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**GEBZE TECHNICAL UNIVERSITY**

**INSTITUTE OF SOCIAL SCIENCES**

# AN EMPIRICAL STUDY OF SUPPLY CHAIN SUSTAINABILITY IN TURKISH AUTOMOTIVE SECTOR

**Sefer Burak KACAR**

**DOCTORATE THESIS**

**GRADUATE SCHOOL OF SOCIAL SCIENCES**

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Advisor

Prof. Dr. Bülent SEZEN

**GEBZE**

**2018**

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| GEBZE TEKNİK ÜNİVERSİTESİ | **DOKTORA JÜRİ ONAY FORMU** |

GTÜ Sosyal Bilimler Enstitüsü Yönetim Kurulu'nun 10/01/2018 tarih ve 02 sayılı kararıyla oluşturulan jüri tarafından 09/02/2018 tarihinde tez savunma sınavı yapılan Sefer Burak Kacar'ın tez çalışması İşletme Anabilim Dalında DOKTORA tezi olarak kabul edilmiştir.

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# ABSTRACT

In current dynamic environment, it has become a necessity for firms to better control their supply chain operations against supply chain vulnerabilities. Little consideration has been paid to the relationship between business environment, supply chain risks, supply chain vulnerability, supply chain performance and sustainability. Hence, we aim with this study to unveil the influence of supply chain variables on supply chain performance and sustainability.

The proposed model consists of 10 hypotheses to disclose the relationship between 6 main constructs; Supply Chain Uncertainty, Supply Chain Risks, Supply Chain Performance, Collaborative Planning Systems, Vulnerability, and Supply Chain Sustainability. The hypotheses are validated by empirical study with 213 domestic and foreign automotive companies operating in Turkey. The results of this dissertation reveals that supply chain sustainability is primarily affected by supply chain performance, collaborative planning systems, and supply chain vulnerability.

The findings of this study could provide the necessary point of view for the managers working in supply chain management area to comprehend the dynamics behind sustainable supply chains.

**Keywords: Regression Analysis, Supply Chain Sustainability, Supply Chain Performance, Supply Chain Risks, Uncertainty.**

# ÖZET

Günümüz dinamik şartlarında, firmaların tedarik zinciri kırılganlıklarına karşı tedarik zinciri operasyonlarını daha iyi kontrol etmeleri bir gereklilik haline gelmiştir. İş çevresi, tedarik zinciri riskleri, tedarik zinciri kırılganlığı, tedarik zinciri performans ve sürdürülebilirliği arasındaki ilişkiye literatürde fazla değinilmemiştir. Bundan dolayı, bu çalışmayla tedarik zinciri değişkenlerinin tedarik zinciri performans ve sürdürülebilirliğine etkisini ortaya çıkarmak amaçlanmaktadır.

Kavramsal model, 6 ana yapıyla beraber 10 araştırma hipotezinden oluşmaktadır: Tedarik Zinciri Belirsizliği, Tedarik Zinciri Riskleri, Tedarik Zinciri Performansı, İşbirlikçi Planlama Sistemleri, Tedarik Zinciri Kırılganlığı ve Tedarik Zinciri Sürdürülebilirliği. Hipotezler, Türkiye'de faaliyet gösteren 213 adet yerli ve yabancı otomotiv firmasıyla görgül olarak test edilmiştir. Bu çalışmanın sonuçları; tedarik zinciri sürdürülebilirliğinin aslen tedarik zinciri performansı, işbirlikçi planlama sistemleri ve tedarik zinciri kırılganlığından etkilendiğini göstermektedir. Bu çalışmanın bulguları; tedarik zinciri alanında çalışan yöneticilere, sürdürülebilir tedarik zincirindeki dinamikleri anlamak için gerekli bakış açısını sağlayabilir.

**Anahtar Kelimeler: Regresyon Analizi, Tedarik Zinciri Sürdürülebilirliği, Tedarik Zinciri Performansı, Tedarik Zinciri Riskleri, Belirsizlik.**

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| AGFI | : Adjusted Goodness of Fit Index |
| ARS | : Average R-squared |
| CFA | : Confirmatory Factor Analysis |
| CMV | : Common method variance |
| CPFR | : Collaborative Planning, Forecasting and Replenishment |
| CR | : Composite Reliability |
| CSP | : Corporate Social and Environmental Performance |
| EDI | : Electronic Data Interchange |
| EFA | : Exploratory Factor Analysis |
| FP | : Financial Performance |
| IA | : Incentive Alignment |
| ICI | : Istanbul Chamber of Industry |
| JIT | : Just in Time |
| KMO | : Kaiser-Meyer-Olkin |
| LV | : Latent Variables |
| MV | : Manifest Variables |
| OLS | : Ordinary Least Square |
| PLS | : Partial Least Squares |
| SCM | : Supply Chain Management |
| SSCM | : Sustainable Supply Chain Management |
| SSCP | : Sustainable Supply Chain Performance |
| SCO | : Supply Chain Orientation |
| SCP | : Supply Chain Performance |
| SCRM | : Supply Chain Risk Management |
| SEM | : Structural Equation Modelling |
| TAYSAD | : Association of Automotive Parts & Components Manufacturers |
| TOSB | : Tuzla Organized Industrial Zone of Automotive Subsidiary Industry |
| TQM | : Total Quality Management |

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# 1. INTRODUCTION

## 1.1 Problem

A supply chain is the network of all the individuals, organizations, resources, activities and technology taking part in the creation and sale of a product, from the delivery of source materials from the supplier to the manufacturer, through to its eventual delivery to the end user. However, supply chain management (SCM) is the administration of materials, information, and finances as they move in a process from supplier to manufacturer to wholesaler to retailer to consumer. In other words, the aim is to integrate all the business processes within the supply chain to increase and sustain customer satisfaction. It has been argued ‘‘the understanding and practicing of supply chain management (SCM) has become an essential prerequisite for staying competitive in the global race and for enhancing profitably.’’(Li et. al., 2004, p. 107). As has been stated in the study by Sarkis et. al. (2011) SCM stems partially from the idea of minimizing waste since waste reduces economic profitability (Beske and Seuring, 2014). SCM practices are defined as the set of activities undertaken by an organization to promote effective management of its supply chain. Stonebraker and Afifi (2004) also have categorized four historical phases of supply chain development and have classified distinct supply chain strategies that are appropriate for each environment.

Costumers and governments are putting pressure on the enterprises to turn into more sustainable organizations. Since the term ‘sustainability’ first has been bandied about over 20 years ago, various definitions of sustainability have been proposed. The World Commission on Environment and Development (WCED, 1987 – Brundtland Commission) has defined sustainability as “*using resources to meet the needs of the present without compromising the ability of future generations to meet their own needs*’’ (Winter and Knemeyer, 2013). The European Commission has declared that “Sustainable development remains a fundamental objective of the European Union under the Lisbon Treaty” (Mota et. al., 2015). Seuring and Müller (2008) has defined Sustainable Supply Chain Management (SSCM) as the management of material, information and capital flows as well as cooperation among organizations while taking the goals for all three dimensions of sustainable development, i.e., economic, environmental and social, into consideration in order to meet customer and stakeholder

requirements. However, in this dissertation, an extra dimension for supply chain sustainability, namely operational sustainability will be added to the construct 'supply chain sustainability'. All the indicators for these four dimensions are adapted from the study by Zailani et. al. (2012). The main idea is to reveal the constructs that have an impact on supply chain sustainability. Although it is a common belief that enterprises employing in the area of sustainability and implementing SSCM practices are susceptible to different and sometimes even higher risks than conventional SCM (Beske and Seuring, 2014), the impact of supply chain risks on supply chain sustainability is mainly examined along the SC Vulnerability.

Dealing with risk in supply chain has become a significant issue in recent years. The topic's significance is owing to several industry trends currently in place: rise in strategic outsourcing by enterprises, globalization of markets, increasing reliance on suppliers for specialized capabilities and innovation, reliance on supply networks for competitive advantage, and emergence of information technologies that enable to control and coordinate extended supply chains. The general attitude towards risk management should commence with the determination of business purposes and performance goals and the related risks (Narasimhan and Talluri, 2009)

Risk identification and risk assessment are the main objectives in supply chain risk management (SCRM), since once the risk is identified, supply chain practitioners face the problem of how to deal with it. The potential impact of risk on a firm's performance is the most crucial thing in order to develop necessary tools to mitigate the risk. In addition to that, supply chain risk management (SCRM) is an emerging interdisciplinary area of research involving operation management, finance and marketing among other disciplines.

A study by Wagner and Bode (2008) will be the guidance for my dissertation. According to the authors, most of the academicians and the practitioners put supply chain risks on their agendas. This is mainly due to the increasing awareness on this topic. In this study, the authors have utilized the definition of supply chain risk as a ''variation in the distribution of possible supply chain outcomes, their likelihood, and their subjective value, which is directly taken from the study by Jüttner et al. (2003, p. 200). In my model, risk is considered as the negative diversion from the expected value of a certain performance measure which ends up with negative consequences for the company in consideration. In addition to that, according to Christopher and Peck (2004, p. 3), supply chain vulnerability can be defined as ''an exposure to serious

disturbance''. According to the authors, supply chain risk could be examined in three sources: demand-side, supply-side, and catastrophic. Demand-side risks result from disruptions emerging from downstream supply chain operations (Jüttner, 2005). This encompasses not only the disruptions in the physical distribution of products to the end-customer with particular issues being transportation operations (e.g., a truck driver strike) (McKinnon, 2006), but also the distribution network (e.g., a fire in a warehouse). On the other hand, demand-side risks can arise from the uncertainty enclosing the random demands of the customers. Moreover, supply-side risks are intrinsic to purchasing, supplier activities, and supplier relationships. Supply-side risks involve supplier business risks, production capacity constraints on the supply market, quality problems, technological changes, and product design changes. Lastly, natural hazards (force majeure), socio-political instability, civil unrest, economic disruptions, and terrorist attacks are types of catastrophic risk. The authors have collected from various studies in the literature that supply chain vulnerability is raised by customer dependence, supplier dependence, supplier concentration, single sourcing, and global sourcing. In my dissertation, I will try to incorporate supply chain vulnerabilities under one roof and try to investigate the relationship between these vulnerabilities via supply chain strategies on supply chain performance and sustainability.

Relatively little research has been conducted to measure and manage supply chain sustainability. According to Wang and Sarkis (2013), supply chain sustainability is increasingly comprehended as a significant origin of cost reduction and fundemental for the long-term profitability of a company. The identification of sustainability-related supply chain risks, the assessment of their impact and the development of risk management tools are crucial for supply chain managers. Therefore, this study will try to illuminate the dynamics behind supply chain sustainability by taking supply chain performance, collaborative planning systems, supply chain vulnerability into consideration.

## 1.2 The Purpose of the Study

The intent of the proposed study is to unveil the dynamics behind the supply chain sustainability and also to provide supply chain practitioners in the automotive sector with the implications of this study.

What are the supply chain measures, which have to be taken into consideration during this study? How are the arbitrary measures eliminated? Finally, what should be inferred from this study?

These are the central questions of this study. I no doubt will add more questions as I proceed through the research process and obtain more clarity on supply chain sustainability measures and their interrelationships.

It is anticipated from the review of the literature I have completed thus far that I have to decide to the variables of the constructs from the vast literature.

I will decide the survey questions for the constructs. First, the preliminary analysis of the performance measures will be completed. Afterwards, a theoretical framework will be established by using regression analysis.

## 1.3 Significance

In current dynamic environment, it has become a necessity for firms to better control their supply chain operations against supply chain vulnerabilities. In order to examine the impacts of supply chain vulnerability and supply chain performance on supply chain sustainability, a new model will be developed and tested by regression analysis. Having determined the interrelationship between factors, new strategies could be developed to mitigate the risk that supply chains in the companies are exposed to.

Despite the theoretical explanations about the vulnerability in the supply chain management in the literature, studies that examine the issue are limited. This study differs from other studies in such a way that it examines the combined impact of the supply chain performance, collaborative planning systems and supply chain vulnerability on supply chain sustainability in big firms by using the regression analysis. The sample of this study consists of 213 of the biggest domestic and foreign automotive companies operating in Turkey. Instead of taking companies as independent units, this approach will evaluate firms' performances extensively in relation to supply chain risks and uncertainty.

