DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

INVESTIGATION OF THE EFFECTS OF SUPPLY CHAIN MANAGEMENT STRATEGIES ON BUSINESS PERFORMANCE

by
Pınar DEMİREL GÜNGÖR

September, 2022
İZMİR

INVESTIGATION OF THE EFFECTS OF SUPPLY CHAIN MANAGEMENT STRATEGIES ON BUSINESS PERFORMANCE

A Thesis Submitted to the
Graduate School of Natural and Applied Sciences of Dokuz Eylül University
In Partial Fulfillment of the Requirements for the Degree of Master of Science in Industrial Engineering, Industrial Engineering Program

by
Pınar DEMİREL GÜNGÖR

September, 2022
İZMİR

M.Sc THESIS EXAMINATION RESULT FORM

We have read the thesis entitled **"INVESTIGATION OF THE EFFECTS OF SUPPLY CHAIN MANAGEMENT STRATEGIES ON BUSINESS PERFORMANCE"** completed by **PINAR DEMİREL GÜNGÖR** under supervision of **ASSOC. PROF. DR. DERYA EREN AKYOL** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

.....

Assoc. Prof. Dr. Derya EREN AKYOL

Supervisor

.....	.....
Prof. Dr. Bilge BİLGEN	Assoc. Prof. Dr. Leyla DEMİR
(Jury Member)	(Jury Member)

Prof. Dr. Okan FISTIKOĞLU

Director

Graduate School of Natural and Applied Sciences

ACKNOWLEDGMENTS

First of all, I would like to express my deepest gratitude to my supervisor Assoc. Prof. Dr. Derya EREN AKYOL for all the support and encouragement she has given me during my M.Sc thesis. I appreciate for her endless patience and guidance.

I'm grateful to thesis defence committee members for attendance and contributions on my engineering career. I'm thankful to all faculty members of the Dokuz Eylül University Industrial Engineering Department for the valuable courses that I took during my M.Sc.

Last but not least, I appreciate my family for their endless love, motivation and supports throughout my life.

PINAR DEMİREL GÜNGÖR

INVESTIGATION OF THE EFFECTS OF SUPPLY CHAIN MANAGEMENT STRATEGIES ON BUSINESS PERFORMANCE

ABSTRACT

Supply chain is a network that consists of manufacturers, suppliers, customers, logistics and distribution systems, and the relationships between them. It includes processes from the manufacturer to the end-user. Supply chain management helps make decisions on which product will be produced, when the proper timing for the manufacturing is, when it will be sold, and which material will be stocked in what quantity. This study mainly focuses on the supply chain management strategies and their possible effects on the company performance for an industrial cluster region in located Izmir/Turkey.

At the beginning of the research a comprehensive literature review is presented. Afterwards, importance of the supply chain network is given. Then, main supply chain management strategies of customer integration, supplier integration, internal integration and information-communication technologies are discussed in detail. In this thesis, a comprehensive supply chain questionnaire is conducted with 223 companies to investigate the effects of supply chain management strategies on firm performance. Firm performance contains operational and financial performance.

Cronbach's alpha method within the SPSS software is used for reliability analysis. Structural equation modelling (SEM) method is applied via IBM Amos software to the collected data set. Then, results are evaluated in terms of data validity, normality and significance. The findings indicate significant relationship between the firm performance and exogenous latent variables of supplier integration, internal integration, information-communication technologies as the significance factor is comparatively lower than 0.05. Information and communication technologies has the most dominant impact on the firm performance with $\beta_1 = 0.852$.

Keywords: Supply chain, business performance, structural equation model, statistical evaluation.

TEDARİK ZİNCİRİ YÖNETİM STRATEJİLERİNİN FİRMA PERFORMANSI ÜZERİNDEKİ ETKLERİNİN İNCELENMESİ

ÖZ

Tedarik zinciri üreticiler, tedarikçiler, müşteriler, lojistik-dağıtım sistemleri ve bunlar arasındaki ilişkilerden oluşan bir ağdır. Üreticiden son kullanıcıya kadar olan tüm süreçleri içerir. Tedarik zinciri yönetimi, hangi ürünün üretileceğine, üretim için doğru zamanın belirlenmesine, ürünün ne zaman satılacağına ve hangi malzemenin hangi miktarda stoklanacağına karar verilmesine yardımcı olur. Bu çalışma, temel olarak tedarik zinciri yönetimi stratejilerine ve bunların İzmir/Türkiye' de konumlanan bir endüstriyel kümelenme bölgesi için firma performansı üzerindeki olası etkilerine odaklanmaktadır.

Araştırmanın başında kapsamlı bir literatür taraması sunulmuştur. Daha sonra tedarik zinciri ağının önemine değinilmiştir. Ardından ana tedarik zinciri yönetimi stratejileri olan tedarikçi entegrasyonu, müşteri entegrasyonu, iç entegrasyon ve bilgi-iletişim teknolojileri ayrıntılı olarak tartışılmaktadır. Bu tezde, tedarik zinciri yönetimi stratejilerinin firma performansı üzerindeki etkilerini araştırmak için 223 firma ile kapsamlı bir tedarik zinciri anketi yapılmıştır. Firma performansı operasyonel ve finansal performansı içermektedir.

Güvenirlik analizi için SPSS yazılımı içerisinde yer alan Cronbach alpha yöntemi kullanılmıştır. Toplanan veri setine IBM Amos yazılımı aracılığıyla yapısal eşitlik modellemesi (YEM) yöntemi uygulanmıştır. Daha sonra sonuçlar veri geçerliliği, normallik ve anlamlılık açısından değerlendirilmiştir. Bulgular, anlamlılık değerlerinin 0.05'ten küçük olması nedeniyle tedarikçi, iç ve bilgi-iletişim teknolojileri entegrasyonlarının firma performansı üzerinde önemli etkisi olduğunu göstermektedir. Bilgi ve iletişim teknolojileri $\beta_1 = 0.852$ değeri ile firma performansı üzerinde en baskın etkiye sahiptir.

Keywords: Tedarik zinciri, işletme performansı, yapısal eşitlik modeli, istatistiksel değerlendirme.

CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

CHAPTER ONE

INTRODUCTION

Supply chain is a network including manufacturers, customers, suppliers, logistics and distribution systems, and the relationships between them. Supply chain starts with the supplier that provides the raw material for the product. All processes, from the manufacturer to the end-user, are included in the structure of this network. The path of the product until it reaches the end-user determines the level of this complexity. The complexity of a supply chain network may differ according to the service and production. Moreover, supply chain management consists of efforts to improve and control the supply chain processes based on customer satisfaction. All the ways until the final product or service reach the end-user are optimized with supply chain management strategies. Effective management of supply chain helps make decisions on which product will be produced, when the proper timing for the manufacturing is, when it will be sold, and which material will be stocked in what quantity. Furthermore, effective supply chain management contributes to how the products/services will be delivered to the end-user in a faster and cheaper way. Therefore, globally competitive environment triggers organizations to have more sustainable and effective supply chain strategies in sort of social and economical points of view (Lahane et al., 2020; Nosratabadi et al., 2019).

Supply chain management can be expressed as the art of managing the forward flow of products, the backward flow of money, and the bidirectional flow of information (Bıçakçı and Üreten, 2017). Increasing competition conditions have pushed companies to improve all their operational processes. These competition conditions are mainly related to price, discount and promotion, substitute or similar product competitions in the product market. The rise in the competitive environment means an increase in the number of alternative vendors for customers (Çiğdem and Erdoğan, 2019; Cui et al., 2005). Thus, companies are trying to produce customer-oriented solutions both to protect their customer portfolio and to gain new customers. Under these conditions, companies that want to maintain their current position in the market develop various strategies to deliver the right product for the customer with

minimum time and cost. The main purpose of these strategies is to provide maximum profit by minimizing the costs of production, stock, and delivery processes (Demirdöğen, 2021). This is possible with the effective management of the supply chain network. Suvacı (2016) investigated supply chain and logistics management strategies, and reported that most companies have already reduced their production costs to relatively lower levels. After this point, cost savings can only be possible with adequate management of the supply chain strategies. Furthermore, it is documented that firms may increase their customer satisfaction with the help of effective logistics and supply chain management.

