers and retailers from the viewpoint of marketing and sales. This means that the efficiency of internal processes is the basis of effectiveness of external processes.

Supply chain collaboration can be explained as interaction and cooperation (Kahn and Mentzer, 1998). The former gives emphasis to communication in inter-departmental meeting or a flow of information. It is about activities for information exchange including committee meetings, video conferencing, telephone conferencing and exchanges of standardised documents. The latter can be defined as a high level of shared value, mutual goals and cooperative behaviour. The characteristics are explained as effective, ambitious, mutual and shared processes. This relates then to the state and quality of collaboration existing among departments which are required of united activities due to the environment. Each viewpoint can provide independent meaning but this research focuses on the complex viewpoints of both of them.

A definition of collaboration can be grasped as joint works among departments from the viewpoint of corporate behaviour, regarded as shared culture from the viewpoint of the corporate culture and be considered as cooperative relationships from the viewpoint of the relationships between firms (Min et al., 2005). Supply chain collaboration can be divided into internal and external collaboration. The

former is to carry out collaborative work among departments in an internal firm and the latter is where two or more firms perform joint work adjusting activities among functions beyond the territory of firms to achieve customer needs (Simatupang and Sridharan, 2002). The latter means the supply chain participants fulfil joint work with other participants in supply chains. In addition, it can create a competitive advantage through performing information sharing, joint decision-making and sharing benefits with customers and suppliers and, consequently, firms can enjoy superior performance through achieving customer needs (Simatupang and Sridharan, 2005).

External collaboration can be divided into supplier collaboration and customer collaboration because they have different roles in supply chains. The basis of the viewpoint can be found in supplier bargaining power and customer bargaining power by Porter (1980). When suppliers have high bargaining power in industry, focal firms have a low level of control in the transaction and, consequently, they cannot enjoy high benefits. In addition, a price rise of raw materials and parts caused by external factors of transaction such as the exchange rate and inflation is directly reflected in the cost of production and, as a result, the benefits are decreased. The conditions under which the bargaining power of suppliers increases are as follows: the case of monopoly or oligopoly in supply, the case that there is not a substitute, the case of low importance of each customer to suppliers, the case that suppliers' products are core products to buyers and the case that there is high transaction cost when buyers want to change suppliers. Focal firms cannot enjoy high benefits if buyers have high bargaining power in the industry because buyers stimulate competition among suppliers to acquire low cost, high quality products and superior services. The conditions which the bargaining power of buyers increases are as follows: the case that the volume purchased by buyers is a considerable portion of the sales volume of suppliers and the case that buyers can easily change suppliers because then there is no product differentiation (Porter, 1980). The differences in the features of suppliers and buyers provide the basis of access. Therefore, supply chain collaboration is divided into three dimensions: internal collaboration, supplier collaboration and customer collaboration.

Supply chain collaboration is a very important factor to enhance ability and performance of firms (Min et al., 2005). Firms would concentrate resources in core competence and, as a result, they would outsource to experts on functions which are not their core competence. This means that supply chain participants can combine their core competence when they are faced with competition that is not inter-firm but inter-supply chain. For this reason, they can enhance capability and achieve high performance through supply chain collaboration. Therefore, collaboration can be approached on the basis of the relationships and business processes among firms as follows.

First, collaboration is regarded as business processes to conduct joint work among mutually collaborative firms which have joint goals to achieve mutual benefits (Stank et al., 2001). Collaborative processes include joint decision-making and the ability for problem solving through information sharing among supply chain participants. This collaborative supply chain includes many firms who enjoy a competitive advantage in the market through joint plans and operations with partners in supply chains rather than an individual response to competition in the market.

Second, collaboration appears as the formation of partnership and cooperation between firms where supply chain participants perform joint work to share information, resources and some of the risks to achieve joint goals. It is performed beyond functional territories of a firm and internal collaboration provides the basis of external collaboration expanded to supply chain participants. Under the circumstances, the participants collaborate with each other on the basis of mutual complementary relationships and, as a result, they enjoy high performance. Therefore, they voluntarily collaborate on human, financial and technological resources to structure a superior supply chain process.

Supply chain collaboration can be divided into two dimensions: structural and behavioural. First, collaboration in a structural dimension can be classified into vertical and horizontal (Barratt, 2004; Mason et al., 2007). Vertical collaboration includes internal collaboration that achieves collaboration between functional areas and external collaboration that connects external partners such as suppliers and customers. Horizontal collaboration includes internal functional areas, competitors (i.e. joint

logistics) and collaborative firms to mutually share ability such as logistics service providers and information system providers. Second, a behavioural dimension is explained as an active aspect of collaboration. Collaboration is measured by width and depth of collaboration (Matopoulos et al., 2007). The width that firms need to decide on requires specific activities in which they have to collaborate because they cannot collaborate in all activities. Firms should maintain close relationships with partners concerned with specific activities. After deciding on the width, they decide on the level in which they collaborate. In other words, the depth is where they decide the scope of collaboration concerned with a strategic, tactical or operational level because they cannot collaborate beyond the whole level in which firms operate. The more the width and the depth increase, the more the number of participants in a supply chain increases, followed by the difficulty of efficient management to collaboration.

In this study, supply chain collaboration is defined as working together among departments within a firm, understanding mutual different viewpoints, sharing resources and information and achieving common goals in supply chains (Ellinger et al., 2000). This research approaches supply chain collaboration from the structural viewpoint. According to prior research, collaboration from the supply chain viewpoint is analysed from the viewpoint of internal collaboration of a focal firm and expanded to external collaboration between supply chain participants. This reflects the characteristics of Korean manufacturing firms in China. As China is now the world's factory, many Koreans firms have invested in China where they collaborate with local firms and suppliers. For this reason, this research classifies collaboration into three aspects: internal collaboration, customer collaboration and supplier collaboration.

The definitions of collaboration in prior research reflect two viewpoints (Bagchi et al., 2005). The first, collaboration is focused on the streams of products, service and information and how firms should perform the streams if they are included in supply chains. The second, collaboration is the best way to achieve the efficiency of supply chains. The former is focused on process, whereas the latter is

focused on performance. From this viewpoint, collaboration can be divided into internal and external. Internal collaboration treats inter-functional collaboration between departments such as marketing, logistics and other departments. Inter-functional collaboration means effective, dependent and mutual sharing processes when firms perform mutual understanding during joint work among departments, have common rules, share resources and achieve common goals (Stank et al., 2001). The core factor in collaboration is the scope of activity beyond departments, responsibility on joint work and common goals. Managers who want to perform collaboration should structure a collaborative mind beyond departments to achieve common goals and attain common goals through interaction. Collaboration can create value through sharing information and adjusting activities over a whole process.

Collaboration in an operating level among firms has need of a change of business practice like information exchange. The scope of collaboration in activities among firms includes a cooperative plan, prediction and procurement. Supply chain participants cope with market information all together through information sharing and long-term prediction rather than individually coping with collected information. This can be achieved by enhancing a level of collaboration over the whole process. The information is continuously renovated on the basis of real demand and a change in the market and, as a result, firms efficiently connect supply with demand through use of real and specific information. Therefore, collaboration can maximize efficiency and effectiveness in the whole supply chains.

According to Stevens (1989), supply chain collaboration is shown in the state of collaboration on three levels such as logistics activities between two or more functions in a firm, logistics activities among departments and logistics activities among supply chain participants. This is similar to the stages of supply chain integration offered by Narasimhan and Kim (2001). They suggested the stages of supply chain integration such as independent operations of each function, functional integration, internal integration and external integration and they also insisted that supply chain integration is performed from functional integration to external integration in sequence (Barratt, 2004; Ellram, 1992; Fawcett and Magnan, 2002; Frohlich and Westbrook, 2001; Hewitt, 1994; Kannan and Tan,

2010; Narasimhan, 1997; Narasimhan and Kim, 2001; Simatupang and Soidharan, 2005; Stevens, 1989; Stock et al. 2000). The stages of supply chain integration are as follows.

Table 3-1 Four integration stages of SCM (Narasimhan and Kim, 2001; Stevens, 1989)

Stage	Definition
Stage 1: Independent operation of each function	· Business functions such as sales, manufacturing, planning, material control, and purchasing are operated on an almost separate basis. · This stage is characterized by organizational boundaries, whereby purchasing might control the incoming material flow of raw material stocks, manufacturing and production control then cover raw material through the processes which convert it into finished goods, and further along the chain, sales and distribution divide the responsibility for outbound supply chain and inventories.
Stage 2: Functional integration	· Limited integration between functions such as shipping and inventory or purchasing and raw material management is accomplished. · This stage is characterized by emphasis on cost reduction rather than performance improvement; discrete business functions, each of which is buffered by inventory; elements of internal trade-off between, for example, purchase discount and the level of inventory investment; high plant-utilization and batch sizing; and reactive customer service.
Stage 3: Internal integration	· All internal functions from raw material management through production, shipping, and sales are connected and integrated real time. · This stage is characterized by full systems-visibility a focus on tactical rather than strategic issues; an emphasis on efficiency rather than effectiveness; and reaction to customer demand rather than managing customer.
Stage 4: External integration	· Full supply chain integration extending the scope of integration outside the company encompassing suppliers and customers is accomplished. · This stage is characterized by the supply of high quality products shipped direct to the line on time; completely shared information on products, processes and specification changes; technology exchange and design support; a focus on strategic rather than tactical issues; and above all long-term commitment, which usually means the elimination of multiple-sourcing.

As shown in Table 3-1, collaboration involves four development stages in SCM: independent operation, functional integration, internal integration and external integration. The stages progress in sequence from functional integration to external integration (Narasimhan and Kim, 2001; Stevens, 1989). The development stages can be explained as follows. First, independent operations of each activity in a firm mean that they are operated separately such as procurement, manufacturing, logistics, marketing, sales, service and distribution and each function is managed on a relatively independent basis. Second, functional collaboration means that firms fulfil limited collaboration between similar functions, such as procurement and management of raw materials or loading/unloading and

transportation of finished goods. This stage stresses cost-efficiency rather than performance improvement. Third, internal collaboration means the real-time collaboration between all internal functional areas from procurement of raw materials to manufacturing, logistics, marketing, sales and service. This stage provides visibility of the entire system, from procurement to distribution. Fourth, external collaboration includes some degrees of supply chain collaboration by extending collaboration with business partners. Supply chain partners structure the efficient relationships between partners through information sharing and cooperative management from the inter-firm viewpoint.

Table 3-2 The classifications of supply chain collaboration

This research (2014)	Morash and Clinton (1998)	Stock et al. (2000)	Narasimhan and Kim (2001)
- independent operation - internal collaboration - external collaboration - supply chain collaboration	- ineffective and inefficient functional silos - intra-organizational process integration - inter-organizational collaborative integration - inter-organizational operational integration	- functional logistics - integrated logistics - inter-firm logistics - enterprise logistics	- independent operation of each function - functional integration - internal integration - external integration
Frohlich and Westbrook (2001)	Flynn et al. (2010)	Thun (2010)	Schoenherr and Swink (2012)
- inward-facing pattern - periphery-facing pattern - supplier-facing pattern - outward-facing pattern	- low uniform pattern - medium uniform pattern - medium customer pattern - high customer learning pattern - high uniform pattern	- non-integrators - moderate integrators - supplier integrators - customer integrators - simultaneous integrators	- inward-facing pattern - periphery-facing pattern - supplier-facing pattern - outward-facing pattern

As shown in Table 3-2, the classification of collaboration in SCM is required to achieve intra-firm collaboration and inter-firm collaboration (Narasimhan and Kim, 2001; Stevens, 1989). In this regard, collaboration is performed from inter-functional areas to external areas. The classification should be developed by recognition of SCM, inter-functional collaboration and collaboration between firms in regular sequence. However, the different levels of supply chain collaboration are regarded as a strategic choice of a firm at a given time in this research. Supply chain participants need to ascertain

where they are in the levels (Gimenez, 2006; Thun, 2010). In this regard, collaboration, in this research, is explained as internal and external aspects in a supply chain and supply chain collaboration is suggested as having four levels: independent operation, internal collaboration, external collaboration and supply chain collaboration. In addition, this classification is equal to the classification of Stock et al. (2000). They classified logistics integration into functional logistics, integrated logistics, inter-firm logistics and enterprise logistics to use internal integration and external integration. Morash and Clinton (1998) also insisted that supply chain integration is concerned with four levels: ineffective and inefficient functional silos, intra-organisational process integration, inter-organisational collaborative integration and inter-organisational operational integration. Frohlich and Westbrook (2001) and Schoenherr and Swink (2012) divided arc of integration into inward-facing pattern, periphery-facing pattern, supplier-facing pattern, customer-facing pattern and outward-facing pattern. Flynn et al. (2010) classified supply chain integration into low uniform pattern, medium uniform pattern, medium customer pattern, high customer learning pattern and high uniform pattern. Thun (2010) classified clusters of integration into non-integrators, moderate integrators, supplier integrators, customer integrators and simultaneous integrators on the basis of the classification of Frohlich and Westbrook (2001). Their basic concepts of configuration on integration are similar to different levels of supply chain collaboration in this research; however, this research has a viewpoint of a strategic choice which reflects firms' circumstances. All the classifications are similar to the contents but different levels of supply chain collaboration in this research are more similar to the classification of Stock et al. (2000). Because the different levels of supply chain collaboration are the simplest and most basic and it embraces all other classifications, the different levels are used in this research. They are shown in Figure 3-1.

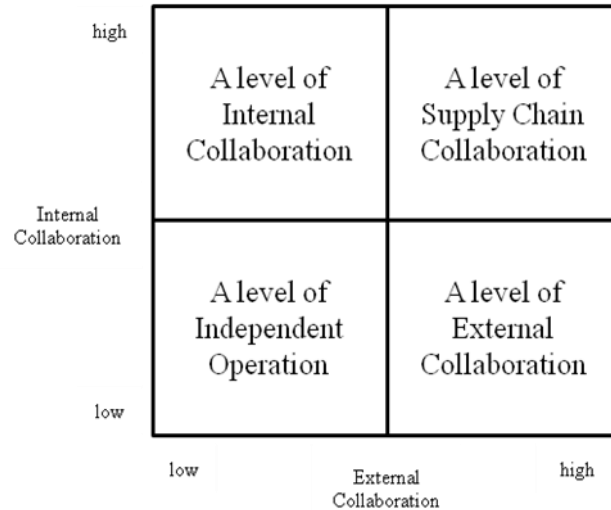


Figure 3-1 Different levels of supply chain collaboration

As shown in Figure 3-1, the level of an independent operation of each function shows low levels of internal and external collaboration and this means that it is a lack of recognition of SCM. In addition, firms maintain efficiency of internal processes through a high level of internal collaboration in response to a stable external the environment. Conversely, firms secure opportunities through a high level of external collaboration if there is high environmental uncertainty. Firms choose supply chain collaboration if they think that it is important to improve the effectiveness of inter-firm processes and the efficiency of internal processes by improving the capability of IS. It is important to test the level of collaboration of firms in this research because one of the objectives of this research is to estimate where firms are in levels of supply chain collaboration. If firms focus on internal collaboration, their supply chain strategy improves internal efficiency; though, if the strategy puts stress on network efficiency, firms focus on external collaboration. In addition, if firms focus on both of these aspects, supply chain effectiveness is maximized. For this reason, this research suggests that different levels of collaboration are not the flow of the levels from inter-functional collaboration to external collaboration, but as the strategic choices concerned with the current decision-making.

3.3.3 Operational performance

Suggestion to measuring methods concerned with performance is a prerequisite to making strategy, which is based on achieving a sustainable competitive advantage in the market. Performance is measured by efficiency and effectiveness of present systems and these are used to design the whole system of a firm to yield the required levels of performance (Beamon, 1998). Therefore, a prerequisite to suggesting strategy is to develop the factors to measure performance.

Measurement of performance starts from the recognition of clear gaps among measuring factors in strategic, tactical and operational dimensions. The measurement in a strategic dimension has an influence on decision-making of top management, financial plan of firms, competitive advantage and goals of firms. The measurement in a tactical dimension deals with measuring performance on goals and procurement of resources in an objective to achieve specific performance of a strategic dimension. Measuring performance of the dimension provides feedback on decision-making for managers. Managers measuring an operational dimension require practical data from workers and they estimate the data for confirming results of decision-making. Managers and workers should make an effort to create and achieve operational goals (Gunarskaran et al., 2004).

Effective measurement of performance should include inclusiveness, universality, measurability and consistency (Beamon, 1999). If performance is measured by a single criterion, it cannot be measured on the basis of the measuring criteria. Therefore, the criteria are prerequisites to measure performance and firms should develop measuring factors to achieve a balance of financial and non-financial aspects and various criteria.

Measuring financial performance for balanced measurement is important for strategic decision-making and non-financial measurement from the viewpoints of tactics and operation is also important in daily operations (Beamon, 1999). For this reason, it is important to consider non-financial aspects as well as financial aspects to measure performance. For example, performance in a strategic aspect of

firms means financial performance such as ROI (return on investment), ROA (return on assets), improved rates of sales and profit rates. In addition, performance from an operational viewpoint can be explained as non-financial performance such as market share and customer service. For this reason, performance can be understood as testing non-financial performance and financial performance from the viewpoints of the whole firm. In addition, measuring performance should include the viewpoint of customers and suppliers (Chow et al., 1994). The goals of firms are to satisfy customers more effectively and efficiently than their competitors (Lai et al., 2002). From this viewpoint, firms should consider the performance viewpoints, which are connected with customer service. Therefore, performance can also be explained as two viewpoints: 1) efficiency that represents a degree of economically using internal resources of firms and 2) effectiveness that means a degree of achieving the goals of firms (Brewer and Speh, 2000; Chow et al., 1995).

Performance is observed in various viewpoints. It can be divided into strategic, tactic and operational dimensions. It should also be reflected in efficiency and effectiveness connected with an internal viewpoint and an external viewpoint. In addition, performance should be measured by service effectiveness as well as cost efficiency to coincide with the goals of whole supply chain participants, including manufacturers, suppliers and customers (Kleinsorge et al., 1991). For this reason, performance of focal firms in a whole supply chain is divided into service performance as a non-financial aspect that is connected with effectiveness and cost performance as a financial aspect that is concerned with efficiency. Therefore, in this research, operational performance is defined as efficiency which means a degree of economically using the internal resources of firms and effectiveness which means a degree of achieving the goals of firms and this is connected with cost performance and service performance (Brewer and Speh, 2000; Chow et al., 1995).

3.4 Different levels of supply chain collaboration

3.4.1 An independent operation of each function

As shown in Figure 3-1, there are four different levels of collaboration in SCM such as a level of an independent operation of each function, a level of internal collaboration, a level of external collaboration and a level of supply chain collaboration. Firstly, a level of independent operation of each function means that managers have no recognition of SCM but they just perform daily operations (Narasimhan and Kim, 2001; Stevens 1989). According to Porter's value chain (1980), primary activities have several logistics activities: inbound logistics, manufacturing logistics, outbound logistics, physical distribution in marketing and service logistics. They overlap areas but they are just classified by the characteristic of each function. Inbound logistics is connected with a procurement function, which has loading, unloading, warehouse and stock management. The characteristic of this function is that they treat raw materials and half finished goods. Manufacturing logistics means that raw materials and parts are put in manufacturing processes. The characteristic of the function is to supply raw materials and parts to the next processes. Outbound logistics is concerned with the management of finished goods. The character of the function is to manage distribution of finished goods, which is an overlapping area with the function of physical distribution. However, the characteristic of outbound logistics is in stock management of finished goods and it is connected with a manufacturing plan. Physical distribution in marketing means how to supply finished goods to wholesalers and retailers and it depends on marketing strategy. Service logistics is concerned with recycling logistics, reverse logistics and supplying parts for service. The characteristic of the function is that they face final customers directly. These functions have an independent basis in a level of an independent operation of each function and they focus on their functions. Firms in the level pursue efficiency of each function rather than efficiency in a whole process. Each department is regarded as

independent entity. They treat collaboration between departments with transactions. Interaction for management of the relationship between departments is explained by transaction cost theory.

According to Williams (1997), the factors which have an influence on transaction cost are as follows: one is explained as bounded rationality and opportunism concerned with human behaviour that executes transactions and the other suggests uncertainty, transaction frequency and asserts specificity concerned with characteristics of transactions (Humphrey et al. 2001). From the viewpoint of transaction cost, managers who emphasize the importance of interaction in the relationship between departments treat the relationship between departments as transactions. Because each department is recognized as an independent entity to compete with other departments to acquire resources, the relationships between departments are regarded as temporary and causing expense. As a result of perceived expense and competition about limited resources, managers regard the relationships between departments as negotiation that makes an effort to acquire the largest resources about information flow or official contact with other departments. Hence, each department in interactive-oriented firms concentrates attention on consumed resources during interdepartmental activities. For example, when a logistics department should offer logistics information to other departments, they would search for a method of offering information in the way that losses are minimized and benefits are maximized. In this regard, each department treats other departments as competitors on limited resources in a firm. Hence, each department performs a strategy which minimizes losses and maximizes benefits when they make a decision. It can be hard to achieve whole efficiency because this leads to distortion of information. Therefore, internal collaboration is an essential element for achieving whole efficiency.

3.4.2 Internal collaboration

Internal collaboration can be explained as how to manage the relationships between departments concerned with interdepartmental activities. The relation is expounded as collaboration (Kahn and Mentzer, 1996). Collaboration of relationships is similar to relationship marketing. It is not an objective to exchange the relationship with all departments including primary activities and supporting activities but an objective to exchange intention concerned with activities of creating value such as collaborative manufacture, R&D or marketing. From the viewpoint of relationships, even if there are some competitors for internal resources, managers do not consider them as rivals and they make an effort for collaborative interdepartmental activities as well as continuously maintaining and improving relationships with other departments. This can be explained as the fact that collaborative interdependent relationships are more valuable than simple trade-oriented relationships.

Collaboration is not treating the relationship with transactions but making an effort to continuously maintain the relationships between departments. This shows collaborative behaviour and collaborative goals among departments: the former is to emphasize informal relationships for managing the relationships and the latter is to collaborate with departments through reward, which is connected with achieving goals. Each department should collaborate and encourage mutual relations with other departments to achieve common goals. Because they have the same goals, the internal environment in a firm is not competitive but collaborative. To illustrate, there is a goal that should achieve high customer service in all departments. At the moment, a logistics department could achieve high customer service through providing other departments with logistics information for the accomplishment of the common goal.

Collaboration consists of interaction and cooperation. Interaction is a formal approach to managing relationships between departments, whereas cooperation is informal such as an attitude, mind and behaviour. A focus on cooperation is constructing a spirit of collaboration rather than connecting

information. In this situation, cooperation and interaction are essential components of the relationship between departments (Kahn and Mentzer, 1996). Inter-departmental relationships are composed of activities of cooperation and interaction because inter-departmental relationships reflect multi-dimensional processes. High dimensional cooperation and interaction are connected with a high level of the relationship but they appear as separate processes. Managers require a different level of cooperation and a different level of interaction to coincide with a specific situation to achieve successful performance in different circumstances. If they want to achieve the best performance in each circumstance, they need to attain cooperation and interaction corresponding to each circumstance.

Internal collaboration is defined as processes of interaction and cooperation for maintenance of the close relationship between departments. Interdepartmental interaction means an exchange of information in activities such as official meetings, telephone meetings, videoconferences and exchanges of standardized documents. Hence, it can be easily supervised because of visibility. Interdepartmental cooperation is defined as the co-work among departments through mutual understanding, awareness of the same goals, shared resources and achievement of goals by cooperation. It emphasizes an attitudinal viewpoint of the relationship between departments that indicates effective mutual processes. Cooperation explains interdepartmental relationships as invisibility, difficulty in regulation and a need of mutual efforts. Therefore, it means reciprocal relationships at a high level.

3.4.3 External collaboration

The relationship between firms can be explained by a viewpoint of supply chains. Supply chains are regarded as the flows of products and information through logistics from raw material suppliers to final customers (Bowersox et al., 2002). All partners that participate in a supply chain are included in the supply chain process and final customers use products after a final stage of the process. The

supply chain includes suppliers, manufacturers, distributors, information system providers, logistics service providers and so on. These firms depend on vertical and horizontal collaboration. If they find sources of inefficiency through pre-communication, firms which focus on supply chains enjoy substantial benefits through the elimination of overlaps and inefficiency. Therefore, collaboration between firms is concerned with managing the relationship between firms.

Exchange theory related with managing the relationship between firms explains the importance of achieving goals through the exchange of resources among firms. Factors of the exchange are information, logistical equipment, know-how, technology and others. According to Benson (1975), the exchange supplies the participants with enough resources such as funds and competence for achieving goals. Information sharing of a firm with the others has two objectives: one is to possess resources and the other is to increase sources of resources. Benson (1975) insisted that firms have need of interaction and cooperation among partners for balance of inter-firm relationships.

Inter-firm cooperation following the above exchange theory is voluntary, whereas the relationships from the viewpoint of political economy are explained as interaction among firms depending on legitimate orders following law or regulation. It is useful when the structure of firms is segmented as mutually dependent organisations which are composed of a value chain structure. Participants in a supply chain transfer duties to downstream partners when they finish their duties. Interaction is governed by law or stipulation and it is also operated on the basis of maintaining their territory. Exchange theory is supported when firms cooperate voluntarily but it is not beneficial when cooperation between firms is regulated in compliance with law or stipulation. When inter-firm interaction is regulated in accordance with law or stipulation, it is useful from the viewpoint of political economy.

External collaboration is concerned with managing the relationship between firms. Firms are operated within supply chains and they remove overlaps and inefficiency through strengthening external collaboration following pre-communication. In consequence, they can achieve supply chain

efficiency. Therefore, external collaboration is explained as a viewpoint of inter-firm relationships in supply chains.

3.4.4 Supply chain collaboration

Firms have need of inter-firm collaboration between supply chain partners as well as inter-departmental collaboration to achieve their goals (Chow et al., 1995). Collaboration is divided into collaboration in an organisation and collaboration between organisations (Kahn and Mentzer, 1996). The former is important for achieving goals of a firm and the latter is to appear as an important factor to achieve goals among supply chain partners. Internal collaboration is focused on connection of internal activities and processes through adjusting functions such as procurement, manufacture and distribution in a firm. The goals of the collaboration are in inter-functional simplification, standardization, cooperation and structural fit. External collaboration is stressed on capability sharing among supply chain partners. They can provide mutual complementary knowledge and know-how each other.

Supply chain collaboration consists of internal collaboration, vertical collaboration and horizontal collaboration (Barratt, 2004). The first is shown as a high level of collaborative relationships between departments from the viewpoint of a firm, the second is to appear a high level of collaborative relationships between firms including suppliers and customers, and the third means a high level of collaborative relationships between firms including collaborators and competitors (i.e. joint logistics). These are affected by the environment which firms face and the environment can be classified into external and internal. From this viewpoint, this research approaches supply chain collaboration from the viewpoint of vertical collaboration, such as internal collaboration, supplier collaboration and customer collaboration because the object of this research is Korean manufacturing firms in China.

Customer collaboration means a cooperative activity and an ability to structure a competitive

advantage in downstream activities. Firms which have a goal of supply chain collaboration should enhance fit, a response and flexibility to customers. Supplier collaboration requires collaboration in management on products and services provided by supply chain partners. Achievement of customer needs is one of the most important factors in supply chain collaboration but it is also important to perform strategic alliance, integration of management, financial collaboration and supplier management in upstream activities to achieve the whole goals. Supplier collaboration is started from efficiently performing the processes of procurement. To enhance a level of collaboration, firms should integrate processes of managing suppliers connected with achieving customer needs (Bowersox et al., 2002). These supplier collaboration and customer collaboration are necessarily required for supply chain collaboration.

According to prior research, supply chain collaboration has four dimensions: independent operations of each function, functional integration, internal integration and external integration (Narasimhan and Kim, 2001; Stevens, 1989). It is carried out from functional collaboration to external collaboration in sequence. It includes all of them including manufacturers, suppliers and customers. Firms, through the dimensions, feasibly perform efficient operation which connects a whole supply chain through integration of information and management. Successful collaboration between firms should appear as efficient operation (Bowersox and Daugherty, 1995). Firms should achieve cost saving and increase production and efficiency through the collaboration. In consequence, benefits are followed by low stock, short lead time, enhanced customer service and improved predictions and plans.

The viewpoints on collaboration shown in prior research are approached to vertical collaboration and horizontal collaboration and supply chain collaboration is also classified into internal and external. However, this research approaches it as a perspective of a strategic choice in the present time rather than a perspective of flow concerned with the collaboration. In this regard, supply chain collaboration is divided into four levels: independent operation, internal collaboration, external collaboration and

supply chain collaboration which are composed of internal and external.

3.5 The research model

Structuring equation modeling can be tested by a reflective indicator or a formative indicator. The former means that measuring items reflect results of a latent variable and the latter means that measuring items are causes of a latent variable (Chin, 1998). Javis et al. (2003) suggested four criteria to use reflective or formative indicators: direction of causality between measuring items and a latent variable, interchangeability among measuring items, covariance between measuring items and nomological net between measuring items and a latent variable. Petter et al. (2007) insisted that the covariance between measuring items is the statistical criterion and the other three factors are theoretical (logical and conceptual) criteria. The first is direction of causality between measuring items and a latent variable. A reflective indicator fits if a latent variable is not changed when measuring items are changed, whereas measuring items are changed when a latent variable is changed. In contrast, a formative indicator fits if a latent variable is changed when measuring items are changed, whereas measuring items are not changed when a latent variable is changed. This research is connected with the former and that is why a reflective indicator matches with this research.

The second is interchangeability among measuring items. A reflective indicator fits if correlations among measuring items and interchangeability are high because measuring items reflect a latent variable. For this reason, there is no effect on a latent variable even if one of measuring items is deleted in a reflective indicator. In contrast, measuring items are inter-independent and there is low interchangeability among the items because measuring items have an influence on a latent variable in a formative indicator. For this reason, there is a significant effect to a latent variable if one of measuring items is deleted in a formative indicator. From this viewpoint, the measuring items show high correlation in this research and as a result, a reflective indicator fits in the case of this research.

The third is covariance between measuring items. It is concerned with confirming interchangeability in statistical criteria (Petter et al., 2007). In other words, it means confirming whether when one of measuring items is changed, the other measuring items are changed as a result of correlation analysis. If it is so, a reflective indicator fits and if it is not so, a formative indicator fits. From this viewpoint, a reflective indicator fits in this research according to the result of correlation analysis.

The fourth is nomological net between measuring items and a latent variable. A reflective indicator fits when there is causality among latent variables. A formative indicator fits when measuring items have an influence on a latent variable because there are the low correlation, interchangeability and covariance between measuring items. In this regard, a reflective indicator fits in this research because the measuring items reflect the latent variables. The research model is shown as follows.

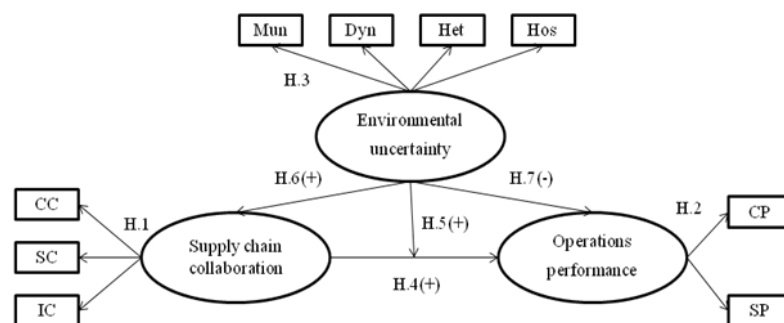


Figure 3-2 The research model

Figure 3-2 is the research model of this research. The three constructs in the left of the model represent three dimensions of supply chain collaboration and the two constructs on the right of the model represent operational performance outcomes. In addition, environmental uncertainty has four sub-dimensions. In this regard, this research model shows causal links among the variables. Part of the model is connected with the development of the measuring variables. Moreover, since supply chain collaboration is considered a strategy which may have an influence on performance, supply

chain collaboration is considered as the independent variable and operational performance is considered as the dependent variable in the model. In addition, there are different relationships between environmental uncertainty, supply chain collaboration and operational performance. The most important aspect of this model is to ascertain the roles of environmental uncertainty on supply chain collaboration and operational performance. One view is that environmental uncertainty moderates the relationship between supply chain collaboration and operational performance. Instead of acting as a moderator, environmental uncertainty is considered as an antecedent of supply chain collaboration (Agbejule and Burrowes, 2007; Paulraj and Chen, 2007b; Ryu et al., 2008). In other words, the causal links between environmental uncertainty and operational performance are mediated by supply chain collaboration. Moreover, environmental uncertainty may also act as an antecedent of operational performance (Babakus et al., 2006; Dess et al., 1997; Ryu et al., 2008; Wood, 2008). Environmental uncertainty is the exterior of firms and has a negative effect on performance. Therefore, the most important aspect of this research model is to test the roles of environmental uncertainty on supply chain collaboration and operational performance.

In this model, based on contingency theory, environmental uncertainty is considered as a moderator of the relationships between supply chain collaboration and operational performance. In addition, environmental uncertainty is an antecedent of supply chain collaboration, which is a mediator on the relationship between environmental uncertainty and operational performance. Contingency theory emphasizes that the interaction between the environment and strategy has a positive influence on performance (Burns and Stalker, 1961; Hambrick, 1983; Miller, 1988; Venkatraman and Prescott, 1990). According to Miller and Friensen (1983), strategy is changed by managers' recognition of the environment and performance is also changed by choosing a proper strategy regarding the environment. In this regard, supply chain collaboration can be considered as strategy of Korean manufacturing firms in conformity with the recognition of environmental uncertainty. Such a contingency effect is called the "fit as moderation" and "fit as mediation" (Venkatraman, 1989). In

other words, this model suggests that the relationship between supply chain collaboration and operational performance is moderated by environmental uncertainty and supply chain collaboration mediates the relationship between environmental uncertainty and operational performance.

As shown in Figure 3-2, the research model can be divided into two parts. One part is concerned with the moderator role of environmental uncertainty on the relationship between supply chain collaboration and operational performance. This relationship is tested by an analysis of structural equation modelling (SEM). The method is the most suitable because it shows goodness of fit and suggests the best fit model (whether environmental uncertainty as a moderator of the relationship between supply chain collaboration and operational performance or an antecedent of supply chain collaboration). It allows researchers to examine the direct and indirect relationships between variables under the influence of other variables in the whole model. In addition, it provides researchers with the result of path analysis among variables and it is concerned with finding dimensions among variables. This means that it is more informative than others. That is why the methods are used for analysing the moderating effect in this research. The other part is connected with a causal link between environmental uncertainty, supply chain collaboration and operational performance. The causal link is verified by an analysis of SEM. The results of the SEM provide the most abundant information compared with the other method for verifying causal links, such as regression analysis, and, in addition, SEM is the best method to test a path analysis among variables because the result can demonstrate the direct and indirect relationships between the variables.

As shown in Figure 3-2, there is a causal link among environmental uncertainty and operational performance. The relationship is focused on the role of environmental uncertainty as an antecedent of operational performance. There are various theories which explain the relationship between the environment and performance. In particular, contingency theory can explain the relationship very well. The environment exists out of organisations and influences organisations. Environmental uncertainty can potentially have an adverse effect on an organisation's performance. Organisations make an effort

to minimize the negative effect of environmental uncertainty on performance. The effort can be shown in strategy, which is connected with supply chain collaboration in supply chain the environment. Supply chain collaboration is one of the attempts which could potentially mitigate the negative consequences of environmental uncertainty on performance. From this viewpoint, in this model, the focus is on the effect of environmental uncertainty on operational performance and the relationship can be tested by an analysis of SEM. The hypotheses for the model are developed in section 3.6.

3.6 Research hypotheses

3.6.1 Confirmatory factor analysis of supply chain collaboration

Supply chain collaboration is defined as various methods in prior research but, in this research, it is defined as working together among departments within a firm, understanding mutual different viewpoints, sharing resources and information and achieving common goals in supply chains (Ellinger et al., 2000; Stank et al., 1999b) because the concept includes external aspects as well as internal aspects concerned with inter-organisational relationships in supply chains. It has three sub-dimensions such as internal collaboration, supplier collaboration and customer collaboration. Abstract concepts cannot be measured and, as a result, they should be changed as the forms which can be measured. Internal collaboration is defined as processes of cooperation and interaction for maintenance of the close relationship between departments (Ellinger et al., 2000; Stank et al., 1999b). It has five measurable items: the possibility of real time acquirement of data concerned with goods and services; sharing information among departments; a degree of integrated inventory control; the possibility of real time management on total stock; a high level of information integration in production processes. External collaboration is defined as the operational cooperation and integration of the relationship between firms in supply chain contexts and it is divided into supplier collaboration and customer

collaboration. The former has five measurable items: an exchange of harmonized information with suppliers; participation of suppliers in inventory control; use of quick response; a degree of network integration with suppliers for stable procurement; a degree of receiving stable goods and services from suppliers. The latter has five measurable items: close contract with customers concerned with goods and services; rapidness of order processes; a high level of information sharing with customers; smooth communication with customers concerned with goods and services; supplying goods and services to coincide with customer needs. In this research, these items reflect the concept of supply chain collaboration and these are tested in this research.

Supply chain collaboration normally starts with internal collaboration and is developed to external collaboration (Stevens, 1989). However, the relationship between internal collaboration and external collaboration is still controversial. Some researchers have found that internal collaboration has a positive influence on external collaboration (Braunscheidel and Suresh, 2009; Chen et al., 2009; Gimenez, 2006; Schoenherr and Swink, 2012) and others have verified that external collaboration has a positive influence on internal collaboration (Bae, 2012b; Salvador et al., 2001; Stank et al., 2001). In addition, there is the research which has ascertained the positive effect of the interaction between internal collaboration and external collaboration on performance (Boon-itt and Wong, 2011b; Droge et al., 2004; Germain and Iyer, 2006) and the research which has confirmed the positive effect of the interaction between customer collaboration and supplier collaboration on performance (Danese and Romano, 2011; Flynn et al., 2010). This explains that supply chain collaboration can be divided into internal collaboration and external collaboration such as supplier collaboration and customer collaboration and it has an influence on performance as a whole concept.

The major perspective on supply chain collaboration which has been shown in prior research is that firms achieve internal collaboration and perform external collaboration on the basis of the internal collaboration (Narasimhan and Kim, 2001; Stevens, 1989). Gimenez (2006) has insisted that external integration is a phenomenon which occurs as a result of internal integration and, in this regard, firms

should first achieve internal collaboration for enhancing external collaboration. This means that firms should perform internal and external collaboration. According to the extant research, the classification of supply chain collaboration is divided into three levels such as supply chain collaboration, internal and external collaboration and internal, supplier and customer collaboration. Some researchers divided supply chain collaboration into internal collaboration and external collaboration (Bae, 2012a, b; Boon-itt and Wong, 2011b; Braunscheidel and Suresh, 2009; Chen et al., 2009; Droge et al., 2004; Germain and Iyer, 2006; Gimenez, 2006; Gimenez and Ventura, 2005; Narasimhan and Kim, 2002, 2006; Rodrigues et al., 2004; Schoenherr and Swink, 2012; Stank et al., 2001). In addition, other researchers classified it into internal, supplier and customer collaboration (Boon-itt and Paul, 2006; Boon-itt and Wong, 2011a; Flynn et al., 2010; Kannan and Tan, 2010; Lee et al., 2004; Stank et al., 2001/2002; Wong et al., 2011). In other cases, researchers have used supply chain collaboration as a whole concept (Aryee et al., 2008; Daugherty et al., 2009; Fynes et al., 2004; Ghobakhloo et al., 2011; Kahn et al., 2006; McCarthy-Byrne and Mentzer, 2011; Morash and Clinton, 1998; Rai et al., 2006; Rosenzweig et al., 2009; Salvador et al., 2001; Sezen, 2008; Zacharia et al., 2009). The results of prior research explain that supply chain collaboration is conceptualised as the whole viewpoint and it can be divided into internal collaboration and external collaboration including supplier collaboration and customer collaboration. The widest classification is supply chain collaboration as a whole concept and this research needs to test sub-dimensions of supply chain collaboration through confirmatory factor analysis. Therefore, the hypothesis is suggested as follows.

<Hypothesis 1> Supply chain collaboration is composed of customer collaboration, supplier collaboration and internal collaboration.

3.6.2 Confirmatory factor analysis of operational performance

Performance can be approached through various viewpoints: corporate performance, business unit performance and operational performance. The first is connected with corporate strategy, the second is connected with business unit strategy and the third is concerned with operational strategy. From a general viewpoint, performance is an objective which firms should achieve through performance of strategy. Because performance is achieved by strategy, firms should decide performance levels which are achieved by strategy before deciding it. Supply chain collaboration can be treated as a strategy and firms should decide performance levels achieved by supply chain collaboration. Prior research has confirmed performance improvement among different levels of supply chain collaboration (Daugherty et al., 1996; Flynn et al., 2010; Frohlich and Westbrook, 2001). This explains that strategy is an antecedent of performance and when managers decide strategy, they should firstly think about performance levels.