## 1.4 Assumptions

Results of this research are expected to shed light on supply chain sustainability practices of manufacturing companies in Turkey. The ultimate implication of this research is to generate useful knowledge for managers and emphasize the importance

of mitigation techniques in supply chain and also make a contribution to the evolution of supply chain management. One should also bear in mind that without support and active contribution by top management, the importance of supply chain risk management cannot be fully realized.

## 1.5 Nature and Limitation of the Study

The proposed study follows a quantitative research approach, involving the use of Likert's scale as the primary method. Some limitations will be imposed on this study with respect to the geographical, cultural and sectorial conditions. Moreover, this study is limited to the Turkish automotive industry, and so further research is needed in other cultures/contexts.

## 1.6 Research Method

The four stages of research method are utilized in this dissertation as described by Stuart et al. (2002):

1. Setting the research questions
2. Instrument development
3. Data collection
4. Data analysis

## 1.7 Research Questions

In this study, deductive approach will be followed, i.e. hypotheses are first developed and then examined by means of empirical observation. In our regression model, the reasoning can be hypnotized as follows:

$H_{1a}$. The level of uncertainty will have a significant influence on supply chain performance.

$H_{1b}$. The level of uncertainty will have a significant influence on collaborative planning systems.

$H_{1c}$. The level of environmental uncertainty will have a significant influence on supply chain vulnerability.

$H_{2a}$. The level of supply chain risks will have a significant influence on supply chain performance.

$H_{2b}$. The level of supply chain risks will have a significant influence on collaborative planning systems.

$H_{2c}$. The level of supply chain risks will have a significant influence on supply chain vulnerability.

$H_3$. The level of supply chain performance will have a positive influence on supply chain sustainability.

$H_4$. The level of collaborative planning systems will have a positive influence on supply chain performance.

$H_5$. The level of collaborative planning systems will have a positive influence on supply chain sustainability.

$H_6$. The level of supply chain vulnerability will have a significant influence on supply chain sustainability.

# 2. RELEVANT LITERATURE

In this section, the constructs used in our research model will be defined in detail and interrelations of these constructs will be explored.

## 2.1 Uncertainty

Uncertainty is omnipresent in supply chains. Although uncertainty has been a subject of research area in the field of organization theory since the seminal work of Thompson (1967), supply chain management has recently tackled uncertainty as a subject of empirical study (Flynn et. al., 2016). Identification of the main sources of uncertainty within the supply chains and developing strategies to manage them is a significant challenge for the industry. Simangunsong et. al. (2016) has used 14 different source of uncertainty adapted from the study by Simangunsong et al. (2012). These sources can be cited as: product characteristics, process/manufacturing, control/chaos uncertainty, decision complexity, organization structure and human behavior, IT/IS complexity, end-customer demand, demand amplification, supplier, parallel interaction, Order forecast horizon/lead-time gap, chain configuration, infrastructure, and facilities, environment, disruption/natural uncertainties

Supply chain uncertainty consists of multiple levels, including individual decision makers, functional departments, organizations and ultimately, supply chains (Carter et. al., 2015). According to Flynn et. al. (2016), three various types of uncertainty has been categorized, namely micro-level uncertainty, meso-level uncertainty, and macro-level uncertainty.

Fynes, Burca and Marshall (2004) have developed a model of environmental uncertainty, supply chain (SC) relationship quality and SC performance. The authors have described SC quality as the higher order construct that encompasses trust, adaptation, communication and co-operation. Uncertainty has been tackled as the problem of adaptation to changes in particular circumstances of time and place. In this study, three different sources of uncertainty have been utilized in the model, which was adapted from the study by Davis (1993). Davis (1993) has suggested that there are three different sources of uncertainty in supply chains: demand uncertainty, supply uncertainty and technological uncertainty. These uncertainty variables were considered to moderate the link between SC relationship quality and SC performance by the authors.

Trkman and McCormack (2009) has put forward that an important division of risks, namely the origin of risks which can either be within a chain or from the outer environment has been neglected in earlier research. The authors have distinguished between the different kinds of risks based on the sources of uncertainty, namely endogenous uncertainty and exogenous uncertainty.

Endogenous uncertainty: This source is intrinsic to SC and can result in changing focal firm and suppliers. Market and technology turbulence are the most outstanding among them.

Exogenous uncertainty: The source of uncertainty/risk originates from outside of the SC. The authors have proposed to divide these risks into the two most remarkable kinds. These are: discrete events (e.g. terrorist attacks, contagious diseases, workers' strikes) and continuous risks (e.g. inflation rate, consumer price index changes).

Few studies in the literature have analyzed the relationship between flexibility, uncertainty, and performance for manufacturing systems in detail (Merschmann, and Thonemann, 2011). However, in this dissertation, the direct impact of uncertainty on supply chain performance will be analyzed. As in most studies in the literature, we expect that supply chain performance is negatively influenced with an increase in uncertainty.

In this study, survey questions regarding uncertainty have been adapted from the studies by Cannon and Homburg (2001) and Inman et al. (2011). Hence, we propose that:

$H_{1a}$. The level of uncertainty will have a significant influence on supply chain performance.

$H_{1b}$. The level of uncertainty will have a significant influence on collaborative planning systems.

$H_{1c}$. The level of environmental uncertainty will have a significant influence on supply chain vulnerability.

## 2.2 Supply Chain Risks

Risk form the consumer's point of view can be defined as the uncertainty and adverse consequences of buying a product or service (Dowling and Staelin, 1994). Risk sources can be cited as environmental, organizational or supply chain related variables that cannot be estimated with accuracy and that impacts the supply chain-

outcome variables. Supply Chain Risk Management can be defined as the management of SC risks through co-ordination or collaboration among the SC partners in order to guarantee profitability and continuity (Tang, 2006). Tang (2006) has classified supply chain risks in two main categories: Operational risk due to the supply and demand misfit and originates from failure of processes, people and systems: and disruption risks encompassing both man-made or natural disasters, such as terrorist attacks, strikes, earthquakes and floods (Chopra & Sodhi 2004).

A study by Faisal, Banwet and Shankar (2007) examined various information risks that could impact a supply chain and developed a conceptual framework to quantify and mitigate them. According to the authors, different information risks of the supply chain can be roughly classified as: information security/breakdown risks, forecast risks, intellectual property right risks, and IT/IS outsourcing risks. Likewise, Kilpatrick and Factor (2000) has stated that in order to reduce information risks in a supply chain, mutual trust for long-term relationships and the confidentiality of information among partners is a necessity.

Risk management process is concentrated on understanding the risks, and minimizing their impact (Faisal, 2006). Since risk is part of every operation, risk management is becoming crucial for the organizations to attain their long term goals (Ali and Shukran, 2016).

The phases of the risk management process diversify from risk identification/analysis (or estimation) via risk assessment (or evaluation) to different ways of risk management (Norrman and Jansson, 2004). Vendor and supplier rating programs, contingency programs or early warning systems can be cited among the elements of risk identification. On the other hand, risk mitigation encompasses practices such as rethinking and re-evaluating their supply and distribution strategy (for instance, by using postponement and changing the location of some facilities, etc.) and supplier development (Manuj and Mentzer, 2008; Blome and Schoenherr, 2011).

Supply Chain Risk Management encompasses various fields such as operations management, marketing, finance and strategy with different points of views working together (Bandaly et. al., 2012). Bandaly et. al.'s study reviewed risks in supply chains, supply chain vulnerabilities, supply chain structure and selection of risk management approaches. Another major contribution of this study is that it brings risk management approaches in literature together. In the study, risk management approaches are classified as avoidance approaches, prevention approaches and mitigation approaches.

A ‘contingency logistics system’ (CLS) is defined by Thomas (2004, p. 36) as a set of processes and methods for providing the procurement, distribution, storage and transportation of people, supplies, materials, and equipment for supporting contingency operations. Likewise, Stauffer (2003) has put forward that the nature of risk could diversify (i.e. political instability, exchange rates, carriage capacity, shelf life, and customer demand). The author has also asserted that although these risks are not new, supply chain managers always keep the dangers related with these risks in mind. Comparably, in early research in this area, risks have been identified as the bulges in a balloon. In order to maintain the risk in supply chain, inventory levels have been kept high. However, keeping inventory levels high, can raise the risk of obsolescence. Another example has been revealed in terms of suppliers. If the company increases the numbers of its suppliers, the enterprise is more prone to risks in protecting its intellectual property.

Wieland and Wallenburg (2012) has supported the view that supply chain strategies and SCRM for the purpose of managing risk by diminishing the vulnerability and ensuring continuity can be seen as being a “two-sided coin”(Wieland and Wallenburg, 2012, p. 888). The authors demonstrated empirically that both proactive (i.e. robust) and reactive (i.e. agile) supply chain strategies lead to reduction of the vulnerability of global supply chains and are in that sense necessary. Christopher and Peck (2004) divided supply chain risks as external and internal risks, which is a similar to the study conducted by Thun and Hoenig (2011). Thun and Hoenig (2011) have examined supply chain risk management in the German automotive industry empirically. The study conducts a survey with 67 manufacturing plants in the German automotive industry. Supply chains’ vulnerability has been investigated and supply chain risks have been identified by analyzing their probability to happen and their potential impact on the supply chain. The trend towards lean supply chains results in low inventories, but leads to high inventories due to the turbulences without safety stocks.

According to Thun and Hoenig (2011), the estimation of the managers related with the key developments driving supply chain risks is depicted in Figure 2.2.1.

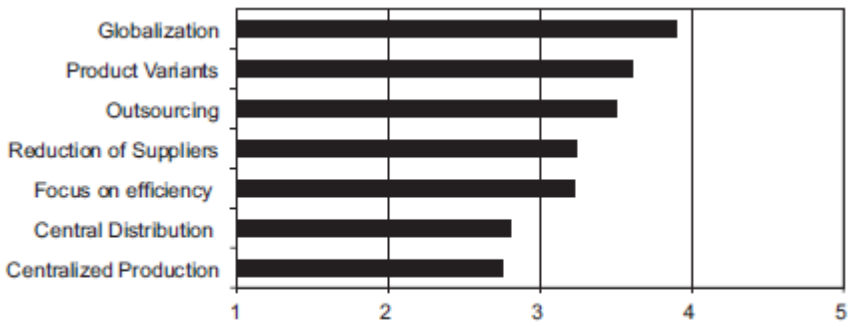


**Fig. 2.** Drivers of supply chain risks.

Figure 2.2.1 Drivers of supply chain risks

Li et. al. (2015) have identified risk information sharing and risk sharing mechanism as two important joint SCRM practices. They argued that the effectiveness of these two joint practices in improving financial performance can be strengthened by collaborative relationship characteristics including relationship length, supplier trust, and shared SCRM understanding. This study has suggested that risk information sharing and risk sharing mechanism was found to be positively related to the financial performance by means of moderating effect of collaborative relationships.

Various authors have identified different supply chain risks and these studies revealed the need for an empirical work in supply chain risk management. It is obvious that more research should be conducted in order to find out the instruments for an effective supply chain risk management. While internal company risks consider mainly the disruptions due to the problems within the enterprise such as machine breakdowns or IT problems, the main attention of the external supply chain risks is environmental causes that lead directly or indirectly to disturbances within the supply chain. These environmental causes can be sociopolitical, economical, technological or geographical reasons (Christopher and Peck, 2004). Examples are earthquakes or hurricanes as well as terrorist attacks or political instabilities (Kleindorfer and Saad, 2005).

Cucchiella and Gastaldi (2006) have also divided supply chain risks into categories of internal (involving such issues as capacity variations, regulations, information delays, and organizational factors) and external (market prices, actions of competitors, manufacturing and yield costs, supplier quality, and political issues). Risk is also a function of the level of uncertainty and the impact of an event. Many sources

contribute to uncertainty in a supply chain (Sinha et. al., 2004). Typical supply chain risks involve supply capacity constraints, quality issues, supplier liquidity problems, supplier dependency, product design changes, delivery delays, procurement related risks such as exchange rates, inventories and stockouts, logistics and transportation risks, supply chain relational risks such as hold up risks and moral hazard, demand risks such as demand volatility and inaccurate forecasts, information distortion and stock accumulation due to the bullwhip effect, and infrastructure and systems risks such as breakdowns, equipment malfunctions. In a study by Wagner and Bode (2008), five different supply chain risk sources have been classified. These could be cited as: (1) demand side; (2) supply side; (3) regulatory, legal and bureaucratic; (4) infrastructure; and (5) catastrophic. As indicated by the authors, while, the first two risk categories manage supply-demand coordination risks that are internal to the supply chain, the last three concentrate on risk sources that are not really inside the supply chain. The study has ended up that supply chain risks do not have a large impact on supply chain performance.