This study uncovers the relationships among the supply chain management strategies and business performance. Different from the studies in the literature, we share all the details on how the questionnaire is applied to industrial companies, in which ways we collect the response data and how we process the data set step by step. We consider receiving replies from the managers or lead engineers working in the related departments rather than collecting responses from any employees out of the supply chain field. The questionnaire contains statements for both literature and industrial perspectives. Furthermore, Covid-19 pandemic issue is considered within the questionnaire to obtain novel results and improve the impact of the study. Replies taken from the professionals related to the supply chain activities are collected, and the data set is examined in terms of reliability and normality. In addition to the business performance investigation, we also document the relavance among each examined supply chain management strategies by the help of structural equation modelling.

1.1 Aim of the Thesis

This thesis mainly focuses on the supply chain management strategies and their possible effects on business performance for an industrial cluster region in Izmir/Turkey. Firm performance depends on many physical, economical, and social parameters, and supply chain management strategies regulate the balance between these variables. The strategies may vary with respect to industrial application field (engineering, food, textile etc.) local factors and the outcomes of the supply chain

strategies improve the business performance. The aim of the thesis is to increase the business performance with effective supply chain management strategies Customer integration (*CI*), supplier integration (*SI*), internal integration (*II*) and information-communication technologies (*ICT*) are determined as the main supply chain management strategies since these strategies are assumed as the main factors affecting business performance. In order to improve the impact of the study a questionnaire is prepared compatible with the industrial applications and literature. The data set is gathered from over 220 companies located in the selected industrial cluster. Survey data are collected from the managers and chief engineers of the firms. In this way, it is aimed to increase the reliability of the data set.

The purpose of this study is to calculate the impact of the supply chain management strategies on firm performance. Structural equation modelling (SEM) method is applied to collected data set via IBM Amos and SPSS softwares. The structural validity and reliability of the data set are tested. Furthermore, a multivariate normality test is conducted and the significance values of the variables are examined to check whether the analysis results provide consistent and correct predictions.In addition, fit indices are examined to test the structural validity of the model. Once the data set and results are obtained statistically in a correct way, the effects of the supply chain management strategies on the company performance are documented. Since the professional life in the industry has changed after Covid 19 pandemic, the questionnaire is formed by considering these consequences.

1.2 Outline of the Thesis

This thesis consists of five chapters, and the contents of the chapters are given as follows:

In Chapter 2, a comprehensive literature review is presented. First, importance of the supply chain network is given. Then main supply chain management strategies of customer integration, supplier integration, internal integration and international-communication technologies are discussed in detail. The relation between the firm performance and supply chain management strategies are presented.

In Chapter 3, we describe the problem, questionnaire, data processing and the main methodology. Survey questions are classified by firm performance and supply chain management strategies (customer integration, supplier integration, internal integration, information and communication technologies). Survey data are analyzed demographically. The SEM methodology and the advantages on the statistical investigations are discussed. Finally, the advantages of Amos software and the reasons for its preference in this study are shared.

In Chapter 4, the reliability and validity results are reported. Then, the findings of the multivariate normality and significance tests are documented, and the test results are discussed with a statistical perspective. Once the data set is found statistically meaningful, the SEM results are presented. The relations between each supply chain management strategies are documented. Finally, the effects of supply chain management strategies, which are examined under 4 headings: supplier integration, customer integration, internal integration, and information-communication technologies, on company performance are given.

Finally, the concluding remarks are provided in Chapter 5. Furthermore, a perspective is presented for future studies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Definition of the Supply Chain

Supply chain is a network that consists of manufacturers, suppliers, customers, logistics and distribution systems, and the relationships between them. It includes processes from the manufacturer to the end-user. Supply chain management helps make decisions on which product will be produced, when the proper timing for the manufacturing is, when it will be sold, and which material will be stocked in what quantity. Moreover, effective supply chain management contributes to how the products/services will be delivered to the end-user in a faster and cheaper way. Increasing customer satisfaction to higher levels and ensuring integration with the customer are among the main objectives of supply chain network.

Today, many companies prefer applications where inventory management is delegated to the supplier. Sales and planning information is shared with the supplier, and inventory management is left to the supplier. Bang & Olufsen Inc., in Denmark, uses an application for stock management. Bang & Olufsen's suppliers have access to the firm's information system to manage inventory (Hvolby et al., 2007). On the other hand, Walmart is among the companies that successfully manage the supply chain in the world. Walmart has become a lesson for supply chain management with its strategies to focus on low-cost leadership. Walmart’s supply chain management strategy is completely based on understanding of performing all operational processes with the lowest cost and reaching the highest level of productivity (Heller, 2017; Jacobs and Chase, 2014). In parallel with this purpose, it strives to offer its customers a wide variety of products of acceptable quality at an affordable price. Walmart aims to minimize the costs of operations such as stock management and distribution in order to implement this sales strategy and sell affordable products.

On the other hand, customers have knowledge and experience that businesses do not have. Some companies prefer including their customers in all operational process

of manufacturing to benefit from the knowledge and experience they lack. It is possible with this strategy to prevent quality errors and deficiencies in the product before it is released to the market. Until the product reaches its final form, it is blended with both the customer's knowledge and the company's expert knowledge. Moreover, applying the customer's ideas in these operations makes the customer feels more special. This strategy aims the contribution of the customers who think that their ideas and suggestions are given importance. The customers will be able to adapt the product more and more resulting from this loyalty. Likewise, logistics management is another crucial factor affecting the supply chain performance. Today, some companies transfer their basic logistics activities to more specialized firms for better supply chain management. This system is called as “third party logistics”. Basic third-party logistics operations may be related to product storage or distribution. The fact that the operation is carried out by experts reduces distribution and stock costs. At the same time, companies will be able to focus on the main field of activity by transferring a large workload to an expert. Therefore, capacity utilization rate of the firm will increase day by day. Despite the superiorities of the strategy, this method also carries various risks. The companies transferring its logistics activities put a foreign intermediary between it and its customer. In this case, customer satisfaction depends on the business performance of this foreigner as well as the performance of the product. In addition, the fact that the expert is also working with a competitor carries a risk of leaking any information.

Technology is another crucial parameter affecting the supply chain and firm success. In recent years, there have been many technological developments that will improve the delivery speed of products. For example, in July 2016, Dominos announced that it would deliver to its customers by drone and started the commercial delivery initiative with drone for the first time in the world (Llewelyn, 2016). Customers who wish to receive drone delivery (Fig. 2.1) service are willing to pay an additional fee. When the drone reaches the delivery area, a notification is sent to the application on the customer's smartphone. The customer then instructs the drone to download its food with the application. The drone delivering the food returns to the company store. Making a difference for customers by making use of such

technological developments is also an important competitive advantage. It is possible to develop new products or new services to create a demand for that product or service.