In this research, operational performance is defined as efficiency and effectiveness. The former is a degree of economically using internal resources of firms and the latter means a degree of achieving the goals of firms (Chow et al., 1995). Moreover, the former is concerned with saving costs in a firm and the latter is concerned with improving service to customers and, in other words, efficiency reflects cost performance and effectiveness reflects service performance (Brewer and Speh, 2000). However, because a conceptual definition is abstractive, it is not measured. In this regard, cost performance has five measurable items: a degree of saving labour costs following reduction and re-disposition of workers; a degree of cost saving concerned with decreasing stock; a degree of cost saving concerned with stock management; a degree of cost saving concerned with order management; a degree of cost saving concerned with contact with partners. Service performance has also five measurable items: a degree of increased flexibility of operations through cooperation with partners; ability to fulfil special requirements of customers; ability to supply estimated quantity on time; ability to provide customers

with value added service; ability to cooperatively overcome any problems with partners if they are occurred. From this viewpoint, operational performance can be divided into cost performance and service performance and this research needs to test sub-dimensions of operational performance through confirmatory factor analysis. Therefore, the hypothesis is suggested as follows.

<Hypothesis 2> Operational performance is composed of cost performance and service performance.

3.6.3 Confirmatory factor analysis of environmental uncertainty

There are various definitions concerned with environmental uncertainty which is come from prior research. The environment means the factors which exist which are exterior to firms and have an influence on firms (Porter, 1980). In this regard, environmental variance has a direct effect on firm performance. It is divided into uncertainty and stability. Firms focus on external-oriented strategy to find opportunities in the market under the environmental uncertainty, whereas firms perform internal-oriented strategy under the stable environment because they cannot find additional opportunities in the market. Some prior research approached environmental uncertainty from a single dimensional viewpoint and the other approached it from the multi-dimensional viewpoint. Environmental uncertainty from the former viewpoint is used by many researchers (Agbejule and Burrowes, 2007; Fink et al., 2006; Hsu and Wang, 2008; Jokipii, 2010; Ryu et al., 2008; Sun et al., 2009; Wong et al., 2011). The second viewpoint is also used by many established researchers. For instance, Miller (1988) divided the environment into uncertainty, unpredictability, dynamism and heterogeneity. Similarly, McGinnis and Kohn (1993) divided environmental uncertainty into munificence, dynamism, heterogeneity and hostility. Dess et al. (1997) classified the environment into environmental uncertainty and environmental heterogeneity. Fynes et al. (2004) classified environmental uncertainty

into demand uncertainty, technology uncertainty and supply uncertainty. Pagell and Krause (2004) divided perceived environmental uncertainty into munificence, instability and complexity. Coelho and Easingwood (2005) classified environmental uncertainty into environmental volatility, environmental heterogeneity and environmental conflict. Babakus et al. (2006) classified environmental uncertainty into labour market uncertainty, supplier market uncertainty, customer market uncertainty and capital market uncertainty. Boon-itt and Paul (2006) divided environmental uncertainty into supply uncertainty, customer uncertainty, competitor uncertainty and technology uncertainty. Paulraj and Chen (2007b) divided environmental uncertainty into demand uncertainty, supply uncertainty and technology uncertainty. Fink et al. (2008) divided environmental uncertainty into technological uncertainty and resource availability. Boon-itt and Wong (2011a) classified environmental uncertainty into technological uncertainty and demand uncertainty. Iyer (2011) divided environmental uncertainty into technological turbulence and market turbulence. Extant research divided environmental uncertainty into various sub-dimensional factors. Environmental uncertainty can be approached to the multi-dimensional viewpoint as well as the single dimensional viewpoint. From this viewpoint, this research applies environmental uncertainty to characteristics and these are multi-dimensional factors such as munificence, dynamism, heterogeneity and hostility (McGinnis and Kohn, 1993).

In this research, environmental uncertainty is defined as a degree of difficulty of prediction of outcomes or the future (Chow et al., 1995) and it is divided into four dimensions: munificence, dynamism, heterogeneity and hostility (McGinnis and Kohn, 1993). Firstly, munificence is defined as a degree of continuous growth of a market caused by environmental variance (Clinton, 1997; McGinnis and Kohn, 1993). Measuring this growth is abstractive because this is a conceptual definition and, as a result, it has three measurable items: potentiality in the market; possibility of success when a firm enters the new market; opportunities of the market growth. Dynamism is defined as the difficulty of predicting a change in the market (Clinton, 1997; McGinnis and Kohn, 1993). Predicting a change in the market is abstractive because this is a conceptual definition and, as a result,

it has three measurable items: the difficulty of forecasting the behaviour of competitors in the market; the difficulty of forecasting demand in the market; the difficulty of confirming customer needs. Heterogeneity is defined as the change of competitive methods of competitors and customers' preferences and expectations (Clinton, 1997; McGinnis and Kohn, 1993). Evaluating customer needs is abstractive because this is a conceptual definition and, as a result, it has four measurable items: a change of competitors' competitive methods; a change of customers' preference for goods/service; a change of customers' level of expectation; the application of various competitive strategies. Hostility is defined as the degree of competition and regulations of the government in the market (Clinton, 1997; McGinnis and Kohn, 1993). Calculating the degree of hostility is abstractive because this is a conceptual definition and, as a result, it has four measurable items: the strength of competition in the market; considering the response of competitors in decision-making; difficulty in analysing the strategies of competitors; the degree of regulations of the government. In order to make accurate predictions of how markets are affected by environmental uncertainty, this research tests sub-dimensions of environmental uncertainty through confirmatory factor analysis. Therefore, the hypothesis is suggested as follows.

<Hypothesis 3> Environmental uncertainty is composed of munificence, dynamism, heterogeneity and hostility.

3.6.4 Supply chain collaboration and operational performance

The relationship between supply chain collaboration and performance can be explained by several theories, such as resource-based theory, relational view, information processing theory and contingency theory. First of all, resource-based theory explains the relationship between collaboration and performance. Inter-departmental collaboration structures the collaborative mind, culture and

behaviour among departments and this can be recognized as one of the resources of firms (Min et al., 2005). The collaboration, as the resource, is the cause of achieving efficiency to remove waste and overlaps in internal processes and attain effectiveness through the collaborative achievement of common goals in external processes. Similarly, relational view explains the relationship between supply chain collaboration and performance. The rationality of internal processes in a firm is based on the inter-corporate rationality, followed by high performance. In addition, information processing theory explains the relationship between collaboration and performance. Managers acquire information from the exterior and, consequently, structure efficient internal processes (Wong et al., 2011). From this viewpoint, suppliers and customers are regarded as the sources of external information (Flynn et al., 2010) and information acquired from them is learnt by managers and disseminated to all departments. As a result, this is the basis of enhancing customer service and achieving efficiency in processes. Contingency theory also explains the relationship between supply chain collaboration and performance. Firms use different strategies on the basis of environmental variance and this is connected with performance (Miller, 1987). The environment which firms face can be approached as an external environment from the external viewpoint of firms, and this includes suppliers and customers. From this viewpoint, the variance of customer needs as an external environment is the basis of the variance of firms' internal processes and this variance leads the variance of whole processes to include suppliers. Therefore, firms which structure processes to coincide with customer needs can achieve high performance.

Collaboration starts with inter-functional collaboration and is developed to inter-corporate collaboration (Stevens, 1989). From this viewpoint, internal collaboration is regarded as the inception. Through internal collaboration, firms can remove overlaps and waste in all activities and achieve efficiency of processes (Larson, 1994). Collaboration makes possible cost savings in inter-departmental activities and the achievement of efficiency from the viewpoint of whole processes. Managers face many barriers in SCM. They make an effort to decrease waste, work delays and

overlaps and seek to perform a seamless flow of goods, services and information in a whole process, followed by efficiency (Matapoulos et al., 2007). The aim of collaboration is to maintain the lowest level of cost without the sacrifice of superior service (Stank et al., 2001). In addition, collaboration has an influence on organisational outcomes such as decreasing working time, new product development, recognition of customer value and customer service (Stank et al., 1999b). From this viewpoint, collaboration is the basis of structuring a collaborative attitude, understanding mutually different viewpoints, sharing resources and information and achieving common goals. This is connected with decreasing overlaps of resources, removing waste and eliminating inefficiency (Lee et al., 2007). As a consequence, cost saving can be achieved by inter-functional collaboration. The collaboration enhances the use of the ability of assets in firms and removes overlapping activities in whole processes, whereas it helps to minimize possession of stock in an inter-functional interface.

Efficient collaboration between supply chain partners includes mutual understanding, common rules, sharing resources and achieving common goals. The development of information technology and communication is used as a means of enhancing inter-corporate collaboration in supply chains. Firms which have a high level of information technology and communication capability can remove the overlaps and inefficiency which exist in distribution processes through collaboration with customers, as well as eliminating overlaps and inefficiency which exist in supply processes through collaboration with suppliers (Bagchi et al., 2005). Accordingly, firms can remove the waste, working delays and inefficiency which previously occurred in the relationship between firms (Stank et al., 2001). Sharing resources and information is the most important outcome provided by collaboration between firms. Manufacturers can perform the management of resources like raw materials and parts through collaboration with suppliers and, consequently, save resources and invest the saved resources in the manufacturing process which is their core competence. In addition, they can achieve financial performance through grasping customer needs and responding to those needs and this is based on collaboration with customers. Therefore, firms can remove overlaps and inefficiency in whole

processes through supply chain collaboration and, as a result, the benefits are the maintenance of the lowest cost and the achievement of high financial performance.

The impact of supply chain collaboration has its origin in the concept of integrated logistics management. Integrated logistics management refers to a simultaneous work process to minimize total logistics cost through integrating all logistics activities (Daugherty et al., 1996). This includes planning, performing and monitoring the human and physical resources included in procurement, manufacturing and distribution. Managers integrate inter-functional processes for increasing value and decreasing waste due to delays in work and overlaps. Thus, the integration of the processes has a direct influence on cost saving. In addition, supply chain collaboration allows firms to achieve functional integration, resulting in efficiency in an internal process and flexible logistical flow with suppliers and customers (Stevens, 1989). Savings of total logistics cost can be achieved through standardization and collaborative activities with supply chain partners. For this reason, successful supply chain collaboration is the cause of an efficient logistics operation, overall efficiency, production and cost saving (Bowersox and Daugherty, 1995). Many researchers have found that cost performance is positively related to supply chain collaboration (Bagchi et al., 2005; Boon-itt and Wong et al., 2011b; Ghobakhloo et al., 2011; Larson, 1994; Lee et al., 2007; Ragatz et al., 2002; Rajaguru and Matanda, 2009; Rosenzweig et al., 2003; Schoenherr and Swink, 2012; Wong et al., 2011).

Prior research has confirmed that internal collaboration has a positive influence on service performance. Researchers have investigated collaboration between marketing and logistics (Daugherty et al., 2009; Ellinger, 2000; Ellinger et al., 2000; Gimenez and Ventura, 2005; Mollenkopf et al., 2000; Stank et al., 1999b), collaboration between logistics and production (Gimenez and Ventura, 2005), and collaboration between logistics, production and R&D (Kahn and Mentzer, 1998). The relationship between departments is based on the cognition of staff working with the other departments. This cognition should be valuable, fair, productive and satisfactory. The effectiveness of

the relationship between departments is based on cognition of the collaboration between functions, forms a collaborative culture among departments and builds a collaborative mind among departments. The construction of a collaborative mind and culture is a prerequisite for collaboration between departments (Bae, 2008). From this viewpoint, inter-functional collaboration is expressed as effective, mutually shared processes when two or more departments share mutual viewpoints, have common regulations, share resources and information, and achieve common goals in working together (Stank et al., 2001). In this regard, key dimensions are the scope of activity beyond the boundary of departments, responsibility for joint work and the achievement of common goals. Managers who want to cooperate with other departments should facilitate the forming of a collaborative mind beyond departments and achieve common goals through interaction with other departments. As a result, collaboration is the cause of achieving a high level of customer service through information sharing and the adjustment of activities in whole processes.

The relationship management of a firm starts with close collaboration between functions and is achieved by effective connection with supply chain partners. From the viewpoint of SCM, the supplier management of a firm constructs mutually collaborative attitudes beyond cost saving and, as a result, contributes to customer service through a collaborative response with suppliers to customer needs (Scannell et al., 2000). In addition, customer-oriented collaboration is followed by behaviour for grasping customer needs, which is connected with a high level of customer service. For this reason, supply chain collaboration can help to attain customer needs, such as low cost and high-quality service, which have an effect on customers' choice through recognizing a firm's commitment to customers' long-term needs, expectations and preferences (Lai et al., 2002). From this viewpoint, firms which want to achieve competitive advantages through supply chain collaboration should first focus on internal collaboration in their internal processes and, consequently, can respond to customer needs very well (Boon-itt and Wong, 2011a). In addition, firms achieve collaboration with suppliers and customers on the basis of internal collaboration (Bowersox and Daugherty, 1995). Successful

inter-corporate collaboration makes possible the achievement of firms' goals through the achievement of customer service in whole processes. Firms, through supply chain collaboration, attain correct predictions and plans concerned with market information, improved process efficiency and enhanced customer service.

The scope of collaboration in inter-corporate activities includes predictions, plans and implementation. All supply chain participants should cooperate because a collaborative response through long-term prediction following mutual information sharing is more effective than an individual response to independently collected information. That is why firms should enhance their level of supply chain collaboration. Information is then continuously renewed on the basis of real demand and variances in the market and, as a result, firms can efficiently connect supply with demand using specific data. Therefore, firms can achieve efficiency and effectiveness through supply chain collaboration.

Effective relationships between departments should include the recognition of staff who works with other departments. The relationships should be valuable, fair, productive and satisfactory. Successful collaboration depends on these relationships when there are strong mutually dependent relationships between departments (Ellinger et al., 2000). In this regard, the effectiveness of the relationship between departments can be developed via collaboration between functions. Collaboration means constructing a collaborative attitude towards common tasks between workers, understanding mutually different viewpoints, sharing resources and information and achieving joint goals. As a result, firms can achieve performance such as a more accurate recognition of customer needs, adaptation to market variance and the flexibility to respond to customer needs. Inter-departmental collaboration has a direct effect on performance, including decreasing work time, developing new products, recognizing customer value and attaining customer service (Stank et al., 1999). The factor which has the largest influence on collaboration is information (Gustin et al., 1995). The sharing of information such as market information, operation plans and financial information brings a number of benefits to the

relationships between departments. In addition, firms can share information regarding sales and production plans, demand forecasts and operations with supply chain partners. In this respect, a collaborative attitude between departments as well as firms through information sharing can enhance the accuracy of long-term plans, demand forecasts and operations. Through information sharing and collaboration, firms can grasp customer needs and provide customers with superior service through joint actions. Extant research has verified that supply chain collaboration has a positive effect on service performance (Boon-itt and Wong, 2011a, b; Rosenzweig et al., 2003; Salvador et al., 2001; Stank et al., 2001; Scannell et al., 2000; Schoenherr and Swink, 2012; Wong et al., 2011). As a result, this research proposes the following hypothesis.

<Hypothesis 4> Supply chain collaboration has a positive influence on operational performance.

3.6.5 The moderating effect of environmental uncertainty between supply chain collaboration and operational performance

The moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance can be explained by contingency theory. Contingency theory explains the effects through dimensions among variables. The environment has an effect on structure and strategy, which have an effect on performance. In this regard, firms change strategy following environmental variance, followed by high performance. From this viewpoint, environmental uncertainty reflects the recognition of firms of the environment and, as a result, firms can improve performance through supply chain collaboration to connect the environment with firms. The core of supply chain collaboration is to share resources and information. Each department treats the others as a source of resource and information. From this viewpoint, each department can consider the other departments as an environment and improve performance through interaction with that

environment (the other departments). Similarly, firms treat suppliers and customers as the origins of resources and information. They can consider suppliers and customers as an environment (Flynn et al., 2010) and enhance performance through interaction with that environment (suppliers and customers). The viewpoint is equal to the fit as moderation model of Venkatraman (1989). From this viewpoint, the environment is treated as a source of information and the higher the environmental uncertainty, the greater the uncertainty of firms because of a lack of necessary information when firms make a decision. Environmental uncertainty has an influence on the awareness of uncertainty of top management, which has an influence on strategic patterns of firms. For this reason, firms adopt a supply chain-oriented strategy in response to environmental uncertainty. Firms which adopt the strategy can respond to a variance as well as recognizing environmental variance. In addition, it is possible that a group which recognizes high environmental uncertainty shows high supply chain collaboration compared with others because it forms collaboration with suppliers and customers as an environment for removing overlaps and inefficiency in whole processes. In this regard, the group shows high cost saving compared with the others because it achieves process efficiency. According to Wang and Tai (2003), it is possible that a strategy planned in advance is performed only partially. They have established that an intended strategy is difficult to apply in practice because firms cannot dominate environments. For this reason, when firms plan a strategy, they should consider the environment and this is connected with the moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance. Similarly, Choe (2003) has found that firms respond voluntarily to environmental variance through the selection of a supply chain-oriented strategy in response to environmental uncertainty. This means that firms which recognize high environmental uncertainty enhance supply chain collaboration, followed by high performance because they lay stress on the effectiveness of the relationship between organisations (Bae, 2011).

Collaboration can be focused on whole corporate activities as well as functional activities; it is

important in logistics operations and is connected with efficiency and production through expanding to other functional areas. From this viewpoint, collaboration provides a method which minimizes total cost by removing overlaps and inefficiency in an entire process. In this regard, firms which have a high collaborative level can achieve high cost performance compared with other firms (Daugherty et al., 1996). Collaboration is expanded beyond the territory of the firm from the inter-firm viewpoint. Efficient external collaboration should include mutual understanding, common rules, sharing resources and achieving joint goals. Firms, through internal collaboration, can minimize the order process cost of suppliers and customers, custody cost and stock management cost and collaborative relationships between supply chain partners can improve total cost performance (Larson, 1994). Taking those mechanisms in which supply chain collaboration affects performance as a basis, environmental uncertainty signifies the degree of difficulty in predicting the future and the degree of the impossibility of predicting outcomes (Chow et al., 1995; Duncan, 1972). From the viewpoint of supply chain collaboration, firms have need of more integrated logistics management and supply chain collaboration if the environment is uncertain (Daugherty et al., 1996; Kahn and Mentzer, 1996). Firms have responded to uncertainty through supply chain collaboration by including suppliers and customers as well as internal collaboration. Under environmental uncertainty, firms can better grasp customer needs through supply chain collaboration and the needs are shared with suppliers through collaboration. This is connected with performance through achieving customer needs and process efficiency. Firms also collaborate with partners in collecting information regarding environmental uncertainty and this new information is connected with efficiency and effectiveness through collaborative responses and information sharing among all departments. Firms respond to market variance through these processes and waste and inefficiency in supply chains are removed. This can be explained by the fit as moderation of Venkatraman (1989). In addition, prior research has verified that environmental uncertainty enhances the relationship between supply chain collaboration and cost performance (O'Leary-Kelly and Flores, 2002; Fynes et al., 2004; Wong et al., 2011).

Collaboration between marketing and logistics can achieve superior customer service through identifying and fulfilling customer needs (Ellinger et al., 2000). From the viewpoint of supply chain collaboration, manufacturing firms can achieve high levels of effectiveness through collaboration between internal activities such as production, transportation and custody and external activities such as procurement and distribution (Vargas et al., 2000). In addition, environmental uncertainty refers to the degree of difficulty in forecasting the future and outcomes (Chow et al., 1995; Duncan, 1972). To enhance customer service under high environmental uncertainty, firms need to recognize customer needs more accurately, which is achievable via supply chain collaboration especially when the supply chain environment is rather uncertain. Under environmental uncertainty, firms which have focused on supply chain collaboration are found to have achieved superior customer service (Lambert et al., 1998). In addition, prior research has confirmed that environmental uncertainty enhances the relationship between supply chain collaboration and service performance (Boon-itt and Wong, 2011a; Fynes et al., 2004; Wong et al., 2011). This viewpoint is explained by fit as moderation (Venkatraman, 1989). Therefore, this research suggests the following hypothesis.

<Hypothesis 5> Environmental uncertainty moderates the relationship between supply chain collaboration and operational performance.

3.6.6 A causal link between environmental uncertainty and supply chain collaboration

The causal link between environmental uncertainty and supply chain collaboration can also be explained by contingency theory. From the viewpoint of contingency theory, the environment exists outside a firm and is an exogenous factor which firms cannot dominate. The environment is the source of information and firms collect information to find opportunities in the market under environmental uncertainty. To use the information, firms decide a strategy which minimizes the effect of an uncertain

environment on performance. Supply chain collaboration is one of these strategies and firms can enhance performance through supply chain collaboration under environmental uncertainty. For this reason, contingency theory can explain the relationship between environmental uncertainty and supply chain collaboration. According to the research model, environmental uncertainty acts as the antecedent of supply chain collaboration. In another word, supply chain collaboration mediates the relationship between environmental uncertainty and operational performance (fit as mediator, see Venkatraman, 1989). This view differs from the one hypothesized in H.5, where environmental uncertainty is considered a moderator for the relationships between supply chain collaboration and operational performance. According to the research model, environmental uncertainty means the degree of forecast difficulty regarding the future and outcomes (Chow et al., 1995; Duncan, 1972). When the environment is uncertain, firms try to achieve a high level of supply chain collaboration through improving inter-firm as well as inter-function relationships for achieving competitive advantages in the market (Lambert et al., 1998). A department tends to collaborate with other departments beyond traditional functional areas in order to respond to the uncertain environment. They can achieve efficient flows of raw materials through collaboration with suppliers. They can also provide customers with the most suitable services by adopting a high level of supply chain collaboration, for example, through communication with customers (Daugherty et al., 1996). In this regard, prior research has found that environmental uncertainty has a positive influence on collaboration (Helfat and Teece, 1987; Paulraj and Chen, 2007b; Ragatz et al., 2002; Williamson, 1985). Therefore, this research proposes the following hypothesis.

<Hypothesis 6> Environmental uncertainty has a positive influence on supply chain collaboration.

3.6.7 A causal link between environmental uncertainty and operational performance

The relationship between environmental uncertainty and operational performance can be explained by information processing theory. According to Porter (1980), the environment is all factors which have an influence on firms and do not exist in firms. When managers make a decision, they are faced with uncertainty because of a lack of information. To minimize the uncertainty, managers acquire information through interaction with the environment (Flynn et al., 2010) and, as a result, the negative effect on uncertainty on performance is minimized. In addition, the relationship between the environment and performance can be also explained by contingency theory. Managers' recognition of the environment is the cause of performance gaps. If they recognize environmental uncertainty, organisations are changed by managers to minimize the negative effect of the uncertainty on performance. Moreover, environmental uncertainty is the basis of a lack of information when managers would perform strategy and the lack of information is the cause of the negative relationship between environmental uncertainty and performance. Venkatraman (1989) explained the intervening effect of strategy on the direct relationship between the environment and performance as fit as mediation. This represents the relationship between the environment and performance as the direct effect and the intervening effect of strategy on the relationship between the environment and performance as the indirect effect. The former relationship is negative because of managers' recognition on the uncertainty and the latter relationship is positive because of the intervening role of strategy.

Extant research has classified the environment into the approach to components and approach to characteristics. The former divides the environment into the task environment and the general environment. The latter divides the environment into various sub-dimensions such as munificence, dynamism, heterogeneity and hostility (McGinnis and Kohn, 1993). The environment can be classified into various dimensions and it is not controlled by firms. From this viewpoint, the

environment is the basis of uncertainty and the high environment uncertainty is the basis of a lack of information, followed by inferior performance. This means the negative effect of environmental uncertainty on performance. From this viewpoint, environmental uncertainty has a negative effect on performance because of a lack of information when managers make a decision. Similarly, extant research has verified that environmental uncertainty has a negative effect on performance (Fink et al., 2008; Ryu et al., 2008; Wood, 2008). Therefore, this research proposes the following hypothesis.

<Hypothesis 7> Environmental uncertainty has a negative influence on operational performance.

3.7 Summary

In this chapter, extant research concerned with measuring variables is performed. First of all, theoretical background is focused on contingency theory, resource-based theory, information processing theory and strategic choice theory. Second, the definitions of the variables come from extant research. Third, there is a research model which is tested in this research. Fourth, the relationship between the variables is shown in the research hypotheses.

Chapter IV Research Methodology

4.1 Introduction

This chapter presents the methodology of this research. This research uses various methods for an empirical analysis of the collected data through survey. In this chapter, the methodology for verifying the hypotheses is explained. This is concerned with verifying the relationships between variables through the analyses of the collected data: first, the reliability and validity of the measuring variables is verified by content validity, estimate and purification of data, construct validity and comparison of average variance extracted (AVE) with the power of two of the correlation coefficients; second, the research model has two parts: 1) confirmatory factor analysis on the variables and 2) the relationships between the variables. Both the former and the latter are verified by SEM. The contents of this chapter show the following: the philosophy of the science, the research methodology and a summary of the research methodology.

4.2 Philosophy of the science

Research on SCM is approached from the viewpoint of various disciplines (Frankel et al., 2005). The core of this research is to extract the variables such as environmental uncertainty, supply chain collaboration and operational performance in SCM and to ascertain the roles of environmental uncertainty on the relationships between supply chain collaboration and operational performance. This is connected with a managerial approach because the model of this research tests the causal links or the moderating effect between the variables. In this regard, research methodology is the most important part for achieving the objectives of this research. Research methodology involves components such as the trust, value and technology shared by members of the society of research and

can be divided into qualitative methodology and quantitative methodology (Mentzer and Kahn, 1995). The choice of methodology is decided by the objectives of the research. The goal of quantitative methodology is to prove the relationships between variables. For this reason, this research extracts conceptual and operational definitions of the measuring variables from prior research, gathers the data from Korean manufacturing firms in China, tests the relationships between variables, and generalizes the results from a neutral viewpoint (Baumgartner and Homburg, 1996; Frankel et al., 2005; Garver and Mentzer, 1999; Mentzer and Flint, 1997). From this viewpoint, as the objective of this research is focused on the supply chain collaboration concerned with managerial research, quantitative methodology is the most appropriate method for verifying the relationships between the variables.

Chua (1986) has insisted that there is a philosophical supposition shared by all theories of social science. Theory is an aggregation of knowledge and the knowledge mediates the relationship between humans and society because it is a product generated through maintaining the relationship between society and human needs. In this circumstance, suppositions concerned with knowledge are divided into epistemology and methodology (Chua, 1986). The former is a necessary supposition when people decide an acceptable truth from the viewpoint of regulating the criteria and processes for measuring truth. The latter means a superior philosophical supposition rather than a simple method as a supposition to indicate proper methods which collect proper proof required in the verification of truth. These two forms of supposition have a close relationship. From this viewpoint, the methods which only classify and investigate data following the method of collecting the data has limitations in treating only descriptive perspectives on the data in superficial conditions and, in this regard, this research tries to find the truth pursued by various theories to emerge from prior research.

In addition, ontology is a field of philosophy concerned with existence (being). It is a branch of metaphysics. The object of study from the viewpoint of ontology is to find the reason of the existence if there is existence of something (Chua, 1986). From this viewpoint, the methodology in this research starts from ontology, which regulates how to define the relationships between an object as the object

of research and a subject as the subject of research in a research process. From the viewpoint of the object and the subject, the researcher becomes a subject of this research and then the subject can analyse an object within this research from an objective viewpoint.

Research methodology from the viewpoint of epistemology regulates processes to measure truth and it can suggest necessary suppositions as the criteria for deciding truth. As a result, epistemological research methodology is classified into positivism and interpretivism. Positivism is based on dichotomous thinking, which supposes an independent relationship between object and subject. In this situation, researchers become an objective existence. In addition, positivistic research from the epistemological viewpoint is that objective researchers observe an independent phenomenon, verify truth and generalize results. In this regard, empirical measurement as a scientific method is the main methodology (Orlikowski and Baroudi, 1991). The advantage of positivism is to grasp comparative importance between variables through numerical data and is concerned with the control of variables in the composition of causal links. The disadvantage is that the relationships between independent variables and dependent variables could be changed if new variables are added. The viewpoint of interpretivism is that the method of natural science has disadvantages in the research of social phenomena. In other words, researchers could interpret identical phenomena as having different meanings. In this regard, researchers want to approach meanings through participating in phenomena for understanding these phenomena in interaction with the environment (Orlikowski and Baroudi, 1991). The advantage of interpretivism is that researchers can overcome the limitation of positivism through connecting variables with contexts from a holistic viewpoint. In addition, it has theoretical openness as to the possibility of variance in conformity with contexts. The disadvantage is that it is impossible to generalize to the wider population and the greater the number of cases, the more complex the causality.

Positivism has been selected as the methodology of this research because the objectives of this research are to verify the roles of environmental uncertainty on the relationship between supply chain

collaboration and operational performance. From this viewpoint, this research needs to find theoretical backgrounds to explain the relationships between the variables, extract conceptual and operational definitions from prior research, gather data by survey, analyse the data by statistical methods, suggest implications following the results and generalize the results to a population. These research processes should coincide with the methodology on the basis of positivism.

4.3 Research design

4.3.1 Science and scientific research

4.3.1.1 Science

Science means the systematic acquisition of knowledge with the aim of discovering a universal truth or law in the natural world. It is divided into social science and natural science. These two branches are similar from the aspect of analysing and structuring a theory to use systematic methods but they have three differences in research methodology. The first is that research in natural science is performed in a closed laboratory, whereas research in social science is carried out in an open field. This means that the former does not receive an upshot from exogenous variables but the latter should consider an effect of the variables. For example, Mount Eyjafjallajökull's volcanic explosion in Iceland had an effect on aircraft services in 2010 and this had an effect on the European economy. The exogenous variables such as the volcanic explosion exist in social science and researchers feel difficulty in testing causality because of the variables. Second, social science mainly explains probability rather than attempting an exact explanation of the relationships between variables because of exogenous variables. Third, when researchers estimate a causal link in social science, they focus on

prerequisites which make it possible to analyse causality rather than the causal link itself. This is of importance because results can be generalized if the prerequisites are correct.

Scientific verification aims at the independent acquisition of knowledge from personal opinions or preferences and also aims at a demonstration of fact on the basis of objective knowledge which comes from data acquired by a survey or observation. In contrast, non-scientific verification could include personal opinions when researchers judge truth. Therefore, science refers to the methodology for the verification of an existing fact or the discovery of a new fact, verifying through objective methods. In addition, scientific verification means the acquisition of knowledge through systematic incremental processes regarding the fact which researchers want to observe.

4.3.1.2 Scientific research

Babbie (1973) defines science as follows: logical, deterministic, general, parsimonious, specific, empirically verifiable, intersubjective and open to modification. The definitions could be explained as various methods and, in particular, intersubjectivity is one of the important characteristics of scientific research because results should be verified by other researchers and, in turn, if they perform the same verification processes, they must obtain the same result. Therefore, it should be possible for scientific research to ascertain fact by verification and the fact can be accumulated as knowledge by repeated verification. A fact accumulated by recurrent verification becomes theory.

Scientific research has two prerequisites. The first is the degree of agreement with prior scientific knowledge or consistency of knowledge. Consistency means the same results represented from prior research. This means the accumulation of the results. The second is that research must be rationally performed by scientific research processes. These processes involve the validity of the objectives, the accuracy of the literature review, strict points of argument, the scope of witness, correct verifying processes, strict interpretation of results, acceptable implications and so on. Research following these

processes is regarded as scientific when the research is rationally recognized by the other researchers in the same field. Therefore, scientific research measures processes that empirically verify the hypothesized relationships between observed or developed variables through established theory.

4.3.2 The process of quantitative analysis

4.3.2.1 Basic assumptions

Research on SCM is executed through various academic approaches such as business administration, economics, jurisprudence and industrial engineering (Frankel et al., 2005). It is carried out in accordance with a behavioural approach and the approach of interpretivism (Mentzer and Kahn, 1995). The former is based on an approach to positivism which has the objective of predicting and explaining fact. Positivism starts with making hypotheses regarding research questions and is performed by testing the hypotheses. It is performed by the following process: suggesting research questions, ascertaining theory through prior research, suggesting hypotheses, collecting data, analysing data, testing hypotheses, interpreting results and generalizing results. The latter has the objective of understanding a phenomenon in contrast to the former. It can illuminate a substantial phenomenon through collecting a specific social fact. This kind of research is conducted not to consider causal links but to consider a specific, contingent and individual fact. Therefore, the approach of interpretivism is achieved by the observation of various factors.

Both approaches can provide an important basis for research on SCM. Both viewpoints could solve problems but the core of positivism as a behavioural approach is to emphasize the clarity of the procedures and the accumulation of knowledge through correct verifying processes. Accumulated knowledge can contribute to the development of knowledge through suggesting theoretical backgrounds to future research. The research processes are started by finding research objectives, are

ascertained by testing the objectives and are continued by rotated research to investigate another objective which has materialised from the results. This rotated research makes feasible the accumulation of knowledge and this forms the basis of the theory.

4.3.2.2 The structure of research on SCM

Research on SCM is approached from various academic viewpoints and there are a vast number of research methods, such as surveys, interviews, observation, focus groups, case studies, experiments, literature reviews and content analysis (Frankel et al., 2005). However, this research is performed utilizing positivism on the basis of a behavioural approach. Mentzer and Kahn (1995) explained a research process relating to SCM. The process is performed in three sequential research stages: collecting ideas and prior research, a proposal of research methodology and tests of and suggestions for a conclusion, as follows.

4.3.2.3 Collecting ideas and prior research

A research process is started by collecting ideas, which is accomplished by a literature review and observation. The aim of a literature review is to recommend the theoretical validity and discrimination of research. This research suggests validity and discrimination through prior research in Chapter I. In addition, this research suggests integrative, methodological and theoretical directions through prior research in Chapters II and III. Prior integrative research is the basis for proposing an objective for the present research through ascertaining future research directions from prior research. Prior methodological research is the basis for suggesting the most appropriate research methodology through analysing various research methods for performing present research from prior research. Prior theoretical research is the basis for explaining the definitions of the variables and the relationships

between the variables through a literature review (Mentzer and Kahn, 1995). Extant research advocates substantive justification for this research. In the literature review, this research suggests the theoretical backgrounds, the present findings following prior research, the conceptual and operational definitions of extracted variables and the methods for an analysis. In this respect, this research is regarded as performing three directions as referred to above in Chapters II and III. The objectives of this research are also proposed by observation as well as prior research (Wilson and Natale, 2001). Observation devises general principles and various approaches can be suggested by observation following contexts and the environment. If researchers repeatedly propose the same results through observation, the results are repeated social phenomena. In this regard, this research provides justification for the objectives of this research through interviews with workers and experts. Interviews are one of the methods for observing social phenomena. Therefore, this research has value because a theoretical basis for how to contribute to academia and society is suggested in Chapter I.

4.3.2.4 A proposal for the research methodology

After presenting the objectives of this research, a theory concerned with the research subjects is suggested. A theory is ascertained by prior research and refers to a fact generally accepted by academia and society. For instance, the external environment is a factor which has an effect on firms but is located outside firms. This can be explained by contingency theory. Resource-based theory explains useful resources which have an effect on performance on the basis of the internal resources of firms. Information processing theory explains that firms acquire information from the external environment and the information is then the basis of efficient internal processes. From this viewpoint, managers mediate the relationship between the environment and firm. In addition, firms choose different strategies and these are based on the managers' recognition of the environment. This is explained by strategic choice theory. The theories can be empirically tested in relation to the goals of

explaining, predicting, understanding and adjusting the behaviour of firms. The process of finding a theory is fulfilled by applying logic, performing methods and procedures, standardizing verification and observing estimation. From this viewpoint, researchers should judge a theory in connection with accepted theory, estimating the present exceptions, leading findings in future and generalizing research results to society (Mentzer and Kahn, 1995). Similarly, the theories used in this research are extracted from prior research and so can explain the relationships between the variables.

Theory comes from prior research, which is the background of hypotheses. In addition, hypotheses are conceptually connected with theory through the process of logical inference. Hypotheses are defined as propositions to explain the relationship between variables. Hypotheses can be divided into two types: a directional hypothesis, such as positive or negative, and a non-directional hypothesis, such as differences between groups. The former elucidates a causal link between variables and the latter explains the classification of clusters. From this viewpoint, the former is more informative than the latter. The difference between the two types of hypothesis lies in the methods of measurement and both results can provide significant implications. In this research, the hypotheses are treated using the former.

There are two types of definition: conceptual and operational. The former refers to abstract conceptions of variables and the latter involves the measurable forms of the former. Concepts have systematic meanings for variables and the measurability of the concepts is related to items in questionnaires. Systematic meanings indicate that the conceptions are explained by theory and the measurability represents the way in which an abstract conception is changed as a measurable item. From this viewpoint, this research suggests the conceptual definitions and the operational definitions concerned with the variables used in this research.

Researchers should recommend methodology after explaining the relationships between the variables. In this research, the methodology is suggested in the research methodology chapter. It includes the process of collecting data, the composition of samples, the volume of samples,

measurable methods and a process for analysing data. This research is designed by this scientific research process and, as a result, the results have high acceptability in the research field of SCM.

4.3.2.5 Tests and suggestions for a conclusion

In this research, the collected data are required to test reliability and validity before the analyses of the relationships between the variables (Garver and Mentzer, 1999). Reliability means a consistent degree between multivariate variables and is proved by the dispersion of measured data when researchers repeatedly measure identical conceptions. It is composed of stability of measurement, consistency, predictability, accuracy and so on. The measuring methods are test-retest reliability, split-half reliability, item-total correlation, Cronbach's alpha alternative reliability and inter-item reliability. This research tests the reliability of the collected data through inter-item correlation, item-total correlation, Cronbach's alpha and comparison of AVE with the power of two of the correlation coefficients. On the other hand, validity means whether the conceptions or characteristics of variables are correctly measured. It estimates whether items developed for measuring variables reflect the character of the variables. To estimate validity, content validity, estimate and purification of data and construct validity are demonstrated in this research. If there are no problems regarding reliability and validity, the hypotheses are tested on the basis of the collected data.

Before verifying the hypotheses, non-respondent bias should be tested. This is performed by the analytical procedure recommended by Armstrong and Overton (1977). The method has three steps: the first is to calculate the number of collected questionnaires in sequence; the second is to divide the questionnaires into four groups in the arrived order; and the third is to analyse differences in the average between the first group and the last. As the first group makes the most active response to the survey and the last group makes a response to the survey after deep consideration, there is not considered to be any non-respondent bias if there are no gaps in responses between the two groups.

After analysing the data, this research proposes implications and a conclusion on the basis of the results and implications and a conclusion as the rational explanation for the relationships between the variables as a result of analysing the collected data. The results of this research are included in the implications and the conclusion consists of theoretical implications and is the basis for managerial implications. In addition, the results of this research have an effect on future research directions through supporting or refuting the proposed theories and hypotheses, re-confirming the present theory through repeated research and promoting generalization of the hypotheses to academia and society. Therefore, this research is performed through scientific research processes.

4.3.3 Research methodology

4.3.3.1 The choice of research methodology

This research basically aims at deepening knowledge about supply chain collaboration with a focus on clarifying the roles of environmental uncertainty in the relationship between supply chain collaboration and operational performance and as an antecedent of supply chain collaboration. This is performed by testing the hypotheses. In this regard, the choice of research method is rather obvious. The methodology of this research is as follows. First, three literature reviews are performed in this research: one to establish the conceptual and operational definitions of the variables used in this research through prior research; another to develop the research models and hypotheses to be tested in this research; and the third to ascertain the theoretical relationships between the variables through prior research (Mentzer and Flint, 1997; Mentzer and Kahn, 1995). The next step is to develop measuring items for a survey on the basis of the research model. The most important aspect of creating a questionnaire is to confirm internal and external validity, and is achieved in two stages. In the first stage, the internal validity is ensured by developing the measuring items on the basis of items

suggested in prior research. However, the items are regarded as having low external validity because the goals of prior research are different from the goals of this research. Therefore, to overcome the problems, this research identifies external validity through field interviews, which reflects practical perspectives not grasped in literature reviews. In the second stage, a pilot test of the questionnaire through interviews with scholars and experts in business practice contributes to minimizing vague items. They pointed out vague items concerned with environmental uncertainty and the vague items were amended following their recommendations. The other items have no problems in the contents.

The population comprises of Korean manufacturing firms in China. China is treated as the world's factory and, consequently, many Korean manufacturing firms have invested in China. Similarly, many Korean manufacturing firms have invested in China for reasons such as market-seeking, resource-seeking and efficiency-seeking. This is why the questionnaire is sent to Korean manufacturing firms in China. Before testing the hypotheses, the reliability and validity of the collected data are verified through various analytical methods, such as non-response bias, the basic suppositions of multivariate analysis (linearity, homoscedasticity and normality), content validity, estimate and purification of data, construct validity, AVE, Cronbach's alpha, and comparison of AVE with the power of two of the correlation coefficients, as explained in 4.3.3.4 Data analysis.

The relationships between the variables are tested by two analytical methods. First, the measurement of sub-variables in each variable is performed by confirmatory factor analysis (H.1, H.2 and H.3). There are three variables such as environmental uncertainty, supply chain collaboration and operational performance. The first has four sub-variables such as munificence, dynamism, heterogeneity and hostility. The second has three sub-variables such as internal collaboration, supplier collaboration and customer collaboration. The third has two sub-variables such as cost performance and service performance. Confirmatory factor analysis can show the authenticity of sub-variables on the variables. That is why confirmatory factor analysis is used in this research.