In this dissertation, we endeavor to respond three important research questions regarding supply chain risks: How does SCRs influence supply chain performance? Are SCRs related to collaborative planning systems? What is the relationship between SCRs and supply chain vulnerability?

This study makes a contribution to the literature from two points of view. First, this study is among the first ones that examine the impact of SCRs on collaborative planning systems empirically. Second, this study attempts to examine the relationship between two close constructs, i.e. SCRs and vulnerability. Moreover, the findings of this study provide managerial implications for manufacturing companies in the globe.

Survey questions excluding the third one, which is added by the authors, regarding supply chain risks has been adapted from the study by Wagner and Bode (2008). Hence, we propose that:

$H_{2a}$. The level of supply chain risks will have a significant influence on supply chain performance.

$H_{2b}$. The level of supply chain risks will have a significant influence on collaborative planning systems.

$H_{2c}$. The level of supply chain risks will have a significant influence on supply chain vulnerability.

## 2.3 Supply Chain Performance

Numerous studies in literature explored the factors, which have impact on supply chain performance. Most of them concentered on the relationship between supply chain management strategies and performance. Two different supply chain management strategies can be cited as: (1) risk and (2) opportunities, which are motivated by different intentions (assess and reduce risks vs increase and realize opportunities) (Schaltegger and Burritt, 2014, p.234). Wieland and Wallenburg (2012) revealed empirically that both proactive (i.e. robust) and reactive (i.e. agile) supply chain strategies are essential for lessening of the vulnerability in global supply chains. The research by the authors has provided strong support for the assumption that both agility and robustness strategies may be vital for the progress of the supply chain's customer value and business performance. Bavarsad et. al. (2013) attempted to reveal the relationship between supply chain management strategy with logistics performance and organizational performance (marketing and financial). The authors have considered that supply chain management strategy depends on universality and integration, i.e, their organizational performance (marketing and financial) will be increased with implementing this strategy in production organizations. In order to measure logistics performance; five criteria, namely, delivery speed, delivery flexibility, order full capacity, responsiveness, and delivery dependability, have been utilized. Moreover, average market share growth, average sales volume growth and average sales (in dollars) growth are used for the evaluation of marketing performance with respect to the competitors in the industry. Return on sales, profit growth and average profit and return on investment in comparison with the rivals are used for the evaluation of financial performance. According to Morana (2013), supply chain performance contains five factors: availability, product and service offerings, timeliness, profitability and growth.

Furthermore, according to Green et. al. (2014), organizational performance, or success, is defined and determined by a firm's ability to compete and is measured as return on investment, return on sales, and profitability as compared to its competition.

Similar study conducted by Chow et. al. (2008) have conducted an empirical survey of middle-line managers in the US and Taiwan to examine the relationship of supply chain management components and organizational performance. Supply chain management components in this study can be cited as supply chain practices, supply

chain concerns, and supply chain competencies. SCM practices in this study encompasses suppliers in strategic and operational decision making, encouraging information sharing and searching for new ways to integrate upstream activities. Furthermore, supply chain competence have been assessed with the constructs of quality and service, operations and distribution, and design effectiveness.

Prajogo and Olhager (2012) have examined the effects of long-term relationships, information technology and sharing, and logistics integration on supply chain integration and performance. In their study, logistics integration has been used to refer to specific logistics practices and operational activities that coordinate the flow of materials from suppliers to customers throughout the value stream. Moreover, information integration has been used refer to the sharing of key information along the supply chain network which is enabled by information technology (IT).

Another study conducted by Qrunfleh and Tarafdar (2012) have examined the relationship between supply chain (SC) strategy and supply chain information systems (IS) strategy, and its impact on supply chain performance and firm performance. The authors support the argument by Gunasekaran and Ngai (2004) proposing that 'to successfully managing the supply chain depends on measuring and monitoring information about its main operational and performance parameters (e.g. inventory, delivery schedules and lead times)'. Qrunfleh and Tarafdar (2013) have examined the role of strategic supplier partnership and postponement respectively, on the relationship between lean and agile supply chain responsiveness. The authors have attempted to demonstrate that implementing proper supply chain practices to support and execute supply chain strategy will enhance the responsiveness of the supply chain and the performance of the focal firm. The main objective of supply chain strategy is to build up the focal firm's supply chain responsiveness with regard to its customers. The objective of this article is to analyze the mediating effect of supply chain practices (i.e. set of supply chain activities and resources) on the relationship between supply chain strategies. Inman et. al. (2011) conducted a study to develop and test a structural model combining agile manufacturing as the focal construct. This model includes the primary components of JIT (JIT-purchasing and JIT-production) as antecedents. Operational performance and firm performance are measured as a consequence of JIT strategy. Nevertheless, the commonly used JIT inventory system is a typical example of a supply chain practice that evokes material shortage risks in enterprises (Bandaly et. al., 2012).

A study conducted by Vanichchincha and Igel (2011) have investigated the relationship among total quality management practices (TQMP), supply chain management practices (SCMP) and firm's supply performance (FSP) in the automotive industry in Thailand. The authors have measured firm's supply performance with the indicators of cost, flexibility, relationship and responsiveness. The results of the study suggest that TQMP significantly and positively impacts its firm's supply performance (FSP). In addition, TQMP had a significant indirect positive effect on FSP through SCMP.

In this dissertation, survey questions regarding supply chain performance has been adapted from the study by Kim (2009). In our study, we propose that:

$H_3$. The level of supply chain performance will have a positive influence on supply chain sustainability.

## 2.4 Collaborative Planning Systems

The onset of Collaborative Planning Systems dates back to 1998 with a study by Cooke (1998). The effects of collaborative planning, forecasting and replenishment in the performance of supply chains have been a topic of debate in the literature (Ramanathan and Gunasekaran, 2014). A new tool called Collaborative Planning, Forecasting and Replenishment (CPFR) framework was firstly brought out as a pilot project between Wal-Mart and Warner-Lambert in the mid-nineties in order to respond rapidly to customer demands (Ireland and Crum, 2005). CPFR is a technological innovation tool that was first registered as a trademark by Voluntary Interindustry Commerce Standards (VICS) Association (1998) and is defined by VICS as a collection of new business practices that utilize the internet and EDI in order to attain two goals: ineradicably lower inventories and expenses while enhancing customer service (Panahifar et. al., 2015). Panahifar et. al. (2015) has reviewed 93 papers published from 1998 to 2013 on CPFR. The articles reviewed are classified according to 5 dimensions, namely Collaborative Planning, Collaborative Forecasting, Collaborative Replenishment, Implementation of CPFR, and lastly comparison with other techniques. Panahifar et. al. (2015) have identified four main constructs for the successful implementation of CPFR: CPFR enablers, CPFR barriers, trading partner selection and incentive alignment (IA). The most encountered CPFR enablers in the literature can be cited as: the creation of high level of trust, the significance of information. Top management support and commitment and a clear

communication/business plan are main requirements for successful collaboration. Important inhibitors to the successful implementation of CFPR gathered from the literature can be identified as: no shared targets; lack of demand variability; lack of budget for software; lack of partner trust; difficulties to calculate benefits; executive support obstacles; lack of real time coordination of information exchange; no adequate information technology and expertise. The significance of partner selection in successful collaboration has been commonly acknowledged in the literature. Improper partner selection is known as the main reason for a bad performance between trading partners. Incentive alignment (IA) can be defined as the process of sharing costs, risks and benefits among supply chain partners. An IA can assure the loyalty between trading partners. The implications of the study by Panahifar et. al. (2015) reveal that wrong selection of partners causes main barriers to CPFR implementation such as compatibility of partners' abilities, lack of trust and cultural conflicts.

Collaborative Planning Forecast and Replenishment (CPFR) is a cohesive bundle of business processes by means of supply chain (SC) trading partners share information, synchronized forecasts, risks, costs and benefits with the intent of improving overall SC performance through joint planning and decision making (Thome et. al., 2014). Thome et. al. (2014) have reviewed and examined 47 papers by using 'collaborative planning forecasting and replenishment' as search keywords. The main success factor in CPFR has been cited as organizational readiness consisting of adequate technological capacity, educated employees, financial sufficiency and willingness and organizational culture to collaborate with trading partners. Nevertheless, there is no agreement about the steps and agenda for CPFR. Moreover, amount of investment for the collaboration, particularly for ICT and organizational changes should not exceed the expected benefits.

According to Attaran and Attaran (2007), lack of collaborative planning leads to negative impacts on supply chain performance. Early implementation of inter-enterprise trading partnership concentrated on the utilization of electronic data interchange (EDI). EDI has utilized to transfer information such as purchase orders, invoices, material releases, shipping notices, and product inquiries electronically. Further steps in trading partnership embraces information sharing and data exchange. CPFR assists to eliminate demand and supply uncertainty by means of communications between supply chain partners. However, it should be kept in mind that SC collaboration will be gainful to the parties only when all members in SC

collaborate. The evolution of CPFR has been depicted in Figure 2.4.1 (Attaran and Attaran, 2007). CPFR can be examined in four stages. These are: planning, forecasting of demand and supply, execution, and lastly analysis.

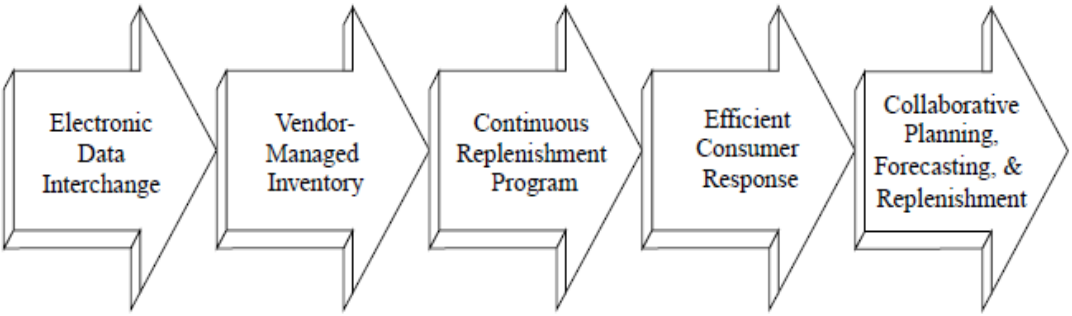


Figure 2.4.1 Evolution of supply chain solutions

The CPFR can be implemented in three phases, which can be defined as Basic CPFR, Developing CPFR, and Advanced CPFR. The CPFR process model can be depicted in Figure 2.4.2 (Wang et. al., 2005).