Figure 2.1 Drone model used in Dominos delivery (Llewelyn, 2016)

Businesses try to obtain maximum benefit from both their customers and suppliers with supply chain management. Furthermore, the knowledge level and operational capabilities of the companies increase by the customer integration (Chatterjee et al., 2022) and supply chain management strategies. An effective supply chain management will both save time and provide adequate time for innovation studies, and it will improve the innovation capability of companies. Companies will be able to offer new services/products into the market by improving its ability to develop new products thanks to increasing the flexibility (Güçlü and Karakaş, 2018). The superiorities of supply chain management are not only limited to a single company, i.e., but these advantages also provide significant benefits to all members of the chain (Çiğdem ve Erdoğan, 2019). One of these benefits is information exchange. Information exchange among the members of the chain is essential for the effective supply chain organization. This information exchange can be between customers, suppliers, manufacturers or distribution channels. Firms always face problems such as demand uncertainty, market volatility or supply disruptions. Information sharing among supply chain members helps to reduce and control these uncertainties or problems. Thus, information exchange will increase transparency throughout the supply chain. In

addition, the acceleration of information flow also positively affects the company's ability to process information and make quick decisions. On the other hand, Toyota has taken a different approach to supplier collaboration (Ro et al., 2007). When Toyota started production, it did not have enough financial power and equipment. Toyota had to take risks and rely on suppliers to enhance its business. Toyota promised its partners the opportunity for mutual benefit and growth in the long term. As Toyota has grown, suppliers have become part of the Toyota family, taking advantage of the Toyota production system. This mutual relationship continues unless the supplier exhibits bad behaviour. Another supplier's more favourable price cannot deter Toyota from its supplier.

2.2 Definition of the Firm Performance

In this thesis, we consider both financial and operational performance parameters to accurately measure business performance. The parameters and measurement methodology are determined in accordance with the industrial applications and literature investigations. Here the financial performance is evaluated by the distance from the firm's financial targets. Furthermore, financial targets mainly include profitability, sales, costs, market share, and returns on investments. Financial statements expressing financial performance indicators are frequently used in the literature. Financial statements clearly depict the past financial structure of the company, and they also provide important information about future financial performance (Buzduga, 2020). On the other hand, operational performance indicators indicate non-financial parameters. Quick response, information processing, employee effectiveness, and internal coordination are related to the internal capabilities of the company, and these indicators reflect the internal integration of the firm. Criteria such as flexibility, benefiting from innovation, competitiveness, delivery, brand reputation, quality, ability to adapt to market and demand changes, and customer satisfaction help us to determine the position and potential power of the company in the market. In other words, these performance indicators try to measure the company's capabilities and market power. In addition, the satisfaction of supply chain partners is also counted among the operational performance indicators.

Firm performance is directly related to the manufacturing processes as the dimensions of the processes/services have a dominant impact on business performance (Das and Canel, 2022). Complexity of the manufacturing processes is progressing exponentially with the rapid technological developments and the expansion of the market. This complexity reveals the need for reliable and efficient supply chain network and management. Competition levels were previously in the level of individual companies, yet it now takes place at the level of the entire chain (Marek et al., 2020). All links of the chain must work in an integrated manner in order to be successful against competitors. On the other hand, rising in vendor alternatives, substitutes or similar products, marketing strategies (advertisements, discounts, promotions) cause an increase in the competitive environment in the market. In addition, the consumption period of the products has been shortened with developing technology. Having the chance to quickly reach the desired product and to choose from among many alternatives has increased the expectations of the customers. Therefore, businesses have started to give more importance to performance measurement studies to satisfy the customer expectations.

Today, companies set various targets in accordance with their short/long-term plans and performance measurement methods are used to determine the success rate of these targets. We need to know the real situation of the company to understand whether the company is getting better or worse, and this evaluation is only possible by measuring the firm performance (Buzduga, 2020). Moreover, performance measurement provides a clear view of the distance between the current position of the firm and the target set. Performance measurement, which provides a monitoring and control mechanism for companies, helps prepare the necessary ground for objective decision making and evaluation. In addition, follow-up and control mechanism acts as driving motivation, increasing their quality and efficiency. Note that improving the quality and efficiency will contribute to high customer satisfaction (Yüreğir and Nakıboğlu, 2007). Consequently, we can explain the importance of performance measurement as follows; "Measure and control, control and manage, manage and improve!”

Although finance/profitability is the first criterion that comes to mind when a company performance is mentioned, this view has gradually changed in recent years. Note that the financial performance is only one aspect of the total business performance. Firm performance is not only limited to financial aspect, but also includes operational performance (Demirdöğen, 2021). For this reason, non-financial parameters such as manufacturing speed, delivery, quality, and flexibility are among the criteria of firm performance in order to measure accurate and reliable firm performance (Öztemiz and Karaa, 2018). Firm performance indicators have been classified differently by different researchers in the literature. Cao et al. (2015) classify performance indicators under four headings: finance, customers, internal operations, and learning and growth. Finance parameter consists of concepts such as sales profitability and operating income. The customer parameter includes market share, customer satisfaction, growth rate of export sales, and brand reputation. They interpret the internal operation in terms of benefit from innovation, satisfaction of supplier partners, and value of new product output. Furthermore, in the learning and growth parameter, more social issues such as charity, education, and company culture, were mentioned. Likewise, company's operational performance indicators were grouped by Marek et al. (2020) under four headings: cost, efficiency, time, quality, and flexibility. According to Marek et al. (2020), company performance can be measured at strategic and operational levels. Long-term decisions are taken into account when measuring performance at the strategic levels. The ways in which the firm implements the strategies are the operational processes.

On the other hand, Yu (2015) divides firm performance into two parts: financial and operational performance. Operational performance covers parameters such as delivery, cost, quality, and flexibility. Parameters such as profitability, market share and return on investment constitute financial performance indicators. Similarly, performance indicators are divided into two classes by Bayyurt (2011). In the first group, there are indicators that express the priority targets of the companies such as profitability and growth. In the second group, the indicators affecting the first group such as quality and innovation were documented. In addition, factors that are unlikely to be observed such as management style, chance, and environment were also included

in the second group. Bayyurt (2011) states that although profitability is an important target, it cannot be a performance indicator on its own, i.e., firms should perform performance appraisals in multiple ways.

2.3 Definition of the Supply Chain Management Strategies

In this thesis, supply chain management strategies and their effects on business performance are investigated in detail. It is obvious that numerous supply chain management strategies can be derived according to the application field, local needs, customer profile, and firm targets. However, customer integration, supplier integration, internal integration, and information-communication technologies are the main management strategies from both industrial and academic perspectives. Here we determine the strategies compatible with these main parameters, and we prepare a comprehensive questionnaire by diversifying the main supply chain management strategies. Survey questions within the similar literature papers are examined in detail to both determine effective questions for all sections and to improve the impact of the investigation.

Supplier integration means that the suppliers of a chain system take roles in some of the business activities. Integration of the suppliers directly improves supplier compliance and increases firm performance. The incidents during the manufacturing processes can be resolved quickly by effective supplier integration. Gyampah et al. (2020) investigate in which ways the supplier integration affect company performance. The data set is collected from 149 different firms in Ghana. Operational capabilities are grouped under 4 headings: cost, delivery, flexibility, and quality. They use confirmatory factor analysis (CFA) to check the validity of the data set. Structural equation modelling (SEM) method is utilized for the statistical evaluations. The findings indicate that resource sharing leads to trust and loyalty among supply chain members over time. This situation positively contributes to the performance increase of the companies. The results uncover that supplier integration increases the competitiveness of companies. Furthermore, the positive effect of flexibility, which is the result of good supplier integration, on business performance has been proven. Likewise, the moderating role of supplier integration among supply chain risk

management and operational performance is explored by Shou et al. (2018). The results indicate that collaboration with suppliers provides flexibility with information sharing, especially in complex and uncertain situations. Furthermore, this flexibility positively and significantly contributes financial performance. They also conclude that firms need supplier integration to cope with uncertainty.