Second, an analysis of SEM is used for the verification of the relationships between variables (H.4, H.5, H.6 and H.7). The most important aspect of the relationship is the roles of environmental uncertainty on the relationship between supply chain collaboration and operational performance. There are two roles of environmental uncertainty: one is the moderating effect on the relationship between supply chain collaboration and operational performance and the other is an antecedent of supply chain collaboration and operational performance. SEM can provide various results of the analysis of causal links and is particularly useful for path analysis. The result includes goodness of fit for data and shows whether the character of the sample firms is equal to the character of a population. In addition, the result can show the path relationship between variables. This means that the result shows the indirect effect of an independent variable on dependent variables as well as the direct effect of independent variables on parameters. That is why SEM is used in this research.

4.3.3.2 Sampling and data collection

The population of this research comprises of Korean manufacturing firms in China because the majority of Korean manufacturing firms have invested in China, which is recognized as the world's factory. Many Korean manufacturing firms are manufacturing in China and selling products made in China to the world market. Therefore, it is important to ascertain whether the Korean manufacturing firms in China carry out supply chain collaboration and this reflects the goals of this research.

The sample frame means a membership list to stand for the population which is the object of this research. In this research, the sample frame is shown in a Chinese membership list of the Korea International Trade Association. These are selected for three reasons: one is that almost all Korean manufacturing firms in China are members of the association; another is that the association manages Korean manufacturing firms in China; and the third is that the members of the association are

manufacturing firms, which means that service firms such as hotels, tourist agencies and personal service firms are not the object of this research.

This research uses random sampling as a sampling method of respondent firms. The population is composed of 7,987 firms and 1,000 firms of the population are chosen in the sample frame. The process of the choice is as follows: all members are numbered in order and then one firm from each of the eight orders is selected. The selected firms are the respondents. A questionnaire is sent to the staff of the marketing or logistics departments of the respondents because they perform the work concerned with SCM in business practice and, in addition, they have a good deal of knowledge concerned with supply chain collaboration.

Almost all questionnaires are collected by personal visits or by Korean students of Renmin University in China who helped to collect data for the survey. The researcher instructed the helpers in the objectives of this research and the content of the questionnaire before having them carry out the survey. The object of this research is Korean manufacturing firms in China and, therefore, a questionnaire is written in the Korean language. The variables used in this research come from prior research (see Table 4-1, Table 4-2 and Table 4-3) and this is originally written in English and translated in Korean by the researcher. Moreover, the content validity of the items was tested by experts (see 5.3.1.2 Verification by experts). The helpers performed pre-contact by telephone with the respondents and made an appointment for the survey to be carried out in person. The respondents were also allowed to answer the questionnaire using mail, facsimile, telephone or email. In addition, the helpers explained the objectives of this research to the respondents before the survey if they wanted to answer by mail, facsimile, telephone or email.

In addition, the relationships between the items of the questionnaire, the knowledge gaps, the research questions and the hypotheses in this thesis are as follows. The items come from extant research (see Table 4-1, Table 4-2 and Table 4-3). The items concerned with supply chain collaboration and operational performance address research question one and the items concerned

with environmental uncertainty address research question two. The first and the third of the knowledge gaps are concerned with research question one and two because the knowledge gaps are concerned with measuring items of the variables and the research questions are concerned with the definitions of the variables. In addition, this concerns hypothesis one, two and three because they are concerned with components of the variables. The second knowledge gap is explained by the causal link between supply chain collaboration and operational performance. This is connected with research question one and hypothesis four because they show the relationship between supply chain collaboration and operational performance. The fourth and fifth knowledge gaps are concerned with the roles of environmental uncertainty. This is connected with research question two and hypothesis five and six because they are concerned with the roles of environmental uncertainty on the relationship between supply chain collaboration and operational performance. The knowledge gap sixth is concerned with the direct effect of environmental uncertainty on operational performance. This is connected with research question two and hypothesis seven because they are concerned with the relationship between environmental uncertainty and operational performance.

The survey was performed from July 2006 to December 2006. A total 211 questionnaires were collected and the rate of the response was 21.1%. Three questionnaires were not used in the analysis because they included improper responses such as the same answers in all items. 190 questionnaires were collected by personal visits and 18 questionnaires were collected by mail, email, telephone or facsimile, three questionnaires come from the latter. Finally, a total 208 questionnaires were used in the analysis.

The power analysis of this research is that there are 208 in the sample size. The items used in this research are 39 and five times 39 is 195 (but normally accepted ten times of the number of items for theory testing and nevertheless, the results of confirmatory factor analysis show that there are no problems in goodness of fit). This means that the sample size of this research is bigger than the

requested number of data (Fisher, 1990). Therefore, there is no problem in a power analysis and the statistical power of this model concerned with the results is regarded as acceptable.

4.3.3.3 The conceptual and operational definitions of measuring variables

This research develops conceptual definitions and operational definitions through prior research for testing hypotheses. The environment which firms face has two major dimensions to consider when it is measured. The first dimension is ability of decision-makers. They need to predict the behaviour and expectation of participants in the market. When these predictions are made, they should consider competitors as well as customers and suppliers. The second dimension is the scope of behaviour and expectation of the participants. From the viewpoint of supply chains, the behaviour has an internal viewpoint of a focal firm and the expectation has an external viewpoint of a focal firm to suppliers and customers. Both dimensions are very important to grasping supply chain contexts from the viewpoint of a focal firm (Chow et al., 1995; Lee et al., 2007; McGinnis and Kohn, 1993).

On the basis of above perspective, the definitions and measuring items on variables used in this research are as follows. This research divides environmental uncertainty into munificence, dynamism, heterogeneity, and hostility because these dimensions are to explain environmental uncertainty in detail, to variously classify sub-dimensions of environmental uncertainty and to sufficiently reflect the factors of environmental uncertainty. Compared with the definitions of the variables in prior research, the definitions of environmental uncertainty are shown in Table 4-1. All items are measured as perceptions on a seven Likert scale (1: strongly disagreed and 7: strongly agreed).

Table 4-1 The definitions of environmental uncertainty

The definitions of this research	The definitions of prior research
Environmental uncertainty is defined as a degree of difficulty of prediction to outcomes or the future (Chow et al., 1995) and it is divided into four dimensions such as munificence, dynamism, heterogeneity and hostility (McGinnis and Kohn, 1993).	Environmental uncertainty is defined as a degree of difficulty of prediction to outcomes or the future (Chow et al., 1995) and it is divided into four dimensions such as munificence, dynamism, heterogeneity and hostility (McGinnis and Kohn, 1993).
Munificence: a degree of continuous growth of a market caused by environmental variance (Clinton, 1997; McGinnis and Kohn, 1993) ENV 1: potentiality in the market ENV 2: possibility of success when a firm entries into the new market ENV 3: opportunities of the market growth	Munificence: the extent to which the environment can support sustained growth (Kohn et al., 1990; Dess and Beard, 1978) (1) Many new opportunities are available to my company/division in existing and/or new markets. (2) There are many opportunities avail to my company/division in the form of existing and/or new products (3) The potential for growth in the markets served by my company/division is substantial.
Dynamism: the difficulty of predicting a change in the market (Clinton, 1997; McGinnis and Kohn, 1993) ENV 4: the difficulty of forecasting the behaviour of competitors in the market ENV 5: the difficulty of forecast on demand of the market ENV 6: the difficulty of confirming customer needs	Dynamism: the extent of unpredictability and change in customer taste, technology, and modes of competition (Kohn et al., 1990; Miller and Friensen, 1978) (1) Competitive strategies of firms that compete with my company/division and not predictable. (2) The markets served by my company/division are different to predict.
Heterogeneity: the change of competitive methods of competitors and customers' preferences and expectations (Clinton, 1997; McGinnis and Kohn, 1993) ENV 7: a change of competitors' competitive methods ENV 8: a change of customers' preference for goods/service ENV 9: a change of customers' level of expectation ENV 10: the application of various competitive strategies	Heterogeneity: differences in competitive tactics, customer tastes, product lines, and channels of distribution (Kohn et al., 1990; Miller and Friesen, 1978) (1) Distribution of the products marketed by my company/division requires working with may different types of wholesalers, distributors, and customers. (2) Competitive tactics vary greatly in the markets served by my company/division (3) Customers served by my company/division vary greatly in terms of product preferences, expected service levels, and price expectations. (4) In order to compete effectively in the markets served by my company/division.
Hostility: the degree of competition and regulations of the government in the market (Clinton, 1997; McGinnis and Kohn, 1993) ENV 11: the strength of competition in the market ENV 12: considering the response of competitors in decision-making ENV 13: difficulty in analysing the strategies of competitors ENV 14: the degree of regulations of the government	Hostility: level of competition, severity of regulatory restrictions, shortages, and unfavourable demographic trends (Kohn et al., 1990; Miller and Friesen, 1978) (1) Competition in the markets served by my company/division is severe. (2) In the markets served by my company/division, the firm that eases up usually loses markets/customers to its competitors.

The items of munificence were changed from the original items but did not changed in meaning.

ENV 1 is potentiality in the market and this means that there are new opportunities in existing markets (Dess and Beard, 1978). ENV 2 is the possibility of success in the new market and this means that there are new opportunities in new markets (Dess and Beard, 1978). ENV 1 and ENV 2 are divided into the existing and new markets. ENV 3 is opportunities of the market growth and this means that there is potential for growth in the markets (Dess and Beard, 1978). Therefore, from the viewpoint of the meanings, the items of munificence are not different from the original meanings.

There were originally two items in the dynamism but they were divided into three items in the research. In the original meanings, dynamism means the extent of unpredictability and change in customer taste, technology, and modes of competition (Miller and Friensen, 1978). This means the difficulty of predicting a change in the market. In addition, customer taste, technology and modes of competition can be treated as the market environment. Therefore, modes of competition are shown as the difficulty of forecasting the behaviour of competitors in the market (ENV 4), customer taste is shown as the difficulty of confirming customer needs (ENV 6) and unpredictability is shown as the difficulty of forecast on demand of the market (ENV 5) in this research.

There are four items of heterogeneity: a change of competitors' competitive methods (ENV 7) is connected with competitive tactics, a change of customers' preference for goods/service (ENV 8) is connected with product preferences, a change of customers' level of expectation (ENV 9) is connected with expected service levels and the application of various competitive strategies (ENV 10) is connected with competing effectively in the markets.

Hostility is concerned with survival and growth of firms in the market. For example, the strength of competition in the market (ENV 11) is connected with competition in the market, a level of competition is divided into considering the response of competitors in decision-making (ENV 12) and difficulty in analysing the strategies of competitors (ENV 13) and the degree of regulations of the government (ENV 14) is connected with severity of regulatory restrictions.

Supply chain collaboration can be defined as working together among departments within a firm, understanding mutual different viewpoints, sharing resources and information and achieving common goals in supply chains (Ellinger et al., 2000; Stank et al., 1999a, 2001, 2001/2002; Stock et al., 2000). It includes interaction and cooperation (Kahn and Mentzer, 1998). The former means communication between departments following a stream of information and official contact with other departments and the latter means the trustful relationships between departments. In this regard, supply chain collaboration can be approached from the viewpoints of interaction and cooperation between departments in a firm. The collaboration can make an efficient relationship through connecting suppliers and customers as well as departments because of removing overlaps and inefficiency in a whole process. Therefore, it can be divided into internal collaboration, supplier collaboration and customer collaboration. The focus is in a focal firm such as raw material suppliers, manufacturing firms or distributors, however, this research focuses on Korean manufacturing firms in China. Compared with the definitions of the variables in prior research, the definitions of supply chain collaboration are shown in Table 4-2. All items are measured as perceptions on a seven point Likert scale.

Table 4-2 The definitions of supply chain collaboration

The definitions of this research	The definitions of prior research
Supply chain collaboration can be defined as working together among departments within a firm, understanding mutual different viewpoints, sharing resources and information and achieving common goals in supply chains (Ellinger, 2000; Stank et al., 2001/2002).	Supply chain collaboration can be defined as an affective, volitional, mutual shared process where two or more departments work together, have mutual understanding, have a common vision, share resources, and achieve collective goals (Schrage, 1990; Stank et al., 2001/2002).
Customer collaboration: understanding for needs of core customers and responding to the needs (Ellinger, 2000; Stank et al., 2001/2002) SCC 1: close contact with customers concerned with goods and services SCC 2: rapidness of order processes SCC 3: a high level of information sharing with customers SCC 4: smooth communication with customers concerned with goods and services SCC 5: supplying goods and services to coincide with customer needs (Kim and Lee, 1999)	Customer collaboration: building distinctiveness with customers of choice (Stank et al., 2001/2002) (1) Cooperation with customers (2) Interdependence with customers (3) Flexibility with customers (4) Informal relationship with customers (5) Ongoing relationship with customers (6) Information sharing with customers (Stock et al., 2000)
Supplier collaboration: structuring collaborative relationships with core suppliers for stock management and stable supply of raw materials and parts (Ellinger et al., 2000; Stank et al., 2001/2002) SCC 6: an exchange of harmonized information with suppliers SCC 7: participation of suppliers in inventory control SCC 8: use of quick response SCC 9: a degree of network integration with suppliers for stable procurement SCC 10: a degree of receiving stable goods and services from suppliers (Kim and Lee, 1999)	Supplier collaboration: the competency linking externally performed work into a seamless congruency with internal work processes (Stank et al., 2001/2002) (1) Cooperation with suppliers (2) Interdependence with suppliers (3) Flexibility with suppliers (4) Informal relationship with suppliers (5) Ongoing relationship with suppliers (6) Information sharing with suppliers (Stock et al., 2000)
Internal collaboration: processes of cooperation and interaction for maintenance of the close relationship between departments (Ellinger et al., 2000; Kahn and Mentzer, 1998; Mollenkopf et al., 2000; Stank et al., 1999b). SCC 11: the possibility of real time acquirement of data concerned with goods and services SCC 12: sharing information among departments SCC 13: a degree of integrated inventory control SCC14: the possibility of real time management on total stock SCC 15: a high level of information integration in production processes (Kim and Lee, 1999)	Internal collaboration: the competency of linking internally performed work into a seamless process to support customer requirements (Stank et al., 2001/2002) (1) Informally working together (2) Sharing ideas, information, and/or resources (3) Working together as a team (4) Conducting joint planning to anticipate and resolve operational problems (5) Achieving goals collectively (6) Developing a mutual understanding of responsibilities (7) Making joint decisions about ways to improve overall cost efficiency (Stank et al., 1999b)

Operational definitions provide measurable forms of conceptual definitions. From this viewpoint, the relationship with customers in the prior research is connected with close contact with customer (SCC 1), cooperation with customers is divided into rapidness of order processes (SCC 2) and smooth communication with customers (SCC 4), information sharing with customers is connected with a high level of information sharing with customers (SCC 3) and interdependence with customers is measured by supplying goods and services to coincide with customer needs.

In the extant research, the items of supplier collaboration were the same as the items of customer collaboration. In this regard, this research used different items but the meanings are similar to the original items. For instance, cooperation with suppliers is divided into participation of suppliers in inventory control (SCC 7) and use of quick response (SCC 8), interdependence with suppliers is concerned with a degree of receiving stable goods and services from suppliers (SCC 10), information sharing with suppliers is translated with an exchange of harmonized information with suppliers (SCC 6) and ongoing relationship with suppliers is concerned with a degree of network integration with suppliers for stable procurement (SCC 9).

The definitions of internal collaboration are slightly different between this research and extant research. This research is focused on collaboration in real processes among departments and prior research is focused on the competency of linking internally works into a seamless process. In this regard, informally working together and working together as a team are shown as a degree of integrated inventory control (SCC 13). Sharing ideas, information and/or resources are divided into the possibility of real time acquirement of data concerned with goods and services (SCC 11), sharing information among departments (SCC 12), the possibility of real time management on total stock (SCC14) and a high level of information integration in procurement processes (SCC 15).

Operational performance can be measured in terms of efficiency and effectiveness. The former is a degree of economically using internal resources of firms and the latter means a degree of achieving the goals of firms (Chow et al., 1994). In this regard, operational performance is measured as cost

performance from the viewpoint of efficiency and service performance from the viewpoint of effectiveness in this research (Brewer and Speh, 2000). Compared with the definitions of variables in prior research, the definitions of operational performance are shown in Table 4-3. All items are measured as perceptions on a seven Likert scale.

Table 4-3 The definitions of operational performance

The definitions of this research	The definitions of prior research
Operational performance is defined as efficiency which means a degree of economically using internal resources of firms and effectiveness which means a degree of achieving the goals of firms and this is connected with cost performance and service performance (Brewer and Speh, 2000).	Operational performance is defined as efficiency and effectiveness in accomplishing a given task in relation to how well a goal is met (Lai et al., 2002; Mentzer and Konrad, 1991).
Cost performance (Beamon, 1998; 1999) OP 1: a degree of saving of labour costs following reduction and re-disposition of workers OP 2: a degree of cost saving concerned with decreasing stock OP 3: a degree of cost saving concerned with stock management OP 4: a degree of cost saving concerned with order management OP 5: a degree of cost saving concerned with contact with partners	Cost (1) Reduce order management costs (2) Reduce costs associated with facilities/equipment/manpower used in providing the services (3) Reduce warehouse costs (4) Reduce transportation costs (5) Reduce logistics administration costs (Lai et al., 2002)
Service performance (Beamon, 1998; 1999) OP 6: a degree of increased flexibility of operations through cooperation with partners OP 7: ability to fulfil special requirements of customers OP 8: ability to supply estimated quantity on time OP 9: ability to provide customers with value added service OP 10: ability to cooperatively overcome any problems with partners if they are occurred	Customer facing (1) Supply chain reliability: delivery performance, order fulfilment performance and perfect order fulfilment (2) Flexibility and responsiveness: supply chain response time and production flexibility (Lai et al., 2002) (3) Customer satisfaction (4) Customer complaints (Fawcett and Cooper, 1998)

Performance is divided into cost and service. In cost performance, reduction of order management costs is connected with a degree of cost saving concerned with order management (OP 4), reduction of costs associated with facilities/equipment/manpower is connected with a degree of saving of labour costs following reduction and re-disposition of workers (OP 1), reduction of warehouse costs is divided into a degree of cost saving concerned with decreasing stock (OP 2) and a degree of cost

saving concerned with stock management (OP 3) and reduction of logistics administration costs is connected with a degree of cost saving concerned with contact with partners (OP 5).

In service performance, order fulfilment performance is connected with ability to fulfil special requirements of customers (OP 7), perfect order fulfilment is connected with ability to supply estimated quantity on time (OP 8), production flexibility is connected with a degree of increased flexibility of operations through cooperation with partners (OP 6), customer satisfaction is connected with ability to provide customers with value added service (OP 9) and customer complaints are connected with ability to cooperatively overcome any problems with partners if they are occurred (OP 10).

Some items used in this research are different from the definitions of prior research because the characteristics of the population in this research are different from the characteristics of population in prior research. For this reason, some items were changed in meanings but not changed from their original meanings. The other information is integrated from several items which come from prior research. In particular, environmental uncertainty is divided into four sub-dimensions because they are the most comprehensive classification and it is not tested in Korean manufacturing firms.

These items were originally written in English and translated into the Korean language by the researcher. This means that there was no back translation and this means that there is face validity in the items. The items were validated by two Korean professors; both of them are associate professors and both have worked for over five years in a Korean university.

4.3.3.4 Data analysis

The details of the proposed analysis methods are as follows. Before testing validity and reliability, non-response bias and common method bias were tested. The former is performed by the method recommended by Armstrong and Overton (1977), which is proved by the comparison of annual

turnovers between early and late responses, comparison of the number of employees between early and late responses and comparison of measuring items between early and late responses. In addition, common method bias is verified by an analysis of Harmon's single-factor test of common method bias, which is tested by Eigenvalue and dispersion. Moreover, it can be tested by the method recommended by Sanchez and Brock (1996), which is tested by goodness of fit using the result of confirmatory factor analysis.

This research uses various methods for testing reliability and validity. Firstly, content validity is ascertained by prior research and verification of experts because prior research is the basis of the conceptual and operational definitions of measuring variables in this research concerned with internal validity and verification of experts is the basis of external validity concerned with the definitions. Secondly, estimate and purification of data are carried out in three stages, as follows: the first is to perform data screening and an evaluation of the assumptions required in multivariate analysis (normality, homoscedasticity and linearity); the second is to analyse inter-item correlation, item-total correlation, internal consistency and reliability; and the third is exploratory factor analysis to measured items, including Bartlett's test of sphericity, a measure of sample adequacy such as Kaiser-Meyer-Olkin and common method bias. Thirdly, construct validity can be tested by convergent validity and discriminant validity, which are tested by confirmatory factory analysis (Graver and Mentzer, 1999; Mentzer and Flint, 1997) and, in addition, this research ascertains AVE and tests a Cronbach's alpha coefficient for testing reliability. Lastly, this research compares AVE with the power of two of the correlation coefficients, which is used to verify discriminant validity (Segars, 1997). These complex processes are the basis of the reliability and validity of the collected data.

Sub-dimensions in each variable are tested by confirmatory factor analysis. Confirmatory factor analysis is an analytical method to verify consistency between theory and measuring items and exploratory factor analysis is an analytical method to identify consistency of measuring items which has no theoretical backgrounds. Form this viewpoint, the researcher need to verify consistency

between theory and the measuring items extracted by exploratory factor analysis through confirmatory factor analysis. Therefore, this research ascertains sub-dimensions in each variable through confirmatory factor analysis.

The relationships between the variables are tested by SEM. This method establishes causal links between a measuring model and a structural model (Garver and Mentzer, 1999). SEM is used as a confirmatory technique to test the hypotheses for the research model in Figure 3-2. SEM is selected as the main method for estimating and testing the relationships between variables. The basic structure of this research is that the relationship between supply chain collaboration and operational performance is tested. In addition, there are two roles of environmental uncertainty: one is an antecedent of supply chain collaboration and operational performance and the other is the moderating effect on the relationship between supply chain collaboration and operational performance. From this viewpoint, this research verifies four relationships between the variables: the first is the relationship between supply chain collaboration and operational performance, the second is the moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance, the third is the path analysis on the relationship between environmental uncertainty, supply chain collaboration and operational performance, and the fourth is the relationship between environmental uncertainty and operational performance. The result of SEM is more informative than the result of multiple regression analysis and can show the path relationships between the variables. From this viewpoint, SEM as a tool to assess model fit was the preferred analytical method in the verification of path analysis on the relationships between the variables compared with others.

4.4 Summary

This chapter has explained the methodology of this research. This research uses various analytical methods for achieving its objectives. Before testing the hypotheses, this research ascertains whether

the collected data corresponds to strict prerequisites for a multivariate analysis and, before explaining the methodology, this research has suggested the population and the sampling method. Therefore, this chapter has explained the scope of this research, an estimate of the basic prerequisites and the methodology for the empirical tests.

Chapter V Descriptive Statistics, Validity and Reliability Tests

5.1 Introduction

This chapter presents the results of analysing reliability and validity on the collected data. There are three stages as follows. The first stage is the results of descriptive statistics as general characteristics of the responding firms. The second stage is the results of reliability and validity of the collected data. This is followed by the summary in the third stage.

5.2 General characteristics of the responding firms

The population of this research is Korean manufacturing firms in China and 208 questionnaires were collected from the sample firms. Non-response bias is tested by three methods: comparison of annual turnovers between early and lately responses, comparison of the number of employees between early and late responses and comparison of the averages of the variables between early and late responses which are the method recommended by Armstrong and Overton (1977). The collected data are divided into four clusters in order of response. First quarter and last quarter are compared in the average. If there are no differences in the average, there is no problem in non-response bias. The analysis is performed through ANOVA and the criterion for insignificant difference is over 0.05 in p value. The result is as follows. The first test of an average in annual turnovers has 0.757 in p value and this means that there is no problem in a difference in annual turnovers. In addition, the second test of an average number of employees has 0.755 in p value and this means that there is no problem in a difference in the number of employees. These mean that there are no significant differences in both responses. Moreover, differences in the averages of the variables show the results as follows. Munificence has no problem ($t = 0.606$, $p = 0.438$). Dynamism has no problem ($t = 0.453$, $p = 0.502$).

Heterogeneity has no problem ($t = 0.000$, $p = 0.985$). Hostility has no problem ($t = 0.308$, $p = 0.580$). As a result, environmental uncertainty has no problems in non-response bias. Customer collaboration has no problem ($t = 2.768$, $p = 0.099$). Supplier collaboration has no problem ($t = 1.292$, $p = 0.258$). Internal collaboration has no problem ($t = 0.298$, $p = 0.587$). For this reason, supply chain collaboration such as customer collaboration, supplier collaboration and internal collaboration has no problem in non-response bias. However, cost performance has a problem in the result ($t = 7.572$, $p = 0.007$) and service performance has also a problem in the result ($t = 4.295$, $p = 0.041$) because alternative hypotheses are supported. This means that there are differences between the two groups such as the first responding group and the last responding group. In this regard, the verification of non-response bias is performed to the items of the two variables. Cost performance has five items which are OP 1 to OP 5 and the results are as follows. OP 1 ($t = 12.731$, $p = 0.001$), OP 2 ($t = 8.007$, $p = 0.006$) and OP 4 ($t = 4.793$, $p = 0.031$) show that they have non-response bias. However, OP 3 has no problem ($t = 1.505$, $p = 0.223$) and OP 5 has no problem ($t = 2.143$, $p = 0.147$). Similarly, service performance has five items such as OP 6 to OP 10 and the results are as follows. OP 7 has problem ($t = 5.106$, $p = 0.026$) but OP 6 ($t = 2.695$, $p = 0.104$), OP 8 ($t = 2.914$, $p = 0.091$), OP 9 ($t = 1.475$, $p = 0.227$) and OP 10 ($t = 3.915$, $p = 0.051$) have no problems in non-response bias. In this regard, the averages between the first answer group and the last answer group concerned with the four items - OP 1, OP 2, OP 4 and OP 7- are compared. The result is mixed as follows: the first group (OP 1: 4.52, OP 2: 4.31, OP 4: 4.23 and OP 7: 4.06) and the last group (OP 1: 3.60, OP 2: 3.50, OP 4: 3.62 and OP 7: 4.63). That means the first group did not score consistently higher average values than the last group in these four items; the differences between the two groups appear to be rather random. For this reason, the results are acceptable in non-response bias.

The general characteristics of the responding firms on the basis of the collected data are presented. The classification of the types of business on the responding firms is to ascertain whether the collected data have various extents. The result is as follows.

Table 5-1 The types of business on the responding firms

Section	Chemistry/ Rubber	Electronics/ Electricity	Metal/ Nonmetal	Machine/ Transport/ Equipment	Fiber/ Clothing/ Lather
Frequency	12	48	51	14	50
Ratio (%)	5.8	23.1	24.5	6.7	24.0

Section	Lumber/ Paper/ Furniture	Food/ Beverage	Others	No answer	Total amount
Frequency	8	12	8	5	208
Ratio (%)	3.8	5.8	3.8	2.4	100

As shown in Table 5-1, there are 51 firms in Metal and Non-metal industries, which are the highest percentage (24.5%) and followed by Fibre, Clothing and Leather industries, which have 50 firms and the percentage shows 24.0%. Electronics and Electricity industries have 48 firms and 23.1% in the percentage. Machine, Transportation and Equipment industries have 14 firms which reach 6.7%, Food and Beverage as well as Chemistry and Rubber industries have 12 firms each and they show 5.8% in the percentage. The lowest number of the collected data is Lumber, Paper and Furniture industries, which have 8 firms and show 3.8% in the percentage. In addition, others have the same numbers of the collected data with Lumber, Paper and Furniture industries. No answer was given by 5 firms, which is 2.4% of the sample. The total amount of the responding firms is 208 firms and the collected data have various extents in the types of business.

Table 5-2 Annual turnover of the responding firms (unit: U\$ one million)

Section	below 1	1-2	2-3	3-5	5-10	10-100	over 100	No answer	Total amount
Frequency	41	34	23	21	15	24	6	44	208
Ratio (%)	19.7	16.3	11.1	10.1	7.2	11.5	2.9	21.2	100

Annual turnover of the responding firms is to grasp the volume of firms. As shown in Table 5-2, the highest percentage of annual turnover is below U\$ 1 million, which has 41 firms (19.7%), followed by

U\$ 1-2 million which has 34 firms (16.3%). 24 firms are in U\$ 10-100 million and they show 11.5% of the sample and next is U\$ 2-3 million which has 23 firms (11.1%) and, in order, 21 firms are in U\$ 3-5 million which show 10.1%. U\$ 5-10 million has 15 firms which show 7.2% of the sample. Over U\$ 100 million has 6 firms (2.9%) which is the lowest percentage. No answer is 44 firms which show 21.2% of the sample. They do not want to inform their annual turnover because they treat it as strictly confidential. As a result of the analysis, there are distributed from small size firms to large size firms.

Table 5-3 The year when the responding firms have invested in China

Section	before 1990	1991-1995	1996-2000	2001-2005	After 2006	No answer	Total amount
Frequency	2	13	39	122	6	6	208
Ratio (%)	1.0	6.2	18.7	58.7	2.9	12.5	100

Investment year can show the environmental context of the Chinese market. As shown in Table 5-3, there are only 2 firms (1.0%) to have invested in the country before 1990 because the Republic of Korea and the People's Republic of China concluded a treaty of friendship in 1992. 13 Firms (6.2%) have invested in the country from 1991 to 1995 and 39 firms (18.7%) have invested in the country from 1996 to 2000. However, during the period between 2001 and 2005, there were 122 firms (58.7%) investing in the country and this was the highest percentage. In 2006, there are 6 firms (2.9%) investing in the country. According to the statistical data, 128 firms have invested in the country after 2001 and this means that the investment environment of the Chinese market improved after 2001. In fact, the Chinese government launched various promotions for investment such as tax reduction, rent exemption and regulation of labour unions.

Table 5-4 The number of employees

Section	below 50	51-100	101-300	301-500	501-1,000	Over 1,001	No answer	Total amount
Frequency	59	26	54	14	18	19	18	208
Ratio (%)	28.4	12.5	26.0	6.7	8.7	9.1	8.6	100

The number of employees can indicate the size of the responding firms. As shown in Table 5-4, there are 59 firms (28.4%) in below 50 employees, which give the highest percentage, followed by 26 firms (12.5%) in 50 to 100 employees. This means that 85 firms (40.9%) have below 100 employees and this means that they are small and medium size firms. 54 firms (26.0%) have in 100 to 300 employees which is the second highest percentage. In addition, 19 firms (9.1%) have over 1,000 employees, 18 firms (8.7%) have in 500 to 1,000 employees and 14 firms (6.7%) have in 300 to 500 employees and they are the large scale firms. No answer is 18 firms (8.7%). This means that there are various firms including small and medium size enterprises and large size firms. Next is to test control variables concerned with firm size.

Table 5-5 Control variables 1: Firm size on operational performance

Variable	First step	Second step	Third step
Constant	2.775***	2.619**	2.704***
EU	2.192**	2.189**	2.209*
SCC	9.023***	8.980***	8.648***
Employees	-	0.138	-0.106
Turnover	-	-	0.905
F	50.353***	33.364***	25.198***
R square	0.392	0.392	0.396
adj R square	0.385	0.381	0.380

Note) EU: environmental uncertainty; SCC: supply chain collaboration; ***, P < 0.01, **, P < 0.05, *, P < 0.1

As shown in Table 5-5, all F values are supported and this means that the number of employees and annual turnover have no effect on operational performance. The result explains that the collected data have high external validity.

Table 5-6 Control variables 2: The number of employees on operational performance

Variable	First step	Second step	Third step
Constant	2.841***	2.096**	2.089***
EU	2.128**	2.233**	2.272**
SCC	9.535***	9.591***	9.232***
Firm size	-	1.183	1.281
Turnover	-	-	0.984
F	54.752***	37.060***	28.032***
R square	0.408	0.413	0.417
adj R square	0.400	0.402	0.402

Note) EU: environmental uncertainty; SCC: supply chain collaboration; ***, P < 0.01, **, P < 0.05, *, P < 0.1

As shown in Table 5-6, all F values are supported and this means that the number of firm size and annual turnover have no effect on operational performance. The result shows that the collected data have high external validity.

Table 5-7 Control variables 3: Annual turnover on operational performance

Variable	First step	Second step	Third step
Constant	3.161***	2.463**	2.241**
EU	2.532**	2.602**	2.607**
SCC	10.149***	10.188***	10.063***
Firm size	-	0.332	1.031
Employees	-	-	0.381
F	65.654***	44.072***	32.936***
R square	0.416	0.419	0.420
adj R square	0.410	0.410	0.407

Note) EU: environmental uncertainty; SCC: supply chain collaboration; ***, P < 0.01, **, P < 0.05, *, P < 0.1

As shown in Table 5-7, all F values are supported and this means that the number of firm size and employees have no effect on operational performance. The result shows that the collected data have high external validity.

5.3 Reliability and validity tests

5.3.1 Contents validity

Content validity means how well measuring items reflect the contents of the variables which researchers want to measure (Lewis-Beck et al., 2004). To verify content validity, this research carries out three processes: to extract items from prior research, to verify the items by experts and to ascertain the average of the items.

5.3.1.1 The extraction of the items

This research makes use of three variables: environmental uncertainty, supply chain collaboration and operational performance. Environmental uncertainty means difficulty of prediction on outcomes or the future (Chow et al., 1995; Lee et al., 2007; McGinnis and Kohn, 1993). It is divided into munificence, dynamism, heterogeneity and hostility (McGinnis and Kohn, 1993). This classification of the environmental uncertainty is to explain the environment most comprehensively. For example, munificence means a degree of continuous growth of a market caused by environmental variance, dynamism means the difficulty of predicting a change in the market, heterogeneity means the change of competitive methods of competitors and customers' preference and expectations and hostility means the degree of competition and regulations of the government in the market. The perspectives reflect variance of the market as the general environment and a degree of competition as work in the environment. For this reason, they explain environmental uncertainty as the difficulty of prediction on outcomes or the future. Supply chain collaboration means working together among departments within a firm, understanding mutual different viewpoints, sharing resources and information and achieving common goals in supply chains (Ellinger et al., 2000; Kahn and Mentzer, 1998; Mollenkopf

et al., 2000; Stank et al., 1999b). It is classified into internal collaboration, supplier collaboration and customer collaboration (Boon-itt and Wong, 2011a; Boon-itt and Paul, 2006; Flynn et al., 2010; Lee et al., 2007; Stank et al., 2001/2002; Wong et al., 2011). Supply chain collaboration is divided into internal collaboration and external collaboration by many researchers in prior research (Boon-itt and Wong, 2011b; Braunscheidel and Suresh, 2009; Chen et al., 2009; Droge et al., 2004; Gimenez, 2006; Gimenez and Ventura, 2005; Narasimhan and Kim, 2002; Schoenherr and Swink, 2012; Stank et al., 2001). However, external collaboration is divided into supplier collaboration and customer collaboration. In addition, suppliers and customers have different roles in supply chains. From this viewpoint, supply chain collaboration is divided into internal collaboration, supplier collaboration and customer collaboration in this research. Operational performance is explained in terms of efficiency and effectiveness (Brewer and Speh, 2000). It can be divided into cost performance and service performance. The former means a degree of economically using internal resources of firms and the latter means a degree of achieving the goals of firms (Chow et al., 1994, 1995). Performance should reflect efficiency and effectiveness as well as financial and non-financial aspects. In this regard, service performance measures performance from the viewpoint of effectiveness and non-financial aspect and cost performance measures performance from the viewpoint of efficiency and a financial aspect. This makes it possible to capture comprehensive measurement of performance of firms from the operational viewpoint.

This research extracted the measuring items for the above constructs through prior research and a questionnaire was made on the basis of these extracted items. Environmental uncertainty has fourteen measuring items, supply chain collaboration has fifteen items and operational performance has ten items. All measuring items were used in prior research. However, the items were properly amended to fit the objectives of this research because the objectives of prior research were different with the objectives of this research. The amendment was performed to coincide with the objectives of this research but the original meanings were not changed. Therefore, the amended measuring items

consisted of the measuring items of the questionnaire which was used in the survey.

5.3.1.2 Verification by experts

Contents validity of measuring items was established with the help of experts. Nine experts participated in the process: three professors, three researchers and three managers. All of them are Korean and the questionnaire is also written in Korean language. All professors have over five years of teaching experience in the fields concerned with logistics and SCM and they have at least two research papers in the fields. All researchers have over five years research experience in a national or private research institute which is concerned with logistics and SCM and they have at least two research reports or consulting experience in the same fields. All managers have worked over ten years at Korean manufacturing firms in China which have over 500 employees and their positions are as managers or senior managers of logistics department or marketing department. On the basis of research experience or practice experience, they can be treated as experts. In addition, there is no back translation and this means that there is face validity in the measuring items.

Experts helped to improve content validity of the measuring items. The criteria are as follows. If there are over five experts who found inappropriate measuring items, the items must be deleted. As a result of verification by experts, there were no inappropriate items but managers pointed out the abstract of the contents concerned with environmental uncertainty. In this regard, the items were properly amended through discussion with the experts. Therefore, final measuring items are composed of fourteen items in environmental uncertainty, fifteen items in supply chain collaboration and ten items in operational performance.

5.3.1.3 The average of the items

The measuring items are used as the contents of a questionnaire. The average of the measuring items is a criterion to estimate the fit of the items (1: strongly disagreed and 7: strongly agreed). The results of the analysis are as follows in Table 5-8.

Table 5-8 The average of the items in environmental uncertainty

Section	ENV 1	ENV 2	ENV 3	ENV 4	ENV 5	ENV 6	ENV 7
Average	4.58	4.05	4.52	4.73	4.25	4.05	5.07
Standard deviation	1.53	1.45	1.49	1.50	1.54	1.56	1.60

Section	ENV 8	ENV 9	ENV 10	ENV 11	ENV 12	ENV 13	ENV 14
Average	5.05	5.27	4.69	5.59	4.93	4.59	5.16
Standard deviation	1.55	1.62	1.53	1.48	1.54	1.58	1.66

Environmental uncertainty has fourteen measuring items. The highest average is ENV 11 which shows 5.59 in an average and 1.48 in standard deviation. In addition, the lowest average is ENV 2 and ENV 6 which show 4.05 in an average. ENV 2 shows 1.45 in standard deviation and ENV 6 shows 1.56 in standard deviation.

Table 5-9 The average of the items in supply chain collaboration

Section	SCC 1	SCC 2	SCC 3	SCC 4	SCC 5	SCC 6	SCC 7
Average	4.00	4.21	4.13	3.93	4.05	4.06	3.55
Standard deviation	1.56	1.60	1.54	1.56	1.49	1.51	1.72

SCC 8	SCC 9	SCC 10	SCC 11	SCC 12	SCC 13	SCC 14	SCC15
4.25	4.00	4.05	3.58	3.96	4.27	4.22	4.02
1.64	1.72	1.61	1.58	1.50	1.52	1.60	1.53

As shown in Table 5-9, supply chain collaboration has fifteen measuring items. The highest average is SCC 13 which shows 4.27 in an average and 1.52 in standard deviation. The lowest average is SCC

7 which shows 3.55 in an average and 1.72 in standard deviation.

Table 5-10 The average of the items in operational performance

Section	OP 1	OP 2	OP 3	OP 4	OP 5	OP 6	OP 7	OP 8	OP 9	OP 10
Average	4.08	4.08	4.14	4.07	4.08	4.21	4.32	4.41	4.09	4.28
Standard deviation	1.37	1.43	1.44	1.39	1.32	1.30	1.36	1.41	1.42	1.47

As shown in Table 5-10, operational performance has ten measuring items. The highest average is OP 8 which shows 4.41 in an average and 1.41 in standard deviation and the lowest average is OP 4 which shows 4.07 in an average and 1.39 in standard deviation. As a result of above analyses, all measuring items are regarded as satisfying content validity.

5.3.2 Estimate and purification of data

Estimate and purification of data are carried out three stages: one is data screening and evaluation of the assumptions, another is internal validity, and the third is exploratory factor analysis for extracting items.

5.3.2.1 Data screening and evaluation of the assumptions

The process of data screening is to ascertain errors and missing data to occur in responding and coding processes. As a result, there are fifteen missing data in ten questionnaires and these are substituted by the method of multiple imputation in SPSS because it is generally used for substitution of missing data. There are no other problems excepting the missing data.

The collected data are tested by normality, homoscedasticity and linearity as prerequisites for a multivariate analysis. Normality can be tested by various methods but this research ascertains it by the

Kolmogorov-Smirnov test, according to the following hypothesis. The criterion of the test is over 0.05 in p value. It can suggest a correct result because it tests normality by testing a hypothesis. In addition, the normal probability plots of the variables are shown in Appendix 12.

H_0 : A variable shows normality.

H_A : A variable does not show normality.

As a result of the analysis, the distribution of environmental uncertainty shows 4.704 in an average and 0.813 in standard deviation and an alternative hypothesis is supported ($p = 0.031$). This means that environmental uncertainty does not show normality. In specifically, the distribution of munificence shows 4.383 in an average and 1.199 in standard deviation and a null hypothesis is supported ($p = 0.064$). This means that munificence shows normality. The distribution of dynamism shows 4.345 in an average and 1.283 in standard deviation and a null hypothesis is supported ($p = 0.159$). Because the distribution of heterogeneity shows 5.020 in an average and 1.240 in standard deviation, an alternative hypothesis is supported ($p = 0.015$). In addition, the distribution of hostility shows 5.067 in an average and 1.099 in standard deviation and an alternative hypothesis is supported ($p = 0.019$). Therefore, it does not show normality on environmental uncertainty.