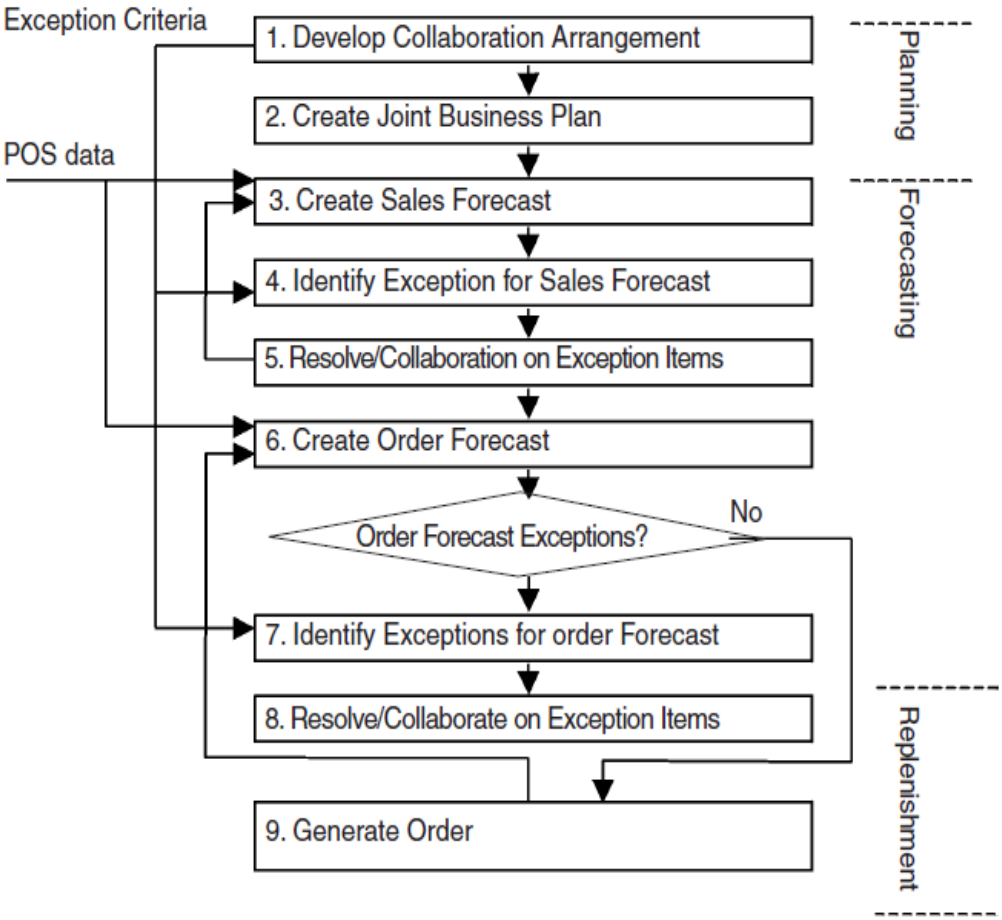


Figure 2.4.2 CPFR Process Model

7 dimensions of collaboration has been named as: information sharing, goal congruence, decision synchronization, incentive alignment, resource sharing, communication and joint knowledge creation (Ramanathan and Gunasekaran, 2014). The authors have utilized three significant principal terms of SC collaboration from the existing literature namely collaborative planning, collaborative decision making and collaborative execution in order to disclose the impact on success of collaboration (SoC) and future collaboration.

Another remarkable study has been conducted by Yang (2012) by developing and empirically testing a conceptual framework to assess the effect of knowledge sharing on the development of supply chain capabilities and the effects of such capabilities on supply chain performance. The authors have grounded this study in the knowledge-based view and strategic choice theory. Two types of knowledge, which are explicit and tacit knowledge, has been utilized in this study. Sharing explicit knowledge can be achieved through a variety of techniques such as cognitive mapping, decision trees, knowledge taxonomies and task analysis whereas the sharing of tacit knowledge is a socialisation process such as feelings, emotions, experiences and mental models.

Construct of collaborative planning systems in this dissertation encompasses survey questions regarding information sharing, collaborative planning systems, supply network structure, and distribution network structure. As has been stated in the study by Kocoglu et. al. (2011): ‘‘Information sharing essentially makes contribution to diminishing supply chain costs, enhancing partner relationships, expanding material flow, enabling faster delivery, improving order fulfillment rate and hence contributing to customer satisfaction, enhancing channel coordination, and enabling the success of competitive advantage’’. The literature in general supports the view that the supply chain collaboration (characterized by sharing, decision synchronization, resource sharing, collaborative communication, goal congruence and incentive alignment) plays a vital role in improving risk management practices among the supply chain partner which results in improved firm performance (Yip and Cheng 2012; Zhang and Cao 2011).

Li et. al. (2006) analyzed the effect of supply chain management practices on competitive advantage and organizational performance. The research has devised five dimensions of SCM practice (strategic supplier partnership, customer relationship, level of information sharing, quality of information sharing, and postponement) and

has tested the relationships between SCM practices, competitive advantage, and organizational performance. Organizational performance in this study refers to how well an organization achieves its market-oriented goals as well as its financial goals.

The elements of SCM in the study by Mentzer et. al. (2001) could be cited as agreed vision & goals, agreed supply chain leadership, information sharing, long-term relationship, risk & reward sharing, process integration, and cooperation.

In this dissertation, information sharing, collaborative planning systems, supply network structure and distribution network structure has been gathered under a single roof, i.e. collaborative planning systems. Survey questions regarding collaborative planning systems has been adapted from the studies by Cook and Heiser (2010) and Chen and Paulraj (2004). Thus, in our study, we propose that:

$H_4$. The level of collaborative planning systems will have a positive influence on supply chain performance.

$H_5$. The level of collaborative planning systems will have a positive influence on supply chain sustainability.

## 2.5 Supply Chain Vulnerability

Vlajic et. al. (2012, p. 179) have defined vulnerability as '*sources as characteristics of the supply chain or its environment that lead to the occurrence of unexpected events and as such, they are direct or indirect causes of disturbances'*. The authors have asserted that the competitive power of vulnerable supply chains in the market may be lowered. Furthermore, The Intergovernmental Panel on Climate Change (IPCC) defined vulnerability as "the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes" (IPCC, 2001).

It is commonly accepted that enterprises operating within a highly integrated supply chains are vulnerable to disruptions due to the natural and man-made disasters (Kurniawan et. al., 2017). Vulnerability mitigation techniques must be employed in order to avoid the severe effects of vulnerability within the supply chain development (Kurniawan et. al., 2017). The authors have proposed a conceptual model to examine the impacts of vulnerability strategies on supply chain effectiveness. Moreover, they also explore the moderating effect of risk management culture on the relationships between vulnerability strategies and supply chain effectiveness. Vulnerability

strategies can be cited as: Supply Chain Visibility, Supply Chain Flexibility, Supplier Development, and Inventory Control.

In addition to that, Christopher and Peck (2004, p. 3) have attempted to conceptualize supply chain vulnerability as an exposure to serious disturbance, originating from both internal and external supply chain risks. Stecke and Kumar (2009) have brought forward that vulnerabilities for a specific enterprise may be associated with various factors such as the industry, location, operating strategies, suppliers, customers, political situation, and government policies. According to the authors, identification of industry-specific vulnerabilities could assist to supply chain practitioners in making robust decisions. The same article has cited vulnerability causing factors as: increase in the number of exposure points, increase in distance/time, decrease in flexibility, and decrease in redundancy. Enterprises are often incapable of coping with supply chain risks due to the reason that these risks are simply beyond their foresight. Kersten et. al. (2006) have defined this phenomenon, which is responsible for the increasing supply chains risk, as supply chain vulnerability.

Kungwalsong and Ravindran in Industrial and Systems Engineering Research Conference in 2012 have illustrated supply chain hazards and their impacts in Table 2.5.1:

Table 2.5.1 Summary of supply chain hazards and their impacts

| **Year/Location** | **Event** | **Impact** |
|---|---|---|
| 2011/Japan | Earthquake/Tsunami | $ 210 Billion |
| 2011/Thailand | Floods | $ 30 Billion |
| 2011/New Zealand | Earthquake | $ 20 Billion |
| 2011/United States | Tornado | $ 15 Billion |
| 2011/Australia | Floods | $ 7 Billion |
| 2010/Worldwide | Piracy and hijacking of the ships | $ 7- $ 12 Billion |
| 2008/Thailand | Airport closure | $ 8.5 Billion |
| 2002/US West Coast | Port Strike | > $ 300 Billion |
| Annual/Egypt | Ships re-route to avoid piracy | $ 642 Billion loss of revenue from Suez Canal fees |

As can been observed from the Table 2.5.1, outcomes of natural disasters can be very detrimental. In their study, they took a supply chain network of a typical multinational company into consideration that consists of suppliers, manufacturing plants, distribution centers, and customer zones. In order to determine the hazard score, the authors proposed the following equation consisting of predictability, occurrence, and impact.

$$Hazard\ score = Predictability\ \times Occurence\ \times Impact$$

In addition to that, the authors put forward the equation for determining vulnerability as follows:

$$Facility\ vulnerability\ score = Location \times Political\ \times Financial\ \times Economic$$

Several publications refer to how certain supply chain characteristics might increase or decrease the vulnerability of the supply chain. Jüttner (2005) has stressed that the identification and management of risks for the supply chain, through a coordinated approach amongst supply chain members, to reduce supply chain vulnerability as a whole. The author come up with the finding that 44 per cent of all

eight responding companies in his study expect the vulnerability of their supply chains to increase in the next five years.

Wagner and Bode (2006) have found assumptions in the literature that supply chain vulnerability is increased by customer dependence, supplier dependence, supplier concentration, single sourcing, and global sourcing. Moreover, the survey questions of this dissertation regarding the supply chain vulnerability has been adapted from the study by Thun and Hoenig (2011). The authors have examined supply chain risk management in the German automotive industry empirically. The empirical study is executed based on a survey with 67 manufacturing plants in the German automotive industry. Supply chains' vulnerability has been investigated and supply chain risks have been identified by analyzing their likelihood to occur and their potential impact on the supply chain. Based on empirical results they deduce that supply chains are mostly thought of being vulnerable. A probable reasoning for that is linked to be low implementation level of the instruments of the supply chain risk management which is in compliance with the literature (Jüttner, 2005; Tang, 2006b). Moreover, factors increasing complexity such as globalization and product variants on the one hand, and factors increasing efficiency such as outsourcing or reduction of suppliers on the other hand are identified as the main developments triggering supply chain risks and hence increasing supply chain vulnerability. Globalization brings about supply chain risk since the resulting dependencies might convey to risks both on the demand and supply side. In addition to that, the ongoing trend towards offshoring will also rise the vulnerability of supply chains due to the complexity of supply relationships and susceptibility to faults owing to cross-national connections. Survey questions regarding supply chain vulnerability has been adapted from the study by Thun and Hoenig (2011). In our study, we propose that:

$H_6$. The level of supply chain vulnerability will have a significant influence on supply chain sustainability.

## 2.6 Supply Chain Sustainability

Sustainability has been defined by Carter and Rogers (2008, p. 368) as 'the strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key interorganizational business processes for improving the long-term economic performance of the individual company and its supply chains'. Sustainability can also

be acknowledged as the degree to which present decisions of organizations impress the future situation of the natural environment, societies and business viability (Krysiak, 2009). According to the definition of Krysiak (2009), sustainability strategies should regard the level of future uncertainty and hence the risks that decisions may impose on the natural and social environments, in addition to the investment costs that are required to make supply chains more sustainable. As has been stated in the study by Schaltegger and Burritt (2014), the objective of sustainability performance management has initially served for the identification of social and environmental deficiencies and risks in the supply chain and therefore is a foundation for improved risk management. Sustainability management and action take also environmental factors and social aspects of organizational activities into account, as well as their integration with conventional economic performance (Seuring and Müller, 2008). Cheung and Rowlinson (2011) have examined, by means of case studies, the mechanisms by which relationships can be managed and by which communication and cooperation can be enhanced in sustainable supply chains. The research has adopted a triangulated approach in which quantitative data were collected by survey, interviews were conducted to explore and enrich the quantitative data and case studies were undertaken in order to illustrate and validate the findings. The development of a sustainable supply chain has been seen by the authors to depend, in part, on the transfer of knowledge and capabilities from these larger players down the chain. From the point view of the authors, if a firm is to maintain a competitive advantage and its sustainability, it needs to develop core competences which are capable of being developed further over time in response to both environments and internal resources. The works of Carter and Easton (2011) have aimed to review sustainable supply chain management (SSCM) literature in the principal logistics and supply chain management journals, across a 20 year time frame. The authors have suggested that the broad concept of sustainability, and the key interfaces that sustainability has with supply chain management, strongly suggests that sustainability is instead license to do business in the twenty-first century and supply chain management is an integral component of this license.

The three main dimensions of sustainability can be cited as environmental, social and economic. The environmental dimension encompasses the set of objectives, plans and mechanisms that encourage environmental responsibility and the development and diffusion of environmentally friendly technologies. Social dimension requires that

enterprises incorporate various stakeholders with different goals, demands, and opinions. On the other hand, economic dimension is mainly quantitative and is concentrated on the efficient use of resources and succeeding return on investment (Winter and Knemeyer, 2013).