Duhaylongsod and Giovanni (2018) investigate the effects of innovation strategies in order to improve the relevance among supplier integration and firm performance. They collect their data set from 173 different firms. SEM is utilized to estimate the relation between supplier integration and operational success. The findings indicate that supplier integration and innovation improvements have a positive effect on internal operational performance. Similarly, Zhu et al. (2016) use SEM with partial least-squares (PLS) predictions to analyze their data set. They examine the role of inter-organizational learning among the supply chain integration and firm performance. The results of the investigations reveal that close relationship with suppliers facilitates information exchange, improves production planning and delivery performance. On the other hand, the impacts of internal-external integrations on logistical performance is investigated by Gimenez and Ventura (2005). The data set analyses showed that internal functions facilitate coordination among different firms. Moreover, external integration has also great impact on internal integration. It is also discussed that if companies cooperate more with supply chain partners, they have to ensure their internal integration. Hvolby et al. (2007) investigate the buyer-supplier relations, and they document that collaborating on planning and forecasting provides visibility throughout the supply chain. This simplifies production scheduling and reduces costs. As a summary, supplier integration is a crucial factor affecting the firm performance and manufacturing cost. For example, BMW had to close some of its factories in 2017 due to Bosch not being able to supply some of its gears on time (Boston, 2017). These examples show the larger effects of a small deficiency.

Customer integration is the second supply chain management strategy investigated in this thesis. It is obvious that customer orientation and integration are critical parameters on business performance. Ariadi et al. (2021) examine the lean and agile

supply chain strategies with mediating the customer integration. The data set is collected via 139 firms located in Indonesia. They apply partial least squares and SEM methods to analyze the data set. The results show that customer integration slightly mediates the relationship among lean supply chain strategies and financial success. The findings indicate that manufacturers having intense relations with their customers enable a better understanding of customers' needs. Thanks to this information obtained with customer integration, companies are in a position to quickly satisfy customer needs in matters such as packaging, possible current and future demand changes, quality expectations. This contributes positively to the financial performance of companies. On the other hand, Yeh et al. (2020) examine the relavance among the customer integration, firm performance, and supplier integration. The data set of 466 enterprises was gathered in Taiwan. Survey data are checked according to the Cronbach's alpha method for reliability. The results show that manufacturers can obtain strategic market information via the customer and supplier integration. In addition, they're able to utilize these feedbacks in their long-term operational decisions.

Yıldız and Sayın (2020) investigate a different perspective of the customer integration. They focus on the mediating role of innovation capacity in the impact of customer integration on company performance. Data set is collected from 96 different firms and processed using structural modeling with PLS estimations. It is documented that customer integration occurs when manufacturers see their customers as an important part of the supply chain and start to include them in the processes. Moreover, integration between the customers and manufacturer can create a suitable basis for new ideas and technological developments. Likewise, Füller et al. (2019) highlight the importance of customer integration on supply chain management and firm performance. They report customer's involvement in supply chain integration helps gaining a positive user experience. It is also conculuded that higher customer satisfaction provides higher quality contributions by spending more effort and time while fulfilling its role in integration. On the other hand, Ganbold et al. (2019) investigates the customer integration and its effects on operation performance indicators. The data set is collected from 108 large manufacturing capacity firms, and

the data is processed via SEM. Among the investigated supply chain integration strategies, customer integration shows much significant impact on all operational outputs. It improves all dimensions of operational performance indicators of operational flexibility, quality, manufacturing cost, customer service and stock level.

In recent years, companies have included their customers in the design processes of their products for better understand their needs. They have not limited this to only R&D but have started to include it in all their processes. Pado (2017) investigates the impact of customer integration on design and manufacturing steps. The results indicate that the risk of innovation failure is low and resource expenditure is less when products developed with customer integration. Another advantage gained via customer integration is to increase the success of the design and expectation before the product is released to the market. Likewise, Chavez et al. (2015) examine the contribution of information quality among customers and operational success. Data set is collected from 228 industrial firms located in Ireland. The relationships among the parameters within the survey data are analyzed by regression analysis. They report that improvements in quality, flexibility and delivery can be achieved with effective and successful customer integration. Furthermore, the quality of information is emphasized as extremely important in the success of customer integration. Sharing information is also concluded as facilitating factor for joint forecast development and inventory management. Furthermore, customer integration in innovation projects is documented as a reducing factor for the development cycle time of product (Song et al., 2013). They utilize an integrated novel approach containing the analytic hierarchy and merit of rough set theory to evaluate the data set. It is concluded that although customer integration offers many opportunities for manufacturers, it also brings risks like excessive dependence on customers and lack of information due to disloyal customers. Similarly, Danase and Romano (2011) investigate the interactions among the supplier and customer integrations. The data set collected from 200 manufacturing plant is analyzed by regression analysis methods. The findings indicate that the customer integration comparatively depends on supplier integration. Moreover, customer integration may decrease supply chain efficiency in state of low-level supplier integration. On the other hand, customer integration has risks of misunderstandings,

incremental innovation only, and overdependence on the customer (Enkel et al., 2005). However, it is obvious that the risks of not integrating the customer are much more significant than the risks of customer integration.

In addition to the supplier and customer integrations, internal integration is a crucial supply chain management strategy focusing on the relationship among all employees (from simple workers to managers) and their performance effectiveness. Internal integration regulates firms' own dynamics to improve the supply chain management and business performance. Toker and Pınar (2019) investigate the mediating effects of internal integration on connections with customers/suppliers and operational performance. They utilize hierarchical regression method to process the data gathered from Turkey's top 500 large-scale manufacturing firms. The findings indicate that internal integration has significant and mediating effect between long-term relationship and business performance. It is documented that companies desiring to establish sustainable relations with their suppliers and customers must first ensure their own integration. Otherwise, an increase in operational performance should not be expected. Feyissa et al. (2018) classify the firm strategy into four headlines: defenders, reactors, prospectors, and analysers. The data set is obtained from 112 companies operating in various countries in order to investigate the effects or management strategies on supply chain integration. The findings indicate that internal integration makes a variable contribution on companies' innovation strategy, supplier, and customer integrations. However, the study does not take into account of the relationships in between different organizational strategies.

Internal integration is a system where all departments work in harmony and cooperation to meet customer demands where functional barriers are removed rather than an organizational structure based on specialized departments. Errassafi et al. (2019) examine the effects of supply chain success on operational success. Furthermore, mediating effects of internal integration management among operational efficiency and external integration are investigated. Data set is collected from five Moroccan manufacturing companies, and they use PLS-SEM coupling methods. The findings indicate that customer, supplier, and internal integration strategies positively

affect the company performance. Moreover, internal integration doesn't contribute relationship among the supplier integration strategy and business success. It mainly deals with information exchange and collaboration within the firm, while external integration covers collaboration with all customers and suppliers in the firm's supply chain. It is also concluded that a firm can improve firm performance by increasing supplier and customer integration. Effects of knowledge, process and strategic management techniques by the help of suppliers on firm performance are investigated by Zhang et al. (2018). Data set gathered from 261 manufacturing companies located in Vietnam are used and SEM methodology is utilized. It is documented that working for common goals within the company and taking decisions in a mass allow the company to increase process flexibility and reduce costs by taking quick action against changes in the market and production interruptions. The results show that relevance among the supplier integration strategy and firm performance is depended on internal integration. Furthermore, both internal and external integration strategies improve firm performance. Zhang et al. (2018) conclude that companies cannot get a reward for their efforts for supplier integration without providing internal integration, and managers should primarily develop internal integration deu to this reason.