The distribution of supply chain collaboration shows 4.010 in an average and 1.139 in standard deviation and a null hypothesis is supported ($p = 0.749$). In specifically, the distribution of internal collaboration shows 4.009 in an average and 1.289 in standard deviation and a null hypothesis is supported ($p = 0.101$). The distribution of supplier collaboration shows 3.960 in an average and 1.414 in standard deviation and a null hypothesis is supported ($p = 0.688$). The distribution of customer collaboration shows 4.064 in an average and 1.276 in standard deviation and a null hypothesis is supported ($p = 0.157$). This means that supply chain collaboration shows normality.

The distribution of operational performance shows 4.176 in an average and 1.044 in standard

deviation and a null hypothesis is supported ($p = 0.746$). In specifically, the distribution of cost performance shows 4.089 in an average and 1.153 in standard deviation and a null hypothesis is supported ($p = 0.203$). The distribution of service performance shows 4.264 in an average and 1.156 in standard deviation and a null hypothesis is supported ($p = 0.118$). This means that operational performance shows normality.

According to the results of the analysis, there are no problems in normality excepting environmental uncertainty. Environmental uncertainty does not show normality but it is ascertained in munificence and dynamism. Therefore, the possibility of using environmental uncertainty depends on the results of the other analyses concerned with reliability and validity.

Homoscedasticity means that the variances for all variables are identical. It can be tested by comparing the amount of a variance of an independent variable with a dependent variable. There are three figures concerned with homoscedasticity on the relationship between the variables: one is homoscedasticity of environmental uncertainty and supply chain collaboration, another is homoscedasticity of supply chain collaboration and operational performance, and the third is homoscedasticity of environmental uncertainty and operational performance.

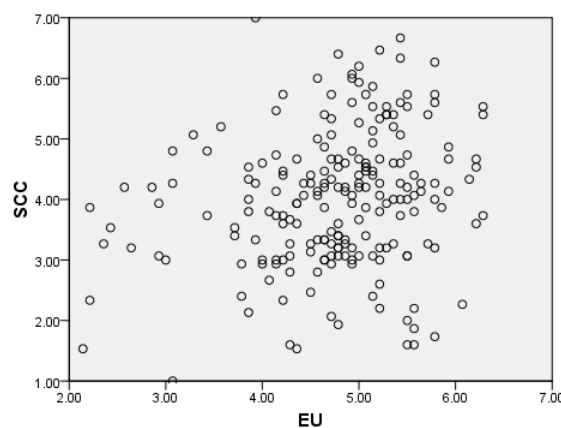


Figure 5-1 Homoscedasticity of environmental uncertainty and supply chain collaboration

As shown in Figure 5-1, the x-axis is environmental uncertainty which is an independent variable and the y-axis is supply chain collaboration which is a dependent variable. The two variables show different dispersion which means heteroscedasticity. The reason is that environmental uncertainty does not show normality.

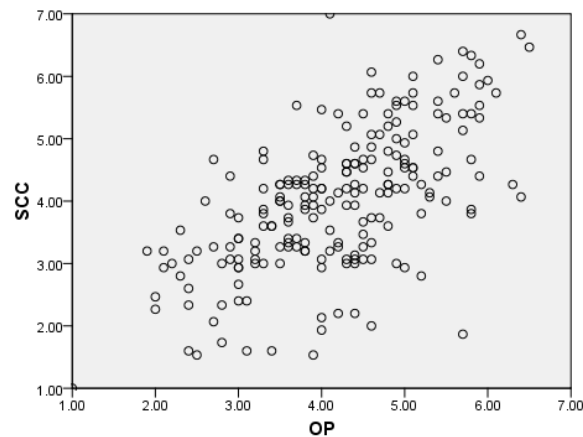


Figure 5-2 Homoscedasticity of supply chain collaboration and operational performance

Figure 5-2 shows homoscedasticity between supply chain collaboration as an independent variable and operational performance as a dependent variable. They show identical transformation, which means that there is homoscedasticity.

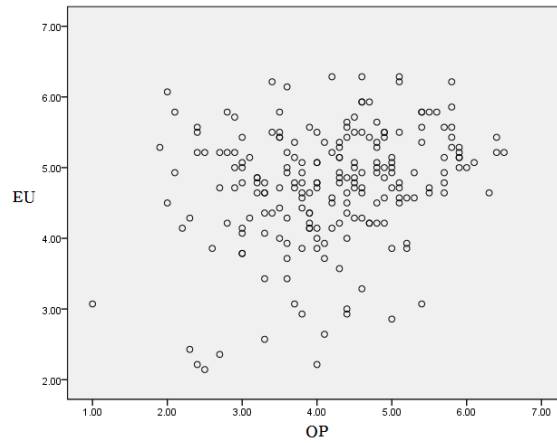


Figure 5-3 Homoscedasticity of environmental uncertainty and operational performance

Figure 5-3 shows homoscedasticity between environmental uncertainty as an independent variable and operational performance as a dependent variable. The two variables show different dispersion which means heteroscedasticity. The reason is that environmental uncertainty does not show normality. Therefore, there are no problems in homoscedasticity excluding environmental uncertainty.

Linearity is also one of basic assumptions for multivariate analysis. It means the correlation between variables has to be linear. The degree of a same variance of a dependent variable following variance of an independent variance means a linear relationship of a function. It can be tested by simple regression analysis.

The result of an analysis on linearity between environmental uncertainty and supply chain collaboration is ascertained as supported ($F = 10.290$, $R^2 = 0.048$, $t = 3.208$ and $p = 0.000$). As a result, the relationship between the two variables is ascertained as a linear relationship. The result of an analysis between supply chain collaboration and operational performance is established as supported ($F = 134.627$, $R^2 = 0.395$, $t = 11.603$ and $p = 0.000$). In addition, the result of an analysis between environmental uncertainty and operational performance is also verified as significant ($F = 13.470$, $R^2 = 0.061$, $t = 3.670$ and $p = 0.000$). Therefore, the relationship between the two variables is regarded as a linear relationship.

This research performs three processes in data screening and evaluation of the assumptions such as normality, homoscedasticity and linearity. The results verify that environmental uncertainty has problems in normality and homoscedasticity. The other variables such as supply chain collaboration and operational performance are satisfied in prerequisites for a multivariate analysis. Therefore, purification of environmental uncertainty is ascertained by additional tests.

5.3.2.2 Internal consistency

Internal consistency means the consistency between measuring factors. The consistency between measuring items should be high and the consistency between measuring variables should be low. The internal consistency of the measuring items can be established by inter-item correlations, item-total correlations and Cronbach's alpha coefficients. The criterion of item-total correlation is over 0.5 and if an item shows below 0.5, it should be deleted (Hair et al., 1998). The criterion of inter-item correlation is over 0.3 and if an item shows below 0.3, it should be deleted (Hair et al., 1998). In addition, the criterion of a Cronbach's alpha coefficient is over 0.6 (Nunnally, 1978). The results of the analysis are as follows.

Table 5-11 Internal consistency of munificence

Items	Average	Standard deviation	Inter-item correlations			Item-total correlations	Cronbach's alpha	Cronbach's alpha (deleted)
			ENV 1	ENV 2	ENV 3			
ENV 1	4.58	1.53	1.000			0.504	0.728	0.697
ENV 2	4.05	1.45	0.381***	1.000		0.528		0.667
ENV 3	4.52	1.49	0.500***	0.535***	1.000	0.622		0.552

*** p < 0.01

As shown in Table 5-11, munificence has three items: ENV 1, ENV 2 and ENV 3. The inter-item correlations of the items are 0.381 to 0.535 and all coefficients are significant in 1%. In addition, all item-total correlations are satisfactory in the criterion and the Cronbach's alpha coefficient is also satisfactory. Therefore, there are no problems in internal consistency of munificence.

Table 5-12 Internal consistency of dynamism

Items	Average	Standard deviation	Inter-item correlations			Item-total correlations	Cronbach's alpha	Cronbach's alpha (deleted)
			ENV 4	ENV 5	ENV 6			
ENV 4	4.73	1.50	1.000			0.549	0.787	0.792
ENV 5	4.25	1.54	0.614***	1.000		0.763		0.556
ENV 6	4.05	1.56	0.385***	0.656***	1.000	0.582		0.760

*** p < 0.01

As shown in Table 5-12, dynamism has three items: ENV 4, ENV 5 and ENV 6. The inter-item correlations of the items are 0.385 to 0.656 and all coefficients are significant in 1%. In addition, all item-total correlations are satisfactory in the criterion and the Cronbach's alpha coefficient is also satisfactory. Therefore, there are no problems in internal consistency of dynamism.

Table 5-13 Internal consistency of heterogeneity

Items	Average	Standard deviation	Inter-item correlations				Item-total correlations	Cronbach's alpha	Cronbach's alpha (deleted)
			ENV7	ENV8	ENV9	ENV10			
ENV7	5.07	1.60	1.000				0.660	0.795	0.716
ENV8	5.05	1.55	0.646***	1.000			0.705		0.694
ENV9	5.27	1.62	0.518***	0.610***	1.000		0.609		0.742
ENV10	4.69	1.53	0.416***	0.403***	0.354***	1.000	0.458		0.812

*** p < 0.01

As shown in Table 5-13, heterogeneity has four items: ENV 7, ENV 8, ENV 9 and ENV 10. The inter-item correlations of the items are 0.354 to 0.646 and all coefficients are significant in 1%. However, the item-total correlation of ENV 10 is 0.458, which is removed and when ENV 10 is removed, the Cronbach's alpha coefficient of the other items is 0.812.

Table 5-14 Internal consistency of hostility

Items	Average	Standard deviation	Inter-item correlations				Item-total correlations	Cronbach's alpha	Cronbach's alpha (deleted)
			ENV11	ENV12	ENV13	ENV14			
ENV11	5.59	1.48	1.000				0.468	0.660	0.576
ENV12	4.93	1.54	0.427***	1.000			0.526		0.534
ENV13	4.59	1.58	0.317***	0.460***	1.000		0.448		0.587
ENV14	5.16	1.66	0.294***	0.259***	0.226***	1.000	0.334		0.668

*** p < 0.01

As shown in Table 5-14, hostility has four items: ENV 11, ENV 12, ENV 13 and ENV 14. The inter-item correlations of the items are 0.226 to 0.460 and all coefficients are significant in 1%. In addition, the item-total correlations of ENV 11, ENV 13 and ENV 14 are shown below 0.5. Therefore, hostility cannot be used in a multivariate analysis. Therefore, it is removed.

Table 5-15 Internal consistency of customer collaboration

Items	Average	Standard deviation	Inter-item correlations					Item-total correlations	Cronbach's alpha	Cronbach's alpha (deleted)
			SCC 1	SCC 2	SCC 3	SCC 4	SCC 5			
SCC 1	4.00	1.56	1.000					0.616	0.881	0.879
SCC 2	4.21	1.60	0.490***	1.000				0.676		0.866
SCC 3	4.13	1.54	0.556***	0.644***	1.000			0.789		0.839
SCC 4	3.93	1.56	0.546***	0.580***	0.756***	1.000		0.781		0.840
SCC 5	4.05	1.49	0.519***	0.570***	0.637***	0.694***	1.000	0.725		0.854

*** p < 0.01

As shown in Table 5-15, customer collaboration has five items: SCC 1, SCC 2, SCC 3, SCC 4 and SCC 5. The inter-item correlations of the items are 0.490 to 0.756 and all coefficients are significant in 1%. In addition, the item-total correlations are satisfactory in the criterion and the Cronbach's alpha coefficient is also satisfactory. Therefore, there are no problems in internal consistency of customer collaboration.

Table 5-16 Internal consistency of supplier collaboration

Items	Average	Standard deviation	Inter-item correlations					Item-total correlations	Cronbach's alpha	Cronbach's alpha (deleted)
			SCC 6	SCC 7	SCC 8	SCC 9	SCC 10			
SCC 6	4.06	1.51	1.000					0.696	0.885	0.866
SCC 7	3.55	1.72	0.513***	1.000				0.599		0.889
SCC 8	4.25	1.64	0.633***	0.539***	1.000			0.787		0.844
SCC 9	4.00	1.72	0.577***	0.407***	0.705***	1.000		0.748		0.854
SCC 10	4.05	1.61	0.603***	0.559***	0.702***	0.752***	1.000	0.793		0.843

*** p < 0.01

As shown in Table 5-16, supplier collaboration has five items: SCC 6, SCC 7, SCC8, SCC 9 and SCC 10. The inter-item correlations of the items are 0.470 to 0.752 and all coefficients are significant

in 1%. In addition, the item-total correlations are satisfactory in the criterion and the Cronbach's alpha coefficient is also satisfactory. Therefore, there are no problems in internal consistency of supplier collaboration.

Table 5-17 Internal consistency of internal collaboration

Items	Average	Standard deviation	Inter-item correlations					Item-total correlations	Cronbach's alpha	Cronbach's alpha (deleted)
			SCC 11	SCC 12	SCC 13	SCC 14	SCC 15			
SCC 11	3.58	1.58	1.000					0.641	0.891	0.888
SCC 12	3.96	1.50	0.657***	1.000				0.751		0.863
SCC 13	4.27	1.52	0.510***	0.698***	1.000			0.790		0.854
SCC 14	4.22	1.60	0.497***	0.551***	0.769***	1.000		0.739		0.866
SCC 15	4.02	1.53	0.560***	0.627***	0.659***	0.683***	1.000	0.750		0.863

*** p < 0.01

As shown in Table 5-17, internal collaboration has five items: SCC 11, SCC 12, SCC 13, SCC 14 and SCC 15. The inter-item correlations of the items are 0.497 to 0.769 and all coefficients are significant in 1%. In addition, the item-total correlations are satisfactory in the criterion and the Cronbach's alpha coefficient is also satisfactory. Therefore, there are no problems in internal consistency of internal collaboration.

Table 5-18 Internal consistency of cost performance

Items	Average	Standard deviation	Inter-item correlations					Item-total correlations	Cronbach's alpha	Cronbach's alpha (deleted)
			OP 1	OP 2	OP 3	OP 4	OP 5			
OP 1	4.08	1.37	1.000					0.674	0.886	0.873
OP 2	4.08	1.43	0.684***	1.000				0.784		0.847
OP 3	4.14	1.44	0.627***	0.783***	1.000			0.795		0.844
OP 4	4.07	1.39	0.530***	0.628***	0.656***	1.000		0.743		0.857
OP 5	4.08	1.32	0.441***	0.490***	0.551***	0.673***	1.000	0.626		0.883

*** p < 0.01

As shown in Table 5-18, cost performance has five items: OP 1, OP 2, OP 3, OP 4 and OP 5. The inter-item correlations of the items are 0.441 to 0.783 and all coefficients are significant in 1%. In addition, the item-total correlations are satisfactory in the criterion and the Cronbach's alpha coefficient is also satisfactory. Therefore, there are no problems in internal consistency of cost

performance.

Table 5-19 Internal consistency of service performance

Items	Average	Standard deviation	Inter-item correlations					Item-total correlations	Cronbach's alpha	Cronbach's alpha (deleted)
			OP 6	OP 7	OP 8	OP 9	OP 10			
OP 6	4.21	1.30	1.000					0.597	0.888	0.891
OP 7	4.32	1.36	0.588***	1.000				0.763		0.856
OP 8	4.41	1.41	0.517***	0.675***	1.000			0.774		0.852
OP 9	4.09	1.42	0.421***	0.592***	0.658***	1.000		0.702		0.870
OP 10	4.28	1.47	0.551***	0.691***	0.719***	0.694***	1.000	0.805		0.845

*** p < 0.01

As shown in Table 5-19, service performance has five items: OP 6, OP 7, OP 8, OP 9 and OP 10. The inter-item correlations of the items are 0.421 to 0.719 and all coefficients are significant in 1%. In addition, the item-total correlations are satisfactory in the criterion and the Cronbach's alpha coefficient is also satisfactory. Therefore, there are no problems in internal consistency of service performance.

As a result of the above analysis, hostility is removed because all item-total correlations excluding ENV 12 are below 0.5. In addition, ENV 10 is removed because the item-total correlation is below 0.5. The other variables are satisfactory in the criterion. Therefore, environmental uncertainty has three variables - munificence, dynamism and heterogeneity. Supply chain collaboration has three variables - internal collaboration, supplier collaboration and customer collaboration and operational performance has two variables - cost performance and service performance. Next are Cronbach's alpha coefficients of the variables.

Table 5-20 Cronbach's alpha coefficients of the variables

Variables	Environmental uncertainty	Supply chain collaboration	Operations performance
Items	ENV 1-9	SCC 1-15	OP 1-10
Cronbach's alpha	0.737	0.933	0.914

As shown in Table 5-20, the Cronbach's alpha coefficients of environmental uncertainty is 0.737

and it is good for reliability because the criterion is over 0.6 (Nunnally, 1978). The coefficient of supply chain collaboration is 0.933, which is good for reliability and the coefficient of operation performance is 0.914, which is also no problem in reliability. Therefore, there are no problems in all variables for reliability. Internal consistency is tested by inter-item correlation, item-total correlation and Cronbach's alpha and all variables excluding hostility have good results. This means that they are satisfactory in the criteria.

5.3.2.3 Exploratory factor analysis

To test validity of the collected data, exploratory factor analysis is used in this research. A principal component analysis and a Varimax orthogonal rotation are used for extracting factors. There are three criteria: one is that items show over 0.5 in a factor loading coefficient, another is that each variable shows over 1.0 in Eigenvalue, and the third is factor cross-loading which means that one item is just included in one variable (Hair et al., 1998). In addition, reliability can be tested by a Cronbach's alpha coefficient and the criterion is over 0.6 in the coefficient (Nunnally, 1978).

Table 5-21 The results of exploratory factor analysis and Cronbach's alpha on environmental uncertainty

Items	Factor 1 (het)	Factor 2 (dyn)	Factor 3 (mun)	Variance		Cronbach's alpha
				before	after	
ENV 1	0.059	-0.012	<u>0.789</u>	3	3	<u>0.728</u>
ENV 2	0.168	0.035	<u>0.763</u>			
ENV 3	0.252	-0.077	<u>0.808</u>			
ENV 4	0.338	<u>0.726</u>	-0.090	3	3	<u>0.787</u>
ENV 5	0.080	<u>0.913</u>	-0.042			
ENV 6	-0.067	<u>0.843</u>	0.068			
ENV 7	<u>0.825</u>	0.072	0.155	3	3	<u>0.812</u>
ENV 8	<u>0.843</u>	0.054	0.225			
ENV 9	<u>0.807</u>	0.128	0.129			
Eigenvalue	2.263	2.103	1.963	-	-	-
Variance (%)	25.141	23.365	21.809	-	-	-

Notes) het: heterogeneity, dyn: dynamism, mun: munificence

As shown in Table 5-21, environmental uncertainty is divided into three sub-variables. The result of Bartlett test of sphericity on environmental uncertainty is significant (chi-square: 635.339, df: 36 and p value: 0.000) and the result of KMO as measure of sample adequacy shows 0.715 (Criterion: > 0.5). This means that there are no problems in the results. As shown in Table 5-19, there are three factors such as heterogeneity, dynamism and munificence. Factor 1 is heterogeneity which has factor loading coefficients from 0.807 to 0.843. It is classified in just one factor and shows 2.263 in Eigenvalue and 25.141 in percentage of variance extracted. This means that heterogeneity has no problem in validity. In addition, a Cronbach's alpha coefficient is 0.812, which has no problem in reliability. As a result, heterogeneity has three items and has no problem in reliability and validity. Factor 2 is dynamism which has factor loading coefficients from 0.726 to 0.913. It is classified in just one factor and shows 2.103 in Eigenvalue and 23.365 in percentage of variance extracted. This means that dynamism has no problem in validity. In addition, a Cronbach's alpha coefficient is 0.787, which has no problem in reliability. As a result, dynamism has three items and has no problem in reliability and validity. Factor 3 is munificence which has factor loading coefficients from 0.763 to 0.808. It is classified in just one factor and shows 1.963 in Eigenvalue and 21.809 in percentage of variance extracted. This means that munificence has no problem in validity. In addition, a Cronbach's alpha coefficient is 0.728, which has no problem in reliability. As a result, munificence has three items and has no problem in reliability and validity. Therefore, environmental uncertainty is good for reliability and validity.

Table 5-22 The results of exploratory factor analysis and Cronbach's alpha on supply chain collaboration

Items	Factor 1 (cus)	Factor 2 (int)	Factor 3 (sup)	variance		Cronbach's alpha
				before	after	
SCC 1	<u>0.747</u>	0.216	0.085	5	5	<u>0.881</u>
SCC 2	<u>0.677</u>	0.206	0.332			
SCC 3	<u>0.823</u>	0.157	0.224			
SCC 4	<u>0.813</u>	0.167	0.274			
SCC 5	<u>0.742</u>	0.198	0.298			
SCC 6	0.551	0.384	0.474	5	4	<u>0.866</u> (deleted SCC 6)
SCC 7	0.259	0.073	<u>0.740</u>			
SCC 8	0.465	0.293	<u>0.665</u>			
SCC 9	0.238	0.327	<u>0.759</u>			
SCC 10	0.264	0.423	<u>0.750</u>			
SCC 11	0.187	<u>0.620</u>	0.407	5	5	<u>0.891</u>
SCC 12	0.258	<u>0.753</u>	0.248			
SCC 13	0.166	<u>0.842</u>	0.222			
SCC 14	0.120	<u>0.828</u>	0.200			
SCC 15	0.291	<u>0.816</u>	0.080			
Eigenvalue	3.848	3.717	3.006	-	-	-
Variance (%)	25.654	24.780	20.037	-	-	-

Notes) cus: customer collaboration, int: internal collaboration, sup: supply chain collaboration

The result of Bartlett test of sphericity on supply chain collaboration is significant (chi-square: 2148.393, df: 105 and p value: 0.000) and the result of KMO shows 0.901. This means that there are no problems in the results. As shown in Table 5-22, there are three factors such as customer collaboration, internal collaboration and supplier collaboration. Factor 1 is customer collaboration which has factor loading coefficients from 0.677 to 0.823. It is classified in just one factor and shows 3.848 in Eigenvalue and 25.654 in percentage of variance extracted. This means that customer collaboration has no problem in validity. In addition, a Cronbach's alpha coefficient is 0.881, which has no problem in reliability. As a result, customer collaboration has five items and has no problem in reliability and validity. Factor 2 is internal collaboration which has factor loading coefficients from 0.620 to 0.842. It is classified in just one factor and shows 3.717 in Eigenvalue and 24.780 in percentage of variance extracted. This means that internal collaboration has no problem in validity. In addition, a Cronbach's alpha coefficient is 0.891, which has no problem in reliability. As a result, internal collaboration has five items and has no problem in reliability and validity. Factor 3 is supplier

collaboration which has factor loading coefficients from 0.665 to 0.759. It is classified in just one factor and shows 3.006 in Eigenvalue and 20.037 in percentage of variance extracted. This means that supplier collaboration has no problem in validity. In addition, a Cronbach's alpha coefficient is 0.866, which is no problem in reliability. However, SCC 6 is removed because of cross-loading with factor 1. As a result, supplier collaboration has four items and has no problem in reliability and validity. Therefore, supply chain collaboration is good for reliability and validity.

Table 5-23 The results of exploratory factor analysis and Cronbach's alpha on operational performance

Items	Factor 1 (ser)	Factor 2 (cos)	Variance		Cronbach's alpha
			before	after	
OP 1	0.173	<u>0.788</u>	5	5	<u>0.886</u>
OP 2	0.225	<u>0.858</u>			
OP 3	0.264	<u>0.843</u>			
OP 4	0.465	<u>0.705</u>			
OP 5	0.328	<u>0.669</u>			
OP 6	<u>0.616</u>	0.403	5	5	<u>0.888</u>
OP 7	<u>0.811</u>	0.260			
OP 8	<u>0.838</u>	0.234			
OP 9	<u>0.773</u>	0.254			
OP 10	<u>0.858</u>	0.238			
Eigenvalue	3.549	3.420	-	-	-
Variance (%)	35.485	34.197	-	-	-

Note) ser: service performance, cos: cost performance

The result of Bartlett test of sphericity on operational performance is significant (chi-square: 1344.418, df: 45 and p value: 0.000) and the result of KMO shows 0.886. This means that there are no problems in the results. As shown in Table 5-23, there are two factors such as cost performance and service performance. Factor 1 is service performance which has factor loading coefficients from 0.616 to 0.858. It is classified in just one factor and shows 3.549 in Eigenvalue and 35.485 in percentage of variance extracted. This means that service performance has no problem in validity. In addition, a Cronbach's alpha coefficient is 0.888, which has no problem in reliability. As a result, service performance has five items and is no problem in reliability and validity. Factor 2 is cost performance

which has factor loading coefficients from 0.669 to 0.858. It is classified in just one factor and shows 3.420 in Eigenvalue and 34.197 in percentage of variance extracted. This means that cost performance is no problem in validity. In addition, a Cronbach's alpha coefficient is 0.886, which has no problem in reliability. As a result, cost performance has five items and has no problem in reliability and validity. Therefore, operational performance is good for reliability and validity.

The data used in this research can show the potential for common method bias because a questionnaire was administrated on the basis of cross-sectional design during the same period of time. It can be tested by the analysis of Harmon's single-factor test of common method bias (Podsakoff and Organ, 1986; Podsakoff et al., 2003). If there is common method bias, the result of exploratory factor analysis shows one factor which dominates the model. Harmon's single-factor test can be ascertained by exploratory factor analysis and if the coefficients of Eigenvalue are over 1.0, there are no problems in common method bias. The results reveal distinct factors with Eigenvalue such as heterogeneity (2.263), dynamism (2.103) and munificence (1.963) and 25.141%, 23.365% and 21.809% in the variance (see <Table 5-20>), customer collaboration (3.848), internal collaboration (3.717) and supplier collaboration (3.006) and 25.654%, 24.780% and 20.037% in the variance (see <Table 5-21>) and service performance (3.420) and cost performance (3.549) and 35.485% and 34.197% in the variance (see Table 5-22). This means that there is no problem in common method bias. In addition, the bias can be tested by the method recommended by Sanchez and Brock (1996). If a single factor is not acceptable, this can be regarded as low common method bias. This means that there is no problem in the bias when goodness of fit of confirmatory factor analysis of a whole model is not significant. The result is shown as 926.456 in chi-square (df: 467), 0.793 in GFI, 0.751 in AGFI, 0.890 in CFI, 0.892 in IFI, 0.803 in NFI and 0.069 in RMSEA. The result shows that there is no problem in common method bias. Both of the results show that the data used in this research has no problems in common method bias.

5.3.3 Construct validity

Construct validity means the consistent theoretical relation between variables with its measurement. It can be tested by convergent validity and discriminant validity. The former explains that measuring items to explain a variable should have high correlation with one another and the latter means that measuring variables should have low correlation with one another.

5.3.3.1 Convergent validity

Convergent validity is verified by confirmatory factor analysis (O'Leary-Kelly and Vokurka, 1998). The confirmation on fit of the model in this research is assessed by seven indices: p value on chi-square, GFI (goodness of fit index), AGFI (adjust goodness of fit index), CFI (comparative fit index), NFI (normal fit index), IFI (incremental fit index) and RMSEA (root mean square error of approximation). Chi-square is an index to test a null hypothesis which means that when a model of a sample is completely correspondent with a model of a population and if the p value is over 0.5, the model is good. Q coefficient explains whether a model reflects the characteristics of a population; chi-square divided by degree of freedom is Q. If Q is below 2.0, the model has good fit (Carmines and McIver, 1981; Kline, 1998). GFI is a scale to measure covariance and comparative dispersion of a measuring model which is explained by a predicted model; if GFI is over 0.9, the model has good fit (Tabachnick and Fidell, 2007). AGFI is an index to adjust GFI through degree of freedom of a model; if AGFI is over 0.9, the model has good fit (Tabachnick and Fidell, 2007). CFI is a parameter showing the distribution of a population; if CFI is over 0.9, the model has good fit (Hu and Bentler, 1999). NFI means an improved degree of a measuring model compared with an original model; if NFI is over 0.9, the model has good fit (Bentler and Bonnet, 1980). IFI means a goodness of fit index to compare a null model with a measuring model; if IFI is over 0.9, the model has good fit (Miles and Shevlin,

2007; McDonald and Ho, 2002). RMSEA means an average of a residual between an observing matrix and a measuring matrix, which is developed for overcoming the limitation of chi-square; if RMSAE is below 0.8, the model has good fit (Bagozzi and Yi, 1988; Hu and Bentler, 1995; MacCallum et al., 1996). The criteria of the indices are summarized in Table 5-24.

Table 5-24 The criteria of a goodness of fit indices (Baumgater and Homburg, 1996; Hu and Bentler, 1999; Segars and Grover, 1993)

Fit indices		Criteria
Absolute fit indices	Chi-square (Jöreskog and Sörbom, 1993)	> 0.05
	Q (Tabachnick and Fidell, 2007)	< 2.0
	GFI (Hooper et al., 2008)	> 0.9
	RMSEA (MacCallum et al., 1996)	< 0.08
Incremental fit indices	CFI (Hu and Bentler, 1999)	> 0.9
	NFI (Bentler and Bonnet, 1980)	> 0.9
	IFI (McDonald and Ho, 2002)	> 0.9
	AGFI (Tabachnick and Fidell, 2007)	> 0.9

Absolute fit indices explain whole fit of a measuring model and incremental fit indices means fit indices to compare a null model with a structural equation modelling. P value on chi-square is an index which is generally used for testing a model but it can sensitively respond to the number of data. Therefore, if there are over 200 data, P value on chi-square may be used as a material for a reference (Baumgater and Homburg, 1996). In addition, this research uses modification indices. The most important aspect of theory testing is goodness of fit and it is improved by modification indices, which are connected with consistency between the measuring model and the model of the population (Grant, 2003). The analysis is performed by confirmatory factor analysis of each sub-variable and confirmatory factor analysis of variables such as environmental uncertainty, supply chain collaboration and operational performance. Analytical results are as follows.

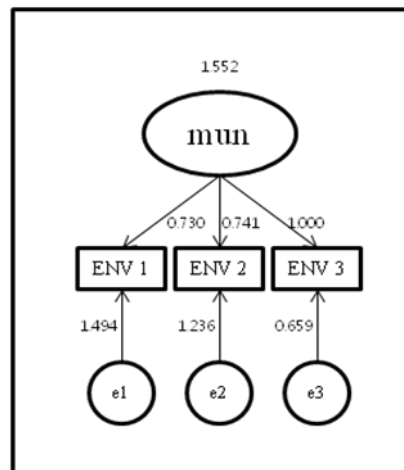
Table 5-25 The result of confirmatory factor analysis of munificence

Variance	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
mun	ENV 1	0.730	0.119	6.155	0.000	0.597	0.489
	ENV 2	0.741	0.118	6.273	0.000	0.639	
	ENV 3	1.000	-	-	-	0.838	

Notes) mun: munificence, S.E.: standard error, C.R.: critical ratio

There are three items and this means that the goodness of fit of the variable has no meaning. Actually, if there are over four items, goodness of fit of a variable has meaning. Therefore, the goodness of fit of munificence has no meaning. In addition, according to Table 5-25, there are three items such as ENV 1, ENV 2 and ENV 3. The coefficients of C.R. are over 1.96 (significant in 0.05) and P vales are significant. Moreover, factor loading coefficients (standardised regression weights) are shown as over 0.5 but AVE is below 0.5. However, it has no problem because it is near the criterion which is 0.5. Therefore, the measurements for munificence are of acceptable psychometric properties. Next is the drawing of confirmatory factor analysis of munificence in Figure 5-4.

Figure 5-4 The drawing of confirmatory factor analysis of munificence



Note) mun: munificence

Variance means the rate of information and this can be explained as follows. It is $\text{Variance} = (\text{estimate}^2 \times \text{variance}) + (1^2 \times \text{variance of error})$. This can be calculated as follows. The variance of ENV

$1 = (0.730^2 * 1.552) + (1^2 * 1.494) = 0.827 + 1.494 = 2.321$. The information of ENV 1 in munificence is as follows. The information = (estimate*variance) / the variance. It is the information = $0.827 / 2.321 = 0.356$ (35.6%). This means that ENV 1 explains 35.6% of munificence. In addition, the variance of ENV 2 = $(0.741^2 * 1.552) + (1^2 * 1.236) = 0.852 + 1.236 = 2.088$ and, also, the information of ENV 2 = $0.852 / 2.088 = 0.408$ (40.8%). This means that ENV 2 explains 40.8% of munificence. Therefore, compared on the basis of the information in the two items of munificence, ENV 2 is more explanative than ENV 1.

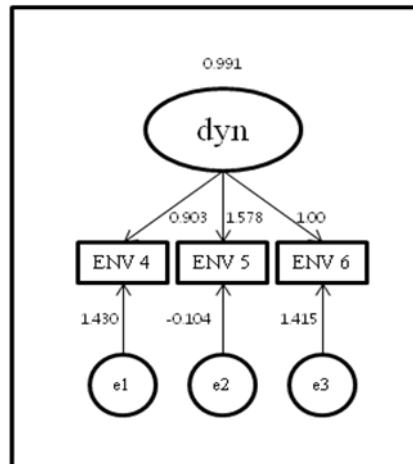
Table 5-26 The result of confirmatory factor analysis of dynamism

Variance	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
dyn	ENV 4	0.903	0.110	8.218	0.000	0.601	0.606
	ENV 5	1.578	0.215	7.340	0.000	1.022	
	ENV 6	1.000	-	-	-	0.642	

Notes) dyn: dynamism, S.E.: standard error, C.R.: critical ratio

There are three items which is the same with munificence and this means that the goodness of fit of the variable has no meaning. In addition, according to Table 5-26, there are three items such as ENV 4, ENV 5 and ENV 6. The coefficients of C.R. are over 1.96 (significant in 0.05) and P values are significant. Moreover, factor loading coefficients (standardised regression weights) are shown as over 0.5 and AVE is also over 0.5. Therefore, there is no problem in confirmatory factor analysis of dynamism. Next is the drawing of confirmatory factor analysis of dynamism in Figure 5-5.

Figure 5-5 The drawing of confirmatory factor analysis of dynamism



Note) dyn: dynamism

Variance means the rate of information and this can be explained as follows. It is $\text{Variance} = (\text{estimate}^2 \times \text{variance}) + (1^2 \times \text{variance of error})$. This can be calculated as follows. The variance of ENV 4 = $(0.903^2 \times 0.991) + (1^2 \times 1.430) = 0.808 + 1.430 = 2.238$. The information of ENV 4 in dynamism is as follows. The information = $(\text{estimate} \times \text{variance}) / \text{the variance}$. It is the information = $0.808 / 2.238 = 0.361$ (36.1%). This means that ENV 4 explains 36.1% of dynamism. In addition, the variance of ENV 5 has no meaning because it has -0.104 of error. This means that it has no meaning. Therefore, ENV 5 explains 36.1% of dynamism.

Table 5-27 The result of confirmatory factor analysis of heterogeneity

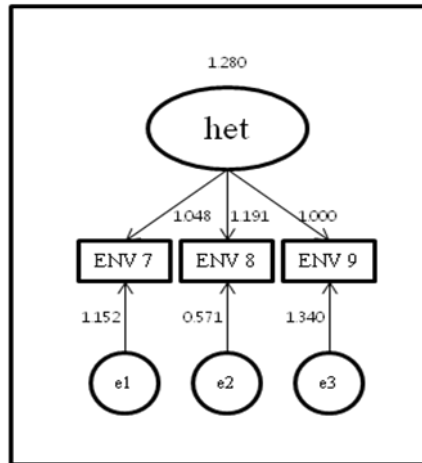
Variance	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
het	ENV 7	1.048	0.114	9.184	0.000	0.741	0.599
	ENV 8	1.191	0.130	9.140	0.000	0.872	
	ENV 9	1.000	-	-	-	0.699	

Notes) het: heterogeneity, S.E.: standard error, C.R.: critical ratio

There are three items which is the same with above two variables and this means that the goodness of fit of the variable has no meaning. In addition, according to Table 5-27, there are three items such as ENV 7, ENV 8 and ENV 9. The coefficients of C.R. are over 1.96 (significant in 0.05) and P vales

are significant. Moreover, factor loading coefficients (standardised regression weights) are shown as over 0.5 and AVE is also over 0.5. Therefore, there is no problem in confirmatory factor analysis of heterogeneity. Next is the drawing of confirmatory factor analysis of heterogeneity in Figure 5-6.

Figure 5-6 The drawing of confirmatory factor analysis of heterogeneity



Note) het: heterogeneity

Variance means the rate of information and this can be explained as follows. It is $\text{Variance} = (\text{estimate}^2 \times \text{variance}) + (1^2 \times \text{variance of error})$. This can be calculated as follows. The variance of ENV 7 = $(1.048^2 \times 1.280) + (1^2 \times 1.152) = 1.405 + 1.152 = 2.557$. The information of ENV 7 in heterogeneity is as follows. The information = $(\text{estimate} \times \text{variance}) / \text{the variance}$. It is the information = $1.405 / 2.557 = 0.579$ (57.9%). This means that ENV 7 explains 57.9% of heterogeneity. In addition, the variance of ENV 8 = $(1.191^2 \times 1.280) + (1^2 \times 0.571) = 0.852 + 0.571 = 2.386$ and, also, the information of ENV 8 = $1.815 / 2.386 = 0.761$ (76.1%). This means that ENV 8 explains 76.1% of heterogeneity. Therefore, compared on the basis of the information in the two items of heterogeneity, ENV 8 is more explanative than ENV 7.

Table 5-28 Fit estimate of the model on environmental uncertainty

Model	Chi-square	df	P	Q	GFI	AGFI	CFI	NFI	IFI	RMSEA
Otiginal	37.387	24	0.040	1.558	0.962	0.928	0.978	0.942	0.979	0.052
amendI	18.708	21	0.604	0.891	0.980	0.956	1.000	0.971	1.004	0.000

Notes) original: the original model; AmendI: the amended model

As shown in Table 5-28, an alternative hypothesis is supported by the original model. This means that the model does not reflect the characteristics of a population. On the other hand, the other indices are good in the criterion. For this reason, the model is amended to use modification indices for improving goodness of fit of the model and the model is improved. As a result, an amended model I shows that a null hypothesis is supported (chi-square: 18.708 and df: 21). This means that the model reflects the characteristics of a population. In addition, Q shows 0.891 and this means that the model is good. The other indices explain that the model is good such as 0.980 in GFI, 0.956 in AGFI, 1.000 in CFI, 0.971 in NFI, 1.004 in IFI and 0.000 in RMSEA. Therefore, all the indices are satisfactory (Hu and Bentler, 1999) and this means that measuring items suggested in an amended model I have no problems in convergent validity.

Convergent validity can be also tested by the results of analysing SEM (Anderson and Gerbing, 1988). To secure the validity, C.R. (critical ratio, estimate divided by standard error is C.R.) should be over 1.96 ($p < 0.05$) and estimate should be larger than double of standard error (Anderson and Gerbing, 1988). In addition, factor loading coefficients should be over 0.5 and if it is over 0.7, it is superior (Anderson and Gerbing, 1988). To strictly test convergent validity, AVE (average variance extracted) is additionally verified. AVE can be shown by an average of squared coefficients of factor loading coefficients. If it is over 0.5, the variable is good for convergent validity (Bagozzi and Yi, 1988; Fornell and Larcker, 1981). The results are as follows.

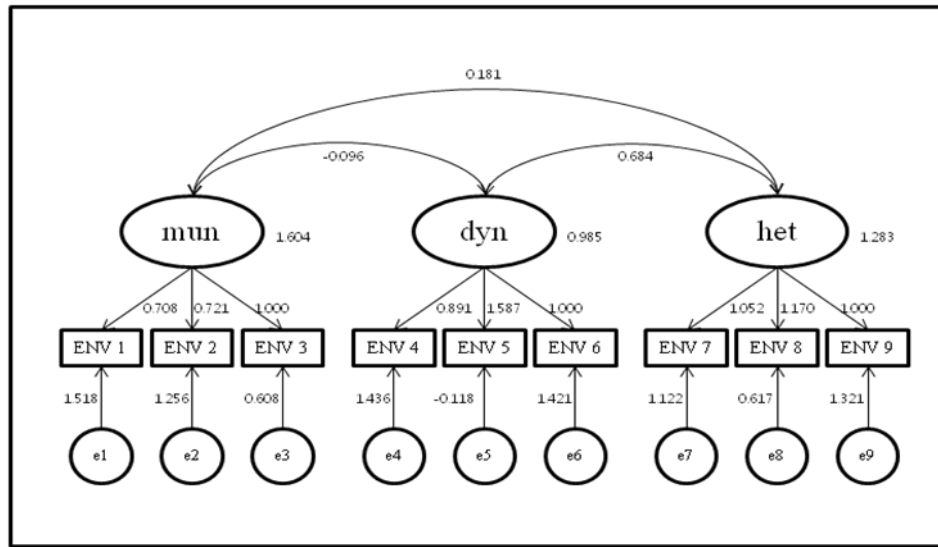
Table 5-29 The result of testing convergent validity on environmental uncertainty

Variance	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
munificence	ENV 1	0.708	0.103	6.892	0.000	0.588	0.690
	ENV 2	0.721	0.100	7.199	0.000	0.631	
	ENV 3	1.000	-	-	-	0.852	
dynamism	ENV 4	0.891	0.109	8.166	0.000	0.594	0.753
	ENV 5	1.587	0.218	7.297	0.000	1.025	
	ENV 6	1.000	-	-	-	0.640	
heterogeneity	ENV 7	1.052	0.113	9.287	0.000	0.747	0.770
	ENV 8	1.170	0.121	9.647	0.000	0.860	
	ENV 9	1.000	-	-	-	0.702	

Notes) S.E. standard error, C.R.: critical ratio

As shown in Table 5-29, munificence is over 1.96 in C.R., factor loading coefficients show 0.588 to 0.852 and AVE is 0.690 and, as a result, it is satisfactory in the criteria. Dynamism is over 1.96 in C.R., factor loading coefficients show 0.594 to 1.025 and AVE is 0.753 and, as a result, it is satisfactory in the criteria. Heterogeneity is over 1.96 in C.R., factor loading coefficients show 0.702 to 0.860 and AVE is 0.770 and, as a result, it is satisfactory in the criteria. Therefore, all variables have no problems in convergent validity because munificence, dynamism and heterogeneity as environmental uncertainty are satisfactory in all criteria. The drawing of environmental uncertainty is as follows.