Ortas et. al. (2014) have examined the relationship between sustainable supply chain and companies' financial performance (FP). Studies in the literature reveal that the link between FP and corporate social and environmental performance (CSP) is U-shaped. Enterprises with low CSP have higher FP than companies with moderate CSP, whereas companies with high CSP have the highest FP. The authors have classified FP into three different categories. These are:

1. Margins/Performance (FP-MA)
2. Profitability/Shareholder Loyalty (FP-PR)
3. Revenue/Customer Loyalty (FP-RE)

The authors have utilized Granger causality test for the bidirectional relationship between sustainable supply chain performance (SSCP) and FP for the 3900 companies over eight years (2004-2011). The most significant finding of the study is that bidirectional relation is supported between SSCP and companies' margins and revenue. However, this holds true for the bull markets, not during the financial crisis. Moreover, the benefits of SSCP from the companies' point of view can be cited as: improved efficiency, higher product quality, a lead on competitors and legislation, penetration to new markets, rise in employee motivation and satisfaction, improved public relations, financial aid, and better organizational reputation.

Marshall et. al. (2015) have examined the moderating role of entrepreneurial orientation between the constructs of sustainability orientation and basic social sustainability practices and between the constructs of sustainability orientation and advanced social sustainability practices. While basic social sustainability supply chain practices concentrates on monitoring and coordinating processes, procedures and performance that are already established, advanced social sustainability supply chain practices are innovative ones for penetrating new markets. The authors have suggested that entrepreneurial orientation plays a significant role in the nature of strategic decision-making and also in the development and adaption of certain sustainable supply chain practices. Basic social sustainable practices mainly encompass issues regarding implementation of environmental management system such as ISO 14001, implementation of health and safety management systems such as OHSAS 18001 and

implementation of social accountability systems such as SA8000. Nevertheless, advanced social sustainable practices encompass new products and processes focused on fair-trade agreements and encouragement of non-traditional partners to participate to the supply chain.

Although, in the literature, there are limited number of studies that take into account of both supply chain risks and sustainability in a conceptual model, adding one more construct i.e. supply chain vulnerability to our conceptual model will illuminate the mechanism behind supply chain sustainability more precisely. Furthermore, unveiling of the elements of sustainability could serve to manage and also to mitigate sustainability related risks as well. In that sense, this study tries to combine constructs affecting supply chain sustainability in the literature as well.

Another survey related with sustainable supply chain management has been conducted by Zailani (2012) among 400 manufacturing companies in Malaysia. Factor analysis of the survey has revealed that four categories of outcomes (environmental, economic, social and operational) have decomposed.

Survey questions regarding supply chain sustainability has been adapted from the study by Zailani (2012).

Figure 2.6.1 presents a framework displaying the relationship between Uncertainty, Supply Chain Risks, Supply Chain Vulnerability, Collaborative Planning Systems, Supply Chain Sustainability, and Supply Chain Performance. The research herein, empirically tests the linkages between 6 main constructs. The dimensions of supply chain performance can be cited as financial performance and market based performance. In our research model, the dimensions of supply chain sustainability are represented by economic sustainability and operational sustainability. Furthermore, while the dimensions of collaborative planning systems can be cited as information sharing, collaborative planning systems, supply network structure and distribution network structure, the dimensions for supply chain risks are represented by regulatory, legal and bureaucratic risk, infrastructural risks, catastrophic risks, and supply side risks. Uncertainty and supply chain vulnerability consist of only one dimension in our conceptual model.

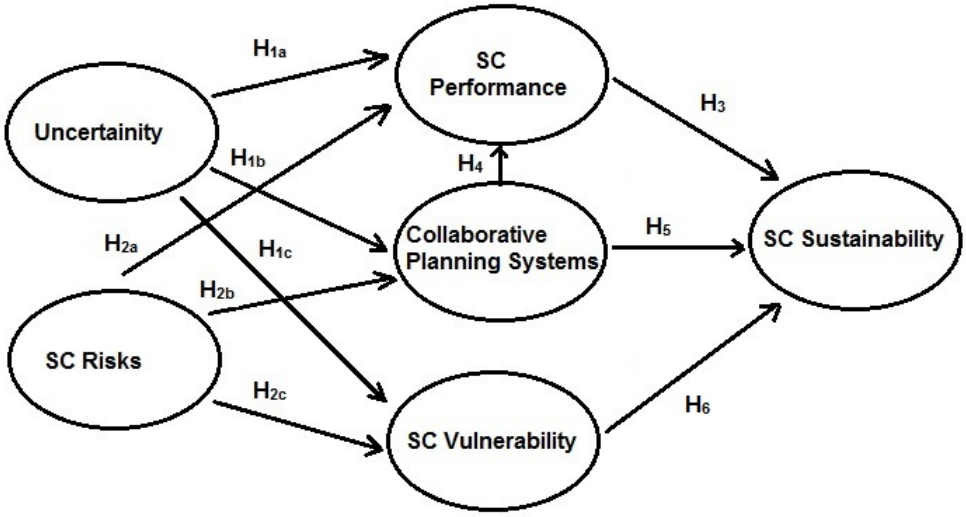


Figure 2.6.1 Conceptual Model

# 3. METHODOLOGY

## 3.1 Prepilot Study

In order to test for the structure of the survey, a prepilot study with 30 participants have been conducted. These 30 surveys have been collected from mid-level or high-level managers working at a diverse spectrum of Turkey's industries. The sample frame of pilot study consisted of a range of sectors including; FMCG, food, energy, plastics, chemistry, health, textile, testing laboratories, white appliances, telecommunications, mining, retailer, and defense industry. Since number of participants is limited, the proposed model has been divided into two parts to conduct Exploratory Factor Analysis more accurately. While the first part encompasses exogenous variables, the second part consists of endogenous variables. Factor analysis results and reliability test results of the exogenous and endogenous variables have been showed in Table 3.1.1 and Table 3.1.2 respectively. A factor loading is the correlation of the variable and the factor, the squared loading is the amount of the variable's total variance accounted for by the factor. Thus, a .30 loading implies to approximately 10 percent explanation, and a .50 loading denotes that 25 percent of the variance is accounted for by the factor. The loadings can be assessed as follows:

- Factor loadings in the range of ±.30 and ±.40 are considered to meet the minimal level for interpretation of the structure.
- Loadings ±.50 or greater are considered practically significant.
- Loadings exceeding ±.70 are considered indicative of well-defined structure and are the goal of any factor analysis (Hair, 2010).

When we take a look at both tables, it can be deduced that all the variables have factor loading greater than .60 and most of them have a factor loading greater than .70. These results are consistent with the purpose of this dissertation.

Also, Cronbach's alpha is measure of reliability that ranges from 0 to 1, with values of .60 to .70 deemed the lower limit of acceptability (Hair, 2010). As can be observed from both tables below, reliability values are higher than .60 both for exogenous and endogenous variables.

Table 3.1.1 Factor loadings and reliability results of the exogenous variables

| | FACTOR 1: EXOGENOUS VARIABLES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Cronbach α** | 0,942 | 0,869 | 0,843 | 0,879 | 0,909 | 0,778 | 0,63 | 0,72 | 0,697 |
| vis_targ1 | | | | | ,785 | | | | |
| vis_targ2 | | | | | ,756 | | | | |
| vis_targ3 | | | | | ,630 | | | | |
| info_share6 | ,661 | | | | | | | | |
| info_share7 | | | | | | | ,794 | | |
| long_term9 | | | | | | | ,705 | | |
| long_term10 | | | | | | | ,650 | | |
| colpsys12 | ,814 | | | | | | | | |
| colpsys13 | ,873 | | | | | | | | |
| colpsys14 | ,895 | | | | | | | | |
| colpsys15 | ,833 | | | | | | | | |
| colpsys16 | ,877 | | | | | | | | |
| colpsys17 | ,798 | | | | | | | | |
| sup_net_st20 | ,629 | | | | | | | | |
| sup_net_st21 | ,759 | | | | | | | | |
| sup_net_st22 | ,652 | | | | | | | | |
| dis_net_st23 | | | | ,820 | | | | | |
| dis_net_st24 | | | | ,820 | | | | | |
| dis_net_st25 | | | | ,721 | | | | | |
| env_unc26 | | | | | | | | ,891 | |
| env_unc27 | | | | | | | | ,722 | |
| env_unc28 | | | | | | ,912 | | | |
| env_unc29 | | | | | | ,728 | | | |
| infrastr33 | | ,645 | | | | | | | |
| infrastr34 | | ,635 | | | | | | | |
| infrastr35 | | ,892 | | | | | | | |
| infrastr36 | | ,723 | | | | | | | |
| catas_risk38 | | | ,866 | | | | | | |
| catas_risk39 | | | ,739 | | | | | | |
| catas_risk40 | | | ,801 | | | | | | |
| unfor_dem41 | | | | | | | | | ,829 |
| unfor_dem42 | | | | | | | | | ,714 |
| supled_risk45 | | ,677 | | | | | | | |
| supled_risk46 | | ,711 | | | | | | | |
| supled_risk47 | | ,711 | | | | | | | |

Table 1.1.2 Factor loadings and reliability results of the endogenous variables

| | FACTOR 2: ENDOGENEOUS VARIABLES | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| **Cronbach α** | 0,94 | 0,874 | 0,749 | 0,712 | 0,944 |
| sup_vul49 | | | ,724 | | |
| sup_vul50 | | | ,826 | | |
| sup_vul51 | | | ,748 | | |
| sup_vul54 | | | | ,778 | |
| sup_vul55 | | | | ,857 | |
| sup_vul56 | | | | ,635 | |
| eco_sus59 | | ,744 | | | |
| soc_sus60 | | ,750 | | | |
| env_sus63 | | ,804 | | | |
| env_sus64 | | ,564 | | | |
| env_sus65 | | ,622 | | | |
| oper_sus67 | | ,739 | | | |
| oper_sus69 | ,664 | | | | |
| oper_sus70 | ,817 | | | | |
| fin_perf71 | ,662 | | | | |
| fin_perf72 | ,884 | | | | |
| fin_perf73 | ,850 | | | | |
| fin_perf74 | ,797 | | | | |
| fin_perf75 | ,827 | | | | |
| mark_perf76 | | | | | ,707 |
| mark_perf77 | | | | | ,778 |

## 3.2 Pilot Study

Primarily, we have selected Turkish automotive sector as our focus sector. We have informed the survey company collecting data on behalf of us that they have to interrupt the data collection before attaining 50 questionnaires. Approximately, in one month time, we have gathered 48 questionnaires and have conducted the pilot study. Since the scales were used with a new sample, exploratory factor analysis in SPSS has been conducted for the items. The best fit of data was acquired with a principal component analysis by means of varimax rotation with Eigenvalues of 1 as a cut of point. In the data reduction procedure, those items having a factor load of lower than 0.50 and those having collinearity with more than one factor, were removed one by one while continuing the factor analysis until attaining the ideal factor table. As in the prepilot study, the variables have been divided into two categories: exogenous and endogenous variables. Factor loading for exogenous values are found out between 0,50

and 0,94, with a total variance explained 81.17%. Moreover, the Kaiser-Meyer-Olkin test which informs the researchers about the adequacy level of the scales has been found as KMO= 0.56. Yet, factor loading for endogenous values have been found out between 0,54 and 0,94, with a total variance explained 75,8%. Moreover, the Kaiser-Meyer-Olkin adequacy test result has suggested that the sample was factorable (KMO= .689).

## 3.3 Sampling and Data Collection

In order to examine empirically what the main supply chain performance drivers are and what the impact of supply chain performance and two more constructs are on the sustainability of companies in automotive sector, a questionnaire was developed and a survey was conducted in years 2015/2016 within a period of 6 months with 213 participants. The survey included 75 empirical questions out of 86 in total designed to assess uncertainty, supply chain risks, supply chain performance, collaborative planning systems, supply chain vulnerability and supply chain sustainability. The initial survey draft was discussed with firms' executives and it was pre-tested by 10 pilot interviews to ensure that the wording, format and sequencing of questions were properly prepared. The reason for selecting automotive sector lies in the accessibility of the data and the intensity of the utilization of supply chain in automotive sector. The data have been collected mainly from Tuzla Organized Industrial Zone of Automotive Subsidiary Industry (TOSB), Association of Automotive Parts&Components Manufacturers (TAYSAD), Istanbul Chamber of Industry (ICI) and Uludag Automotive Industry Exporters' Association (OIB).