Cheng and Chaudhuri (2016) is utilized CFA methodology to examine the data set collected from 606 companies. The aim of the paper is to examine the relevance among supply chain integration, operational performance and interplant coordination. SEM method is utilized to predict the relationship between variables. The results uncover that both internal and external integrations have significant effect on interplant coordination. Furthermore, internal integration slightly affects the operational performance whereas external integration is dominant. On the other hand, Yuen and Thai (2016) use the multi-sampling method to analyze the data collected from 312 firms. The findings show that external integration is more dominant for service supply chain operations. In addition, internal integration has mainly an important and similar impact on external integration for product and service supply chain. Likewise, Riley et al. (2015) utilize SEM method in order to examine the data set. Training and internal integration show positive effects on companies' recovery capabilities in terms of direct and indirect manners. It is documented if companies want to be alerted to supply chain

risks (not being able to supply the product, etc.), they should first bring their internal integration to a certain level. Especially in cases where quick decision making is important, managers need to increase their coordination and information processing abilities within the firm. On the other hand, relationship between multiple dimensions of information-communication technology (*ICT*)-supported supply chain integration has been investigated by Yu (2015). The data set is gathered from 214 industrial companies in China. The results indicate that IT-aided internal integration is related to operational and financial performance. Similarly, Feng et al. (2013) perform a questionnaire to collect data from 176 Chinese manufacturing companies. They investigate relevance among the operational success and external parameters in addition to the contribution of internal integration. The results uncover that internal integration significantly affects the operational efficiency. Furthermore, internal integration slightly contributes the relationship among the operational success and customer involvement.

Furthermore, internal integration can be interpreted as recognizing the need for different departments within a company to behave as part of an integrated process. With internal integration, the diversity of information within the company increases and different perspectives can develop. With these advantages of internal integration, uncertainty is eliminated, and the groundwork is prepared for making fast and correct decisions. It is concluded that companies will not be able to leverage the capabilities of their suppliers/customers without advance internal integration management. Likewise, main effects of main supply chain integration factors on business performance are investigated by Huo (2012). Survey data are collected from 617 firms. Structural equation modelling method is utilized. The collected data set is evaluated in terms of reliability and validity. The results show that internal integration significantly impacts operational performance level and business itself.

On the other hand, Chen et al. (2007) examine the scope of integration and its impact on firm performance. They document that companies must work cross and integrated with all their departments to guarantee success. Good functioning of departments alone does not guarantee success. For example, the introduction of Sony's

PlayStation 3 (PS3) game console was given as a good example to understand the importance of firm-wide integration. Sony had to make the decision to delay the PS3's release in Europe, Asia and Australia by four months. This is a big risk for Sony because it has risked losing its market to Microsoft's Xbox 360 and Nintendo's Wii. Also, missing the end-of-year shopping season is a huge financial loss for Sony. The readiness of the marketing and logistics teams could not change this result. The result is that all functional departments should work in an integrated manner. The study also shows that firm-wide integration not only improves financial performance, but also increases customer satisfaction and competitiveness of the firm. Likewise, Hamali et al. (2020) separated information integration and operational performance into sub-branches such as internal-external information integration, financial success, customer satisfaction. PLS-SEM method is utilized. The results indicate internal information integration has significant impact on supply chain performance, customer satisfaction, and financial success. However, the relationship among the external information integration and customer satisfaction is found to be nonlinear. It is concluded that customer satisfaction level and supply chain management efficiency highly affect financial success of the investigated company.

Information technologies (*IT*) or information and communication technologies (*ICT*) are another crucial branch of supply chain management strategies. Today, all size of commercial structures needs *ICT* integration to improve their business performance and enhance customer relations. Demirdöğen (2021) investigates the effects of information integration on operational performance of enterprises. Data set is collected from 145 firms and examined via SEM method. The results indicate that the information integration contributes the operational performance. They conclude that ensuring information integration is mainly depended on information technologies data quality and information security. In a different perspective, Franceli and Turri (2021) investigate the parameters that lead to enabling of Industry 4.0 technologies and the benefits coming with the effective supply chain. They document that uncertainty and threats to security and privacy in networked systems cause businesses to be reluctant to use advanced new technologies and cause them to ignore the potential benefits of technology. Small-sized firms are reported as slower to adopt new

technologies than large firms, due to limited resources. The result shows that Industry 4.0 technologies help to reduce operating costs by increasing efficiency in the fields of production and logistics. In addition, companies increase their competitiveness in the market by providing information technology integration with Industry 4.0 in supply chain management. Likewise, the relevance among supply chain integration, agility, and financial success are assessed from a dynamic point of view by Eslami et al. (2021). The data set is collected from 274 Swedish manufacturing firms. Digital information systems are documented as a good way to connect supply chains through technological means. They report that supply chain integration and information technologies are very important for the manufacturing industry, which has complex supply chains that cross national borders. The results show that Industry 4.0 digitalization facilitate the monitoring and controlling of supply chain steps.

Impacts of hot technologies, equipment, or processes within the automotive service industry are investigated by Balinado and Young (2020). The service supply chain is reported as critical part of supply chain management. It is documented that usage of technology is very important for businesses that especially provide service. They conclude that technological methods make things faster and easier than traditional ones. By saving time, the satisfaction of existing customers will be increased, and space will be created for new customer portfolios. Effects of information technology (IT) on company performance are examined in detail by Yu et al. (2021). They use SEM method integrated with LISREL model to test the proposed model. The results indicate that information technology indirectly affects financial outputs, while operational success and customer integration only develops financial performance. Information technology applications make all supply chain relations easier for companies that are part of the supply chain to coordinate and cooperate. Smart PLS software is used by Daneshvar et al. (2020) for data processing and another important parameter of IT. This study documents that IT and top management supports directly and positively affected the business performance. Similary, Rajaguru and Matanda (2019) conduct a questionnaire with 302 company executives and analyze values with the SEM model. The study draws an attention to the operational compatibility theory. In other words, they document that there must be harmony in technical processes and

technological systems throughout the chain in order to have cooperation between chain partners. As a result of harmony, a sense of belonging will be created among partners and process complexity will be minimized. It is concluded that companies' supply chain capabilities including logistics management and responsiveness will be enhanced with this integration.

Som et al. (2019) examine information technology and internal operational integration. They examine the relevance among supply chain integration and operational performance. Survey data are checked according to the Cronbach's alpha method for reliability. Variance Inflation Factor (VIF) is also utilized for regression. The findings show that information and operational integration enhance the business performance as also reported by Saengchai and Jermsittiparsert (2019). Cheung et al. (2018) collect data set from 162 different firms in China and Taiwan. Information technology standardization and integration on supply chain performance are investigated. The findings indicate that improvements on information technology positively contribute the operational performance. Similarly, Wu and Chiu (2018) empirically deduct that technology usage is the most dominant factor within whole design parameters. Likewise, how supply chain flexibility contributes and mediates the operational success and information integration is investigated by Yu et al. (2018). The data set is collected from 84 food companies in China and hierarchical regression methods are used. The results show that companies can improve their operational performance by improving information integration in accordance with the traceability system in order to coordinate with their supply chain partners. Similarly, Colin et al. (2015) focus on relationship among the information-communication technologies and supply chain performance. They gather data from 288 small and medium sized enterprises. SEM methodology and regression analysis are utilized. The findings indicate that information and communication technologies contribute to reduce unnecessary costs of the organizations. Boon (2009) also conducts comprehensive research to increase understanding of the application of supply chain integration through a range of IT. Data are analyzed using Analysis of Variance (ANOVA) method. The data set is collected 141 of Thai automotive industry. The results show that using of information technologies facilitates supply chain integration and

information technology integration helps to improve production costs. On the other hand, innovation is another investigated parameter affection ICT and supply chain performance. Ju et al. (2016) examine the effects of technological innovation on company performance in addition to dynamic supply chain capabilities. The collected data set is from 206 firms in Korea. Similarly, the data set is examined with SEM model. They indicate that technological innovation is assumed as a mediating parameter. The analysis shows that the supply chain management directly and positively affects the operational performance. It is concluded that innovation technologies play an integrative role between supply chain capabilities and operational performance.