Figure 5-7 The drawing of confirmatory factor analysis of environmental uncertainty



Notes) mun: munificence, dyn: dynamism, het: heterogeneity, chi-square: 18.708, df: 21, P: 0.604, Q: 0.891, GFI: 0.980, AGFI: 0.956, CFI: 1.000, NFI: 0.971, IFI: 1.004, RMSEA: 0.000

According to Figure 5-7, environmental uncertainty has three sub-variables such as munificence, dynamism and heterogeneity. Each sub-variable has three items and there are nine items in environmental uncertainty. Next are the results of the analysis on supply chain collaboration.

Table 5-30 The result of confirmatory factor analysis of customer collaboration

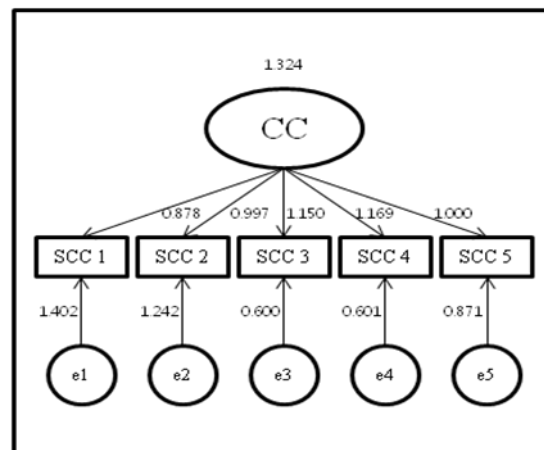
Variable	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
Customer collaboration	SCC 1	0.878	0.093	9.456	0.000	0.649	0.606
	SCC 2	0.997	0.094	10.599	0.000	0.717	
	SCC 3	1.150	0.088	13.109	0.000	0.863	
	SCC 4	1.169	0.089	13.137	0.000	0.865	
	SCC 5	1.000	-	-	-	0.777	

Notes) S.E.: standard error, C.R.: critical ratio, Chi-square: 9.272, df: 5, P: 0.099, Q: 1.854, GFI: 0.983, AGFI: 0.950, CFI: 0.992, NFI: 0.983, IFI: 0.992, RMSEA: 0.064

There are five items and this means that the goodness of fit of the variable has meaning. There are no problems in the results of goodness of fit. For example, P value is rejected and this means that the model reflects the characteristic of the population. The other fit indices are also satisfactory in the criteria. In addition, according to Table 5-30, there are five items such as SCC 1, SCC 2, SCC 3, SCC

4 and SCC 5. The coefficients of C.R. are over 1.96 (significant in 0.05) and P values are significant. Moreover, factor loading coefficients (standardised regression weights) are shown as over 0.5 and AVE is also over 0.5. Therefore, there is no problem in confirmatory factor analysis of customer collaboration. Next is the drawing of confirmatory factor analysis of customer collaboration.

Figure 5-8 The drawing of confirmatory factor analysis of customer collaboration



Note) CC: customer collaboration

According to Figure 5-8, customer collaboration has five items. Variance means the rate of information and this can be explained as follows. The formula is that variance = (estimate²*variance) + (1²*variance of error). This can be calculated as follows. The variance of SCC 1 = (0.878²*1.324) + (1²*1.402) = 1.021+1.402 = 2.423. The information of SCC 1 in customer collaboration is as follows. The information = (estimate*variance) / the variance. It is the information = 1.021 / 2.423 = 0.421 (42.1%). This means that SCC 1 explains 42.1% of customer collaboration. In addition, the variance of SCC 2 = (0.997²*1.324) + (1²*1.242) = 1.316+1.242 = 2.558 and, also, the information of SCC 2 = 1.316 / 2.558 = 0.514 (51.4%). This means that SCC 2 explains 51.4% of customer collaboration. The variance of SCC 3 = (1.150²*1.324) + (1²*0.600) = 1.752+0.600 = 2.352 and, also, the information of SCC 3 = 1.752 / 2.352 = 0.745 (74.5%). This means that SCC 3 explains 74.5% of customer collaboration. The variance of SCC 4 = (1.169²*1.324) + (1²*0.610) = 1.810+0.610 = 2.420 and, also,

the information of SCC 4 = $1.810 / 2.420 = 0.748$ (74.8%). This means that SCC 4 explains 74.8% of customer collaboration. Therefore, compared on the basis of the information in the items of customer collaboration, SCC 4 is more explanative than the others.

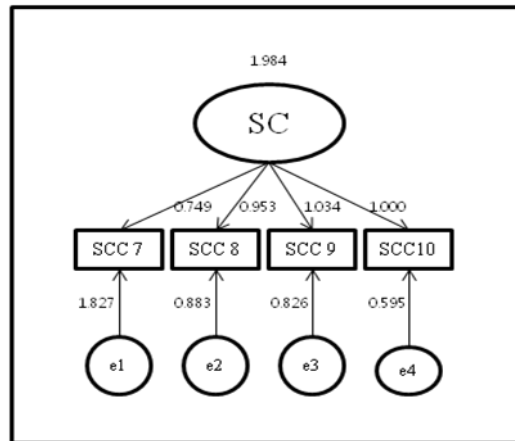
Table 5-31 The result of confirmatory factor analysis of supplier collaboration

Variable	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
Supplier collaboration	SCC 7	0.749	0.079	9.519	0.000	0.615	0.621
	SCC 8	0.953	0.067	14.145	0.000	0.819	
	SCC 9	1.034	0.070	14.779	0.000	0.848	
	SCC 10	1.000	-	-	-	0.877	

Notes) S.E.: standard error, C.R.: critical ratio, Chi-square: 6.573, df: 2, P: 0.037, Q: 3.287, GFI: 0.983, AGFI: 0.950, CFI: 0.992, NFI: 0.983, IFI: 0.992, RMSEA: 0.064

There are four items and this means that the goodness of fit of the variable has meaning. There are no problems in the results of goodness of fit but P value is supported in 5%. This means that the characteristic of the sample is not same as the characteristic of the population. According to Table 5-31, there are four items such as SCC 7, SCC 8, SCC 9 and SCC 10. The coefficients of C.R. are over 1.96 (significant in 0.05) and P vales are significant. Moreover, factor loading coefficients (standardised regression weights) are shown as over 0.5 and AVE is also over 0.5. Therefore, there is no problem in confirmatory factor analysis of customer collaboration. Next is the drawing of confirmatory factor analysis of customer collaboration.

Figure 5-9 The drawing of confirmatory factor analysis of supplier collaboration



Note) SC: supplier collaboration

According to Figure 5-9, supplier collaboration has four items. Variance means the rate of information and this can be explained as follows. It is $\text{Variance} = (\text{estimate}^2 \times \text{variance}) + (1^2 \times \text{variance of error})$. This can be calculated as follows. The variance of SCC 7 = $(0.749^2 \times 1.984) + (1^2 \times 1.827) = 1.113 + 1.817 = 2.940$. The information of SCC 7 in supplier collaboration is as follows. The information = $(\text{estimate} \times \text{variance}) / \text{the variance}$. It is the information = $1.113 / 2.940 = 0.379$ (37.9%). This means that SCC 7 explains 37.9% of supplier collaboration. In addition, the variance of SCC 8 = $(0.953^2 \times 1.984) + (1^2 \times 0.883) = 1.801 + 0.883 = 2.684$ and, also, the information of SCC 8 = $1.801 / 2.684 = 0.671$ (67.1%). This means that SCC 8 explains 67.1% of supplier collaboration. The variance of SCC 9 = $(1.034^2 \times 1.984) + (1^2 \times 0.826) = 2.121 + 0.826 = 2.947$ and, also, the information of SCC 9 = $2.121 / 2.947 = 0.720$ (72.0%). This means that SCC 9 explains 72.0% of supplier collaboration. Therefore, compared on the basis of the information in the items of supplier collaboration, SCC 9 is more explanative than the others.

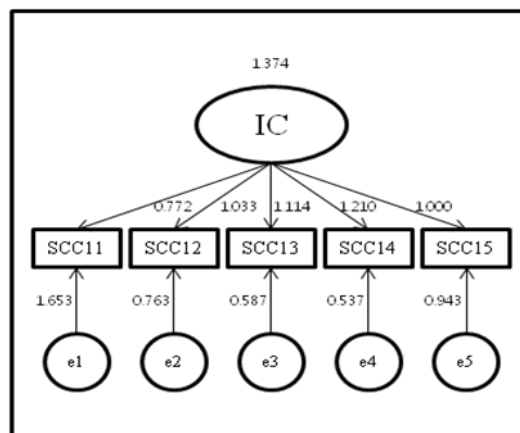
Table 5-32 The result of confirmatory factor analysis of internal collaboration

Variable	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
Internal collaboration	SCC 11	0.772	0.085	9.067	0.000	0.575	0.623
	SCC 12	1.033	0.089	11.616	0.000	0.811	
	SCC 13	1.114	0.081	13.700	0.000	0.862	
	SCC 14	1.210	0.093	12.976	0.000	0.888	
	SCC 15	1.000	-	-	-	0.770	

Notes) S.E.: standard error, C.R.: critical ratio, Chi-square: 0.724, df: 2, P: 0.696, Q: 0.362, GFI: 0.999, AGFI: 0.990, CFI: 1.000, NFI: 0.999, IFI: 1.002, RMSEA: 0.000

There are five items and this means that the goodness of fit of the variable has meaning. There are no problems in the results of goodness of fit. For example, P value is not significant and this means that the model reflects the characteristic of the population. The other fit indices also have no problems in the criteria. In addition, according to Table 5-32, there are five items such as SCC 11, SCC 12, SCC 13, SCC 14 and SCC 15. The coefficients of C.R. are over 1.96 (significant in 0.05) and P values are significant. Moreover, factor loading coefficients (standardised regression weights) are shown as over 0.5 and AVE is also over 0.5. Therefore, there is no problem in confirmatory factor analysis of internal collaboration. Next is the drawing of confirmatory factor analysis of internal collaboration.

Figure 5-10 The drawing of confirmatory factor analysis of internal collaboration



Note) IC: internal collaboration

According to Figure 5-10, internal collaboration has five items. Variance means the rate of

information and this can be explained as follows. The formula is that variance = (estimate²*variance) + (1²*variance of error). This can be calculated as follows. The variance of SCC 11 = (0.772²*1.374) + (1²*1.653) = 0.819+1.653 = 2.472. The information of SCC 11 in internal collaboration is as follows. The information = (estimate*variance) / the variance. It is the information = 0.819 / 2.472 = 0.331 (33.1%). This means that SCC 11 explains 33.1% of internal collaboration. In addition, the variance of SCC 12 = (1.033²*1.374) + (1²*0.763) = 1.466+0.763 = 2.229 and, also, the information of SCC 12 = 1.466 / 2.229 = 0.658 (65.8%). This means that SCC 12 explains 65.8% of internal collaboration. The variance of SCC 13 = (1.114²*1.374) + (1²*0.587) = 1.705+0.587 = 2.292 and, also, the information of SCC 13 = 1.705 / 2.292 = 0.744 (74.4%). This means that SCC 13 explains 74.4% of internal collaboration. The variance of SCC 14 = (1.210²*1.374) + (1²*0.537) = 2.012+0.537 = 2.549 and, also, the information of SCC 14 = 2.012 / 2.549 = 0.789 (78.9%). This means that SCC 14 explains 78.9% of internal collaboration. Therefore, compared on the basis of the information in the items of internal collaboration, SCC 14 is more explanative than the others.

Table 5-33 Fit estimate of the model on supply chain collaboration

Model	Chi-square	df	P	Q	GFI	AGFI	CFI	NFI	IFI	RMSEA
Original	220.648	74	0.000	2.982	0.876	0.825	0.923	0.889	0.923	0.098
Ame I	98.964	57	0.000	1.736	0.938	0.886	0.978	0.950	0.978	0.060
Ame II	97.538	56	0.000	1.742	0.939	0.886	0.978	0.951	0.978	0.060

Notes) Original: the original model; Ame I: the amended model I; Ame II: the amended model II

As shown in Table 5-33, an original model shows that almost indices are not satisfactory in the criteria of goodness of fit. For this reason, the indices of an original model are improved by modification of indices. As a result, all indices are improved. For instance, chi-square is gradually improved such as 220.648 in an original model, 98.964 in an amended model I and 97.538 in an amended model II. Q coefficient is also improved such as 2.982 in an original model, 1.736 in an amended model I but it is slightly increased in an amended model II as 1.742, which is satisfactory in

the criterion (< 2.0). Compared on the basis of the indices, there are few gaps between model I and model II. In addition, an amended model II is satisfactory in all indices excluding P value and AGFI. However, the former can be treated as a reference if there are over 200 data (Baumgater and Homburg, 1996). In addition, some researchers have insisted that the latter has the criterion of over 0.8 because AGFI is an adjusted index of GFI (Byrne, 2009). From this viewpoint, the result of an amended model II is acceptable. An amended model II shows the results as follows: 0.000 in P value on chi-square (97.538), 56 in degree of freedom, 0.939 in GFI (> 0.9), 0.886 in AGFI (> 0.9), 0.978 in CFI (> 0.9), 0.951 in NFI (> 0.9), 0.978 in IFI (> 0.9) and 0.060 in RMSEA (< 0.08). Therefore, the indices of supply chain collaboration are regarded as satisfactory (Hu and Bentler, 1999) and this means that items suggested in an amended model II have no problem in convergent validity. Convergent validity can be also tested by the analytical results of a measuring model and, in addition, AVE is analysed for ascertaining the validity. The results are as follows.

Table 5-34 The result of testing convergent validity on supply chain collaboration

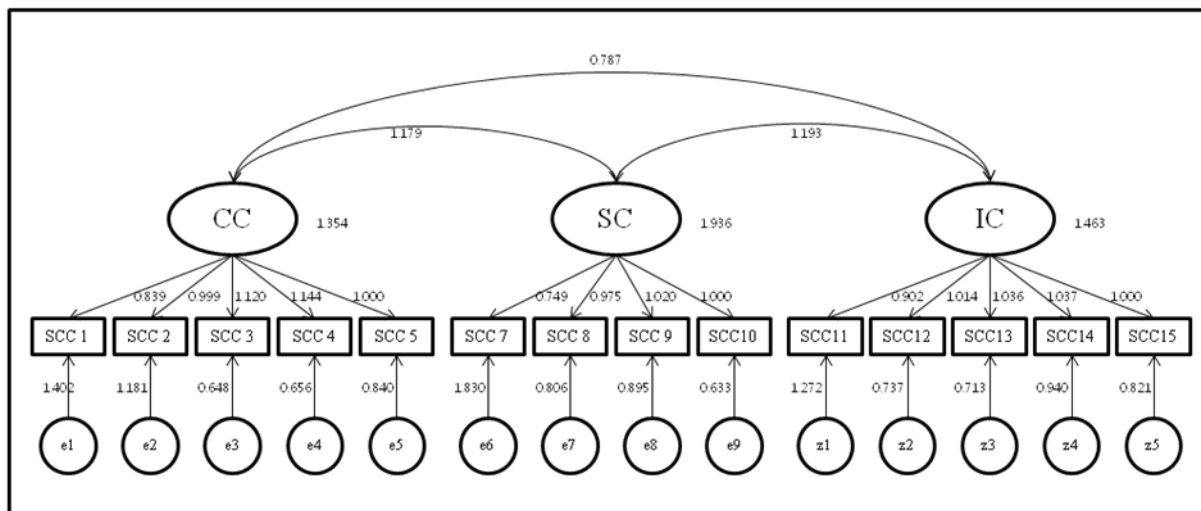
Variables	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
Customer collaboration	SCC 1	0.839	0.088	9.490	0.000	0.636	0.602
	SCC 2	0.999	0.090	11.075	0.000	0.730	
	SCC 3	1.120	0.084	13.300	0.000	0.851	
	SCC 4	1.144	0.085	13.425	0.000	0.854	
	SCC 5	1.000	-	-	-	0.786	
Supplier collaboration	SCC 7	0.749	0.078	9.553	0.000	0.610	0.628
	SCC 8	0.975	0.065	15.087	0.000	0.834	
	SCC 9	1.020	0.068	15.028	0.000	0.832	
	SCC 10	1.000	-	-	-	0.868	
Internal collaboration	SCC 11	0.902	0.090	10.030	0.000	0.695	0.621
	SCC 12	1.014	0.081	12.565	0.000	0.819	
	SCC 13	1.036	0.081	12.746	0.000	0.829	
	SCC 14	1.037	0.089	11.611	0.000	0.791	
	SCC 15	1.000	-	-	-	0.800	

Notes) S.E.: standard error, C.R.: critical ratio

As shown in Table 5-34, C.R. of all measuring items is to satisfy the criterion (> 1.96). Customer collaboration shows the coefficients between 9.490 and 13.425, supplier collaboration has the

coefficients between 9.553 and 15.087 and internal collaboration indicates the coefficient between 10.030 and 12.746. In addition, all factor loading coefficients are satisfactory (> 0.5). Customer collaboration displays the coefficients between 0.636 and 0.854, supplier collaboration reveals the coefficients between 0.610 and 0.868 and internal collaboration discloses the coefficients between 0.695 and 0.829. Moreover, AVE is also satisfactory (> 0.5). Customer collaboration shows 0.602, supplier collaboration represents 0.628 and internal collaboration displays 0.621. Therefore, the analytical results of customer collaboration, supplier collaboration and internal collaboration as supply chain collaboration are satisfactory and this means that supply chain collaboration has no problem in convergent validity. Next are the results of the analysis on operational performance. The drawing of supply chain collaboration is as follows.

Figure 5-11 The drawing of confirmatory factor analysis of supply chain collaboration



Notes) CC: customer collaboration, SC: supplier collaboration, IC: internal collaboration, chi-square: 97.538, df: 56, P: 0.000, Q: 1.742, GFI: 0.939, AGFI: 0.886, CFI: 0.978, NFI: 0.951, IFI: 0.978, RMSEA: 0.060

According to Figure 5-11, supply chain collaboration has three sub-variables such as customer collaboration, supplier collaboration and internal collaboration. The first has five items, the second has four items and the third has five items. There are fourteen items in supply chain collaboration.

Next are the results of the analysis on operational performance.

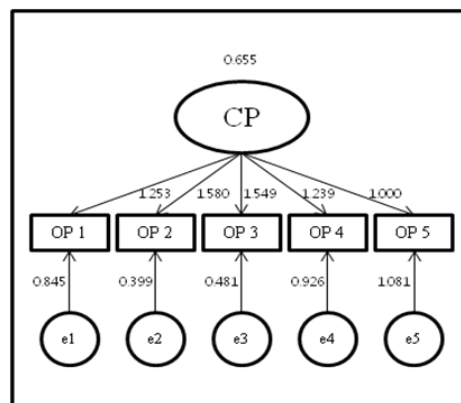
Table 5-35 The result of confirmatory factor analysis of cost performance

Variable	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
Cost performance	OP 1	1.253	0.150	8.338	0.000	0.741	0.604
	OP 2	1.580	0.175	9.023	0.000	0.897	
	OP 3	1.549	0.169	9.162	0.000	0.875	
	OP 4	1.239	0.118	10.489	0.000	0.722	
	OP 5	1.000	-	-	-	0.614	

Notes) S.E.: standard error, C.R.: critical ratio, Chi-square: 3.830, df: 3, P: 0.280, Q: 1.277, GFI: 0.993, AGFI: 0.963, CFI: 0.999, NFI: 0.994, IFI: 0.999, RMSEA: 0.037

There are five items and this means that the goodness of fit of the variable has meaning. There are no problems in the results of goodness of fit. For example, P value is significant and this means that the model reflects the characteristic of the population. The other indices are also no problems in the criteria. In addition, according to Table 5-35, there are five items such as OP 1, OP 2, OP 3, OP 4 and OP 5. The coefficients of C.R. are over 1.96 (significant in 0.05) and P values are significant. Moreover, factor loading coefficients (standardised regression weights) are shown as over 0.5 and AVE is also over 0.5. Therefore, there is no problem in confirmatory factor analysis of cost performance. Next is the drawing of confirmatory factor analysis of cost performance.

Figure 5-12 The drawing of confirmatory factor analysis of cost performance



Note) CP: cost performance

According to Figure 5-12, cost performance has five items. Variance means the rate of information and this can be explained as follows. $\text{Variance} = (\text{estimate}^2 * \text{variance}) + (1^2 * \text{variance of error})$. This can be calculated as follows. The variance of OP 1 = $(1.253^2 * 0.655) + (1^2 * 0.845) = 1.028 + 0.845 = 1.873$. The information of OP 1 in cost performance is as follows. The information = $(\text{estimate} * \text{variance}) / \text{the variance}$. It is the information = $1.028 / 1.873 = 0.549$ (54.9%). This means that OP 1 explains 54.9% of cost performance. In addition, the variance of OP 2 = $(1.580^2 * 0.655) + (1^2 * 0.399) = 1.638 + 0.399 = 2.037$ and, also, the information of OP 2 = $1.638 / 2.037 = 0.805$ (80.5%). This means that OP 2 explains 80.5% of cost performance. The variance of OP 3 = $(1.549^2 * 0.655) + (1^2 * 0.481) = 1.571 + 0.481 = 2.052$ and, also, the information of OP 3 = $1.571 / 2.052 = 0.766$ (76.6%). This means that OP 3 explains 76.6% of cost performance. The variance of OP 4 = $(1.239^2 * 0.655) + (1^2 * 0.926) = 1.005 + 0.926 = 1.931$ and, also, the information of OP 4 = $1.005 / 1.931 = 0.520$ (50.2%). This means that OP 4 explains 50.2% of cost performance. Therefore, compared on the basis of the information in the items of cost performance, OP 2 is more explanative than the others.

Table 5-36 The result of confirmatory factor analysis of service performance

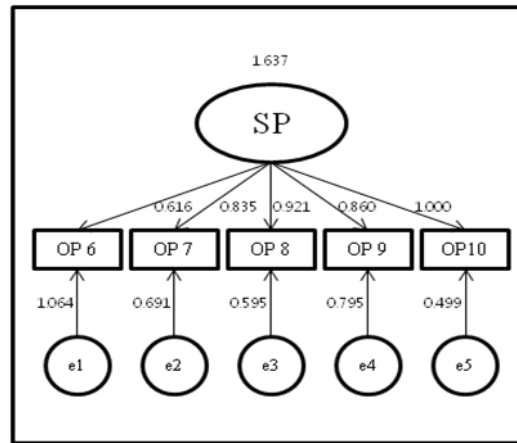
Variable	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
Service performance	OP 6	0.616	0.066	9.298	0.000	0.607	0.612
	OP 7	0.835	0.062	13.522	0.000	0.789	
	OP 8	0.921	0.062	14.786	0.000	0.836	
	OP 9	0.860	0.065	13.257	0.000	0.777	
	OP 10	1.000	-	-	-	0.876	

Notes) S.E.: standard error, C.R.: critical ratio, Chi-square: 4.675, df: 4, P: 0.322, Q: 1.169, GFI: 0.991, AGFI: 0.968, CFI: 0.999, NFI: 0.992, IFI: 0.999, RMSEA: 0.029

There are five items and this means that the goodness of fit of the variable has meaning. There are no problems in the results of goodness of fit. For example, P value is not significant and this means that the model reflects the characteristic of the population. The other indices are also satisfactory. In addition, according to Table 5-36, there are five items such as OP 6, OP 7, OP 8, OP 9 and OP 10. The

coefficients of C.R. are over 1.96 (significant in 0.05) and P vales are significant. Moreover, factor loading coefficients (standardised regression weights) are shown as over 0.5 and AVE is also over 0.5. Therefore, there is no problem in confirmatory factor analysis of service performance. Next is the drawing of confirmatory factor analysis of service performance.

Figure 5-13 The drawing of confirmatory factor analysis of service performance



Note) SP: service performance

According to Figure 5-13, service performance has five items. Variance means the rate of information and this can be explained as follows: $\text{Variance} = (\text{estimate}^2 \times \text{variance}) + (1^2 \times \text{variance of error})$. This can be calculated as follows. The variance of OP 6 = $(0.616^2 \times 1.637) + (1^2 \times 1.064) = 0.620 + 1.064 = 1.684$. The information of OP 6 in service performance is as follows. The information = $(\text{estimate} \times \text{variance}) / \text{the variance}$. It is the information = $0.620 / 1.684 = 0.368$ (36.8%). This means that OP 6 explains 36.8% of service performance. In addition, the variance of OP 7 = $(0.835^2 \times 1.637) + (1^2 \times 0.691) = 1.141 + 0.691 = 1.832$ and, also, the information of OP 7 = $1.141 / 1.832 = 0.623$ (62.3%). This means that OP 7 explains 62.3% of service performance. The variance of OP 8 = $(0.921^2 \times 1.637) + (1^2 \times 0.595) = 1.388 + 0.595 = 1.983$ and, also, the information of OP 8 = $1.388 / 1.983 = 0.700$ (70.0%). This means that OP 8 explains 70.0% of service performance. The variance of OP 9 = $(0.860^2 \times 1.637) + (1^2 \times 0.795) = 1.211 + 0.795 = 2.006$ and, also, the information of OP 9 = $1.211 /$

2.006 = 0.604 (60.4%). This means that OP 9 explains 60.4% of service performance. Therefore, compared on the basis of the information in the items of service performance, OP 8 is more explanative than the others.

Table 5-37 Fit estimate of the model on operational performance

Model	Chi-square	df	P	Q	GFI	AGFI	CFI	NFI	IFI	RMSEA
Original	158.036	34	0.000	4.648	0.867	0.784	0.907	0.885	0.907	0.133
Amend	39.904	23	0.016	1.735	0.964	0.913	0.987	0.971	0.987	0.060

Notes) Original: the original model; Amend: the amended model

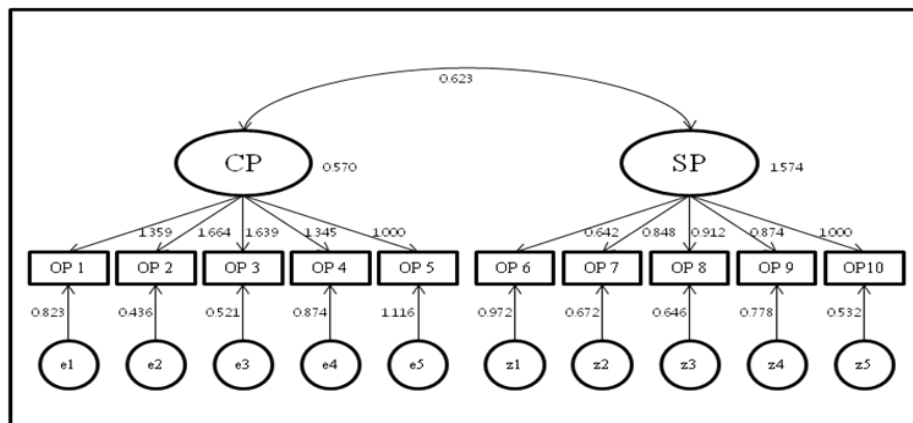
As shown in Table 5-37, the result of an original model is serious because Q coefficient is 4.645 and the other indices are not satisfactory. In this regard, the indices of an original model are amended by modification of indices. As a result, chi-square is improved from 158.036 to 39.904, Q is changed from 4.648 to 1.735, GFI makes better from 0.867 to 0.964, AGFI is improved from 0.784 to 0.913, CFI is increased from 0.907 to 0.987, NFI is gone up from 0.885 to 0.971, IFI is changed from 0.907 to 0.987 and RMSEA makes better from 0.133 to 0.060. However, P value on chi-square is significant on alternative hypothesis and this means that the characteristics of the sample are different from the characteristics of the population. However, this research may use the result of chi-square as a reference because there are over 200 data (Baumgater and Homburg, 1996). All the indices excluding P value are satisfactory. An amended model has the results of the analysis as follows: 0.016 in P value on chi-square (> 0.05), 1.735 in Q (< 2.0), 0.964 in GFI (> 0.9), 0.913 in AGFI (> 0.9), 0.987 in CFI (> 0.9), 0.971 in NFI (> 0.9), 0.987 in IFI (> 0.9) and 0.060 in RMSEA (< 0.08). Therefore, the indices of operational performance are satisfactory and the variables suggested in an amended model have no problems in convergent validity (Hu and Bentler, 1999). The results of analysing SEM and the result of AVE on operational performance are as follows.

Table 5-38 The results of testing convergent validity on operational performance

Variables	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
Cost performance	OP 1	1.359	0.160	8.515	0.000	0.749	0.594
	OP 2	1.664	0.182	9.165	0.000	0.885	
	OP 3	1.639	0.180	9.126	0.000	0.864	
	OP 4	1.345	0.127	10.607	0.000	0.736	
	OP 5	1.000	-	-	-	0.582	
Service performance	OP 6	0.642	0.063	10.210	0.000	0.633	0.610
	OP 7	0.848	0.061	13.855	0.000	0.792	
	OP 8	0.912	0.063	14.493	0.000	0.818	
	OP 9	0.874	0.066	13.294	0.000	0.779	
	OP 10	1.000	-	-	-	0.864	

As shown in Table 5-38, C.R. of all measuring items is to show excess of the criterion (> 1.96). Cost performance has 8.515 to 10.607 in C.R. and service performance has 10.210 to 14.493 in C.R. In addition, all factor loading coefficients are satisfactory in the criterion which is over 0.5. Cost performance has 0.582 to 0.885 in factor loading coefficients and service performance has 0.633 to 0.864 in factor loading coefficients. AVE is also satisfactory. Cost performance has 0.594 and service performance has 0.610. Therefore, the analytical results of cost performance and service performance as operational performance are satisfactory and this means that the variables have no problems in convergent validity. The drawing of operational performance is as follows.

Figure 5-14 The drawing of confirmatory factor analysis of operational performance



Notes) CP: cost performance, SP: service performance, chi-square: 39.904, df: 23, P: 0.016, Q: 1.735, GFI: 0.964, AGFI: 0.913, GFI: 0.987, NFI: 0.971, IFI: 0.987, RMSEA: 0.060

According to Figure 5-14, operation performance has two sub-variables such as cost performance and service performance. The former has five items and the latter has five items. There are ten items in operational performance. As a result of analysing convergent validity, all variables are satisfactory in the criteria.

5.3.3.2 Discriminant validity

The method of testing discriminant validity is to compare AVE with the power of two of a correlation coefficient (Segars, 1997). If there is discriminant validity, AVE of a variable is larger than all the power of two of correlation coefficients which include the variable. The result is as follows.

Table 5-39 The result of a correlation analysis

var	ave	sd	mun	dyn	het	CC	SC	IC	CP	SP
mun	4.383	1.199	1.000 0.690							
dyn	4.345	1.283	-0.018 (0.000)	1.000 0.753						
het	5.020	1.240	0.401*** (0.161)	0.200** (0.040)	1.000 0.770					
CC	4.064	1.276	0.208** (0.043)	-0.124 (0.015)	0.255*** (0.065)	1.000 0.602				
SC	3.960	1.414	0.201** (0.040)	-0.091 (0.008)	0.190* (0.036)	0.662*** (0.438)	1.000 0.628			
IC	4.009	1.289	0.191* (0.036)	-0.078 (0.006)	0.278*** (0.077)	0.521*** (0.271)	0.626*** (0.392)	1.000 0.621		
CP	4.089	1.153	0.158 (0.025)	0.088 (0.008)	0.203** (0.041)	0.360*** (0.130)	0.293*** (0.086)	0.443*** (0.196)	1.000 0.594	
SP	4.264	1.156	0.182* (0.033)	-0.085 (0.007)	0.249*** (0.062)	0.594*** (0.353)	0.592*** (0.350)	0.595*** (0.354)	0.636*** (0.404)	1.000 0.610

Notes) var: variables, ave: average, sd: standard deviation, mun: munificence, dyn: dynamism, het: heterogeneity, CC: customer collaboration, SC: supplier collaboration, IC: internal collaboration, CP: cost performance, SP: service performance, ***: $p < 0.01$, The number of parenthesis is the power of two of the correlation coefficient and the number below 1.000 is AVE.

As shown in Table 5-39, the power of two of the correlation coefficients shows below 0.5 in the coefficients. The criterion of AVE is over 0.5 and, as a result, all coefficients of AVE are higher than all the power of two of the correlation coefficients as shown in Table 5-28, Table 5-33 and Table 5-37.

For example, AVE of munificence is 0.690 and the power of two of the correlation coefficients which include the variable are shown from 0.001 to 0.161. AVE of dynamism is 0.753 and the power of two of the correlation coefficients which include the variable are shown from 0.000 to 0.040. AVE of heterogeneity is 0.770 and the power of two of the correlation coefficients which include the variable are shown from 0.036 to 0.161. AVE of customer collaboration is 0.602 and the power of two of correlation coefficients which include the variable are shown from 0.015 to 0.438. AVE of supplier collaboration is 0.628 and the power of two of correlation coefficients which include the variable are shown from 0.008 to 0.438. AVE of internal collaboration is 0.621 and the power of two of correlation coefficients which include the variable are shown from 0.006 to 0.392. AVE of cost performance is 0.594 and the power of two of correlation coefficients which include the variable are shown from 0.008 to 0.404. AVE of service performance is 0.610 and the power of two of correlation coefficients which include the variable are shown from 0.007 to 0.404. Therefore, the results explain that the measuring variables have no problems in discriminant validity.

The result of correlation analysis has two meanings: one is that the relationships between independent variables should have low correlation and the other is that the relationships between independent variables and dependent variables should have high correlation. The former means that there are high independent relationships between independent variables. The latter means that independent variables explain dependent variables very well. As shown in Table 5-29, the correlation coefficients among independent variables such as munificence, dynamism and heterogeneity and dependent variables such as customer collaboration, supplier collaboration and internal collaboration are -0.078 to 0.662. In particular, the correlation coefficient between dynamism and supplier collaboration represents -0.091 and the correlation coefficient between dynamism and internal collaboration appears -0.078. This means that the relationships between these dependent and independent variables are inferior. However, this research uses dynamism for the analysis because there is no criterion on a correlation coefficient. In addition, the correlation coefficients among

independent variables such as munificence, dynamism and heterogeneity and dependent variables such as cost performance and service performance are -0.085 to 0.249. In particular, the correlation coefficient between dynamism and cost performance represents 0.088 and the correlation coefficient between dynamism and service performance appears -0.085. This means that the relationships between these dependent and independent variables are inferior. However, this research uses dynamism for the analysis because there is no criterion on a correlation coefficient. Moreover, the correlation coefficients among independent variables such as customer collaboration, supplier collaboration and internal collaboration and dependent variables such as cost performance and service performance appear 0.293 to 0.595. This means that the relationships between these dependent and independent variables are superior. Therefore, there are no problems in the result of the correlation analysis because the results of a correlation analysis show high correlation between independent variables and dependent variables.

5.3.3.3 Multicollinearity analysis

Multicollinearity means that there is high correlation between independent variables. It can be tested by tolerance and MAX-VIF. It explains that one divided by tolerance is MAX-VIF. If tolerance is over 0.1 and MAX-VIF is below 10.0, there is no problem in multicollinearity (Hair et al., 1998; Neter et al., 1996). The result is as follows.

Table 5-40 Multicollinearity diagnostics

Variables	tolerance	MAX-VIF
munificence	0.815	1.226
dynamism	0.917	1.091
heterogeneity	0.734	1.363
customer collaboration	0.523	1.911
supplier collaboration	0.449	2.226
internal collaboration	0.569	1.759

As shown in Table 5-40, there are two folds on multicollinearity. One is concerned with munificence, dynamism and heterogeneity as environmental uncertainty and the other is connected with customer collaboration, supplier collaboration and internal collaboration as supply chain collaboration. The former shows that there are no problems in munificence, dynamism and heterogeneity concerned with multicollinearity. All tolerance coefficients show over 0.1 and all MAX-VIF coefficients represent below 10.0. The latter also shows that there are no problems in customer collaboration, supplier collaboration and internal collaboration concerned with multicollinearity. All tolerance coefficients show over 0.1 and all MAX-VIF coefficients represent below 10.0. As a result, there are no problems in multicollinearity.

5.4 Summary

This research examines three variables - environmental uncertainty, supply chain collaboration and operational performance. The first has three sub-variables such as munificence, dynamism and heterogeneity, the second has three sub-variables such as customer collaboration, supplier collaboration and internal collaboration, and the third has two sub-variables: cost performance and service performance. The variables are extracted from prior research and validity and reliability of the measuring items are tested by various analytical methods such as content validity, estimates and purification of data and construct validity. The results are as follows.

First of all, experts estimated validity of the measuring items and verified that there are no problems with content validity. Second, the averages of the items have no problems. Third, there are three processes for prerequisites of a multivariate analysis: normality, homoscedasticity and linearity. Normality is established by Kolmogorov-Smirnov test. The results show that heterogeneity and hostility supports alternative hypothesis but the others supports null hypothesis. This means that all the variables excluding heterogeneity and hostility show normality. Homoscedasticity is tested by

identical transformation between the variables. The transformation between environmental uncertainty and supply chain collaboration and the transformation between environmental uncertainty and operational performance is not identical but the transformation between supply chain collaboration and operational performance is identical. This means that environmental uncertainty has a problem in homoscedasticity. Linearity is tested by simple regression analysis and, as a result, there are no problems in linearity. Fourth, in the test of internal consistency, hostility shows below 0.5 in item-total correlations and, as a result, it is removed. In addition, ENV 10 in heterogeneity shows below 0.5 in the item-total correlation, which is removed. The other variables are satisfied in the criteria of internal consistency. Fifth, Cronbach's alpha of each variable has no problem. All the coefficients are over 0.6 which is a criterion. Sixth, exploratory factor analysis is tested for extracting items. There is just one item removed which is SCC 6 because of factor cross-loading with customer collaboration. The other items have no problems in factor loading coefficients and Cronbach's alpha coefficients. Seventh, convergent validity is tested by confirmatory factor analysis. There are no problems in goodness of fit indices and the results of analysing measuring models. Eighth, discriminant validity is verified by comparison of the power of two of correlation coefficients with AVE. There are no problems because all coefficients of AVE are higher than the power of two of correlation coefficients. Ninth, multicollinearity analysis is also no problem in the criteria such as over 0.1 in tolerance and below 10.0 in MAX-VIF.

As a result of the analyses of reliability and validity, hostility as environmental uncertainty is removed. It has low item-total correlations in the result of analysing internal consistency among the items. The item-total correlations show 0.468 in ENV 11, 0.526 in ENV 12, 0.448 in ENV 13 and 0.334 in ENV 14 but the criterion is over 0.5. That is why the variable is removed. In addition, ENV 10 is removed because it has 0.458 in an item-total correlation. The other variables have no problems in all results. Finally, eight variables are extracted in this research: three items in munificence (ENV 1, ENV 2 and ENV 3), three items in dynamism (ENV 4, ENV 5 and ENV 6), three items in

heterogeneity (ENV 7, ENV 8 and ENV 9), five items in customer collaboration (SCC 1, SCC 2, SCC 3, SCC 4 and SCC 5), four items in supplier collaboration (SCC 7, SCC 8, SCC 9 and SCC 10), five items in internal collaboration (SCC 11, SCC 12, SCC 13, SCC 14 and SCC 15), five items in cost performance (OP 1, OP 2, OP 3, OP 4 and OP 5) and five items in service performance (OP 6, OP 7, OP 8, OP 9 and OP 10). All items are measured by a seven Likert scale in which it was revealed that one strongly disagreed and seven strongly agreed. In addition, the definition of environmental uncertainty is a degree of unpredictability to outcomes or the future. It has three dimensions such as munificence, dynamism and heterogeneity (Chow et al., 1995; Lee et al., 2007; McGinnis and Kohn, 1993). Munificence means a degree of continuous growth of a market caused by environmental variance. Dynamism means the difficulty of predicting a change in the market. Heterogeneity can be explained as the change of competitive methods of competitors and customers' preferences and expectations. Supply chain collaboration can be defined as working together among departments within a firm, understanding mutual different viewpoints, sharing resources and information and achieving common goals in supply chains (Ellinger et al., 2000; Kahn and Mentzer, 1998; Mollenkopf et al., 2000; Stank et al., 1999b). Internal collaboration can be defined as processes of cooperation and interaction for maintenance of the close relationship between departments. Supplier collaboration means structuring collaborative relationships with core suppliers for stock management and stable supply of raw materials and parts and customer collaboration means understanding for needs of core customers and responding to the needs. Operational performance is measured as cost performance from the viewpoint of efficiency and service performance from the viewpoint of effectiveness in this research (Brewer and Speh, 2000). These variables are used in the analysis of this research.