The questionnaire was applied simultaneously through online surveys and face-to-face interviews to the sample. The respondents who deal with supply chain management were asked to complete the questionnaire.

First, a web-based survey at site www.surveey.com has been developed in order to facilitate data collection and also to enable data transfer from website to SPSS or Excel file format to process data. In order to collect data, a contract has been signed with a survey company within a frame of a grant of Scientific Research Project.

## 3.4 Data Collection Tools

A structured questionnaire is selected as the data collection tool. Most of the constructs utilized in this study have been compiled from the literature. These include

Supply Chain Management Practices, Business Environment, Supply Chain Risks, Supply Chain Vulnerability, Supply Chain Performance, and Supply Chain Sustainability. Measures of attributes have been adapted from the literature and modified to meet the purpose of the study.

## 3.5 Questionnaire Design

The instruments to measure the constructs were generated from an extensive literature review of this topic. The items describe main content of the definition of the constructs.

As has been mentioned in previous sections, question items for the constructs in the proposed model has been adopted from the literature and then translated into Turkish. List of the constructs has been displayed from Table 3.5.1 to Table 3.5.6, respectively.

Table 3.5.1 Constructs for Collaborative Planning Systems

| Collaborative Planning Systems | Survey items | Survey statements | References |
|---|---|---|---|
| Agreed Vision & Goals | Vistarg1 | Our supply chain members have common, agreed to goals for supply chain management. | Min and Mentzer (2004) |
| | Vistarg2 | Our supply chain members are actively involved in standardizing supply chain practices and operations. | |
| | Vistarg3 | Our supply chain members clearly define roles and responsibilities of each other cooperatively. | |
| | Vistarg4[a] | We all know which supply chain members are responsible for what activity within the supply chain. | |
| Information sharing | Infosh1 | We share information on inventory levels with our supply chain partners. | |
| | Infosh2 | We share forecasts of customer demand with our supply chain partners. | |

| | | | |
|---|---|---|---|
| | Infosh3 | We share information on price promotions with our supply chain partners. | Cook and Heiser (2010) |
| | Infosh4[a] | We share information on transport and logistics (modified question). | |
| Long Term Relationships | Longterm1 | We choose suppliers based upon their flexibility and speed of delivery. | Cook and Heiser (2010) |
| | Longterm2 | We build long-term, mutually beneficial relationships with key suppliers. | |
| | Longterm3 | We negotiate long-term contracts with our suppliers. | |
| Collaborative Planning Systems | Colpsys1 | Supply chain members manage raw material and finished good inventories cooperatively. | Cook and Heiser (2010) |
| | Colpsys2 | Supply chain members manage work-in-process inventories cooperatively. | |
| | Colpsys3 | Supply chain members use material requirements planning (MRP) systems cooperatively. | |
| | Colpsys4 | Supply chain members use ERP systems cooperatively. | |
| | Colpsys5 | Supply chain members use collaborative planning, forecasting, and replenishment (CPFR). | |
| | Colpsys6 | Supply chain members use activity-based costing (ABC) accounting methods. | |
| Supply Network Structure | Supnet1[a] | A good communication infrastructure with supply chain members has been established. | Chen and Paulraj (2004) |
| | Supnet2[a] | Our relation with supply chain members is based on interdependence rather than power. | |
| | Supnet3 | Our organizational structure can be characterized as a flexible value-adding network. | |

| | | | |
|---|---|---|---|
| | Supnet4 | The mechanism of codeciding with supply chain members has been established. | |
| | Supnet5 | Our organization has few management levels with supply chain members. | |
| Distribution Network Structure | Disnet1 | Supply chain members decide cooperatively where to locate facilities. | Cook and Heiser (2010) |
| | Disnet2 | Supply chain members decide where to hold inventory in a distribution network. | |
| | Disnet3 | Supply chain members choose between different transportation and distribution modes. | |

[a] *This item is dropped after Exploratory Factor Analysis in the prepilot study.*

Table 3.5.2 Constructs for Environmental Uncertainty

| Business Environment | Survey items | Survey statements | References |
|---|---|---|---|
| Environmental Uncertainty | Envunc1 | Attainability of the products contains high uncertainty (modified). | Cannon and Homburg (2001) Inman et. al. (2011) |
| | Envunc2 | The uncertainty of the manufacturing and distribution of the products poses a problem in the market (modified). | |
| | Envunc3 | The market we purchased the product is highly complex (modified). | |
| | Envunc4 | The supply of the products in the market is turbulent. | |
| | Envunc5[a] | Prices of the products are volatile. | by the author |

[a] *This item is dropped after Exploratory Factor Analysis in the prepilot study.*

Table 3.5.3 Constructs for Supply Chain Risks

| Supply Chain Risks | Survey items | Survey statements | References |
|---|---|---|---|
| Regulatory, Legal and Bureaucratic Risk | Legist1 | Changes in the political environment due to the introduction of new laws, stipulations affect firm's operations. | Wagner and Bode (2008) |
| | Legist2 | Administrative barriers for the setup or operation of supply chains (e.g. authorizations) affect firm's operations. | |
| | Legist3 | Bureaucratic Risks affect our firm's operations adversely. | by the author |
| Infrastructural Risks | Infrstr1 | In our business environment, downtime is increased due to local disruptions (e.g., labor strike, fire, explosion, industrial accidents). (modified question) | Wagner and Bode (2008) |
| | Infrstr2 | Perturbation or breakdown of internal IT infrastructure takes place caused by computer viruses and software bugs. | |
| | Infrstr3 | Loss of own production capacity occurs due to technical reasons (e.g., machine deterioration). | |
| | Infrstr4 | Problems in infrastructure of the companies, which we got service from affect our operations (modified question). | |
| Catastrophic Risks | Ctsrisk1 [a] | In our business environment, political instability, war, civil unrest, or other socio-political crises are seen. | Wagner and Bode (2008) |
| | Ctsrisk2 | In our business environment, diseases or epidemics (e.g. SARS) are seen. | |
| | Ctsrisk3 | In our business environment, natural disasters (e.g. earthquake, | |

| | | | |
|---|---|---|---|
| | | flooding, extreme climate, and tsunami) are seen. | |
| | Ctsrisk4 | In our business environment, international terror attacks are seen. | |
| To what extent has your firm in the past three years experienced a negative impact in the supply chain management due to… (not at all-to a very large extent) | | | |
| Demand Side Risks (Unforeseen and volatile demand) | Unfordem1 | Orders/ unanticipated or very volatile demand from customers have increased (modified question). | Wagner and Bode (2006) |
| | Unfordem2 | Uncertainty of orders from customers or length of term of orders has increased (modified question). | |
| Supply Side Risks | Supledrisk1 | Poor logistics performance of suppliers | Wagner and Bode (2006) |
| | Supledrisk2 | Supplier quality problems | |
| | Supledrisk3 | Sudden demise of a supplier (e.g., due to bankruptcy) | |
| | Supledrisk4 | Poor logistics performance of logistics service providers | |
| | Supledrisk5 | Capacity fluctuations or shortages on the supply markets | |

[a] *This item is dropped after Exploratory Factor Analysis in the prepilot study.*
[b] *This item is added after pilot study.*

Table 3.5.4 Constructs for Supply Chain Vulnerability

| Please evaluate the effects of the vulnerability causing the termination of the supply chain. (1: Strongly disagree, 7: Strongly agree) | | | |
|---|---|---|---|
| Supply Chain Vulnerability (termination of supply chain) | Supvul1 | Focus on efficiency instead of security aspects increases vulnerability. | Thun and Hoenig (2011) |
| | Supvul2 | Management of a global supply chain increases vulnerability. | |
| | Supvul3 | Focus on central distribution rather than regional warehouses increases vulnerability. | |
| | Supvul4 | Inforced Outsourcing increases vulnerability. | |

| | | | |
|---|---|---|---|
| | Supvul5[a] | Working with limited number of supplier increases vulnerability. | |
| | Supvul6[a] | Raise in product variety in supply chain increases vulnerability. | |
| | Supvul7 | Centralized production increases vulnerability. | |
| | Supvul8 | Product/Process Complexity increases vulnerability. | |
| | Supvul9 | Litigation between supply chain members increases vulnerability. | |

[a] *This item is dropped after Exploratory Factor Analysis in the prepilot study.*

Table 3.5.5 Constructs for Supply Chain Sustainability

| Supply Chain Sustainability | Survey items | Survey statements | References |
|---|---|---|---|
| To what extent has your firm in the past three years achieved…. Seven point Likert Scale (1=strongly disagree – 7=strongly agree) | | | |
| Economic Sustainability | Ecosus1 | Significant reduction in terms of wastes and its disposal costs. | Zailani, S. et. al. (2012) |
| | Ecosus2 | Significant improvement in terms of sales and market share. | |
| | Ecosus3 | Significant improvement in terms of resources management efficiency. | |
| Social Sustainability | Socsus1 | Significant improvement in product image. | Zailani, S. et. al. (2012) |
| | Socsus2[a] | Significant improvement in relations with community stakeholders, e.g., Nongovernmental organizations (NGO) and community activists. | |
| | Socsus3[a] | Significant improvement in its image in the eyes of its customers. | |
| Environmental Sustainability | Envsus1 | Significant improvement in its compliance to environmental standards. | Zailani, S. et. al. (2012) |
| | Envsus2 | Significant reduction in consumption for | |

| | | | |
|---|---|---|---|
| | | hazardous/harmful/toxic materials. | |
| | Envsus3 | Energy consumption of the organization has significantly reduced. | |
| Operational Sustainability | Opersus1 | Ability to fulfill perfect order (complete, without any delays and damage free) has increased. | Zailani, S. et. al. (2012) |
| | Opersus2 | Ability to quickly respond to changes to competitors product offerings has increased. | |
| | Opersus3 | A supply chain to respond to plan, source, make and deliver unexpected demand variations has gotten better. | |
| | Opersus4 | Manufacturing and operating costs have reduced. | |
| | Opersus5 | Inventory turnover rate has increased. | |

[a] *This item is dropped after Exploratory Factor Analysis in the prepilot study.*

Table 3.5.6 Constructs for Supply Chain Performance

| Supply Chain Performance | Survey items | Survey statements | References |
|---|---|---|---|
| Please rate your organization's performance in each of the following areas as compared to past. (1=strongly disagree – 7=strongly agree) | | | |
| Financial Performance | Finperf1 | Total cost has decreased. | Kim (2009) |
| | Finperf2 | Return on investment has increased. | |
| | Finperf3 | Return on assets has increased. | |
| | Finperf4 | Financial liquidity has increased. | |
| | Finperf5 | Net profit has increased. | |
| Market Based Performance | Markperf1 | Sales in the market has increased. | Kim (2009) |
| | Markperf2 | Market share has increased. | |

## 3.6 Common Method Variance

Common method variance (CMV) is controversial in quantitative studies and any self-report survey (Spector, 2006), as it threatens the validity of the findings on the linkage results between constructs (Reio, 2010; Williams and Brown, 1994). CMV is ‘‘variance that is attributable to the measurement method rather than to the constructs the measures represent’’ (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003: 879). CMV creates a false internal consistency, that is, an apparent correlation among variables generated by their common source. Podsakoff et al. (2003) explore four general sources of CMV: the use of a common rater, the manner in which items are presented to respondents, the context in which items on a questionnaire are placed, and the contextual influences (time, location and media) used to measure the constructs (latent variables). According to Reio (2010), procedural design and statistical control are two solutions to reduce the probability of CMV. Following Podsakoff et al. (2003), this study addressed the CMV issue at the questionnaire design stage (common rate effects, acquiescence biases (yea- saying and nay-saying), item characteristic effects, common scale formats, item priming effects and scale length were avoided throughout the questionnaire). The use of exploratory factor analysis allows us to check for the potential of common method bias using Harmon's single-factor test (Podsakoff and Organ, 1986). All of the extracted factors have eigenvalues greater than one. Therefore, the statistical results demonstrate that CMV is not a concern in this study.