CHAPTER THREE

PROBLEM DEFINITION

3.1 Framework of the Study

The framework of the study is given in Figure 3.1. First, we form a comprehensive questionnaire with the help of literature investigations. Attention is paid to keep the questions short and understandable in order not to bore the reader. The questionaire is applied by using Google Forms with the defined questions. The population has been determined as İzmir Atatürk Industrial Cluster which includes 508 companies. The minimum sample set is calculated with the modified Cochran's formula which corresponds to 219. The departments related to purchasing, sales and supply chain in the companies have been determined as the primary target for the questionnaire. The survey data collection process proceeds in two separate ways; sending the questionaire to the official e-mail addresses of the companies and trying to reach the company employees via the Linkedin social platform. After reaching the sufficient number of questionnaires, the survey study is finalized, and the collected data are evaluated. In the next step, the reliability analysis of the data is performed in SPSS software. Then, structural equation model (SEM) is established in AMOS software to start Confirmatory Factor Analysis (CFA). Once the data set is transferred to AMOS, we start analysis. We check whether the model complies with the multivariate normality assumption. After confirming that the data set conforms to multivariate normality, the significance value of each observed variable is examined. In another step, the suggestions given in the modification indice (MI) are evaluated. Then, the model fit is investigated in order to examine the accuracy and structural validity of the model. After completing the steps mentioned so far, the following topics are investigated and documented:

1- Determining the relationship of each latent variable with the observed variables underneath.
2- Investigation of relevance between latent variables of *SI*, *CI*, *II*, and *ICT*.
3- Analyses on the effects of *SI*, *CI*, *II* and *ICT* on business performance.

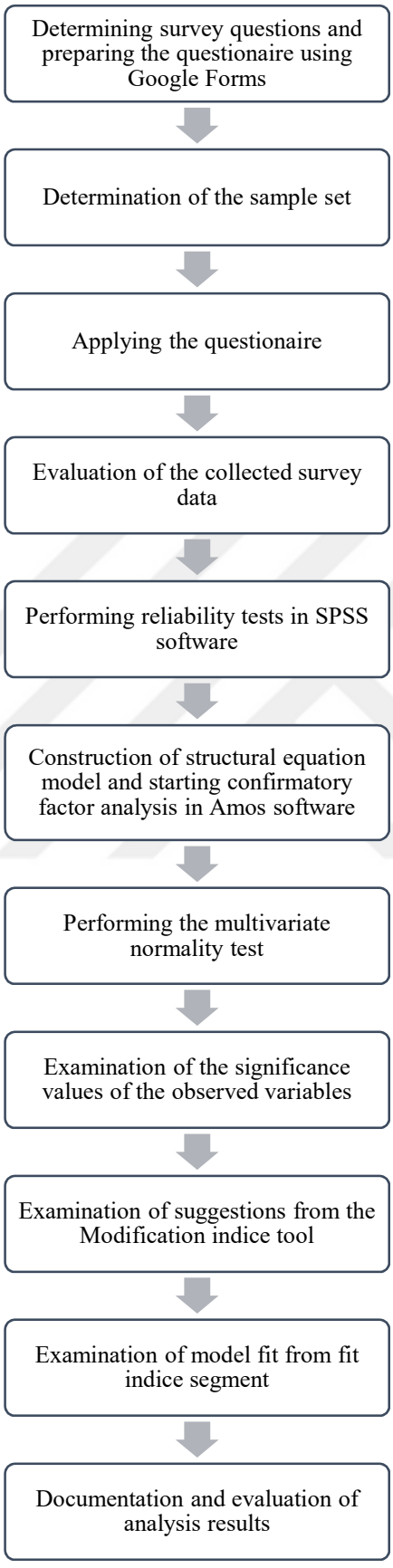

Figure 3.1 Framework of the study

3.2 Questionnaire and Survey Data

This thesis mainly aims to investigate the effects of supply chain management strategies on firm performance. İzmir Atatürk Industrial Cluster, where 508 large-sized companies are located, has been determined as the population of this study. Especially in large population situations, the Cochran's formula is used to calculate an ideal sample size. A given sample size provides more information for a small population than for a large population. Therefore, the sample size in small population problems can be reduced by the modified Cochran's formula (Nanjundeswaraswamy and Divakar, 2021). In this thesis, the minimum sample size is calculated via modified Cochran's formula, and the calculations show that we have to conduct at least 219 firms to obtain meaningful results at the 95% confidence interval. Modified Cochran's formula is given as follows:

$$n = \frac{n_0}{1+\left(\frac{n_0-1}{N}\right)} \text{ and } n_0 = \frac{z^2 p(1-p)}{e^2} \quad (1)$$

where "*N*" represents the total population within the industrial cluster, "*e*" is the tolerance, "*p*" is the standard deviation, "*z*" represents the z-score value, and "*n*" denotes the minimum sample size ensuring 95% confidence, "n_0" represents the Cohrans's sample size recommendation. Note that since the total population of the investigated industrial cluster is limited, we prefer using modified Cochran's formula which fits small population problems better than other approaches. Table 3.1 presents the population size and statistical assumptions taken before the supply chain management questionnaire.

Table 3.1 Statistical parameters used in the investigated industrial cluster

Population	**Tolerance**	***z*-score**	**Confidence Interval**	**Standard Deviation**	**Sample Size**	**Cochran's sample size recommendation**
N	*e*	*z*	*μ*	*p*	*n*	n_0
508	0,05	1,96	0,95	0,5	218,8	384,16

Gathered survey data are collected from the managers or lead engineers of each firm within the investigated industrial cluster. The questionnaire was prepared using Google Forms and consists of six parts. In the first part, a brief explanation of the questionnaire is made to inform the reader. Afterwards, three personal questions are listed: e-mail address, company name, and position. This section has been made mandatory to answer the company name question in order to distinguish the survey data coming from the same company. The reader cannot access the survey questions without completing this information. The remaining sections consist of questions to determine the effects of supply chain strategies on firm performance. The questionnaire consists of a total of 26 questions, with five possible answers each. These responses are presented in the following options: strongly disagree, disagree, neutral, agree and strongly agree. The reader marks the closest answer among the options. The questions are short and clear so as not to bore the reader. In order to reduce the number of questions, the most important points of the supply chain management strategies are discussed. Note that the questions are set as mandatory to answer, and the reader must answer all the questions in order to complete the questionnaire. The departments related to purchasing, sales and supply chain in the companies have been determined as the primary target for the questionnaire. The main purpose here is to reach the opinions of experts who have knowledge about the subject and to be able to analyze with accurate data. A different supply chain strategy is mentioned in each section of the questionnaire. The titles of these sections are given below:

1- Supplier integration (*SI*),
2- Customer integration (*CI*),
3- Internal integration (*II*),
4- Communication and information technology (*ICT*),
5- Firm performance (*FP*).

In the preparation of the questionnaire, the problems that are frequently encountered in real working life are utilized. Furthermore, many literature papers (Errassafi et al., 2019; Yeh et al., 2020; Cheng et al., 2016; Danase and Roman, 2011; Daneshvar et al., 2020; Feyissa et al., 2018; Huo, 2012; Som et al., 2019) were

examined in detail to determine accurate and effective questions. It is aimed to attract the attention of the reader by including the problems encountered in real business life in the questionnaire. The Covid-19 pandemic, which has been on the agenda of the world since 2019, is also mentioned in the survey questions. Here we understood from the feedbacks received from the readers that the survey questions are frequently encountered situations in the industry. We contacted with the general directorate of Izmir Ataturk Industrial Cluster in order to reach the contact addresses of the companies, and the communication info of all firms were obtained. Note that there is a total of 508 companies' contact information in this list. Emails were sent daily to these contact addresses. The questionnaire prepared with Google Forms was shared as an attachment in the e-mail. However, the rate of survey data collection was slow due to the lack of up-to-date or incomplete information in the list. Therefore, Linkedin social platform was used to speed up the process. An attempt via Linkedin was made to reach the employees of companies that could not be contacted. In summary, the survey data collection process proceeded in two different ways: by sending e-mails to the companies in the industrial cluster and by trying to reach the company managers/lead engineers via Linkedin platform. It has been concluded that using Linkedin platform gave much faster result and data collection.