Chapter VI Hypotheses Testing

6.1 Introduction

This chapter presents the results of hypotheses testing and analyses of the research model. The research model is tested in order as follows: confirmatory factor analysis on supply chain collaboration (H.1), confirmatory factor analysis on operational performance (H.2), confirmatory factor analysis on environmental uncertainty (H.3), the causal link between supply chain collaboration and operational performance (H.4), the moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance (H.5), the causal link between environmental uncertainty and supply chain collaboration (H.6) and the causal link between environmental uncertainty and operational performance (H.7). There are two objectives of this research: one is to ascertain confirmatory factor analysis of the variables and the other is to verify the roles of environmental uncertainty on the relationship between supply chain collaboration and operational performance. The results are as follows.

6.2 The results of confirmatory factory analysis on supply chain collaboration (H.1), operational performance (H.2) and environmental uncertainty (H.3)

The sub-variables of supply chain collaboration are verified by confirmatory factor analysis. Goodness of fit has no meaning because there are just three sub-variables of supply chain collaboration. If there are over four sub-variables, it has meaning. The results of the confirmatory factor analysis are as follows.

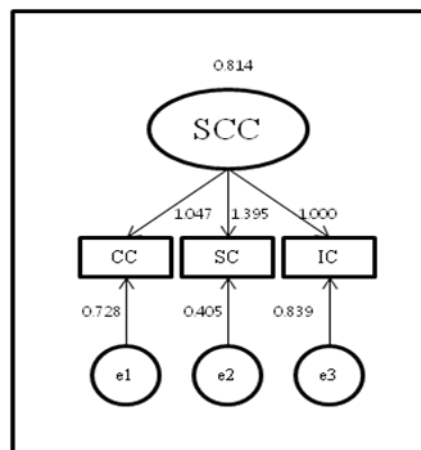
Table 6-1 The result of confirmatory factor analysis of supply chain collaboration

Variance	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
Supply chain collaboration	CC	1.047	0.111	9.448	0.000	0.742	0.613
	SC	1.395	0.148	9.412	0.000	0.892	
	IC	1.000	-	-	-	0.702	

Notes) CC: customer collaboration, SC: supplier collaboration, IC: internal collaboration, S.E.: standard error, C.R. critical ratio

There are three sub-variables and this means that the goodness of fit of the variable has no meaning. Actually, if there are over four items, goodness of fit of a variable has meaning. For this reason, the goodness of fit of supply chain collaboration has no meaning. In addition, according to Table 6-1, there are three sub-variables such as customer collaboration, supplier collaboration and internal collaboration. The coefficients of C.R. are over 1.96 (significant in 0.05) and P values are significant. Moreover, factor loading coefficients (standardised regression weights) are shown as over 0.5 and AVE is also over 0.5. Therefore, there is no problem in confirmatory factor analysis of supply chain collaboration (H. 1 supported). Next is the drawing of confirmatory factor analysis of supply chain collaboration.

Figure 6-1 The drawing of confirmatory factor analysis of supply chain collaboration



Notes) SCC: supply chain collaboration, CC: customer collaboration, SC: supplier collaboration, IC: internal collaboration

Variance means the rate of information and this can be explained as follows. The formula is that

Variance = (estimate²*variance) + (1²*variance of error). This can be calculated as follows. The variance of customer collaboration = (1.047²*0.814) + (1²*0.728) = 0.892+0.728 = 1.620. The information of customer collaboration in supply chain collaboration is as follows. The information = (estimate*variance) / the variance. It is the information = 0.892 / 1.620 = 0.551 (55.1%). This means that customer collaboration explains 55.1% of supply chain collaboration. In addition, the variance of supplier collaboration = (1.395²*0.814) + (1²*0.405) = 1.584+0.405 = 1.989 and, also, the information of supplier collaboration = 1.584 / 1.989 = 0.796 (79.6%). This means that supplier collaboration explains 79.6% of supply chain collaboration. For this reason, compared on the basis of the information in the two sub-variables of supply chain collaboration, supplier collaboration is more explanative than customer collaboration. Therefore, H.1 is supported.

There is no meaning of confirmatory factor analysis of operational performance because it has two sub-variables. If there are two items in confirmatory factor analysis, the result has no meaning. However, the two sub-variables such as cost performance and service performance have five items each. The results of confirmatory factor analysis of the two sub-variables have no problems (see Table 5-33 and Table 5-34). This means that there are no problems in confirmatory factor analysis of operational performance. Therefore, H.2 is regarded as supported.

The sub-variables of environmental uncertainty are verified by confirmatory factor analysis. Goodness of fit has no meaning because there are just three sub-variables of environmental uncertainty. If there are over four sub-variables, it has meaning. The results of the confirmatory factor analysis are as follows.

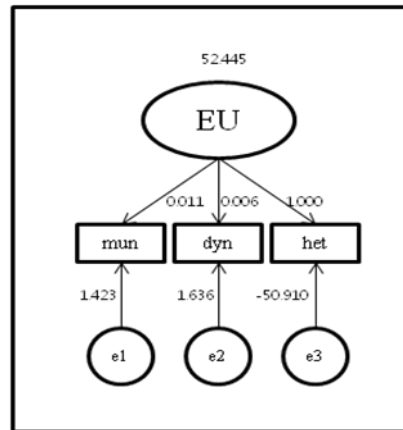
Table 6-2 The result of confirmatory factor analysis of environmental uncertainty

Variance	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
Environmental uncertainty	mun	0.011	0.322	0.035	0.972	0.069	34.170
	dyn	0.006	0.178	0.035	0.972	0.035	
	het	1.000	-	-	-	5.845	

Notes) mun: munificence, dyn: dynamism, het: heterogeneity S.E.: standard error, C.R.: critical ratio

There are three sub-variables and this means that the goodness of fit of environmental uncertainty has no meaning. Actually, if there are over four sub-variables, goodness of fit of the variable has meaning. For this reason, the goodness of fit of environmental uncertainty has no meaning. In addition, according to Table 6-2, there are three sub-variables such as munificence, dynamism and heterogeneity. The coefficients of C.R. are not significant and P values are also not supported. Moreover, factor loading coefficients (standardised regression weights) are not good in the criterion and AVE is also not significant. The reason is that environmental uncertainty is not significant in the preconditions of multivariate analysis. The result is that environmental uncertainty does not show normality. It has three sub-variables such as munificence, dynamism and heterogeneity. The result shows that there are no problems in munificence and dynamism but heterogeneity is problem. In addition, the homoscedasticity between environmental uncertainty and supply chain collaboration is a problem. The two variables show different dispersion, which is heteroscedasticity. That is why environmental uncertainty is not significant in the result of confirmatory factor analysis. The goodness of fit of the items of each sub-variable is good (see Table 5-28, Table 5-33 and Table 5-37). For this reason, the result of confirmatory factor analysis of environmental uncertainty as hypothesis 3 is partially supported. Next is the drawing of confirmatory factor analysis of environmental uncertainty.

Figure 6-2 The drawing of confirmatory factor analysis of environmental uncertainty



Notes) EU: environmental uncertainty, mun: munificence, dyn: dynamism, het: heterogeneity

Variance means the rate of information and this can be explained as follows. It is $\text{Variance} = (\text{estimate}^2 \times \text{variance}) + (1^2 \times \text{variance of error})$. This can be calculated as follows. The variance of munificence = $(0.011^2 \times 52.445) + (1^2 \times 1.423) = 0.000 + 1.423 = 1.423$. The information of munificence in environmental uncertainty is as follows. The information has no meaning because estimate times variance is zero. In addition, the variance of dynamism = $(0.006^2 \times 52.445) + (1^2 \times 1.636) = 1.636$ and, also, the information of dynamism is no meaning because of the same reason with munificence. Therefore, hypothesis 3 is partially significant because there is no problem in the result of confirmatory factor analysis in measuring items of environmental uncertainty.

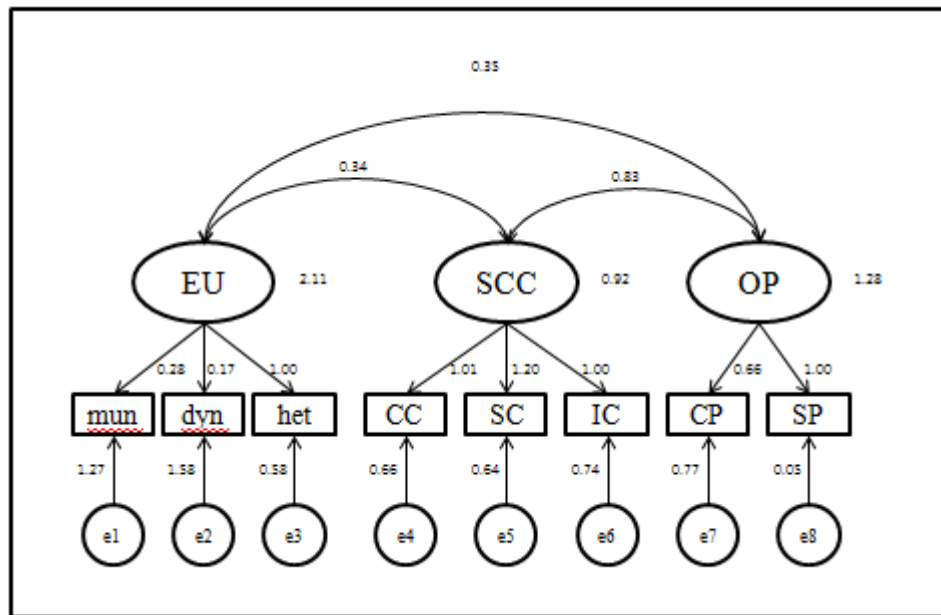
Table 6-3 The result of analysing SEM on environmental uncertainty, supply chain collaboration and operational performance

Variables	Items	Estimate	S.E.	C.R.	P	Factor loading	AVE
EU	mun	0.284	0.166	1.715	0.086	0.344	0.510
	dyn	0.166	0.108	1.539	0.124	0.188	
	het	1.000	-	-	-	1.174	
SCC	CC	1.011	0.098	10.348	0.000	0.765	0.605
	SC	1.201	0.110	10.935	0.000	0.821	
	IC	1.000	-	-	-	0.745	
OP	CP	0.660	0.090	7.328	0.000	0.648	0.692
	SP	1.000	-	-	-	0.982	

Notes) S.E.: standard error, C.R.: critical ratio, Factor loading: factor loading coefficient, EU: environmental uncertainty, SCC: supply chain collaboration, OP: operational performance, mun: munificence, dyn: dynamism, het: heterogeneity, CC: customer collaboration, SC: supplier collaboration, IC: internal collaboration, CP: cost performance, SP: service performance

As shown in Table 6-3, all of the critical ratios in the variables are satisfactory in the criteria (> 1.96) excluding munificence and dynamism. In addition, all P values are significant in the criterion (< 0.05) excluding munificence and dynamism and the factor loading coefficients of the variable are satisfactory in the criterion (> 0.05) excluding munificence and dynamism. Moreover, all AVEs are satisfactory and that is why these are no problems in the result excluding environmental uncertainty. The drawing for confirmatory factor analysis on environmental uncertainty, supply chain collaboration and operational performance is as follows.

Figure 6-3 The drawing for confirmatory factor analysis on environmental uncertainty, supply chain collaboration and operational performance



Notes) EU: environmental uncertainty, SCC: supply chain collaboration, OP: operational performance, mun: munificence, dyn: dynamism, het: heterogeneity, CC: customer collaboration, SC: supplier collaboration, IC: internal collaboration, CP: cost performance, SP: service performance

The result for the confirmatory factor analysis on the relationship between environmental uncertainty, supply chain collaboration and operational performance is shown in Figure 6-3. The goodness of fit is 22.898 in chi-square, 12 in degree of freedom, 0.029 in P value, 1.908 in Q, 0.974 in GFI, 0.922 in AGFI, 0.980 in CFI, 0.960 in NFI, 0.981 in IFI and 0.066 in RMSEA. In addition, all critical ratios are over 1.96 (< 0.05) excluding munificence and dynamism. This means that the model has discriminant validity (Anderson and Gerbing, 1988). Moreover, AVE is 0.510 in environmental uncertainty, 0.605 in supply chain collaboration and 0.692 in operational performance (> 0.5). This means that the model has convergent validity (Bagozzi and Yi, 1988; Fornell and Larcker, 1981). Therefore, the model is no problem in the result of the confirmatory factor analysis.

This research verified the confirmatory factor analysis to environmental uncertainty, supply chain collaboration and operational performance. In fact, the confirmatory factor analysis to all items is

already verified in Chapter Five and, as a result, there are no problems in the results. However, the results of the above variables have problems in environmental uncertainty. For instance, the result of confirmatory factor analysis to environmental uncertainty shows low C.R. and P values are not significant. In addition, factor loading coefficients are shown below 0.5 in munificence and dynamism. However, this is the variables but there are no problems in sub-dimensions of the variables. In addition, there are no problems in the other variables such as supply chain collaboration and operational performance. Therefore, supply chain collaboration is composed of customer collaboration, supplier collaboration and internal collaboration (H.1 supported), operational performance is made up of cost performance and service performance (H.2 supported) but the results represent that munificence, dynamism and heterogeneity as environmental uncertainty have significant measuring items but environmental uncertainty as a whole variable is not significant (H.3 partially supported). Next are to analyse the roles of environmental uncertainty on the relationship between supply chain collaboration and operational performance.

6.3 The result of the causal links between the variables

There are three hypotheses concerning the relationships among environmental uncertainty, supply chain collaboration and operational performance: the positive effect of supply chain collaboration on operational performance (H.4), the positive effect of environmental uncertainty on supply chain collaboration (H.6) and the negative effect of environmental uncertainty on operational performance (H.7).

First of all, there is a plenty of prior research on the relationship between supply chain collaboration and performance. Many researchers have already verified the causal link between the two variables and this means that supply chain collaboration has a positive effect on performance. Similarly, this research tests the causal relationship between supply chain collaboration and operational performance

but this research focuses on second order constructs of the variables. Second, the causal link between environmental uncertainty and supply chain collaboration is based on prior research (Coelho and Easingwood, 2005; Jokipii, 2010) and they found that environmental uncertainty has a positive effect on supply chain collaboration. Similarly, this research tests the causal relationship between the variables and the roles of environmental uncertainty on the relationship between supply chain collaboration and operational performance are focused in this research. Third, the causal link between environmental uncertainty and performance is based on prior research. Ryu et al. (2008) and Wood (2008) found that environmental uncertainty has a negative effect on performance but Hsu and Wang (2008) and Jokipii (2010) verified that environmental uncertainty has a positive effect on performance. For this reason, this research tests the causal relationship between the variables and also needs to verify whether environmental uncertainty has a positive or negative effect on performance. The result of the analysis is shown in as follows.

Table 6-4 Goodness of fit of the model

Model	Chi	df	P	Q	GFI	AGFI	CFI	NFI	IFI	RMSEA
original	16.510	12	0.169	1.376	0.980	0.940	0.992	0.971	0.992	0.043

As shown in Table 6-4, there are no problems with the goodness of fit. For example, p value is not supported and this means that the characteristics of the sample are equal to the characteristics of the population. The other indices are also no problems. For instance, the coefficients of GFI (0.980), AGFI (0.940), CFI (0.992), NFI (0.971) and IFI (0.992) are shown over 0.9, Q (1.376) is below 2.0 and the coefficient of RMSEA (0.043) is shown below 0.08. Therefore, the goodness of fit of the model is acceptable (according to Baumgater and Homburg, 1996; Hu and Bentler, 1999; Segars and Grover, 1993).

In the model, a sub variable of environmental uncertainty is deleted, which is hostility because it has a problem in item-total correlation. As a result, environmental uncertainty has three sub-variables:

munificence, dynamism and heterogeneity. The first has three items, the second has three items and the third has three items. This means that ENV 10 is deleted because it has a problem in item-total correlation. Supply chain collaboration has three sub-variables: customer collaboration, supplier collaboration and internal collaboration. The first has five items, the second has five items and the third has also five items. In addition, operational performance has two sub-variables: service performance and cost performance. The former has five items and the latter has five items. Therefore, there are three variables in the model and environmental uncertainty has three sub-variables, supply chain collaboration has three sub-variables and operational performance has two sub-variables. The result can be shown as follows.

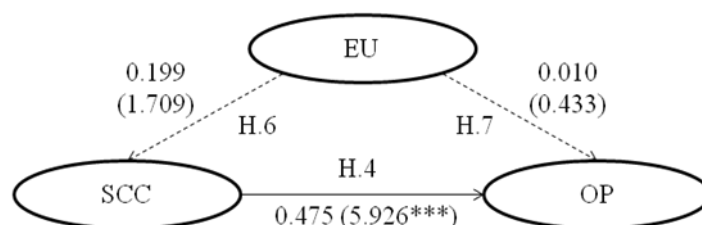
Table 6-5 The result of a causal link among the variables

Hypotheses	Path	Estimate	S.E.	C.R.	P	Results
H.4	SCC→OP	0.475	0.080	5.921	0.000	supported
H.6	EU→SCC	0.199	0.111	1.769	0.072	rejected
H.7	EU→OP	0.010	0.024	0.433	0.655	rejected

Notes) EU: environmental uncertainty; SCC: supply chain collaboration; OP: operational performance.

As shown in Table 6-5, supply chain collaboration has a positive effect on operational performance but the effects of environmental uncertainty on supply chain collaboration and operational performance are not supported (The criterion is over 0.05). This means that environmental uncertainty is not an antecedent of supply chain collaboration and operational performance.

Figure 6-4 The result of path diagram among the variables



Notes) EU: environmental uncertainty; SCC: supply chain collaboration; OP: operational performance; The dot line means that the hypothesis is rejected; *** $p < 0.01$.

According to Figure 6-4, the relationship between supply chain collaboration and operational performance is positive. When supply chain collaboration is increased in 1.000, operational performance is also increased in 0.457 which is the estimate. In addition, the critical ratio between supply chain collaboration and operational performance is 5.926 and this means that the causal relationship is significant in 1%. Therefore, supply chain collaboration has a positive influence on operational performance (H.4 supported).

The relationship between environmental uncertainty and supply chain collaboration is not significant (H. 6 rejected). Prior research has found the same result (Iyer, 2011). Moreover, environmental uncertainty has no effect on operational performance (H.7 rejected). Prior research has found the same result (Babakus et al., 2006; Wood, 2008). This means that environmental uncertainty has no direct effect on supply chain collaboration and operational performance.

6.4 The moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance

The moderating effect of environmental uncertainty is tested by SEM. The process is as follows. Environmental uncertainty is divided into two groups (the criterion: an average): one is a low group and the other is a high group in environmental uncertainty. An average of environmental uncertainty is used as the criterion. Next step is that the causal link of supply chain collaboration and operational performance is tested in the two groups. Finally, the results are compared with each other. If there are gaps between the models, there is a moderating effect of environmental uncertainty. The result is as follows in Table 6-6.

Table 6-6 The descriptive statistics of environmental uncertainty

Variable	N	The smallest	The largest	Average	Standard
EU	208	2.14	6.29	4.7524	0.83121

Notes) EU: environmental uncertainty, The smallest: The smallest number, The largest: The largest number, Standard: standard deviation

Environmental uncertainty has 208 in the number of the sample. The smallest number in the variable is 2.14 and the largest is 6.29. In addition, the average of the variable is 4.752 and standard deviation is 0.831. Next is the number of the sample firms in each group.

Table 6-7 The number of the sample firms in each group (average: 4.752)

Low group		High group	
Average	n	Average	n
1.00 - 3.00	11	4.76 - 5.00	35
3.01 - 4.00	22	5.01 - 5.50	53
4.01 - 4.50	32	5.51 - 6.00	21
4.51 - 4.75	26	6.01 - 7.00	8
Total	117	Total	91

As shown in Table 6-7, there are two groups in environmental uncertainty: one is a low group and the other is a high group. The average of the variable is 4.752. The low group has 117 data which is included between 1.00 and 4.75 and the high group has 91 data which is included between 4.76 and 7.00. As a result, the sample is divided into two groups in environmental uncertainty. Next is the result of the moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance.

Table 6-8 Goodness of fit of the moderating effect of environmental uncertainty

Model	Chi	df	P	Q	GFI	AGFI	CFI	NFI	IFI	RMSEA
original	23.185	8	0.003	2.898	0.960	0.850	0.966	0.951	0.967	0.096

As shown in Table 6-7, the result is not good because P value is significant and Q, AGFI and RMSEA are not good in the criteria. However, the other indices are good. Next are the results of

analysing the causal links between supply chain collaboration and operational performance in the two groups.

Table 6-9 The result of the low group of environmental uncertainty

Hypothesis	Path	Estimate	S.E.	C.R.	P	Result	Standard estimate
H.5	SCC→OP	0.460	0.147	3.118	0.002	supported	0.614

Notes) SCC: supply chain collaboration, OP: operational performance

As shown in Table 6-8, the result of environmental uncertainty on the relationship between supply chain collaboration and operational performance in a low group is supported. Estimate is 0.460 and this means that if supply chain collaboration is increased 1.0, operational performance also goes up 0.460. Estimate divided by standard error is critical ratio and if it is over 1.96, this means that the relationship is significant in 5%. Therefore, the critical ratio is 3.118 and it is significant in 1% because P value is 0.002.

Table 6-10 The result of the high group of environmental uncertainty

Hypothesis	Path	Estimate	S.E.	C.R.	P	Result	Standard estimate
H.5	SCC→OP	0.558	0.125	4.459	0.002	supported	0.751

Notes) SCC: supply chain collaboration, OP: operational performance

As shown in Table 6-9, the result of environmental uncertainty on the relationship between supply chain collaboration and operational performance in a high group is supported. Estimate is 0.558 and this means that if supply chain collaboration is increased 1.0, operational performance also goes up 0.558. In addition, standard error is 0.125 and this is connected with critical ratio which is 4.459. It is significant in 1% because P value is 0.000.

There are different regression weights between the high group and the low group. The high group has 0.558 and the low group has 0.460 in the estimates. In addition, standard regression weights between the two groups are different. The high group has 0.751 but the low group has 0.614.

Moreover, the hypotheses are significant in both of the two groups. This means that the relationship between supply chain collaboration and operational performance in the high group is stronger than the relationship between in the low group.

Table 6-11 The fit of a multiple group analysis model

Model	NPAR	Chi-square	df	P	Q
Unconstrained	22	23.185	8	0.003	2.898
Measurement weights	19	26.049	11	0.006	2.368
Structural weights	18	27.028	12	0.008	2.252
Structural covariances	13	32.046	17	0.015	1.885
Measurement residuals	22	23.185	8	0.003	2.898
Saturated residuals	30	0.000	-	-	-
Independence model	10	471.171	20	0.000	23.559

Table 6-11 shows the fit of a multiple group analysis model. To verify model fit of regression weights, a gap in chi-square between a model of a structural weights and an unconstrained model should be compared. As a result, chi-square is 23.185 and df is 8 in the former and chi-square is 27.028 and df is 12 in the latter. In this regard, the gap in chi-square is 3.843 (structural weights minus unconstrained). The gap in degree of freedom is 4 (structural weights minus unconstrained).

Table 6-12 Assuming model unconstrained corrected

Model	df	Chi-square	P	NFI Delta-1	IFI Delta-2	RFI Rho-1	TLI Rho-2
Measurement weight	3	2.864	0.413	0.006	0.006	-0.022	-0.023
Structural weight	4	3.843	0.428	0.008	0.008	-0.027	-0.029
Structural covariance	9	8.862	0.450	0.019	0.019	-0.043	-0.045

The hypothesis is as follows.

H₀: The model of regression weight each group is fits with the criterion.

H_A: The model of regression weight each group does not fit with the criterion.

As shown in Table 6-12, P value is 0.428 in a structural weight and this means that a null hypothesis is supported. This can be explained as follows. The model of regression weight each group is fitted. Therefore, environmental uncertainty moderates the relationship between supply chain collaboration and operational performance (H.5 supported).

To sum up, there are two models: one is a moderating effect of environmental uncertainty and the other is an antecedent of environmental uncertainty on supply chain collaboration and operational performance. The former is supported (Table 6-11) but the latter is not supported (Table 6-5). This means that the role of environmental uncertainty is the moderating variable on the relationship between supply chain collaboration and operational performance.

6.5 Summary

This chapter shows the results of testing the hypotheses. The results are summarized in Table 6-13 as follows.

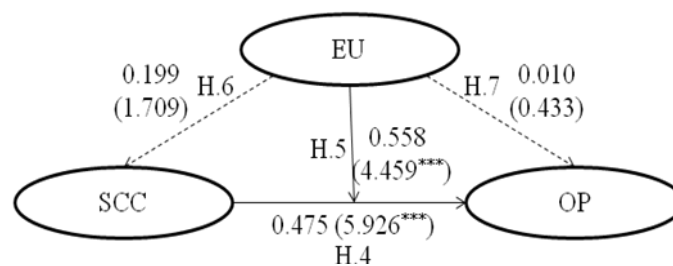
Table 6-13 The result of the empirical tests

H.	Contents	Results
1	Supply chain collaboration is composed of customer collaboration, supplier collaboration and internal collaboration.	supported
2	Operational performance is composed of cost performance and service performance.	supported
3	Environmental uncertainty is composed of munificence, dynamism, heterogeneity and hostility.	partially supported
4	Supply chain collaboration has a positive influence on operational performance.	supported
5	Environmental uncertainty moderates the relationship between supply chain collaboration and operational performance.	supported
6	Environmental uncertainty has a positive influence on supply chain collaboration.	rejected
7	Environmental uncertainty has a negative effect on operation performance.	rejected

As shown in Table 6-13, H.1 and H.2 are supported but H.3 is partially supported. This means that supply chain collaboration and operational performance are not problems but environmental uncertainty is unclear. However, environmental uncertainty such as munificence, dynamism and

heterogeneity are not problems (see Table 5-24, Table 5-25 and Table 5-26). This means that sub-variables of environmental uncertainty such as munificence, dynamism and heterogeneity are not problems when used in the analytical model. The causal link between supply chain collaboration and operational performance is verified and this means that H.4 is supported. Moreover, the moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance is ascertained and this means that H.5 is supported. However, the relationship between environmental uncertainty and supply chain collaboration and the relationship between environmental uncertainty and operational performance are not verified and this means that H.6 and H.7 are not supported. This is shown as follows in Figure 6-5.

Figure 6-5 The result of path diagram



Notes) EU: environmental uncertainty; SCC: supply chain collaboration; OP: operational performance; The numbers of parentheses are C.R. and the dot lines mean that the hypotheses are rejected; ***: $p < 0.01$.

The result can be interpreted as follows. The role of environmental uncertainty is a moderator between supply chain collaboration and operational performance because the moderating effect of environmental uncertainty is supported but environmental uncertainty as the antecedent of supply chain collaboration and operational performance is rejected. Next is discussion of the results.

Chapter VII Discussion of the Results

7.1 Introduction

The objectives of this research are to develop measurement scales for environmental uncertainty, supply chain collaboration and operational performance and to test the roles of environmental uncertainty on the relationship between supply chain collaboration and operational performance. Many researchers have already verified the relationship between supply chain collaboration and performance but this research has differentiation with prior research. First, this research focuses on the second order constructs of environmental uncertainty, supply chain collaboration and operational performance. Second, this research develops measurement scales of the variables for Korean manufacturing firms in China. Third, this research focuses on estimates and purification of the variables. Fourth, this research proves the role of environmental uncertainty on the relationship between supply chain collaboration and operational performance; which is, whether it is a moderator between supply chain collaboration and operational performance or an antecedent of supply chain collaboration and operational performance. The results of this research are interpreted in two viewpoints: 1) the reconfirmation of the results suggested by prior research and 2) the finding of new results. As a result, theory and knowledge can be developed and verified. Discussion of the results is performed in sequence as follows.

There are two research objectives of this research. First, this research verifies confirmatory factor analysis of the variables and, secondly, this research tests the roles of environmental uncertainty on the relationship between supply chain collaboration and operational performance which are a moderator and/or an antecedent. The results of the empirical tests are shown in chapter VI and the discussion of the results is divided into five sections: 1) confirmatory factor analysis of the variables (H.1, H. 2 and H.3), 2) the causal link between supply chain collaboration and operational

performance (H.4), 3) the moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance (H.5), 4) the causal link between environmental uncertainty and supply chain collaboration (H.6) and 5) the causal link between environmental uncertainty and operational performance (H.7). In addition, theoretical implications and managerial implications of the discussion follow later in this chapter.

7.2 Confirmatory factor analysis of environmental uncertainty, supply chain collaboration and operational performance

7.2.1 Confirmatory factor analysis of supply chain collaboration (H.1)

Supply chain collaboration is composed of three sub-variables such as customer collaboration, supplier collaboration and internal collaboration. Some researchers have approached it in the same method (Boon-itt and Wong, 2011a, b; Flynn et al., 2010; Frohlich and Westbrook, 2001; Kannan and Tan, 2010; Lee et al., 2007; Stank et al. 2001/2002; Wong et al., 2011) and, other researchers have divided it into the different methods. The latter are various. For example, there are several classifications such as internal collaboration and external collaboration (Braunscheidel and Suresh, 2009; Chen et al., 2009; Droge et al., 2004; Germain and Iyer, 2006; Gimenez, 2006; Gimenez and Ventura, 2005; Green et al., 2012; Morash and Clinton, 1998; Narasimhan and Kim, 2002; Stank et al., 2001) and supply chain collaboration as a whole (Aryee et al., 2008; Fynes et al., 2004; Ghobakhioo et al., 2011; McCarthy-Byrne and Mentzer, 2011; Mollenkopf et al., 2000; Rai et al., 2006; Rajaguru and Matanda, 2009; Richey et al., 2009; Rosenzweig et al., 2003; Saeed et al., 2011; Salam, 2011; Sezen, 2008). However, the widest classification of supply chain collaboration is customer collaboration, supplier collaboration and internal collaboration. Hence, why this research chose to base the investigation into supply chain collaboration on these three variables..

According to the result of the analysis, customer collaboration, supplier collaboration and internal collaboration are the main underlying dimensions for supply chain collaboration. Prior research has found that supply chain collaboration has various sub-dimensions but, in this research, it has three sub-dimensions as mentioned above. Moreover, comparing, on the basis of the influence of each sub-variable in supply chain collaboration, supplier collaboration is more explanatory than customer collaboration in this research because customer collaboration explains 55.1% of supply chain collaboration and supplier collaboration explains 79.6% of supply chain collaboration. From this viewpoint, supply chain collaboration is divided into three sub-dimensions and this is better than the other classification because it can cover a whole concept of supply chain collaboration. As a result, supply chain collaboration consists of three sub-variables: customer collaboration, supplier collaboration and internal collaboration.

7.2.2 Confirmatory factor analysis of operational performance (H.2)

Performance can be approached from various viewpoints. The most important aspect of performance is to understand internal and external viewpoints simultaneously. In addition, it should include non-financial aspects as well as financial aspects. The former is connected with an external viewpoint and the latter is connected with an internal viewpoint. Some researchers have insisted that performance can be measured by financial performance (Droge et al., 2004; Germain and Iyer, 2006; Kim, 2006; Rajaguru and Matanda, 2009; Saeed et al., 2011) and others have insisted that it can be measured by cost and service (Lee et al., 2007; Morash and Clinton, 1998; Schoenherr and Swink, 2012). Moreover, some researchers have insisted that cost and service is antecedents of financial performance (O'Leary-Kelly and Flores, 2002; Rajaguru and Matanda, 2009; Rosenzweig et al., 2003). This viewpoint is concerned with dimensions of performance. Cost and service are treated with a business unit dimension but financial performance is treated with a corporate dimension. From this

viewpoint, cost and service are regarded as antecedents of financial performance. However, this research uses cost performance and service performance because the former is connected with financial and internal aspects and the latter is concerned with non-financial and external aspects.

According to the result of the analysis, operational performance is not analysed because it has two sub-variables such as cost performance and service performance. If there are two items in confirmatory factor analysis, the result has less meaning. The reason is that a correlation coefficient between two items has negligible meaning. In addition, if there are three items in confirmatory factor analysis, goodness of fit in the result of confirmatory factor analysis has provides little meaning. However, the result of the analysis of three variables is significant because correlation coefficients between the variables are strong. Unfortunately, operational performance has two sub-variables and, as a result, the result has no meaning. For this reason, this research substitutes the results of confirmatory factor analysis of each sub-variables of operational performance. As shown in Table 5-36 and Table 5-37, the results show no problems. This means that items of cost performance and service performance reflect operational performance. Performance coming from prior research has various dimensions but, in this research, it has two sub-dimensions such as cost performance concerned with financial and internal aspects and service performance concerned with non-financial and external aspects. This reflects an operational viewpoint of firms and the viewpoint is comprehensively treated in measuring performance. Therefore, operational performance is composed of cost performance and service performance.

7.2.3 Confirmatory factor analysis of environmental uncertainty (H.3)

The environment is approached in various aspects. Prior research has defined it as overall factors to have potentially and substantially an influence on organisations and these are beyond the control of firms (Porter, 1980). Researchers have divided the environment into three aspects: one is the task

environment and the general environment (Buchko, 1994; Damanpour, 1996; Dess and Beard, 1984; Freel, 2005; Lumpkin and Gregory, 2001; Milliken, 1987), another is simplicity and complexity (McGinnis and Kohn, 1993), and the third is the external environment and the internal environment (Newkirk and Lederer, 2007; Pawlraj and Chen, 2007b; Wood, 2008). Furthermore, it is classified into various sub-dimensions. For example, many researchers have defined the environment as uncertainty (Chow et al., 1995; Fynes et al., 2004; Lee et al., 2007; Lio and Tu, 2008; McGinnis and Kohn, 1993; Wong et al. 2011) and the environment uncertainty is divided into munificence, dynamism, heterogeneity and hostility (Dess and Beard, 1984; Miller and Friesen, 1978; McGinnis and Kohn, 1993). Similarly, some researchers have defined the environment as perceived environmental uncertainty (Babakus et al., 2006; Jokipii, 2010; Pagell and Krause, 2004; Prado, 2006). The two viewpoints on the environment are quite similar. Furthermore, other researchers have defined the environment as environmental turbulence (Iyer, 2011). These kinds of classifications can be explained as the effect of the external environment on firms and this is connected with the definition of environmental uncertainty used in this research. From this viewpoint, environmental uncertainty is used by many researchers and they divided the environment into munificence, dynamism, heterogeneity and hostility. This research uses this last classification when dealing with the environment.

According to the result of the analysis, munificence, dynamism and heterogeneity as environmental uncertainty are partially supported. Prior research has approached environmental uncertainty with various methods. Some researchers have used perceived environmental uncertainty and this is equal to the concept of environmental uncertainty in this research. In addition, prior research has also classified environmental uncertainty into various sub-variables. In particular, it is divided into munificence, dynamism, heterogeneity and hostility (McGinnis and Kohn, 1993) and this is the same as the sub-variables of environmental uncertainty in this research. However, the result shows that hostility is removed because of its lack of support in the statistic results. As a result, environmental

uncertainty has three sub-variables in this research as above. In addition, confirmatory factor analysis of the sub-variables of environmental uncertainty is good. According to Table 5-24, Table 5-25 and Table 5-26, there are no problems in the results of confirmatory factor analysis. As a result, the hypothesis, that environmental uncertainty is composed of munificence, dynamism and heterogeneity, is partially supported but there are no problems to use the sub-variables.

7.3 The causal link between supply chain collaboration and operational performance (H.4)

According to the result in H.4, supply chain collaboration has a positive influence on operational performance (H.4 supported). This can be explained as follows. The relationship between supply chain collaboration and operational performance can be explained from two viewpoints: one is to verify how firms which achieve a high level of supply chain collaboration improve their operational performance and the other is to ascertain the effect of supply chain collaboration on operational performance.

First of all, performance improvement of firms which achieve a high level of supply chain collaboration is explained as follows. Firms would achieve a high level of supply chain collaboration when they focus on inter-functional collaboration from the internal viewpoint as well as collaboration with suppliers and customers from the external viewpoint. Sharing information and resources and standardization make possible supply chain collaboration. The feature of these firms is that they have a high level of SCM capability and, as a result, the whole production process is efficiently managed. This means that firms enjoy high operational performance such as cost performance and service performance through achieving efficiency among functions in internal processes and effectiveness with suppliers and customers in external processes.

The above perspective is based on the perspective of prior research concerned with the development stages of supply chain collaboration (Narasimhan and Kim, 2001; Stevens, 1989). Prior

research has insisted that supply chain collaboration is started from inter-functional collaboration and develops to external collaboration by way of internal collaboration (Chow et al., 1995; Daugherty et al., 1996; Fawcett and Magnan, 2002; Gustin et al., 1995; Narasimhan and Kim, 2001; Vargas et al., 2000; Stevens, 1989). The perspective of this research is that firms can choose their strategy like achieving a high level of supply chain collaboration and this is a similar perspective with Flynn et al. (2010), Frohlich and Westbrook (2001), Gimenez (2006), Schoenherr and Swink (2012), Stock et al. (2000) and Thun (2010). On the basis of strategic choice theory, firms can choose strategy on the basis of managers' recognition of the environment. Firms which recognize high environmental uncertainty choose an external-oriented strategy like external collaboration to acquire information and to find opportunities in the external environment and this is the basis of performance improvement. Whereas firms which recognize environmental stability focus on an internal-orientated strategy like internal collaboration because they cannot find opportunities in the market caused by stability of the static environment and this is the basis of efficiency improvement (Bae, 2011).

The efficiency of internal processes is the basis of promoting connection with external processes and information generated from exterior is the basis of a variance of internal processes. This viewpoint can be explained by information processing theory. According to Flynn et al (2010), suppliers and customers are treated as environmental factors. Firms acquire information through interaction with suppliers and customers as the external environment and they build efficient internal processes with the information. From this viewpoint, the role of managers is to mediate the relationship between external information and internal processes. From the viewpoint of information processing theory, managers learn external information and, consequently, external information is disseminated to the internal processes. The organisational behaviour is the basis of constructing efficient internal processes and efficient internal processes constructed by this method are also the basis of better connecting suppliers and customers. Therefore, internal collaboration is the basis of external collaboration (Branuscheidel and Suresh, 2009; Chen et al., 2009; Gimenez, 2006;

Schoenherr and Swink, 2012) and external collaboration is also the basis of internal collaboration (Bae, 2012a; Gimenez and Ventura, 2008; Salvador et al., 2001; Stank et al., 2001). This is focused on the role of managers for improvement of internal processes through external information. Therefore, managers can choose internal collaboration and/or external collaboration on the basis of their recognition of the environment and, as a result, performance among firms can be different.

To sum up, prior research has ascertained performance implications from the viewpoint of a high level of supply chain collaboration (Daugherty et al., 1996; Narasimhna and Kim, 2001). In addition, a high level of supply chain collaboration is the basis of a high level of performance (Frohlich and Westbrook, 2001; Schoenherr and Swink, 2012). These results are equal to the result of this research. Moreover, this research creates new knowledge through verifying a causal link in the second order construct of supply chain collaboration and operational performance. This is connected with strategic choice theory and means that a high level of supply chain collaboration is connected with a high level of operational performance. This result can be explained by strategic choice theory. This means that managers should decide strategy through analysing the environment and resources. Through such an analytical approach, the strategic decision making of managers will be the basis for an improvement in performance.

7.4 The roles of environmental uncertainty on the relationship between supply chain collaboration and operational performance (H.5, H.6 and H.7)

In this section, the roles of environmental uncertainty on the relationship between supply chain collaboration and operational performance are the main focus. There are three hypotheses: the first is the moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance (H.5), the second is the positive effect of environmental uncertainty on supply chain collaboration (H.6), and the third is the negative effect of environmental

uncertainty on operational performance (H.7). According to the results of this research, the role of environmental uncertainty is verified as a moderator on the relationship between supply chain collaboration and operational performance (fit as moderation by Venkatraman, 1989) but it has not the role of an antecedent of supply chain collaboration and operational performance. This is explained as follows.