## 3.7 Non-response Bias

Non-response bias has been thought as a “serious concern” and should be tackled by researchers (Etter and Perneger, 1997; Lewis et al., 2013; Rezaei and Ghodsi, 2014), especially in electronic surveys (Menachemi, 2010). “Response bias occurs when individuals who respond to a survey differ systematically from those that were invited to participate but did not respond” (Menachemi, 2010, p. 5) in which “the participants do not represent non-participants” (Thompson et al., 2014). Methods to adjust for nonparticipation are complicated and the impact of nonparticipation on the total sample is difficult to evaluate since researchers seldom have knowledge about nonparticipants (Lin and Schaeffer, 1995). In our research model, we did ignore the impact of non-response bias since the sample has been collected from white collar professionals and the data mainly consist of face to face data and the rest is online survey with compulsory fields.

## 3.8 Explatory Factor Analysis

Explatory Factor Analysis has been conducted and items which have factor loadings greater than 0.4 has been retained in the analysis. We categorized the factors to 56 sub constructs belonging to six main constructs such as Collaborative Planning Systems, Environmental Uncertainty, SC Risks, SC Vulnerability, SC Sustainability, and SC Performance. As can be seen in Table 3.8.1, all the factors are loaded well above 0.56. Overall, the 56 factors explain 72.4% variation in their measurement items.

Table 3.8.1 Results of exploratory factor analysis for measurement items

| | | Component | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Items** | **Questions (please rate from 1 to 7)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| vistarg1 | Our supply chain members have common, agreed to goals for supply chain management. | | | | | | | | | | | | ,705 | | | |
| vistarg2 | Our supply chain members are actively involved in standardizing supply chain practices and operations. | | | | | | | | | | | | ,673 | | | |
| vistarg3 | Our supply chain members clearly define roles and responsibilities of each other cooperatively. | | | | | | | | | | | | ,646 | | | |
| infosh1 | We share information on inventory levels with our supply chain partners. | | | | | | | | | | | | | | | ,805 |
| infosh2 | We share forecasts of customer demand with our supply chain partners. | | | | | | | | | | | | | | | ,703 |
| colpsys1 | Supply chain members manage raw material and finished good inventories cooperatively. | ,773 | | | | | | | | | | | | | | |
| colpsys2 | Supply chain members manage work-in-process inventories cooperatively. | ,784 | | | | | | | | | | | | | | |
| colpsys3 | Supply chain members use material requirements planning (MRP) systems cooperatively. | ,795 | | | | | | | | | | | | | | |
| colpsys4 | Supply chain members use ERP systems cooperatively. | ,816 | | | | | | | | | | | | | | |
| colpsys5 | Supply chain members use collaborative planning, forecasting, and replenishment (CPFR). | ,781 | | | | | | | | | | | | | | |
| colpsys6 | Supply chain members use activity-based costing (ABC) accounting methods. | ,751 | | | | | | | | | | | | | | |
| disnet1 | Supply chain members decide cooperatively where to locate facilities. | | | | | | | | | ,828 | | | | | | |
| disnet2 | Supply chain members decide where to hold inventory in a distribution network. | | | | | | | | | ,794 | | | | | | |
| disnet3 | Supply chain members choose between different transportation and distribution modes. | | | | | | | | | ,852 | | | | | | |
| envunc1 | Attainability of the products contains high uncertainty. | | | | | ,802 | | | | | | | | | | |
| envunc2 | The uncertainty of the manufacturing and distribution of the products poses a problem in the market. | | | | | ,758 | | | | | | | | | | |

| | | Component | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Items** | **Questions (please rate from 1 to 7)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| envunc3 | The market we purchased the product is highly complex. | | | | | ,643 | | | | | | | | | | |
| envunc4 | The supply of the products in the market is turbulent. | | | | | ,701 | | | | | | | | | | |
| legist1 | Changes in the political environment due to the introduction of new laws, stipulations affect firm's operations. | | | | | | | ,776 | | | | | | | | |
| legist2 | Administrative barriers for the setup or operation of supply chains (e.g. authorizations) affect firm's operations. | | | | | | | ,862 | | | | | | | | |
| legist3 | Bureaucratic Risks affect our firm's operations adversely. | | | | | | | ,869 | | | | | | | | |
| infrstr1 | In our business environment, downtime is increased due to local disruptions (e.g., labor strike, fire, explosion, industrial accidents). | | | | | | | | ,680 | | | | | | | |
| infrstr2 | Perturbation or breakdown of internal IT infrastructure takes place caused by computer viruses and software bugs. | | | | | | | | ,671 | | | | | | | |
| infrstr3 | Loss of own production capacity occurs due to technical reasons (e.g., machine deterioration). | | | | | | | | ,766 | | | | | | | |
| infrstr4 | Problems in infrastructure of the companies, which we got service from affect our operations. | | | | | | | | ,704 | | | | | | | |
| ctsrisk2 | In our business environment, diseases or epidemics (e.g. SARS) are seen. | | | | | | | | | | ,817 | | | | | |
| ctsrisk3 | In our business environment, natural disasters (e.g. earthquake, flooding, extreme climate, and tsunami) are seen. | | | | | | | | | | ,826 | | | | | |
| ctsrisk4 | In our business environment, international terror attacks are seen. | | | | | | | | | | ,663 | | | | | |
| unfdem1 | Orders/ unanticipated or very volatile demand from customers have increased | | | | | | | | | | | | | | ,758 | |
| unfdem2 | Uncertainty of orders from customers or length of term of orders has increased. | | | | | | | | | | | | | | ,736 | |
| suprisk1 | Poor logistics performance of suppliers | | | | ,710 | | | | | | | | | | | |
| suprisk2 | Supplier quality problems | | | | ,810 | | | | | | | | | | | |
| suprisk3 | Sudden demise of a supplier (e.g., due to bankruptcy) | | | | ,612 | | | | | | | | | | | |
| suprisk4 | Poor logistics performance of logistics service providers | | | | ,721 | | | | | | | | | | | |
| suprisk5 | Capacity fluctuations or shortages on the supply markets | | | | ,560 | | | | | | | | | | | |

| | | Component | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Items** | **Questions (please rate from 1 to 7)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| supvul1 | Focus on efficiency instead of security aspects increases vulnerability. | | | ,718 | | | | | | | | | | | | |
| supvul2 | Management of a global supply chain increases vulnerability. | | | ,706 | | | | | | | | | | | | |
| supvul3 | Focus on central distribution rather than regional warehouses increases vulnerability. | | | ,679 | | | | | | | | | | | | |
| supvul4 | Inforced Outsourcing increases vulnerability. | | | ,746 | | | | | | | | | | | | |
| supvul7 | Centralized production increases vulnerability. | | | ,682 | | | | | | | | | | | | |
| supvul8 | Product/Process Complexity increases vulnerability. | | | ,639 | | | | | | | | | | | | |
| supvul9 | Litigation between supply chain members increases vulnerability. | | | ,583 | | | | | | | | | | | | |
| ecosus1 | Significant reduction in terms of wastes and its disposal costs. | | | | | | | | | | | ,673 | | | | |
| ecosus2 | Significant improvement in terms of sales and market share. | | | | | | | | | | | ,792 | | | | |
| ecosus3 | Significant improvement in terms of resources management efficiency. | | | | | | | | | | | ,703 | | | | |
| opersus1 | Ability to fulfill perfect order (complete, without any delays and damage free) has increased. | | | | | | ,790 | | | | | | | | | |
| opersus2 | Ability to quickly respond to changes to competitors product offerings has increased. | | | | | | ,794 | | | | | | | | | |
| opersus3 | A supply chain to respond to plan, source, make and deliver unexpected demand variations has gotten better. | | | | | | ,792 | | | | | | | | | |
| finperf1 | Total cost has decreased. | | ,691 | | | | | | | | | | | | | |
| finperf2 | Return on investment has increased. | | ,794 | | | | | | | | | | | | | |
| finperf3 | Return on assets has increased. | | ,855 | | | | | | | | | | | | | |
| finperf4 | Financial liquidity has increased. | | ,864 | | | | | | | | | | | | | |
| finperf5 | Net profit has increased. | | ,842 | | | | | | | | | | | | | |
| ltrlt1 | We choose suppliers based upon their flexibility and speed of delivery. | | | | | | | | | | | | | ,729 | | |
| ltrlt2 | We build long-term, mutually beneficial relationships with key suppliers. | | | | | | | | | | | | | ,739 | | |
| ltrlt3 | We negotiate long-term contracts with our suppliers. | | | | | | | | | | | | | ,559 | | |

Total Variance Explained:%72,4

## 3.9 Reliability

Reliability analysis on all of the factors has been conducted. As shown in Table 3.9.1, the Cronbach's alpha value of all factors are above 0.60, which satisfy the limit accepted to ensure constructs' internal consistency. Table 3.9.1 also shows the results of a descriptive and correlation analysis. The analyses reveal that the correlations between independent variables are relatively weak or moderate, which could indicate low multicollinearity among the variables. This is important for the subsequent multiple regression analysis because high multicollinearity could reduce the variables' predictive power (Hair et al., 2010).

Table 3.9.1 Results of descriptive, reliability and correlation analysis for sub-constructs

| | | Mean | SD | CR Alpha | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Agreed Vision & Goals | 4,99 | 1,39 | ,80 | | | | | | | | | | | | | | |
| 2 | Information sharing | 4,97 | 1,57 | ,66 | ,411(**) | | | | | | | | | | | | | |
| 3 | Collaborative Planning Systems | 4,34 | 1,51 | ,91 | ,543(**) | ,402(**) | | | | | | | | | | | | |
| 4 | Distribution Network Structure | 3,34 | 1,89 | ,90 | ,300(**) | ,226(**) | ,468(**) | | | | | | | | | | | |
| 5 | Environmental Uncertainty | 3,56 | 1,55 | ,81 | -,056 | -,061 | ,029 | ,059 | | | | | | | | | | |
| 6 | Regulatory, Legal and Bureaucratic Risk | 4,06 | 1,88 | ,89 | -,003 | ,024 | -,017 | ,016 | ,398(**) | | | | | | | | | |
| 7 | Infrastructural Risks | 3,71 | 1,59 | ,78 | -,018 | ,054 | -,037 | -,030 | ,395(**) | ,401(**) | | | | | | | | |
| 8 | Catastrophic Risks | 1,98 | 1,30 | ,74 | -,002 | -,156(*) | -,057 | ,063 | ,225(**) | ,157(*) | ,255(**) | | | | | | | |
| 9 | Unforeseen Demand | 4,15 | 1,84 | ,87 | -,024 | -,027 | -,037 | -,001 | ,392(**) | ,297(**) | ,343(**) | ,129 | | | | | | |
| 10 | Supply Side Risks | 3,39 | 1,34 | ,81 | -,095 | -,113 | -,036 | ,049 | ,382(**) | ,334(**) | ,386(**) | ,331(**) | ,460(**) | | | | | |
| 11 | Supply Chain Vulnerability | 4,36 | 1,22 | ,84 | ,020 | -,036 | -,029 | -,011 | ,366(**) | ,289(**) | ,389(**) | ,297(**) | ,391(**) | ,428(**) | | | | |
| 12 | Economic Sustainability | 5,07 | 1,46 | ,81 | ,337(**) | ,233(**) | ,308(**) | ,278(**) | -,030 | ,022 | -,015 | -,053 | -,101 | -,129 | ,131 | | | |
| 13 | Operational Sustainability | 5,47 | 1,25 | ,86 | ,260(**) | ,231(**) | ,321(**) | ,126 | ,021 | ,118 | -,024 | -,085 | ,040 | -,062 | ,088 | ,433(**) | | |
| 14 | Financial Performance | 4,11 | 1,56 | ,91 | ,272(**) | ,216(**) | ,357(**) | ,374(**) | -,070 | -,168(*) | -,166(*) | ,050 | -,111 | -,154(*) | -,047 | ,417(**) | ,384(**) | |
| 15 | Long Term Relationships | 5,84 | 1,07 | ,64 | ,383(**) | ,325(**) | ,354(**) | ,229(**) | -,042 | ,053 | -,070 | -,158(*) | ,000 | -,164(*) | ,013 | ,336(**) | ,287(**) | ,185(**) |

** *P< 0.01*
* *P< 0.05*

Table 3.9.2 Results of descriptive, reliability and correlation analysis for main constructs

| | | Mean | SD | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|
| 1 | Collaborative Planning Systems | 4,70 | 1,04 | | | | | |
| 2 | Environmental Uncertainty | 3,56 | 1,55 | -,012 | | | | |
| 3 | SC Risks | 3,46 | 1,07 | -,049 | ,543(**) | | | |
| 4 | SC Vulnerability | 4,36 | 1,22 | -,015 | ,366(**) | ,532(**) | | |
| 5 | SC Sustainability | 5,27 | 1,15 | ,448(**) | -,007 | -,042 | ,131 | |
| 6 | SC Performance | 4,11 | 1,56 | ,414(**) | -,070 | -,173(*) | -,047 | ,474(**) |

** *P< 0.01*
* *P< 0.05*

## 3.10 Testing of Hypotheses

Regression analysis is conducted for 4 different models. Table 3.10.1 shows the results of the regression analyses for SC Vulnerability. Generally, SC Risks have a highly, statistically significant, positive effect on SC Vulnerability, whereas Environmental Uncertainty have a positive effect on Vulnerability at 10 % significance level. Therefore, hypothesis $H_{1c}$ ($\beta$=0.11, p<0.10) and $H_{2c}$ ($\beta$=0.47, p<0.01) have been accepted.