Likert type scaling is used in the questionnaire, and readers are being asked whether agree or not. Responses are scored between 1 and 5. Highest point given to a question sometimes reflect a strong consensus, while it may also indicate low approval of the idea in another case. Therefore, in order to perform a consistent and accurate analysis on data set, all data must be in the same direction before analysis. Items with negative statements should be reverse coded to achieve this consistency (Alvarez et al., 2018). The normal scoring in the questionnaire was scored from 1 to 5, starting with the option "Strongly Disagree". Here the items *SI5*, *CI5* and *CI6*, which have negative rooted expressions in the questionnaire, were transferred to the data file and reverse coding was performed to observe the consistency. The purpose of reverse scoring is to convert the high score to the corresponding small score on the scale. In other words, it was scored from 5 to 1, starting with the option "Strongly Disagree". Table 3.2 presents the

questionnaire details for each investigated supply chain management strategies and output parameter of firm performance.

Table 3.2 Questions used in the questionnaire

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
SUPPLIER INTEGRATION	SI1-Sharing long and short-term plans with suppliers ensures that the company is ready for future actions	1	2	3	4	5
	SI2-The awareness of the suppliers in the market increases the brand awareness and reliability of the company.	1	2	3	4	5
	SI3-We must help our suppliers improve their processes so that they better meet our needs.	1	2	3	4	5
	SI4-If we want our needs to be better met, we must share our stock levels with our suppliers.	1	2	3	4	5
	SI5-Over-dependence on suppliers can pose a risk to the firm in the long run.	5	4	3	2	1
	SI6-Supplier integration increases the competitiveness of companies.	1	2	3	4	5
CUSTOMER INTEGRATION	CI1-Involving customers in product design processes contributes positively to the financial performance of the company by preventing problems such as producing faulty and poor-quality products.	1	2	3	4	5
	CI2-Customer integration enables the customer to establish an emotional connection with the manufacturer. This prevents the customer from looking for a substitute product.	1	2	3	4	5
	CI3-The customer is expected to take ownership of the product that he contributed to the design. Therefore, they tend to adopt and own the producer.	1	2	3	4	5
	CI4-Involving the customer in processes (such as design) allows the customer to spend more time and effort to contribute more to the product/service.	1	2	3	4	5
	CI5-High customer integration creates a risk of failure for the firm by being too dependent on the customer.	5	4	3	2	1
	CI6-Customer integration causes the manufacturer to be limited to incremental innovation efforts only.	5	4	3	2	1

Table 3.2 Continues

INTERNAL INTEGRATION	II1-Companies that want to establish long-term solid relations with suppliers and customers should first ensure their own internal integration.	1	2	3	4	5
	II2-The fact that departments work well alone never guarantees success. It is not possible to achieve common goals without cross and integrated work.	1	2	3	4	5
	II3-Internal integration increases the diversity of information within the enterprise and paves the way for the development of different perspectives. This increases the operational performance of the firm.	1	2	3	4	5
	II4-Companies improve response time and information processing capabilities by internal integration.	1	2	3	4	5
	II5-If the departments do not work in sync, the business will face financial and operational loss.	1	2	3	4	5
	II6-Improving internal integration will increase the competitiveness of companies.	1	2	3	4	5
COMMUNICATION AND INFORMATION TECHNOLOGY	ICT1-Companies that follow technology closely during the pandemic period have increased their competitiveness (digital meetings, remote work, etc.)	1	2	3	4	5
	ICT2-The fact that advanced artificial intelligence technologies approach all customers with the same sincerity does not adversely affect customer-manufacturer relations and does not prevent the customer from feeling special. (live support and customer service software etc.)	1	2	3	4	5
	ICT3-Technological innovations always reduce the workload of employees while facilitating supply chain management (software, communication technologies etc.).	1	2	3	4	5
	ICT4-Processing and storing all of the company's information in a digital environment does not increase the company's dependence on the system and does not pose a security risk.	1	2	3	4	5
	ICT5-As a result of technology, continuous accessibility by the customer positively affects the performance of employees/businesses (fast communication with smart phones, calling-mailing).	1	2	3	4	5
	ICT6-The initial cost and unforeseen operating costs of acquiring new technologies are negligible compared to the potential benefits of the technology to the firm.	1	2	3	4	5
FIRM PERFORMANCE	SCS1-Parameters such as competitiveness, quality, responsiveness, customer satisfaction, and profitability are important criteria in measuring company performance.	1	2	3	4	5
	SCS2-Internal abilities such as employee productivity, ability to process information, fast access to information and readiness for future actions are directly related to company performance.	1	2	3	4	5

The data was collected everyday and we reached about 280 respondents at the end of a three-months period. At this point, questionnaire results performed by the same companies and questionnaires out of the determined industrial cluster were extracted from the collected data set. The demographic characteristics of the data to be used for analysis are given in Table 3.3. At the beginning of the questionaire, the reader is asked to fill in the title information in the company. The quantity column given in the table indicates the total number of people working in the relevant position. Percent column expresses these data as a percentage.

Table 3.3 Demographic characteristics of the investigated industrial cluster

Department	**Quantity**	**Percent (%)**
Research and development	13	5.83
Stock management	4	1.79
Finance	13	5.83
Business development	3	1.35
Quality	10	4.48
Planning	18	8.07
Project	8	3.59
Purchasing	25	11.21
Sales and marketing	38	17.04
Supply chain	2	0.90
Technical support and maintenance	5	2.24
Production	20	8.97
Senior manager	47	21.08
Others	17	7.62
Total	223	100.00

3.3 Data Accuracy and Structutal Equation Modelling (SEM)

Literature indicates that Structural Equation Modelling (SEM) method is frequently used in studies and investigations related to supply chain strategies. SEM technique is a statistical method used to predict cause and effect relationships between observed and unobserved variables (Zhou, 2022; Polat, 2018). The SEM method is used both in supply chain related studies and in many different fields such as social sciences (Khan et al., 2022), educational sciences (Makransky and Lilleholt, 2018), marketing (Xie et al., 2022). For example, a life satisfaction questionnaire (LSQ) was performed with

362 women diagnosed with breast cancer, in Sweden (Carlsson and Hamrin, 2002). In the light of the collected data, a model was created using six hidden and thirty-four observed variables. The model was analyzed with SEM using the STREAMS software. As a result of the analysis, the degree of relationship between latent and observed variables and the extent to which these variables affect life satisfaction were revealed.

It is possible to handle the testing of models containing multiple hypotheses via SEM methodology (Zhang, 2022). Being able to consider the model as a whole facilitates the solution of the complex and difficult models. On the other hand, tests with a small number of variables are insufficient to understand the theories, i.e., most of proposed models are insufficient to be understood with a single variable. Therefore, all the dominant factors should be taken into account when testing the model. Note that need for multivariate calculations makes the SEM method different from univariate analysis methods. In the SEM method, structural equations created in the model can also be supported by drawing using symbolic visuals. These images illustrate a path diagram to summarize the model. Each icon represents different objectives and situations. These drawings make it easier to understand the relationships within the model. Some illustrations of the path diagram are given in Figure 3.2.