First of all, environmental uncertainty moderates the relationship between supply chain collaboration and operational performance (H.5 supported). The relationship between environmental uncertainty and strategy can be explained by contingency theory. This means that the external environment has a positive effect on strategy and, consequently, performance is improved. As shown in the result of the analysis, the result of this research shows that standard estimate (regression weight) of the relationship between supply chain collaboration and operational performance of firms which recognize high environmental uncertainty is higher than standard estimate (regression weight) of the relationship between supply chain collaboration and operational performance of firms which recognize low environmental uncertainty. This means that differences in recognition of environmental uncertainty between two clusters enhance the relationship between supply chain collaboration and operational performance. The similar results concerned with the moderating effect of environmental uncertainty on the relationship between strategy and performance are shown in prior research (Fynes et al., 2004; Narasimhan and Kim, 2002; Liao and Tu, 2008; O'Leary-Kelly and Flores, 2002). From the viewpoint of the moderating effect of environmental uncertainty on the relationship between internal collaboration and performance, manufacturing system integration has a positive effect on manufacturing performance on the basis of high environmental uncertainty (Liao and Tu, 2008). This means that if there is high environmental uncertainty, firms improve performance through collaboration between departments. Moreover, the interaction between marketing/sales planning integration and demand uncertainty has a positive effect on perceived profitability (O'Leary-Kelly and Flores, 2002). In other words, demand uncertainty moderates the relationship between internal

integration and performance. Similarly, from the viewpoint of the moderating effect of environmental uncertainty on the relationship between external collaboration and performance, demand uncertainty and supply uncertainty moderate the relationship between supply chain relationship quality and supply chain performance (Fynes et al., 2004). This means that the relationship with suppliers has a determinant role in managing the relationship with partners in environmental uncertainty. In addition, the interaction between supplier integration and international market diversification has a positive effect on performance such as sales growth, market share growth and profitability and the interaction between customer integration and international market diversification has a positive effect on performance (Narasimhan and Kim, 2002). The results are also explained as the facts that collaboration which does not consider environmental contexts can be the cause of problems because of gaps of collaborative behaviour or capability among partners (Rai et al., 2006) and that technological turbulence has a positive effect on demand chain collaboration (Iyer, 2011).

Prior research shows the same results with the result of this research (Dess, 1997; Fynes et al., 2004). If there is high uncertainty of supply and demand, firms try to increase correctness of forecasts in timing and quantities and, consequently, they enhance the relationship between supply chain partners. Firms have need of a high level of collaboration with supply chain partners on the basis of cooperation and interaction for achieving superior performance in environmental uncertainty. The collaboration minimizes the effect of environmental uncertainty on performance. The perspective is the same explanation with a corporate strategic variance following environmental uncertainty from the viewpoint of contingency theory. In addition, prior research has proved that the relationship between collaboration and service performance is enhanced by environmental uncertainty (Boon-itt and Wong, 2011a; Wong et al., 2011). These results are also explained as information processing theory. The environment is the root of information and managers' recognition of uncertainty is connected with enhancing supply chain collaboration, followed by high performance. Similarly with the above results, firms, which recognize high environmental uncertainty has a positive effect of

manufacturing system integration on manufacturing performance (Liao and Tu, 2008), achieve better performance. These results can be interpreted in the same viewpoint with the result of this research. Firms, which recognize the difficulty of prediction and high competition in the market, show the high positive relationship between collaboration and performance and this can be explained from the viewpoint of contingency theory and information processing theory. Therefore, this research ascertains that environmental uncertainty moderates the relationship between supply chain collaboration and operational performance.

The result of this research shows that environmental uncertainty is not an antecedent of supply chain collaboration and operational performance. This means that environmental uncertainty has not a direct effect on supply chain collaboration and operational performance in Korean manufacturing firms in China. This can be explained as follows.

According to the result, the hypothesis concerned with the positive influence of environmental uncertainty on supply chain collaboration is rejected (H.6 not supported). The result is similar with the results of prior research. Paulraj and Chen (2007b) have verified that demand uncertainty has no influence on strategic supply relationship. They treated the reason with the difficulty of management to deal with the demand uncertainty. Generally, supply uncertainty or technology uncertainty can be managed by vertical integration or innovation but demand uncertainty is not easy to manage (Paulraj and Chen, 2007b). In this regard, they found that demand uncertainty has no effect on strategic supply relationship. The viewpoint is concerned with difficulty of forecasts on the market. Demand uncertainty reflects the difficulty of cognition on requirement of customers in the market. This difficulty carries the same meaning as the difficulty of prediction on a market variance. This uncertainty is not easy to manage and, as a result, this is the basis of no direct effect of the uncertainty on supply chain collaboration.

In this research, the effect of environmental uncertainty on supply chain collaboration is rejected. This means that Korean manufacturing firms have difficulty learning to predict a market variance in

China because of environmental uncertainty. The difficulty of management on uncertainty is the basis of no effect of environmental uncertainty on supply chain collaboration. In addition, prior research has verified that environmental uncertainty has no effect on performing firms' strategy (Babakus et al., 2006; Dess et al., 1997; Fink et al., 2008; Paulraj and Chen, 2007b; Wood, 2008). These results give justification to the result of this research. On the basis of the result of this research, this research ascertains that environmental uncertainty is a moderator on the relationship between collaboration and performance rather than an antecedent of supply chain collaboration. In other words, this research verifies that environmental uncertainty is a moderator to enhance the relationship between collaboration and performance, which is fit as moderation (Venkatraman, 1989). This fit is a new finding on the effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance.

In addition, the negative relationship between environmental uncertainty and operational performance is not significant (H.7 not supported). Lawrence and Lorsch (1967) have insisted that the environment exists out of firms and it is one of important factors which affect operations of firms. In this regard, environmental uncertainty is the cause of a lack of information when managers make strategic decisions and this behaviour is connected with inferior performance. From this viewpoint, contingency theory explains that a negative relationship between environmental uncertainty and performance is mediated by strategy and, as a result, the direct, negative relationship between environmental uncertainty and performance is changed as the indirect, positive relationship through mediating strategy such as supply chain collaboration. In addition, information processing theory also explains the relationship between environmental uncertainty and performance. This theory suggests the role of managers on the relationship between the environment and performance. Managers need to acquire information from the external environment because the variance of the environment is the basis of the variance of firms. This kind of information is disseminated to internal firms and, as a result, performance is improved. This is also the same viewpoint with contingency theory because the

intervention of managers is the same as strategic behaviour of firms and it mediates the relationship between environmental uncertainty and performance. Similarly, strategic choice theory also explains the relationship between environmental uncertainty and performance. Firms need to respond to the uncertain environment and, as a result, managers have need of strategic decision making, followed by high performance. The strategic decision making is also regarded as a mediator on the relationship between environmental uncertainty and performance. From this viewpoint, strategy mediates the relationship between environmental uncertainty and performance. However, the direct relationship between environmental uncertainty and performance has the negative effect because environmental uncertainty is the basis of lack of information and this is the cause of inferior performance. In this research, environmental uncertainty recognized by Korean manufacturing firms in China has not had a direct effect on operational performance. Some prior research has found the same result with this research (Babakus et al., 2006; Dess et al., 1997) in spite of the negative effect of environmental uncertainty on performance from the other prior research (Wood, 2008). This result explains that the relationship between environmental uncertainty and performance is not definite. Therefore, this is one of future research directions; that is, researchers need to verify the direct effect of environmental uncertainty on performance.

To sum up, Korean manufacturing firms in China enhance the relationship between supply chain collaboration and operational performance under high environmental uncertainty. However, they did not find the direct effect of environmental uncertainty on supply chain collaboration and operational performance. This is concerned with the speed of environmental variance in China. The speed is fast and the firms have not followed the variance and disseminated to other departments or partners. That is why there is no effect of environmental uncertainty on collaboration and performance. In comparison, the moderating effect of environmental uncertainty is the same as the results of prior research (O'Leary-Kelly and Flores, 2002; Liao and Tu, 2008). Korean manufacturing firms in China, in high environmental uncertainty, remove overlaps and inefficiency that existed in firms through

supply chain collaboration, followed by high operational performance. In addition, if there are high competition and difficulty of prediction in the market, the firms achieve standardization and resource sharing through collaboration with suppliers and customers, followed by high operational performance. The moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance can be explained by contingency theory and this is the same viewpoint with the result shown in prior research. Moreover, environmental uncertainty is divided into munificence, dynamism and heterogeneity and this is a new approach to the moderating effect of environmental uncertainty.

In addition, Korean manufacturing firms in China, in difficulty of prediction and high competition in the market, collaborate with customers so they can gather market information and respond to customer needs. The information and the needs are shared with departments in internal aspects for achieving their goals and, in addition, collaboration with suppliers is the basis of structuring superior performance. In this regard, collaboration with suppliers and departments as well as customers is the key factor to achieve operational performance following difficulty of prediction and high competition in the market and this is explained by contingency theory and information processing theory. This is the same viewpoint as in prior research.

7.5 Theoretical implications

7.5.1 The theoretical implication of the positive effect of supply chain collaboration on operational performance

This research verified the positive effect of supply chain collaboration on operational performance. This finding suggests the power of information processing theory and strategic choice theory in explaining the performance implications of supply chain collaboration. Korean manufacturing firms

in China need to increase supply chain collaboration on the basis of recognition of how paying attention to the environment is often followed by performance improvement. In addition, prior research has ascertained that firms achieve a high level of performance if they attain a high level of supply chain collaboration (Daugherty et al., 1996; Flynn et al., 2010; Frohlich and Westbrook, 2001; Gustin et al., 1995; Kannan and Tan, 2010; Kim, 2006). The results of prior research have explained the relationship between supply chain collaboration and performance. On the other hand, this research shows advanced results compared with the result of prior research. For instance, the result of this research ascertains the positive effect of supply chain collaboration on operational performance and suggests to managers the importance of information processing and strategic choice for performance improvement. This result provides a new insight to the research of supply chain collaboration.

The result of the positive effect of supply chain collaboration on operational performance leads to four novel aspects. The first, the result of the analysis shows that there is the positive effect of supply chain collaboration on operational performance. This means that this research verifies a link between the variables in the second order construct. The second, from the viewpoint of strategic choice theory, supply chain collaboration is one of strategies which managers can choose for improving performance. Third, a new finding from this research implies that there is a positive effect of supply chain collaboration on operational performance from the viewpoint of Korean manufacturing firms in China. Fourth, from the viewpoint of information processing theory, firms can achieve high performance through supply chain collaboration. This means that they need to gather information from the environment and to apply it to an internal aspect (Flynn et al., 2010). The novel aspects have an influence on the firms which would improve operational performance from the viewpoints of information processing theory and strategic choice theory. The result shows the positive relationship between supply chain collaboration and operational performance and, in addition, the result explains the importance of internal and external collaboration in supply chains. The novel aspects provide managers with the need for supply chain collaboration and the method for performance improvement.

This can be explained by information processing theory and strategic choice theory.

7.5.2 The theoretical implication of the role of environmental uncertainty on supply chain collaboration and operational performance

Korean manufacturing firms in China enhance operational performance through supply chain collaboration to respond to high environmental uncertainty. Environmental uncertainty is the cause that firms collaborate with suppliers and customers for acquiring information in the market from the viewpoint of contingency theory. In addition, firms share the acquired information with all departments to minimize the effect of environmental uncertainty on performance. This viewpoint can be explained as information processing theory. Under the environmental uncertainty, firms can achieve superior performance through supply chain collaboration. On the basis of these theoretical backgrounds, the moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance is ascertained by prior research (Boon-itt and Wong, 2011a; Dess, 1997; Fynes et al., 2004; Liao and Tu, 2008; Wong et al, 2011). However, the dimension of uncertainty shown in prior research is different with this research. Prior research treated uncertainty as demand uncertainty (O'Leary-Kelly and Flores, 2002) or technology turbulence (Iyer, 2011) and, this is different with environmental uncertainty such as munificence, dynamism and heterogeneity shown in this research. In this regard, this research has differentiation with prior research and the moderating effect of environmental uncertainty proved by this research produced new data. There are two new findings. The first, environmental uncertainty is the cause of enhancing the relationship between supply chain collaboration and operational performance (Dess et al., 1997; Liao and Tu, 2008). The second, the moderating effect of environmental uncertainty from the viewpoint of Korean manufacturing firms in China is verified and this is a new finding. This is explained by contingency theory and information processing theory.

The relationships between environmental uncertainty, supply chain collaboration and operational performance can be explained by contingency theory. The theory is focused on finding efficient managing methods of firms to consider the external environment. This explains the relationships between the environment, strategy and performance. In other words, the theory explains that firms can enhance performance through fit between the environment and organisation. This explanation means that environmental uncertainty and external-oriented strategy is connected with high service performance, whereas environmental stability and internal-oriented strategy is connected with high cost performance (Bae, 2011). In addition, the environment exists in exterior of firms and it has an effect on firms. From this viewpoint, the environment has a negative influence on performance because of a lack of information when managers make a decision and, as a result, managers make an effort to minimize the influence on performance. The theory also emphasizes the role of the environment which is a moderator or an antecedent on the relationship between strategy and performance from the viewpoint of fit (Venkatraman, 1989). From this viewpoint, supply chain collaboration can be approached as the strategic viewpoint of firms. Firms can respond to environmental variance through enhancing the levels of collaboration with suppliers and customers to overcome environmental uncertainty, followed by high performance. In addition, firms achieve process efficiency through increasing collaboration between departments and, consequently, they can minimize the negative effect of the environment on performance. This perspective is equal to the perspective of this research. From the viewpoint of contingency theory, firms collaborate with suppliers and customers for sharing and acquiring information in the market following environmental uncertainty. The information acquired by the collaboration is disseminated to internal firms through learning of managers. The most important factor of information dissemination is collaboration between departments. Collaboration between departments is the cause of absorption of external information on internal processes of firms through communication and information exchange. In this regard, information processing theory is the theoretical background on internal dissemination of

external information, which is connected with high performance. Prior research have supported the positive relationship between environmental uncertainty, supply chain collaboration and operational performance explained by contingency theory and information processing theory (Agbejule and Burrowes, 2007; Boon-itt and Paul, 2006; Boon-itt and Wong, 2011a; Coelho and Easingwood, 2005; Fink et al., 2008; Fynes et al., 2004; Iyer, 2011; Liao and Tu, 2008; Paulraj and Chen, 2007b; Ria et al., 2006; Ryu et al., 2008; Wong et al., 2011).

The result of this research has two differences compared with the results of prior research. The first, prior research has verified the positive relationship between the environment and strategy (Agbejule and Burrowes, 2007; Boon-itt and Paul, 2006; Coelho and Easingwood, 2005). However, this research verifies no causal links between environmental uncertainty and supply chain collaboration and environmental uncertainty and operational performance. The result is the same as the results of some of prior research (Ryu et al., 2008; Wood, 2008). This can be explained by fast environmental variance in China. Korean manufacturing firms can feel environmental variance but the speed is fast. From this viewpoint, the direct effect of environmental uncertainty on supply chain collaboration and operational performance is insignificant but it moderates the relationship between supply chain collaboration and operational performance. In addition, there is another reason why the hypotheses are rejected. According to descriptive statistics (Table 5-3), 128 firms (61.6%) in the sample firms have invested in China after 2001. This means that the firms do not have enough time to understand the Chinese the market environment and this is one of reasons why the hypotheses are rejected. The second, prior research has treated the role of the environment on the relationship between strategy and performance as a moderator or an antecedent (Venkatraman, 1989) but the result of this research supports the claim that environmental uncertainty is a moderator on the relationship between supply chain collaboration and operational performance. This is regarded as a new insight. Moreover, there are three findings. The first, this research ascertains the moderating effect of environmental uncertainty. This is based on the fact that the direct effects of environmental uncertainty on supply

chain collaboration and operational performance are rejected. Second, the role of environmental uncertainty between supply chain collaboration and operational performance is a moderator and this is explained by the fact it is a fit as moderation as stated by Venkatraman (1989). The third, environmental uncertainty as an antecedent of supply chain collaboration and operational performance from the viewpoint of Korean manufacturing firms in China is not verified and this is one of future research directions.

7.6 Managerial implications

7.6.1 The managerial implication of the positive effect of supply chain collaboration on operational performance

The results of this research provide various managerial implications. First, supply chain collaboration of Korean manufacturing firms in China is divided into four dimensions such as an independent operation of each function, internal collaboration, external collaboration and supply chain collaboration in this research. Firms can grasp their level of supply chain collaboration on the basis of these dimensions. In addition, the classification of supply chain collaboration is based on definite theoretical backgrounds and, consequently, the classification has an advantage to cover all firms as well as simplification. Different levels of supply chain collaboration are compared with the classifications of Frohlich and Westbrook (2001), Flynn et al. (2010) and Schoenherr and Swink (2012). An independent operation of each function is similar to low uniform pattern of Flynn et al. (2010) and inward-facing pattern of Frohlich and Westbrook (2001) and Schoenherr and Swink (2012). Internal collaboration is similar to medium uniform pattern of Flynn et al. (2010) and periphery-facing pattern of Frohlich and Westbrook (2001) and Schoenherr and Swink (2012). External collaboration is similar to high customer leaning pattern of Flynn et al. (2010) and supplier-

facing and customer-facing patterns of Frohlich and Westbrook (2001) and Schoenherr and Swink (2012) but the classification of Flynn et al. (2010) did not consider supplier collaboration in their patterns. Supply chain collaboration is similar to high uniform pattern of Flynn et al. (2010) and outward-facing pattern of Frohlich and Westbrook (2001) and Schoenherr and Swink (2012). There is no similar level in this research such as medium customer leaning pattern of Flynn et al. (2010). However, differences among the classifications are clear. First, their viewpoints have the viewpoint of the development stages of supply chain collaboration from internal to external but the classification of this research has a strategic choice viewpoint at the present time. Second, their classifications have overlaps and omissions in the all levels of supply chain collaboration but the classification of this research has no overlaps and omissions because the levels have clear theoretical backgrounds. Although there are some differentiations, they have similar classifications concerned with supply chain collaboration. In addition, this kind of classification is the basis of testing performance improvement among different levels of supply chain collaboration. However, this research tested the causal relationship between supply chain collaboration and operational performance and this is the same with the viewpoint of performance improvement among the levels. That is why this research does not test the viewpoint.

Second, this research ascertained that supply chain collaboration has a positive effect on operational performance. Managers can grasp their collaboration and performance on the basis of the result on supply chain collaboration and operational performance shown in this research. The information is the basis of a strategic approach to the market by manufacturing firms in the future, such as internal-oriented, external-oriented or supply chain-oriented. The strategic approach is directly connected with performance improvement.

Third, managers can grasp their level of present supply chain collaboration on the basis of the above classification and ascertain improving methods of real performance. For instance, if firms are in a level of internal collaboration, they can increase operational performance through enhancing

supplier and customer collaboration. In addition, firms which are in a level of external collaboration can enjoy high operational performance when they focus on internal collaboration. The most important aspect of the viewpoint is to find a weak point of their level of present supply chain collaboration. If firms are in internal collaboration, managers should focus on external collaboration, followed by high performance. Similarly, if firms are in external collaboration, managers should focus on internal collaboration, followed by high performance. To achieve this, managers should generate recognition of staff on SCM and support the activity that innovation (like supply chain collaboration) takes established in internal firms through absorptive capability such as business process reengineering (BPR) and learning. From this viewpoint, supply chain collaboration has an effect on strategic choice of firms for performance improvement.

7.6.2 The managerial implications of the role of environmental uncertainty on supply chain collaboration and operational performance

The environment is recognized as the root of information. Managers should analyse the environment for formulating and performing strategy. The result of this research demonstrates that Korean manufacturing firms in China improve performance through supply chain collaboration in high environmental uncertainty. This means that they enhance performance through supply chain collaboration if there is high unpredictability on a market or outcomes. This result is the same as the results of prior research (Fynes et al., 2004; Boon-itt and Wong, 2011a). In this regard, if there is high environmental uncertainty, Korean manufacturing firms in China enhance a level of supply chain collaboration and, as a result, they can achieve a high level of performance. Contingency theory is the basis of focusing on interior or exterior for adapting to environmental variance from the strategic viewpoint of firms. However, the result of this research is similar with the focused strategy by Porter (1980). High environmental uncertainty is the cause that firms enhance information sharing with

supply chain partners and acquire market information through external collaboration. It is also the basis of enhancing communication and information sharing among departments through internal collaboration. The corporate strategic orientation is enhanced by capability of firms to quickly respond to a market variance, followed by high performance. From this viewpoint, managers should structure a collaborative mind among firms as well as departments on the basis of environmental uncertainty and they perform supply chain collaboration through high communication and information sharing to achieve high performance.

The results of this study indicate that Korean manufacturing firms in China did not react to the high environmental uncertainty with more efforts in supply chain collaboration. Prior research has verified that environmental uncertainty has a positive effect on supply chain collaboration (Agbejule and Burrowes, 2007; Coelho and Easingwood, 2005) and it has a negative effect on performance (Ryu et al., 2008; Wood, 2008). However, in this research, environmental uncertainty moderates the relationship between supply chain collaboration and operational performance. This is connected with the fact that environmental uncertainty enhances the relationship between supply chain collaboration and operational performance. For instance, quick change of competitors' competitive methods as environmental uncertainty means that a product's life cycle is shortened in the market. The shortened product life cycle is the cause and the effect is managers respond to the variance through collaboration with suppliers rather than individual response to a market variance (Bagchi et al., 2005; Scannell et al., 2000). In addition, collaboration with customers is the root of a variance of internal processes. Managers have need of inter-departmental collaboration to apply acquired information from exterior to internal processes under the uncertain environment. Efficient internal processes achieved by the collaboration are the basis of achieving high collaboration with customers (Boon-itt and Wong, 2011b). From this viewpoint, managers need to grasp a variance of customers' preferences and expectations and, as a result, they can reflect customer needs in goods through internal collaboration and supplier collaboration. Firms, through the goods, can enjoy high performance in the market

because it meets customer needs. In addition, managers need to observe the variance of competitive methods of competitors. Various competitive strategies used by competitors in the market mean that there is high competition. To respond to the competition, managers should achieve external effectiveness as well as internal efficiency. The present competition is changed with competition among supply chains rather than competition among firms (Bae, 2012a). In this regard, managers should perform flexible supply chain collaboration including departments, customers and suppliers for survival in against keen market competition. This will be followed by high performance.

7.7 Summary

Discussion on the results of this research is explained in this chapter. H.1, H.2 and H.3 are connected with confirmatory factor analysis of supply chain collaboration, operational performance and environmental uncertainty. According to the results, H.1 and H.2 are supported and H.3 is partially supported. Moreover, the confirmatory factor analysis of the sub-dimensions of environmental uncertainty is good and that is why the variable is used in this research. H.4 is concerned with the causal link between supply chain collaboration and operational performance and this is supported. This is explained by information processing theory and strategic choice theory. The moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance is tested in H.5 and this is supported. This is explained by contingency theory and information processing theory. H.6 is connected with the causal link between environmental uncertainty and supply chain collaboration and H.7 is concerned with the causal link between environmental uncertainty and operational performance. Data from these two hypotheses is not significant to the overall research and can be ignored. To sum up, confirmatory factor analysis of environmental uncertainty is partially supported (H.3). In addition, the two hypotheses, the relationship between environmental uncertainty and supply chain collaboration (H.6) and the

relationship between environmental uncertainty and operational performance (H.7) are rejected. The most important aspect of the objectives of this research is to test the role of environmental uncertainty on the relationship between supply chain collaboration and operational performance. The result shows that the role of environmental uncertainty is a moderator on the relationship between supply chain collaboration and operational performance and this fit is explained as moderation by Venkatraman (1989).

Chapter VIII Conclusion

8.1 Introduction

There are two aims of this research: one is to develop the measurement scales for environmental uncertainty, supply chain collaboration and operational performance and the other is to verify the roles of environmental uncertainty on the relationship between supply chain collaboration and operational performance specifically for Korean manufacturing firms in China. The relationships between the variables are proved by prior research and contingency theory, resource-based theory, strategic choice theory, relational view and information processing theory explain the relationships between the variables. Conceptual and operational definitions of the variables are extracted through prior research, a questionnaire was sent to Korean manufacturing firms in China and 208 data collected by the survey were used in the analysis. To achieve the objectives of this research, various analytical methods are used. First, reliability and validity of the collected data are verified by various methods. The characteristics of the responding firms are proved by descriptive statistics. Content validity is verified by extracting items, verification by experts and the average of items. Estimates and purification of data are ascertained by data screening, evaluation of assumptions, internal consistency and exploratory factor analysis. Construct validity is tested by convergent validity through confirmatory factor analysis, discriminant validity and multicollinearity analysis. Second, the hypotheses are tested by SEM: Firstly, this research verifies theoretical constructs and measurement scales of the variables using CFA and SEM; secondly, the causal links of environmental uncertainty on supply chain collaboration and operational performance is tested by SEM; and thirdly, the moderating effect of environmental uncertainty on the relationship between supply chain collaboration and operational performance is tested by SEM. Summary of the main findings, the limitations of this research and the future research directions are explained in this chapter.

8.2 Summary of main findings

8.2.1 Contributions of the research questions

This research verifies two research questions which have seven hypotheses. The contents are as follows.

Research Question (RQ) 1 -

What is supply chain collaboration and how does supply chain collaboration affect operational performance?

In this research, supply chain collaboration is defined as working together among departments within a firm, understanding mutual different viewpoints, sharing resources and information and achieving common goals in supply chains (Ellinger et al., 2000; Stank et al., 1999b). This reflects the fact that the definition includes all of intra- and inter-corporate viewpoints. According to Stevens (1989), supply chain collaboration is divided into four dimensions. Independent operation means that firms have a lack of recognition of SCM. Internal collaboration means that firms maintain efficiency of internal processes through a high level of internal collaboration in response to the stable external environment. External collaboration means that firms secure opportunities through a high level of external collaboration if there is high environmental uncertainty. In addition, firms choose supply chain collaboration if they think that it is important to improve the effectiveness of inter-firm processes and the efficiency of internal processes by improving the capability of information systems. Korean manufacturing firms can select one of four dimensions to follow their recognition of the environment.

Korean manufacturing firms achieve a high level of operational performance when they achieve a high level of internal collaboration. Collaboration starts from the inter-functional aspect and focuses on the whole activities of firms. It is important in logistical operations that efficiency and production for whole processes are increased because it disseminates to other functional areas. From this viewpoint, firms which have a high level of collaboration achieve higher operational efficiency than others firms (Daugherty et al., 1996). Collaboration provides a means which minimize the whole logistics cost of firms (Schoenherr and Swink, 2012). Firms, through collaboration, maintain the lowest level of cost because they remove overlaps and inefficiency in the whole process. Primary activities such as purchasing, manufacturing and marketing can be collaborated by logistics with each other. The inter-functional collaboration has a positive influence on total cost performance (Larson, 1994). The factors which have a direct effect on the collaboration are teamwork, communication, buyer/seller cooperation and trust. In addition, internal collaboration has a positive effect on cost saving through the removing of inter-functional barriers and constructing agreed goals and developing a cooperative mind beyond functions (Wong et al., 2011). For this reason, internal collaboration has a positive influence on cost performance. Therefore, Korean manufacturing firms which have a high level of internal collaboration achieve a high level of cost performance.

Korean manufacturing firms achieve a high level of service performance when they achieve high levels of internal collaboration. Collaboration between departments provides opportunities which can structure superior relationships. It makes it possible to increase expected sales first and then it can be possible to stably supply goods to wholesalers and retailers. From this viewpoint, collaboration between departments provides the necessary information when firms perform customized service and meet customers' special requirements. The collaborative behaviour between departments is a determinant factor on effectiveness of inter-departmental relationships (Ellinger, 2000). Collaborative behaviour is regarded as a factor which stimulates the whole relationships between departments and, as a result, service performance is improved. In other words, the improvement of the relationships

between departments through collaboration is the basis of improving service performance. Collaborative behaviour, such as developing a mutual understanding of responsibilities, sharing ideas, information, resources and working together as a team for achieving goals, provides firms with superior service systems (Ellinger et al., 2000). For this reason, the effort on collaboration between marketing and logistics provides customers with better services because of cooperatively responding to customer needs. The market and customer information generated in marketing is shared with other departments, which is based on integrating internal capability. The collaboration between departments has a positive influence on customer service through daily operations and formatted strategy (Daugherty et al., 2009). The correct information on orders and the correct understanding of customer needs generated by marketing is shared with logistics (Stank et al., 1999b) and this enhances the capability to coincide with the requirement of customers. The enhanced capability is connected with improved service performance.

Korean manufacturing firms achieve a high level of cost performance when they achieve high levels of supplier and customer collaboration. Collaboration between firms is based on standardization of activities among firms. The standardization is the prerequisite of collaboration, which is connected with cost saving. The scope of activities among firms includes collaborative plans, predictions and operations. Manufacturers collaborate with suppliers in procurement plans of materials and manufacturing plans and they achieve a high level of cost saving connected with the standardization. In addition, manufacturers collaborate with distributors in distributing plans and sales plans and they achieve a high level of cost saving connected with the standardization. In addition, the most important factor which has an influence on collaboration between firms is regarded as information sharing. The development of information and communication technology like the Internet and electronic commerce strengthens the ability to collaborate between supply chain partners. As a result of using the tools like standardization and information sharing, firms save costs by removing overlaps in operations and preventing waste of resources and enjoying high performance through matching customer needs

(Stank et al., 2001). In addition, prior research has found that supplier partnering has a positive influence on cost performance and overall cost reduction (Scannell et al., 2000). This result shows that cost control is the primary goal of collaboration with partners. Firms also perform cost saving through construction of reliable relationships with partners. Integrative strategies are the most important factor to decide cost results (Ragatz, 2002). Similarly, integrative strategy in the inception stage is the important factor for cost saving because the cost of products is decided in the stage of technology which designs products. Collaboration with suppliers in the stage of developing products is also an important factor for cost-containment. Collaboration with customers in the stage of delivering products is also important for cost-containment (Lee et al., 2007). The collaboration between firms can maximize efficiency through information sharing among supply chain partners because customers have increased accessibility to stock information concerned with goods of manufacturers and suppliers have increased accessibility to stock information concerned with materials of manufacturers. From this viewpoint, collaboration has a direct positive effect on cost saving. Therefore, Korean manufacturing firms can save costs through collaboration.

Korean manufacturing firms achieve a high level of service performance when they achieve high levels of supplier and customer collaboration. Collaboration between firms is an important factor to enhance capability and performance of firms (Min et al., 2005). Firms intensively put resources into core competence and the others are outsourced to supply chain partners. In this regard, supply chain participants are linked together by sharing core competence and compete not with other firms but with other supply chains (Bae, 2008). Firms share design and production processes with suppliers and, consequently, they acquire better process capability (Ragatz et al., 2002). In this case, suppliers and manufacturers can share information from the time of products development and they can also achieve mutual standardization of processes. Similarly, core suppliers participate in decision making of manufacturers (Bagchi et al., 2005). This has an important influence on R&D, procurement and logistics directly concerned with suppliers. More specifically, upstream SCM strategy has a positive

effect on flexibility of first-tier suppliers (Scannell et al., 2000). Responses to quick changed technology and customer needs are key factors of superior customer service. In this regard, developing capability with suppliers is an important factor for enhancing responses and flexibility. In addition, firms need to find the method of enhancing competitive advantages with suppliers when they strategically manage supply and this is connected with mutual beneficial partnerships (Paulraj and Chen, 2007b). Inter-corporate collaborative behaviour promotes an inter-functional knowledge transfer in the inter-corporate interface and this increases mutual understanding in the whole business processes. Collaborative understanding as well as trust and mutual dependence in the whole business processes guarantee strategic success such as superior product design, total quality and knowledge creation. For this reason, supply chain partners should collaborate to achieve strategic goals to pursue common aims and mutual benefits. Similarly, Wong et al. (2011) treat customers as providers of information and collaboration and they are the basis of improving internal processes and achieving superior customer service. On the basis of the results of prior research, firms treat suppliers and customers as the root of external information (Flynn et al., 2010) and the acquired information is disseminated to internal processes through the learning of managers. In this regard, the core is capability of partners and knowledge sharing. This means that supply chain partners complement mutual weaknesses through inter-corporate collaboration. The complementary relationship can be also be explained by the viewpoint of knowledge management; that is, firms invest resources in core competence and the others are treated by supply chain partners. This means that supply chain partners can share their knowledge and technology with each other and, as a result, they can enjoy high performance. From this viewpoint, Korean manufacturing firms can provide customers with superior service through collaboration with suppliers.

Research Question (RQ) 2 -

What is environmental uncertainty and how does it affect supply chain collaboration and influence

the relationship between supply chain collaboration and operational performance?

Environmental uncertainty is defined as a degree of difficulty of prediction to outcomes or the future (Chow et al., 1995) and it is divided into four dimensions: munificence, dynamism, heterogeneity and hostility (McGinnis and Kohn, 1993). Munificence means a degree of continuous growth of a market caused by environmental variance. Dynamism means the difficulty of predicting a change in the market. Heterogeneity means the change of competitive methods of competitors and customers' preferences and expectations (Clinton, 1997; McGinnis and Kohn, 1993). In this research, the role of environmental uncertainty on the relationship between supply chain collaboration and operational performance is verified as a moderator rather than an antecedent. This result means that Korean manufacturing firms in China achieve high operational performance through enhancing supply chain collaboration in high environmental uncertainty. In other words, if the firms face a high level of environmental uncertainty, they focus on supply chain collaboration, followed by high operational performance. Korean manufacturing firms, in high environmental uncertainty, remove overlaps and inefficiency, that existed in internal firms, through internal collaboration; this is followed by high cost savings. In addition, if there is high competition and difficulty in predicting the market, Korean manufacturing firms achieve standardisation and resource sharing through collaboration with suppliers and customers, which is followed by high cost savings. Moreover, Korean manufacturing firms, in difficulty of prediction and high competition in the market, collaborate with customers, and they can recognize market information and customer needs. The information and needs are shared with departments in internal firms for achieving their goals and, in addition, collaboration with suppliers is the basis of structuring superior service. In this regard, collaboration with suppliers and departments as well as customers is the key factor to achieve service performance following difficulty of prediction and high competition in the market.

The causal link between environmental uncertainty and supply chain collaboration is not supported

and, in addition, the causal link between environmental uncertainty and operational performance is not supported. This reflects two perspectives: one is the need to develop variables which reflect the character of Chinese environmental uncertainty and the other is to have the need for long-term research on Chinese environmental uncertainty. This result reflects the limitations on Chinese environmental uncertainty. Therefore, this research has verified that the role of environmental uncertainty is a moderator between supply chain collaboration and operational performance.

Moreover, there are six knowledge gaps and this research undertook to fill the gaps. The first, the understanding of different levels of supply chain collaboration is lacking. Prior research has classified supply chain collaboration such as internal collaboration, external collaboration and supply chain collaboration as a whole (Stevens, 1989; Barratt, 2004; Fawcett and Magnan, 2002; Narasimhan and Kim, 2001; Schoenherr and Swink, 2012). This research divides supply chain collaboration into the stages of independent operation, internal collaboration, external collaboration and supply chain collaboration and suggests theoretical backgrounds. It is similar to the viewpoint of Stock et al. (2000) but there are gaps compared with the viewpoints of prior research: theoretical background; clear classifications; comprehensive dimensions; analytic methods. These gaps can add new classifications such as theoretical backgrounds like resource-based theory, relational view, strategic choice theory and information processing theory, and clear classifications such as the stages of independent operation, internal collaboration, external collaboration and supply chain collaboration, comprehensive dimensions like internal and external collaboration and analytic methods such as multiple analysis of variance and analysis of covariance.

The second, the causal link between supply chain collaboration and operational performance is still undetermined. Some prior research did not find the positive effect of supply chain collaboration on performance (Danese and Romano, 2011; Flynn et al., 2010; Sezen, 2008) but this research verifies the positive effect of supply chain collaboration on operational performance (Flynn et al., 2010; Kannan and Tan, 2010; Saeed et al., 2011). In this regard, the result clearly explains the relationship

between supply chain collaboration and operational performance. Moreover, the positive relationship between supply chain collaboration and performance is verified by results of the majority of prior research (Larson, 1994; Wong et al., 2011; Bae, 2012a). However, the positive relationship between the variables from the viewpoint of Korean manufacturing firms in China is verified by the result of this research for the first time. The result highlights the positive effect of supply chain collaboration on performance from the viewpoint of Korean manufacturing firms in China which matches with the results obtained in prior research. This explains that Korean manufacturing firms perform SCM and they can improve performance through it. This also explains that the behaviour of the firms in the Chinese market is equal to the behaviour of other firms in other markets.

Third, the sub-variables of environmental uncertainty, supply chain collaboration and operational performance are still undetermined. The result of this research ascertains that supply chain collaboration has three sub-variables such as internal collaboration, customer collaboration and supplier collaboration and operational performance has two sub-variables such as cost performance and service performance. In addition, environmental uncertainty has three sub-variables such as munificence, dynamism and heterogeneity. The sub-variables of the variables are classified in prior research from various viewpoints. However, prior research did not perform clear verification on the sub-variables. From this viewpoint, for the first time, this research classifies and verifies the sub-variables and the variables. This provides justification to use the sub-variables and the variables.

Fourth, fifth and sixth gaps are concerned with the roles of environmental uncertainty between supply chain collaboration and operational performance. There are two roles of environmental uncertainty such as an antecedent of supply chain collaboration (Liao and Tu, 2008; Ragatz et al., 2002) and operational performance (Ryu et al., 2008; Wood, 2008) and a moderator on the relationship between supply chain collaboration and operational performance (Liao and Tu, 2008; Wong et al., 2011). According to the result, this research verifies that environmental uncertainty has a moderator between supply chain collaboration and operational performance. Korean manufacturing

firms in China, which recognise a high level of environmental uncertainty, achieve high performance through enhancing supply chain collaboration. This explains why the relationship between supply chain collaboration and operational performance is enhanced by their recognition of environmental uncertainty rather than the direct effect of environmental uncertainty on supply chain collaboration and operational performance. This new knowledge reflects the aspect of Korean manufacturing firms in the Chinese market.

8.2.2 Contributions to theory

There are three contributions to the theory as follows. The first, this research, has three variables such as environmental uncertainty, supply chain collaboration and operational performance. Prior research has already verified the relationship between the variables but they did not verify confirmatory factor analysis of the variables. From this viewpoint, this research classifies the variables and the sub-variables. In addition, this research suggests theoretical backgrounds concerned with the variables. For example, supply chain collaboration is explained by internalisation theory and transaction cost theory and it has four different levels: the stages of independent operations, internal collaboration, external collaboration and supply chain collaboration. Environmental uncertainty and operational performance also come from prior research. This means that the variables are supported by the theoretical background research obtained in previous research, which in turn demonstrates that this research is the most up-to-date method.

The second, the relationship between supply chain collaboration and operational performance is explained by resource-based theory, relational view, strategic choice theory and information processing theory. From the viewpoint of an internal firm, collaborative mind and behaviour are regarded as internal resources of firms and if firms have these superior resources, they can achieve high performance. From the viewpoint of relational view, resources of firms are put in the relationship

between firms and this affects the inter-organisational rent-generating process such as learning, lower transaction costs and pooling of resources leading to an increase in performance. Moreover, firms can choose their strategy like supply chain collaboration. When firms face environmental uncertainty, they can choose external collaboration because they need to find opportunities in the market; whereas, when they face environmental stability, they focus on internal collaboration because they need to save costs in internal processes. The strategic choice is connected with high performance. In addition, firms always analyse the market because they need to acquire new information like customer needs and market variance. For this reason, they collaborate with customers and acquire the information. It is disseminated to internal processes and suppliers and they structure efficient supply chain processes. From this viewpoint, the result of this research, the positive effect of supply chain collaboration on operational performance, has a contribution to theory.

The third, the role of environmental uncertainty on the relationship between supply chain collaboration and operational performance is a moderator and this is explained by contingency theory and as a fit as moderation. The former is to start from the supposition; that is, there is no organisational structure which satisfies all conditions. From this viewpoint, firms need to find the fittest structure which is equal to the environment which they face and this is connected with high performance. The latter has two viewpoints such as a moderator and a mediator. In this research, environmental uncertainty is the role of a moderator on the relationship between supply chain collaboration and operational performance. When Korean manufacturing firms in China face environmental uncertainty, they acquire high performance through enhancing supply chain collaboration.

8.2.3 Contribution to practice

There are two managerial contributions concerned with classifications of supply chain collaboration.

The first, this research divides the levels of supply chain collaboration into an independent operation of each function, internal collaboration, external collaboration and supply chain collaboration. This is the criteria of decision making to improve performance. The second, this is the basis of differences in operational performance among levels of supply chain collaboration and, in addition, this can provide managers with recognition on the method of performance improvement.

The positive effect of supply chain collaboration on operational performance has two managerial implications. The first, managers recognize that supply chain collaboration is the cause of performance improvement. They need to find their level of supply chain collaboration and they can achieve performance improvement when they increase supply chain collaboration. The second, collaboration is not just internal or external but simultaneous. Prior research has insisted that internal collaboration has a positive effect on external collaboration (Chen et al., 2009; Gimenez, 2006) and external collaboration has a positive effect on internal collaboration (Bae, 2012a; Stank et al., 2001). In addition, both of them have a positive effect on performance (Schoenherr and Swin, 2012; Stank et al., 2001/2002). For this reason, managers need to focus on internal and external collaboration simultaneously.

The result concerned with the effect of environmental uncertainty on supply chain collaboration and operational performance has two managerial contributions. The first, the environment is the source of information and managers should analyse it for structuring strategy and achieving performance. That is why managers focus on supply chain collaboration to achieve high performance on the basis of environmental uncertainty. The second, managers should collaborate with customers to recognize the changes and the changes are disseminated to departments and suppliers through collaboration if preferences and expectations of customers are quickly changed. This is connected with high performance.