Table 3.10.1 Results of regression analyses for SC Vulnerability

| Model 1 | SC VULNERABILITY | | |
|---|---|---|---|
| | Beta | t | Sig. |
| ENVIRONMENTAL UNCERTAINTY | ,110 | 1,597 | ,066* |
| SC RISKS | ,472 | 6,816 | ,000*** |
| $R^2$ | ,291 | | |
| *F* | 43.126 | | |
| *Sig.* | .000 | | |

**** P< 0.01*
*** P< 0.05*
** P< 0.10*

In Table 3.10.2, the results of the regression analyses for SC Performance have been displayed. The results reveal that Collaborative Planning Systems have a highly, statistically significant, positive effect on SC Performance. On the other hand, SC Risks have a statistically significant and negative impact on SC Performance. This indicates that in order to increase supply chain performance, SC Risks should be mitigated. Hence, hypothesis $H_{2a}$ ($\beta$=-0.17, p<0.05) and $H_4$ ($\beta$=0.41, p<0.01) have been accepted. However, the results for the relationship between environmental uncertainty and supply chain performance have revealed that the hypothesis $H_{1a}$ has been rejected.

Table 3.10.2 Results of regression analyses for SC Performance

| Model 2 | SC PERFORMANCE | | |
|---|---|---|---|
| | Beta | t | Sig. |
| ENVIRONMENTAL UNCERTAINTY | ,026 | ,347 | ,729 |
| SC RISKS | -,167 | -2,257 | ,025** |
| COLLABORATIVE PLANNING SYSTEMS | ,406 | 6,536 | ,000*** |
| $R^2$ | ,195 | | |
| *F* | 16.899 | | |
| *Sig.* | .000 | | |

*** *P< 0.01*
** *P< 0.05*
* *P< 0.10*

In Table 3.10.3, regression results disclose that SC Performance, Collaborative Planning Systems and SC Vulnerability have all statistically significant and positive impact on Supply Chain Sustainability. Hence, hypothesis $H_3$ ($\beta$=0.36, p<0.01), $H_5$ ($\beta$=0.30, p<0.01), and $H_6$ ($\beta$=0.15, p<0.01) have been accepted.

Table 3.10.3 Results of regression analyses for SC Sustainability

| Model 3 | SC SUSTAINABILITY | | |
|---|---|---|---|
| | Beta | t | Sig. |
| SC PERFORMANCE | ,356 | 5,695 | ,000*** |
| COLLABORATIVE PLANNING SYSTEMS | ,303 | 4,861 | ,000*** |
| SC VULNERABILITY | ,153 | 2,683 | ,008*** |
| $R^2$ | ,325 | | |
| *F* | 33.535 | | |
| *Sig.* | .000 | | |

*** *P< 0.01*
** *P< 0.05*
* *P< 0.10*

The last Model, which attempts to explain collaborative planning systems by utilizing uncertainty and supply chain risks as independent variables is statistically not significant. Hence, hypotheses $H_{1b}$ and $H_{2b}$ are rejected. Table 3.10.4 gives the general figure of the results of the hypotheses.

Table 3.10.4 Hypotheses results

| Hypotheses | Results |
|---|---|
| $H_{1a}$: Uncertainty – SC Performance | NS |
| $H_{1b}$: Uncertainty – Collaborative Planning Systems | NS |
| $H_{1c}$: Uncertainty – SC Vulnerability | Supported |
| $H_{2a}$: SC Risks – SC Performance | Supported |
| $H_{2b}$: SC Risks – Collaborative Planning Systems | NS |
| $H_{2c}$: SC Risks – SC Vulnerability | Supported |
| $H_3$: SC Performance – SC Sustainability | Supported |
| $H_4$: Collaborative Planning Systems – SC Performance | Supported |
| $H_5$: Collaborative Planning Systems – SC Sustainability | Supported |
| $H_6$: SC Vulnerability – SC Sustainability | Supported |

# 4. DISCUSSION AND CONCLUSION

The EFA reduces 56 items into six factors which are parsimonious and orthogonal represent constructs of our model. Literature review and expert opinion are utilized to further classify these factors into explanatory or independent variables category and response or dependent variable category.

Supply chain elements are constituted by many variables such as supply chain uncertainty, collaborative planning systems, supply chain vulnerability, supply chain performance, and supply chain sustainability. These variables display differences between various manufacturing enterprises. Hence, a conceptual model is proposed and empirically tested using regression analysis based on data collected from the enterprises in the automotive sector. This dissertation reports on the supply chain performance and sustainability study in the Turkish automotive industry, drawing on a sample of 213 manufacturing firms.

In this study, we aim to make a contribution to the literature by proposing 4 different models, which examines the relationship between the independent variables and 4 dependent variables, namely supply chain performance, collaborative planning systems, supply chain vulnerability and supply chain sustainability. Towards this goal, we combined multiple approaches from the literature mainly focusing on the supply chain performance and its sustainability. We utilized regression to test our hypothesis. Out of 10 hypothesis proposed, only 7 of them are found to be statistically significant. We have selected automotive sector as our focal due to the facility of gathering data and the need for disclosure of vulnerabilities in this sector. Supply chain performance, collaborative planning systems and supply chain vulnerability have all displayed positive relationships with supply chain sustainability. Dubey and Ali (2013) put forth that the dimensions of sustainable supply practices, which are strong predictors of Indian manufacturing firms, are TQM, R&D and technologies. According to the authors, the firms, which have integrated two important dimensions have realized superior extended supply chain performance. Furthermore, it is contrary to our expectations that supply chain vulnerability displays a positive but a minor impact on supply chain sustainability. The possible reason for this result might be that the other constructs i.e. collaborative planning systems and supply chain performance could lessen the impact of supply chain vulnerability on supply chain sustainability. Another interesting results which are derived from this study is that there have been no evidence

found statistically supporting the hypotheses of the relationship between uncertainty and SC performance and the relationship between uncertainty and collaborative planning systems. This situation might be tackled by either using uncertainty construct as a moderator between supply chain risks and supply chain performance or by selecting different measures for uncertainty. Other reason for the relationship between uncertainty and supply chain performance not being supported statistically would be that the construct 'collaborative planning systems' might lessen the impact of uncertainty on supply chain performance. The supply chain management literature proposes that greater information sharing reduces supply chain uncertainty (Lee et. al., 1997). Our results are supporting the view that supply chain risks have a negative and statistically significant impact on supply chain performance, which is in good agreement with the study by Wagner and Bode (2008). Apart from the study by Wagner and Bode (2008), we have taken supply chain risks as a single construct. Moreover, Wagner and Bode (2008) have found that demand side risk and supply chain risk have a negative and statistically significant impact on supply chain performance, while the other risks such as regulatory, legal and bureaucratic risk, infrastructure risk, and catastrophic risk have no impact on supply chain performance. While supply chain risks explained only 6 % of the variance of supply chain performance in the study by Wagner and Bode (2008), environmental uncertainty, SC risks and collaborative planning systems together explains 19.5 % of the supply chain performance.

Uncertainty and SC Risks have demonstrated positive and statistically significant relationship with vulnerability which is in good agreement with the findings in the literature.

As has been mentioned in Section 2.2, survey questions regarding supply chain risks have been adapted from the study by Wagner and Bode (2008). Although only 2 out of 5 hypothesis proposed is supported statistically in the study by Wagner and Bode (2008), our results displayed the converse and negative and statistically significant relationship between supply chain risks and supply chain performance has been found in our study. Moreover, our findings support the fact that SC Risks is a major hindrance of supply chain performance and are also major driver for the rise in supply chain vulnerability. Another important point which should be stressed is that it is very important for the managers to know and understand the risks involved in supply chains. Managers should recognize and manage SC Risks in order to boost their supply chain

performance and also their sustainability.

To summarize, the overall findings of this study indicate that sustainable supply chain practices are an interesting field of research and these practices have a close linkage both with supply chain performance and collaborative planning systems. This main goal of this study is to analyze factors affecting supply chain performance and supply chain sustainability in a conceptual model.

Having a clear understanding of the exact nature of supply chain performance and sustainability will help firms to manage their risks and collaborative planning systems, to be followed by appropriate subsequent action plan.

## 4.1 Limitations and Future Research

Our results provide important explanations both for supply chain performance and supply chain sustainability in the automotive sector. The conceptual model, as a whole, except a few relationships between constructs has been supported empirically. As research limitations, following aspects should be mentioned. This study focuses on the automotive industry exclusively. Further research could be conducted for other industries like machinery, textile or electronics in order to test the general validity of the results. In addition, this study has been conducted in an emerging economy, and the results could change according to the culture, economy and sector. New conceptual models can be proposed by utilizing various measures for each construct. For instance, supply chain performance can be distinguished in 2 parts, i.e. supply chain performance and firm performance. New measures for firm performance can be developed or adapted from the literature in order to evince the relationship between supply chain performance and firm performance.

Since supply chain risks have a positive and direct effect on supply chain vulnerability in this study, SCRM practices like proactive (i.e. robust) and reactive (i.e. agile) supply chain strategies can be used in further studies to reduce the vulnerability of global supply chains and in that sense necessary. Other risk management approaches like avoidance approaches, prevention approaches and mitigation approaches could be evaluated and utilized as a future study or as a continuation of this study.

Obviously, economic, technical and cultural differences play a vital role in the implementation of CPFR. A pilot project from the automotive sector can be investigated in order to find out the best practice. Since CPFR implementation stems from the retail sector in the United States, adapting it to the automotive sector would

be a good alternative for future research.

Moreover, the data was collected from a single respondent for each company. However, most companies, especially the small and medium sized ones, have a group of executives that determine how to mitigate uncertainty, supply chain risks and supply chain vulnerability, hence increasing supply chain performance. Hence, we recommend that future research should collect data from multiple respondents in order to normalize outlier responses.

Quantitative method of this study could be supplemented by case studies in order to collect qualitative data. This qualitative data could provide insight into our conceptual model and this could serve to develop new theoretical framework and thus acquire new knowledge.

As with all research, generalizability is limited by methodology. This research used data from an existing data set, thus, the measurement indicators were not purpose-built. There are opportunities to improve the measurement indicators so that they align more closely with the theoretical foundation. For example, multiple levels of uncertainty can be taken into account in order to explore the relationships between uncertainty and SC performance and uncertainty and collaborative planning systems. Since the data is cross-sectional, we can only determine the associations between various constructs, not the cause and effect relationships.

Future research should also investigate how different types of uncertainty affect supply chain performance and the construct 'supply chain integration' could be utilized as a moderator construct between these two constructs.

Furthermore, the welfare levels of the countries could have an impact on the results. Additionally, an international survey could provide interesting insights regarding the degree of implementation in other countries. Last but not the least, increasing the sample size, broadening the geographic location and adding new constructs or moderators/mediators could improve the generalization of the findings.

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