8.3 Future research directions and limitations of this research

In spite of the useful results in this research, there are various limitations. First, confirmatory factor analysis of environmental uncertainty is partially supported. This result can be explained by various reasons but this research explains the reason in two aspects. The first is concerned with the definitions of environmental uncertainty used in this research. This research uses the definitions of prior research as it is and, consequently, it is not possible for the definitions to reflect the characteristics of Korean manufacturing firms in China. In particular, research on environmental uncertainty which reflects the characteristics of the Chinese market is required. The second, almost all sample firms used in this research have invested in China after 2001. On the basis of the time of the survey (in 2006), 128 firms (61.6%) do not pass five years of investment in China. This means that they have not enough time to perfectly grasp the environment of the Chinese market. Therefore, the long-term investigation on the environment of the Chinese market is required.

Second, the effects of environmental uncertainty on supply chain collaboration (H.6) and operational performance (H.7) are not supported. This means that the causal links between environmental uncertainty, supply chain collaboration and operational performance are still undetermined. Hence, the moderating effect of environmental uncertainty between supply chain collaboration and operational performance is supported and this means that the role of environmental uncertainty is a moderator on relationship collaboration and performance. However, prior research has verified the role of environmental uncertainty which is an antecedent of collaboration and performance. This is one of future direction for research. In addition, prior research has stressed the interactive effect of supplier collaboration with internal collaboration or the indirect effect of supplier collaboration by way of internal collaboration on performance rather than the individual effect of supplier collaboration on performance (Droge et al., 2004; Stank et al., 2001). Therefore, research concerned with the interactive effect or the indirect effect is required.

Third, prior research has suggested that supplier collaboration and customer collaboration are not treated with one variable as external collaboration (Flynn et al., 2010). The reason is that supplier collaboration or customer collaboration has an individual effect on performance but the interactive effect of the two variables on performance is still unconfirmed (Boon-itt and Wong, 2011b; Flynn et al., 2010). From this viewpoint, the verification of the interactive effect of internal collaboration, supplier collaboration and customer collaboration on performance is required. This can also explain the synergy effect among the variables.

Fourth, some researchers proved that internal collaboration has a positive effect on external collaboration (Braunscheidel and Suresh, 2009; Chen et al., 2009; Gimenez, 2006; Gimenez and Ventura, 2005; Schoenherr and Swink, 2012). The other researchers, however, verified that external collaboration has a positive effect on internal collaboration (Bae, 2012a; Gimenez and Ventura, 2005; Salvador et al., 2001; Stank et al., 2001). In addition, some researchers did not find any relationship (Gimenez and Ventura, 2005; Gimenez, 2006). The results explain that the relationship between internal collaboration and external collaboration remains unclear. This is based on the viewpoint of Stevens (1989) as development stages of supply chain collaboration. In addition, information processing theory gives justification in this viewpoint. In this regard, the verification of causal links between internal collaboration and external collaboration from the viewpoint of development stages of supply chain collaboration is needed but this research did not investigate this matter. Therefore, causal links between internal collaboration and external collaboration is left for a future research.

Fifth, information processing theory explains that generation of external information and dissemination of the information to internal processes have a positive effect on performance and managers have a role of mediating information (Swink et al., 2007; Wong et al., 2011). In addition, this theory treats suppliers and customers as the object of interaction and the source of information (Flynn et al., 2010). From this viewpoint, grasping market information and customer needs through collaboration with customers and absorptive capability on the information are the basis of achieving

the efficiency of internal processes. In addition, collaboration with suppliers on information generated from exterior is the cause of maximizing performance because it can make possible to attain customer needs. This can be approached from the viewpoint of the flow of information and researchers need to test whether information is substantially generated from customers, disseminated to internal processes and delivered to suppliers. The viewpoint is different with the viewpoint of this research and, as a result, it is proposed as future research.

Sixth, the methodology used in this research, quantitative research through a survey, explains the relationships between variables but it does not explain how the causal links work. To solve the problem, qualitative research on the relationship between supply chain collaboration and performance can provide useful information. In addition, the effect of environmental uncertainty on supply chain collaboration and performance can be ascertained by the same methodology. The working mechanism of the causal links can be solved by qualitative research and this is one direction for future research.

Seventh, there are some limitations in the concepts of the variables shown in this research. For instance, operational performance is divided into cost performance and service performance. The former is to reflect an internal aspect of firms and the latter is to focus on an external aspect of firms. However, the dimensions of cost and service performance are in an operational level. For this reason, researchers need to additionally test performance in a corporate level like financial performance. This is one area for future research to investigate.

Eighth, there are various variables to explain cost performance and service performance. The performance is explained by environmental uncertainty and supply chain collaboration in this research. In addition, environmental uncertainty is the influencing factors to the collaboration and this research analyses the effect of them. However, from the viewpoint of marketing, the variables such as market orientation and CRM are also the factors to measure the relationship between organisations and the factors to have an effect on cost and service performance. Moreover, from the viewpoint of organisation theory, organisational culture and learning capability are also regarded as the factors

which have an effect on the relationship between organisations. These variables have an influence on cost and service performance and this can better explain the relationship between organisations. This is also treated as one of the future research directions.

8.4 Summary

There are two objectives in this research: one is to test the relationship between supply chain collaboration and operational performance and the other is to verify the roles of environmental uncertainty on the relationship between supply chain collaboration and operational performance. The relationships between the variables are explained by extant research. The results of empirical tests verify the relationships between the variables. The major results of this research are as follows. First, supply chain collaboration has three sub-variables: customer collaboration, supplier collaboration and internal collaboration. Operational performance has two sub-variables such as cost performance and service performance and environmental uncertainty has three sub-variables such as munificence, dynamism and heterogeneity. Second, supply chain collaboration has a positive influence on operational performance. Third, environmental uncertainty moderates the relationship between supply chain collaboration and operational performance. The results of prior research provide theoretical justification on the results of this research. Therefore, the relationship between supply chain collaboration and operational performance is explained by resource-based theory, information processing theory, relational view and strategic choice theory and the moderating effect of environmental uncertainty between supply chain collaboration and operational performance is explained by contingency theory.

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Appendix 1: Prior literature on the performance implications of internal collaboration

Independent variables	Dependent variables	Hypotheses	Empirical results	Authors	Sample & method
- Inter-organizational functional integration	- Total costs	Negative association	- significant	Larson (1994)	532 US manufacturing firms SEM
- Interaction - Collaboration - Composite perspective	- Department performance - Company performance - Product development performance - Product management performance - Satisfaction in working with other departments	Positive association	- Marketing with Manufacturing: significant in collaboration - Manufacturing with marketing: significant in collaboration on product management performance and satisfaction - Marketing with R&D: significant in collaboration - R&D with marketing: significant in collaboration	Kahn and Mentzer (1998)	514 US electronics firms regression
- Collaborative integration elements	- Overall relative performance - Overall marketing/logistics relationship effectiveness	Positive association	- Working together as a team on overall relative performance: significant - Achieving goals collectively, working together as a team and conducting joint planning to anticipate and resolve operational problems on overall M/L effectiveness: significant	Stank et al. (1999b)	309 US manufacturing firms regression
- Inter-departmental connectivity	- Dissemination of information and coordination of activities	Positive association	- significant	Mollenkopf et al. (2000)	186 New Zealand firms (manufacturers, wholesalers and retailers) regression
- Collaboration	- Received effectiveness of relationship	Positive association	- significant	Ellinger et al. (2000)	309 US manufacturing firms regression
- Cross-functional collaboration	- Effectiveness inter-departmental relations	Positive association	- significant	Ellinger (2000)	309 US manufacturing firms

					regression
- Internal collaboration	- Logistical service performance	Positive association	- significant	Stank et al. (2001)	306 US manufacturing firms SEM
- internal integration	- Overall logistics performance	Positive association	- significant in logistics cost, delivery dependability, order fill capability and inventory turn - rejected in customer satisfaction, product customization, delivery speed, responsiveness, order flexibility, delivery flexibility, information systems support, advanced ship notification and ROA	Stank et al. (2001/2002)	306 US manufacturing firms regression
- Internal integration (design-process integration)	- Product development time - Product cycle time - Responsiveness - Financial performance	Positive association	- significant	Droge et al. (2004)	57 car companies (OEMs) in North America regression
- Internal integration (logistics/production) - Internal integration (logistics/marketing)	Logistics performance	Positive association	- Integration (logistics/production) and performance: significant - Integration (logistics/marketing) and performance: rejected	Gimenez and Ventura (2005)	64 Spanish manufacturing firms regression
- Collaborative practices (information sharing, decision synchronization and incentive alignment)	- Operational performance (fulfillment, inventory and responsiveness)	Positive association	- significant in all excluding the effect of IS on responsiveness	Simatupang and Sridharan (2005)	76 New Zealand manufacturing firms regression
- Internal integration	- Logistical performance	Positive association	- significant	Germain and Iyer (2006)	152 US manufacturing firms SEM
- Internal linkage	- Supply chain performance (cost-containment and reliability)	Positive association	- significant	Lee et al. (2007)	122 US manufacturing firms regression

- Manufacturing system integration	- Manufacturing performance	Positive association	- significant	Liao and Tu (2008)	303 US manufacturing firms regression
- marketing/logistics relationship effectiveness	- firm-wide integration	Positive association	- significant	Daugherty et al. (2009)	125 US firms SEM
- Internal integration	- Operational performance - Business performance	Positive association	- significant	Flynn et al. (2010)	617 Chinese manufacturing companies regression
- Internal integration	- Customer delivery performance	Positive association	- significant	Boon-itt and Wong (2011a)	151 Thailand automotive industry regression
- Internal integration	- Operational performance (delivery, production cost, product quality and production flexibility)	Positive association	- significant in all excluding the effect of internal integration on production flexibility	Boon-itt and Wong (2011b)	151 Thailand's automotive firms (34% of Thai-foreign joint ventures and 18% of foreign owned) regression
- Internal integration	- Performance (delivery, production cost, product quality and production flexibility)	Positive association	- significant	Wong et al. (2011)	151 Thailand's automotive firms (34% of Thai-foreign joint ventures and 18% of foreign owned) regression

Appendix 2: Prior literature on the performance implications of external collaboration

Independent variables	Dependent variables	Hypotheses	Empirical results	Authors	Notes
Upstream SCM practice - Supplier development - Supplier partnering - JIT purchasing	- Flexibility - Innovation - Quality - Cost	Positive association	- significant in all excluding the effect of development on quality and the effect of partnering on innovation and quality	Scannell et al. (2000)	57 US manufacturing firms regression
- Interaction for flow management - Interaction for quality	- Punctuality of delivery in interactions with customer - Operations	Positive association	- significant	Salvador et al. (2001)	164 Germany, Italy, Japan, UK and USA manufacturing

management	speed in interactions with customer - Punctuality of delivery in interactions with suppliers - Operations speed in interactions with suppliers				firms regression
- Customer integration - Supplier integration	- Supply chain logistics competencies	Positive association	- significant in the effect of customer integration on SC logistics competencies	Stank et al. (2001/2002)	306 US manufacturing firms regression
- Suppliers-integrative strategies	- New product development (cycle time results, quality results and cost results)	Positive association	- significant	Ragatz et al. (2002)	83 US manufacturing firms SEM
- SC design - Collaboration with suppliers in inventory - Collaboration with suppliers in R&D	- Order fulfillment time - Order fill rate - Production flexibility - Total logistics cost - Return processing cost - Inventory turn - Rate of return	Positive association	- significant	Bagchi et al. (2005)	Total 149 firms 27 Denmark, 14 Finland, 12 Norway, 19 Sweden, 7 Austria, 27 Germany, 7 Netherlands and 36 UK regression
- External integration	- Absolute performance	Positive association	- significant	Gimenez and Ventura (2005)	64 Spanish manufacturing firms regression
- Foreign networking activities - Internal networking activities	- Export performance	Positive association	- significant	Babakus et al. (2006)	257 manufacturing firms (75 Finland, 111 Sweden and 71 Norway) SEM
- Customer linkage - Supplier linkage	- SC performance (cost-containment and	Positive association	- significant in all excluding the effect of customer linkage on SC	Lee et al. (2007)	122 US manufacturing firms regression

	performance reliability)		cost-containment		
- External logistics integration	- Agility performance	Positive association	- significant	Paulraj and Chen (2007a)	221 US manufacturing firms SEM
- Strategic supply management	- Buyer performance - Supplier performance	Positive association	- Significant	Paulraj and Chen (2007b)	221 US manufacturing firms SEM
- External process integration	- Firm performance	Positive association	- Significant	Chen et al. (2009)	304 Chinese electronics manufacturing firms SEM
- inter-organizational integration	- SC organizational performance - Customer responsiveness - Financial performance	Positive association	- Significant in all excluding the effect of inter-organizational integration on customer responsiveness	Rajaguru and Matanda (2009)	231 Australian food and hardware retailing firms SEM
- Customer relationship - Supplier involvement	- Firm performance	Positive association	- Significant	Singh and Power (2009)	418 Australian manufacturing firms regression
- inter-firm collaboration level	- Operation outcomes - Rational outcomes	Positive association	- Significant	Zacharia et al. (2009)	342 US various industries (construction, manufacturing, transportation, communication, wholesale and retail trade industries) SEM
- E-business supported supplier integration - Information sharing in supplier integration	- Regular use of lean manufacturing	Positive association	- Significant	So and Sun (2010)	558 manufacturing firms in 17 countries regression
- Supplier integration - Customer integration	- Customer delivery performance	Positive association	- Significant in the effect of supplier integration on customer delivery performance	Boon-itt and Wong (2011a)	151 Thailand automotive industry regression
- External	- Operational	Positive	- Significant	Boon-itt and	151

integration	performance (delivery, production, product quality and production flexibility)	association		Wong (2011b)	Thailand's automotive firms (34% of Thai-foreign joint ventures and 18% of foreign owned) regression
- Demand chain collaboration	- Operational performance	Positive association	- Significant	Iyer (2011)	152 US manufacturing firms regression
- Supplier integration - Customer integration	- Performance (delivery, production cost, product quality and production flexibility)	Positive association	- Significant	Wong et al. (2011)	151 Thailand's automotive firms (34% of Thai-foreign joint ventures and 18% of foreign owned) regression
- Customer integration - Supplier integration	- Efficiency	Positive association	- Significant in the effect of supplier integration on efficiency	Danese and Romano (2011)	200 Finland, US, Japan, Germany, Sweden, Korea, Italy, Austria and Spain manufacturing firms regression
- Supplier collaboration	- New product performance	Positive association	- significant	Tsai et al. (2012)	201 Taiwanese manufacturing firms Regression and MANOVA

Appendix 3: Prior literature on the performance implications of supply chain collaboration

Independent variables	Dependent variables	Hypotheses	Empirical results	Authors	Notes
- Inter-firm SC coordinating processes	- Absolute performance - Relative performance	Positive association	- significant	Stank et al. (1999a)	47 US food firms regression
- Customer integration - Supplier integration - Internal integration	- SC logistics competencies	Positive association	- significant in all excluding the effect of supplier integration on responsiveness	Stank et al. (2001/2002)	306 US manufacturing firms regression
- Company's	-	Positive	- significant	Narasimhan	623

integration with suppliers - Company's integration with customers - Internal integration - Product diversification - International market diversification	Performance (sales growth, market share growth and profitability)	association		and Kim (2002)	manufacturing firms (Korea-244 and Japan-379) regression
- SC integration intensity	- Competitive capabilities (product quality, delivery reliability, process flexibility and cost leadership) - Business performance (revenue from new products, customer satisfaction, sales growth and ROA)	Positive association	- significant	Rosenzweig et al. (2003)	238 manufacturing firms in various reasons (45% North America, 30.3% Europe, 34% Asia and Pacific and 25% Latin America) regression
- Internal integration - External integration	- Product development time - Product cycle time - Responsiveness - Market share performance - Financial performance	Positive association	- significant in all excluding the effect of internal integration on market share performance and the effect of external integration on financial performance	Droge et al. (2004)	57 car companies (OEMs) in North America regression
- SC relationship quality	- SC performance	Positive association	- significant	Fynes et al. (2004)	200 manufacturing firms in various countries (55% Irish, 5% UK, 14% other EU, 20.5% USA, 2% Japan and 3.5% others) SEM
- Integrated internal	- Logistics performance	Positive association	- not significant but	Rodrigues et al. (2004)	284 US manufacturing

operations - Integrated external operations			significant in the effect of composition of variables on logistics performance		firms SEM
- Internal integration - Downstream integration	- Logistical performance	Positive association	- significant	Germain and Iyer (2006)	152 US manufacturing firms SEM
- Customer linkage - Supplier linkage - Internal linkage	- SC performance (cost-containment and performance reliability)	Positive association	- significant in all excluding the effect of customer linkage on SC cost-containment	Lee et al. (2007)	122 US manufacturing firms regression
- Supply chain process integration - Supply chain collaborative strategies	- Operational performance	Positive association	- significant	Aryee et al. (2008)	29 UK manufacturing firms regression
- Internal process integration - External process integration	- Firm performance	Positive association	- significant	Chen et al. (2009)	SEM
- Orientation on continuous improvement of the processing supply chain integration - Levels of environmental driver of supply chain integration	- Firm performance	Positive association	- significant	Richey et al. (2009)	581 US manufacturing firms regression
- Customer integration - Supplier integration - Internal integration	- Operational performance - Business performance	Positive association	- significant in all excluding the effect of supplier integration on operation and business performance and the effect of customer integration on operational performance	Flynn et al. (2010)	617 Chinese manufacturing companies regression

- Barriers to integration - Facilitators to integration	- Supply chain performance	- Barriers: negative association - Facilitators: positive association	- significant in all excluding the effect of barriers on SC performance	Richey et al. (2010)	254 US manufacturing firms SEM
- Supplier integration - Customer integration - Internal integration	- Customer delivery performance	Positive association	- Significant in all excluding the effect of customer integration on customer delivery performance	Boon-itt and Wong (2011a)	151 Thailand automotive industry regression
- Internal integration - External integration	- Operational performance (delivery, production cost, product quality and production flexibility)	Positive association	- Significant in all excluding the effect of internal integration on production flexibility	Boon-itt and Wong (2011b)	151 Thailand's automotive firms (34% of Thai-foreign joint ventures and 18% of foreign owned) regression
- Supply chain process integration (activity integration and information sharing)	- Business value (market efficiency, financial efficiency and process efficiency)	Positive association	- significant	Ghobakhloo et al. (2011)	214 Iran manufacturing firms SEM
- SC value integration process - Effective supply chain relations	- SC performance	Positive association	- significant	McCarthy-Byrne and Mentzer (2011)	374 US manufacturing firms SEM (PLS)
- Internal integration - Supplier integration - Customer integration	- Performance (delivery, production cost, product quality and production flexibility)	Positive association	- significant	Wong et al. (2011)	151 Thailand's automotive firms (34% of Thai-foreign joint ventures and 18% of foreign owned) regression

Appendix 4: Prior literature on the impacts of environmental uncertainty on supply chain collaboration

Independent variables	Dependent variables	Hypotheses	Empirical results	Authors	Notes
- Technology uncertainty	- integrative strategies with suppliers	Positive association	- significant	Ragatz et al. (2002)	83 US manufacturing firms

					SEM
- Environmental uncertainty	- Manufacturing flexibility	Positive association	- No significnat	Pagell and Krause (2004)	168 US manufacturing firms SEM
- Environmental uncertainty	- Utilization of multiple channels of distribution	Positive association	- significant	Ceolho and Easingwood (2005)	62 UK financial services industries SEM
- Environmental uncertainty	- Domestic networking activities - Foreign networking activities - Export performance	Positive association	- No significant	Babakus et al. (2006)	257 manufacturing firms (75 Finland, 111 Sweden and 71 Norway) SEM
- Environmental uncertainty	- Supplier development and information management	Positive association	- significant	Agbejule and Burrowes (2007)	78 Finland manufacturing firms regression
- Supply uncertainty - Demand uncertainty - Technology uncertainty	- Strategic supply management	Positive association	- significant in the effect of supply and technology uncertainty on strategic supply management - No significant in the effect of demand uncertainty	Paulraj and Chen (2007b)	221 US manufacturing firms SEM
- Environmental uncertainty	- Increased customer purchases from suppliers in short, intermediate and long terms	Positive association	- significant in short and long terms - No significant in intermediate term	Fink et al. (2008)	372 US manufacturing firms SEM
- Environmental uncertainty	- Knowledge sharing policies and practices	Positive association	- significant	Hsu and Wang (2008)	130 Taiwan firms (50% manufacturing, 38.5% service and 11.5% not reported) regression
- Manufacturing system integration in environmental uncertainty	- Manufacturing performance	Positive association	- significant	Liao and Tu (2008)	303 US manufacturing firms regression

- Environmental uncertainty	- A manufacturer's propensity for vertical control over its supplier's decision - Manufacturer's satisfaction with the perceived supplier performance	Positive association	- significant in manufacturer's propensity - negative significant in manufacturer's satisfaction	Ryu (2008)	135 US manufacturing firms regression
- Environmental uncertainty	- Service performance	Positive association	- Negative significant	Wood (2008)	153 US firms (47% services; 23.5% manufacturing; 20% nonprofit or government; 9.5% retail) SEM
- Environmental uncertainty	- Control activities in internal control structure	Positive association	- significant	Jokipii (2010)	741 Finnish firms (44% manufacturing, 31.2% wholesale and retail trade, 12.8% transportation, communications and electronics and 12% others) SEM

Appendix 5: Prior literature on the impacts of environmental uncertainty on performance

Independent variables	Dependent variables	Hypotheses	Empirical results	Authors	Notes
- Technology uncertainty	- New product development (cycle time results, quality results and cost results)	Positive association	- No significant in cycle time - Negative significant in cost	Ragatz et al. (2002)	83 US manufacturing firms SEM
- Environmental uncertainty (labor market, supplier market, customer market and capital market)	- Export performance	Positive association	- No significant	Babakus et al. (2006)	257 manufacturing firms (75 Finland, 111 Sweden and 71 Norway) SEM

- Environmental uncertainty	- Broad scope management accounting systems information	Positive association	- significant	Agbejule and Burrowes (2007)	78 Finland manufacturing firms regression
- Environmental uncertainty	- A manufacturer's satisfaction with the perceived supplier performance	Positive association	- Negative significant	Ryu et al. (2008)	135 US manufacturing firms regression
- Perception of internal environmental uncertainty	- Service performance	Positive association	- Negative significant	Wood (2008)	153 US firms (47% services; 23.5% manufacturing; 20% nonprofit or government; 9.5% retail) SEM

Appendix 6: Prior literature on the moderating effects of environmental uncertainty on the relationship between supply chain collaboration and performance

Independent variables	Dependent variables	Hypotheses	Empirical results	Authors	Notes
- Environmental uncertainty - Environmental heterogeneity - Marketing differentiation	- Sales growth - Profitability - Overall performance	Positive association	- No significant	Dess et al. (1997)	96 data in 32 US firms regression
- Marketing and sales planning decision integration - Manufacturing planning decision integration - Demand uncertainty	- Perceived profitability	Positive association	- significant in the moderating effect of marketing and demand uncertainty on perceived profitability - No significant in the moderating effect of manufacturing and demand uncertainty on perceived profitability	O'Leary-Kelly and Flores (2002)	121 manufacturing firms in various industries (primary metal, fabricated metal products, industrial machinery and equipment, electronic equipment and transportation equipment) regression
- Internal	-	Positive	- significant	Narasimhan	623

integration - Company's integration with suppliers - Company's integration with customers - International market diversification	Performance (sales growth, market share growth and profitability)	association		and Kim (2002)	manufacturing firms (Korea-244 and Japan-379) regression
- SC relationship quality - Demand uncertainty - Technology uncertainty - Supply uncertainty	- SC performance	Positive association	- significant in demand and supply uncertainty - No significant in technology uncertainty	Fynes et al. (2004)	200 manufacturing firms in various countries (55% Irish, 5% UK, 14% other EU, 20.5% USA, 2% Japan and 3.5% others) SEM
- Supplier integration - Customer integration - Internal integration - Technology uncertainty - Demand uncertainty	- Customer delivery performance	Positive association	- significant in the moderating effect of internal and supplier integration and uncertainty on performance - No significant in the moderating effect of customer integration and uncertainty on performance	Boon-itt and Wong (2011a)	151 Thailand automotive industry regression
- Internal integration - External integration	- Operational performance (delivery, production cost, product quality and production flexibility)	Positive association	- signification in the moderating effect of internal and external integration on delivery and flexibility - No significant in the moderating effect of both integration on cost and quality	Boon-itt and Wong (2011b)	151 Thailand's automotive firms (34% of Thai-foreign joint ventures and 18% of foreign owned) regression

- Technology turbulence - Market turbulence - IT analytic capability	- Demand chain collaboration	Positive association	- significant in the moderating effect of technology and IT on collaboration - No significant in the moderating effect of market and IT on collaboration	Iyer (2011)	152 US manufacturing firms regression
- Internal integration - Supplier integration - Customer integration - Environmental uncertainty	- Performance (delivery, production cost, product quality and production flexibility)	Positive association	- significant in all excluding the moderating effect of customer integration and uncertainty on delivery	Wong et al. (2011)	151 Thailand's automotive firms (34% of Thai-foreign joint ventures and 18% of foreign owned) regression

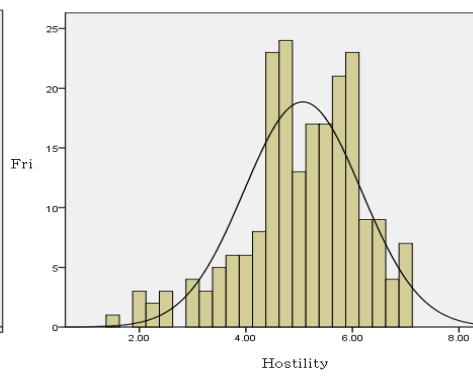
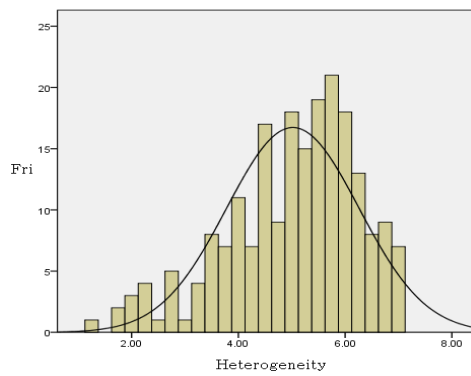
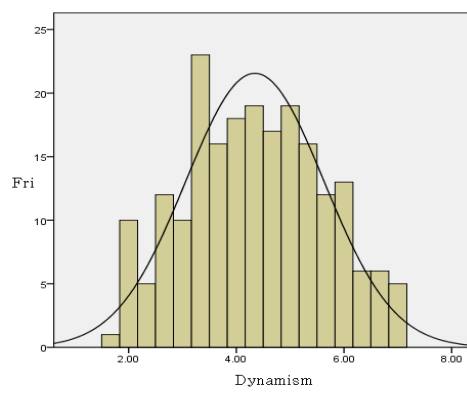
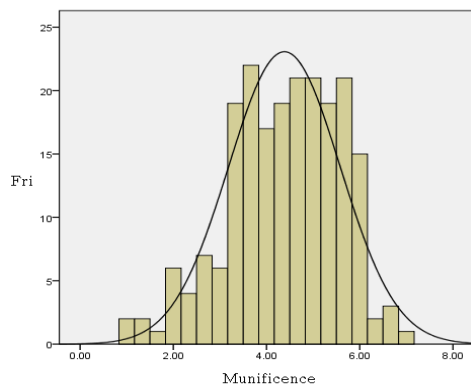
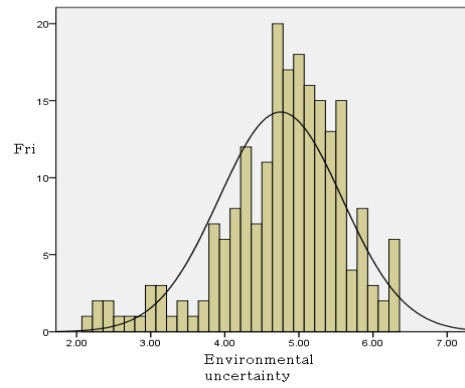
Appendix 7: Prior literature on the performance impacts of supply chain collaboration

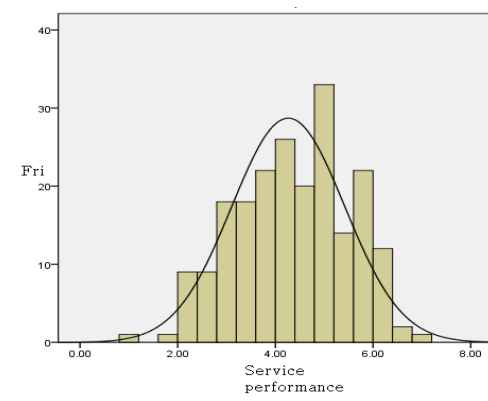
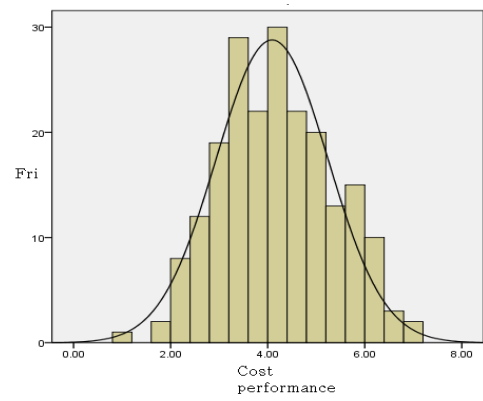
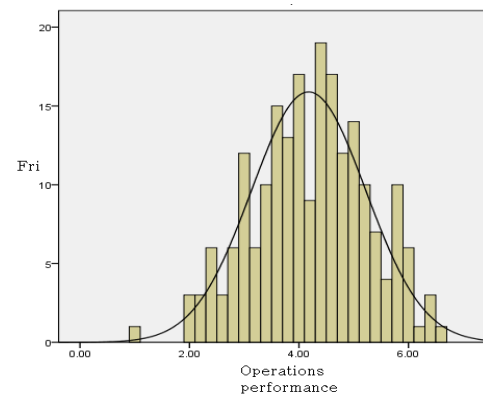
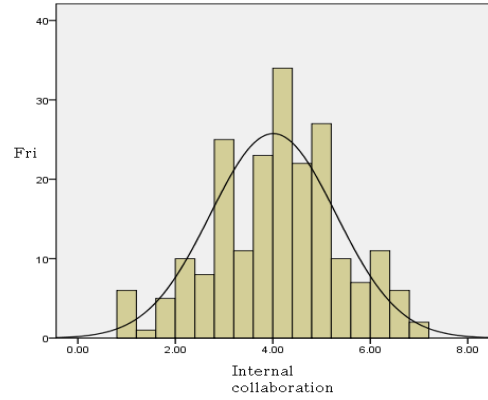
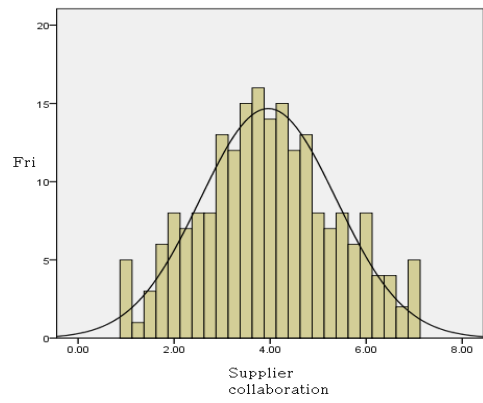
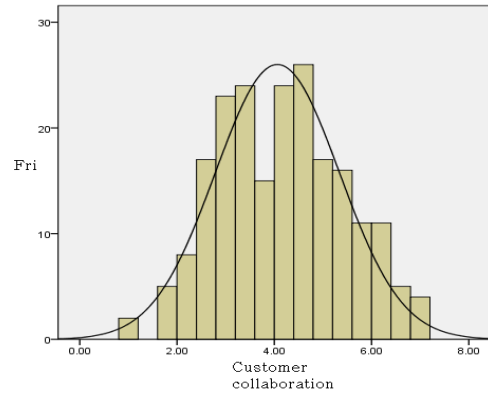
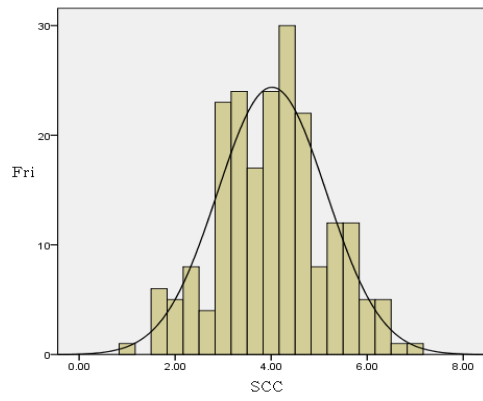
Independent variables	Dependent variables	Hypotheses	Empirical results	Authors	Notes
- IS for infrastructural support - IS for value creation management - IS for logical operation	- SCM performance	Positive association	- significant in the relationship between infrastructural support, value creation, logical operation and performance	Narasimhan and Kim (2001)	244 Korean manufacturing firms SEM
- Information systems	- Integrated internal operations - Integrated external operations	Positive association	- significant in the relationship between information systems and integrated internal operations	Rodrigues et al. (2004)	284 US manufacturing firms SEM
- ERP	- Integration of information flow with suppliers - Integration of physical flow with suppliers	Positive association	- significant	Cagliano et al. (2006)	297 manufacturing firms in various countries (14 Belgium, 30 Denmark, 23 Germany, 30 Hungary,

					25 Ireland, 53 Italy, 39 Norway, 12 Netherlands, 15 Spain, 19 Sweden and 37 UK) regression
- Supply chain integration - Supply chain information sharing	- Supply chain performance (Flexibility, resource and output)	Positive association	- No significant	Sezen (2008)	196 Turkish manufacturing firms regression
- Inter-organizational information systems integration	- SC organizational performance - Customer responsiveness - Financial performance	Positive association	- significant in all excluding the effect of integration on customer responsiveness	Rajaguru and Matanda (2009)	231 Australian food and hardware retailing firms SEM
- E-business supported supplier integration - Information sharing in supplier integration	- Regular use of lean manufacturing	Positive association	- significant	So and Sun (2010)	558 manufacturing firms in 17 countries regression
- Supply chain integration - IT integration			Cluster analysis	Thun (2010)	238 manufacturing firms in various countries (8.8% Austria, 12.6% Finland, 17.2% Germany, 11.4% Italy, 14.7% Japan, 13.0% Korea, 10.1% Sweden and 12.2% US) regression
- Supply chain process integration (activity integration and information)	- Business value (market efficiency, financial efficiency and process)	Positive association	- significant	Ghobakhloo et al. (2011)	214 Iran manufacturing firms SEM

sharing)	efficiency)				
- IT analytic capability	- Demand chain collaboration	Positive association	- significant	Iyer (2011)	152 US manufacturing firms regression
- Internal integration - Supplier integration - Customer integration	- Performance (delivery, production cost, product quality and production flexibility)	Positive association	- significant	Wong et al. (2011)	151 Thailand's automotive firms (34% of Thai-foreign joint ventures and 18% of foreign owned) regression

Appendix 8: Normal probability plots





<QUESTIONNAIRE>

The influencing factors of supply chain collaboration and operational performance

Thank you for a response to this questionnaire.

There are three aims of this study: one is to ascertain gaps in performance among levels of supply chain collaboration, another is to verify the moderating effect of environmental uncertainty and logistics information systems (LIS) on the collaboration and performance and the third is to confirm the causal link of environmental uncertainty and LIS on the collaboration and performance. The results of this research can give the methods of enhancing performance to top management and managers as follows: they can recognize their position in levels of the collaboration and how to improve their performance. The information which you provide is the most important data in this study and it is absolutely required for the completion of this research.

The researcher gives a promise that this information does not be used for the other aims, excluding research. If you have any questions, send the questions to the researcher by e-mail, fax or telephone.

Thank you for a response to the survey again.

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This is an anonymous questionnaire. Please ensure that you do not write your name, or any other comments that will make you identifiable, on the attached questionnaire. By completing the questionnaire you are consenting to take part in this research. You are advised to first read the enclosed letter carefully as it explains fully the intention of this project.

1. Environmental uncertainty

For the following questions, consider environmental uncertainty which you recognize. Please indicate the extent to which you perceive the following situations to be applicable by marking the appropriate number:

Items	← Strongly disagree strongly agree →
Potentiality in the market	①.....②.....③.....④.....⑤.....⑥.....⑦
Possibility of success when your firm entries into the new market	①.....②.....③.....④.....⑤.....⑥.....⑦
A growing opportunity of the market	①.....②.....③.....④.....⑤.....⑥.....⑦
The impossibility of forecasting the behaviour of competitors in the market	①.....②.....③.....④.....⑤.....⑥.....⑦
Impossibility of forecast on demand of the market	①.....②.....③.....④.....⑤.....⑥.....⑦
Impossibility of confirmation of customer needs	①.....②.....③.....④.....⑤.....⑥.....⑦
A change of competitors' competitive methods	①.....②.....③.....④.....⑤.....⑥.....⑦
A change of customers' preference for goods/services	①.....②.....③.....④.....⑤.....⑥.....⑦
A change of customers' level of expectation	①.....②.....③.....④.....⑤.....⑥.....⑦
Application of various competitive strategies	①.....②.....③.....④.....⑤.....⑥.....⑦
The strength of competition in the market	①.....②.....③.....④.....⑤.....⑥.....⑦
Considering the response of competitors in decision-making	①.....②.....③.....④.....⑤.....⑥.....⑦
Difficulty in analysing the strategies of competitors	①.....②.....③.....④.....⑤.....⑥.....⑦
The degree of regulations of the government	①.....②.....③.....④.....⑤.....⑥.....⑦

2. Supply chain collaboration

For the following questions, please indicate the extent to which you perceive the following situations to be applicable by marking the appropriate number:

Items	← Strongly disagree strongly agree →
Close contact with customers concerned with goods and services	①.....②.....③.....④.....⑤.....⑥.....⑦
Rapidity of order processes	①.....②.....③.....④.....⑤.....⑥.....⑦
A high level of information sharing with customers	①.....②.....③.....④.....⑤.....⑥.....⑦
Smooth communication with customers concerned with goods and services	①.....②.....③.....④.....⑤.....⑥.....⑦
Supplying goods and services to respond to customer needs	①.....②.....③.....④.....⑤.....⑥.....⑦
An exchange of harmonized information with suppliers	①.....②.....③.....④.....⑤.....⑥.....⑦
Participation of suppliers in inventory control	①.....②.....③.....④.....⑤.....⑥.....⑦
Use of quick response	①.....②.....③.....④.....⑤.....⑥.....⑦
A degree of network integration with suppliers for stable purchase	①.....②.....③.....④.....⑤.....⑥.....⑦
A degree of receiving stable goods and services from suppliers	①.....②.....③.....④.....⑤.....⑥.....⑦
The possibility of real time checking of data concerned with goods and services	①.....②.....③.....④.....⑤.....⑥.....⑦
Sharing information between departments	①.....②.....③.....④.....⑤.....⑥.....⑦
A degree of integrated inventory control	①.....②.....③.....④.....⑤.....⑥.....⑦
The possibility of real time checking on total stock	①.....②.....③.....④.....⑤.....⑥.....⑦
A high level of information integration in production processes	①.....②.....③.....④.....⑤.....⑥.....⑦

3. Performance

For the following questions, please indicate the extent to which you perceive the following situations to be applicable by marking the appropriate number:

Items	← Strongly disagree strongly agree →
A degree of saving of labour costs following reduction and re-disposition of workers	①.....②.....③.....④.....⑤.....⑥.....⑦
A degree of cost saving concerned with decreasing stock	①.....②.....③.....④.....⑤.....⑥.....⑦
A degree of cost saving concerned with stock management	①.....②.....③.....④.....⑤.....⑥.....⑦
A degree of cost saving in conformity with order management	①.....②.....③.....④.....⑤.....⑥.....⑦
A degree of cost saving concerned with contact with partners	①.....②.....③.....④.....⑤.....⑥.....⑦
A degree of increased flexibility of operations through cooperation with partners	①.....②.....③.....④.....⑤.....⑥.....⑦
Ability to fulfil special requirements of customers	①.....②.....③.....④.....⑤.....⑥.....⑦
Ability to supply estimated quality on time	①.....②.....③.....④.....⑤.....⑥.....⑦
Ability to provide customers with value added service	①.....②.....③.....④.....⑤.....⑥.....⑦
Ability to cooperatively overcome any problems with partners if they are occurred	①.....②.....③.....④.....⑤.....⑥.....⑦

4. Descriptive data

(1) Type of business

- ① Chemical or Rubber ② Electricity or Electronics ③ Metal or Non-metal
 ④ Machine, Transportation, or Equipment ⑤ Textiles, Clothes, or Leather
 ⑥ Lumber, Paper, or Furniture ⑦ Food or Beverage ⑧ others ()

(2) Annual turnover: ()

(3) The year which your company have invested in China: ()

(4) The number of total workers: ()

- ① below 50 ② 50-100 ③ 100-300 ④ 300-500 ⑤ 500-1,000 ⑥ over 1,000

(5) Company name: ()

(6) Department name: ()

* Thank you for your answer