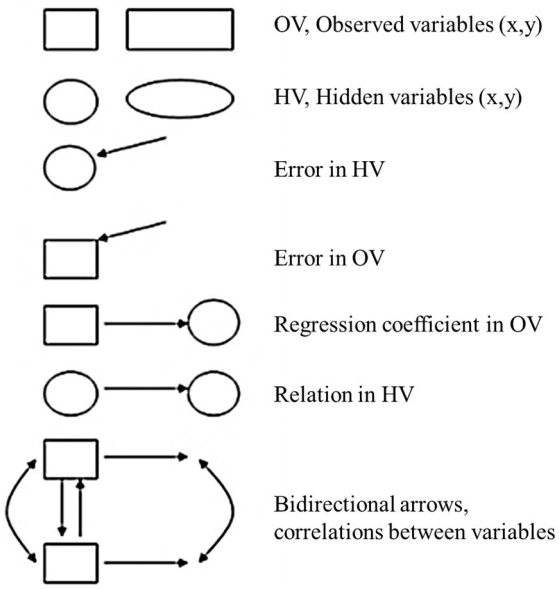

Figure 3.2 Symbols used in SEM and their functions (Yılmaz ve Çelik, 2009)

Traditional methods are insufficient to evaluate measurement errors. Furthermore, error is ignored in most investigated case. The results can lead to serious inaccuracies, especially when the errors are large (Byrne, 2010). At this point, SEM method takes measurement errors into account when analyzing the model (Amini and Alimohammadlou, 2021). Error measurement issue is the main superiority of SEM methodology. The first step of applying the SEM method is to determine the model. Then, the sample for the relevant model is selected and the model is analyzed. Direct or indirect relationships of the variables are graded with an analysis. At the end of this analysis, the outputs are compared with the available data, it is determined whether they are compatible with the model or to what extent, and the findings are discussed. If the fit indices show fitting between the outputs and the model, the hypothesis is accepted, otherwise the hypothesis is rejected (Byrne, 2010). SEM method is preferred in this study because of fitting superiority and model stability.

SEM method mainly investigates and reveals the cause-effect relationships between observed and unobserved variables. It is possible to classify these types of relationships under three headings: relationship, direct effect, and indirect effect. In its plain form, the relationship expresses the relationship between two variables, which is indicated by a double arrow. The direct effect is indicated by a one-way arrow between the two variables. In addition, indirect effect can be summarized as the impact of an independent variable on dependent ones, and it is represented by a one-way arrow (Yılmaz and Dalbudak, 2018). Unobserved variables in the model are also called latent variables. As latent variables cannot be observed, they are linked to observed behaviors for making their measurement possible. The most common statistical method of analyzing the relationships between observed and latent variables is factor analysis. Two types of factor analysis are used: confirmatory (CFA) and explanatory (exploratory).

Exploratory Factor Analysis (EFA) is used when the connections between latent variables and observed variables are unknown (Taherdoost et al., 2022). Therefore, it works with an investigative-exploratory approach to determine how the observed variables are related to the fundamental factors. For example, researchers can use EFA

when they do not know under which factor the variables they have are actually measuring (Byrne, 1994: Şekercioğlu, 2009). EFA also has the feature of collecting a large number of variables under a small number of factors (Tabachnick and Fidell, 2021). On the other hand, CFA is used when there is information about the connection between latent variables and observed variables. It serves to test the model predetermined by the researcher. The CFA method analyzes the relationship among the factors, the relationship between factors and variables, and the independence-dependency status of factors (Erkorkmaz et al., 2013). Note that exploratory factor analysis prepares the infrastructure of the hypothesis, while confirmatory factor analysis tests the hypothesis. In exploratory factor analysis, investigated variables are in relation with each latent variable. On the other hand, in confirmatory factor analysis, analyst/researchers are able to specify the examined factors related to investigated exogenous latent variables. As a result, both analyzes try to reveal them by focusing on relevance among the observed and latent variables, and also the intensity of the relationship (Yaşlıoğlu, 2017). Shematic sample of SEM model methodology is presented in Figure 3.3.

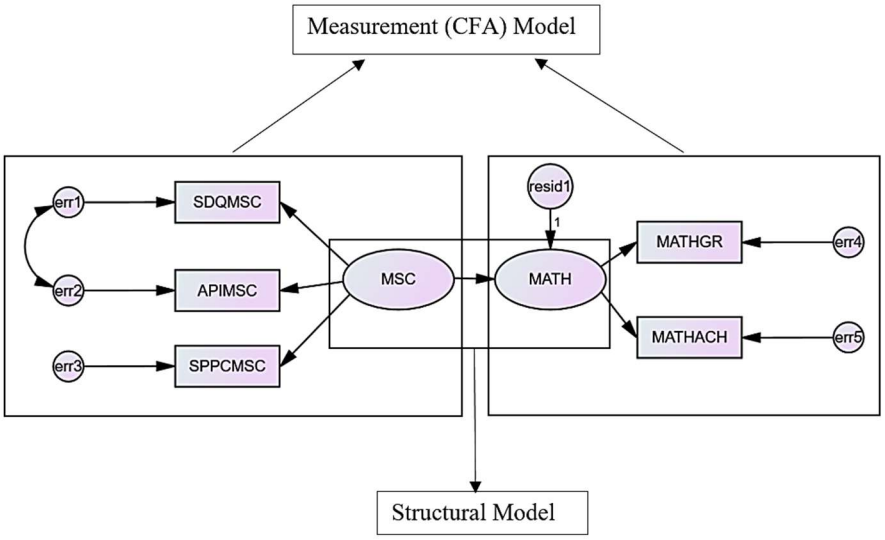

Figure 3.3 A sample for AMOS structural equation modelling design (Byrne, 2010)

The model given in Fig. 3.3 presents math ability (MATH) and math self-concept (MSC), and they are expressed as two latent variables. MSC has three observed variables, while MATH has two observed variables. These five observed variables

represent the underlying reasons of the latent variables they depend on. Furthermore, five measurement errors, one for each observed variable, were assigned as err1, err2, err3, err4, err5. In addition, a residual (residi1) is also assigned to hidden variable of MATH. The initial variable located on the left-side of given model is called the exogenous or independent variable. The variable to the right of the exogenous variable is called the endogenous or dependent variable. MSC influences on the endogenous variable MAT by being in the position of exogenous latent variable. The arrow from MSC to MATH symbolizes this. The variable that mediates the relationship among dependent and independent variables is called the mediating variable. The task of the mediating variable is to help better explain the relevance among the dependent and independent variable. There are three conditions that must be sought for a variable to be an intermediary variable, there must be relationships in between:

1- Dependent and independent variables,
2- Independent and mediating variables,
3- Mediator and the dependent variables.

When the mediating variable mediates the relation among the dependent and independent variable, if the relevance among the dependent and independent variable has weakened or has become meaningless, it is called a full mediator variable. If the relationship among the dependent and the independent variables becomes significant but less significant than the relationship after the mediating variable, the mediator variable is expressed as the partial mediator variable (Yılmaz and Dalbudak, 2018). Note that one-way arrows in the model show the structural regression coefficients, that is, the effects on a variable. Arrows from error symbols to observed variables indicate errors related to observed variables. The double-sided arrow between the two error terms indicates that there is variance or covariance between these variables. The structural model is also defined by the EFA. The relationships among the observed and unobserved variables are expressed as a measurement model. The measurement model is synonymous with CFA.

3.4 Investigations on IBM SPSS AMOS

Analysis of Moment Structures (AMOS) is a widely used SEM software that supports models with graphics and text. AMOS software is preferred for analysis due to its main advantages and user-friendly tools. In the literature, most of the researchers using the SEM systematics consider AMOS software to evaluate the data set in diverse research fields (Bae and Yeom, 2022; Alolayyan et al., 2022; Hride et al., 2022). In this study, CFA is performed with the IBM SPSS Amos software to test whether the sample data confirms the model. CFA is a frequently used and convenient method that does not aim to verify a predetermined structure (Yaşlıoğlu, 2017). Furthermore, AMOS offers a freedom to easily design the model using both text and shapes. The commands in AMOS are also indicated with visual icons which make the program user-friendly. Presenting the commands in simple shapes provides great convenience for the user. It is possible to design an adequate structural equation model using these shapes and commands. Figure 3.4 shows the main software page and symbols which provides easier access to required tools. One of the advantages of AMOS is its ability to offer various modifications to improve the model if the model and data are not suitable (Akinyode, 2016). AMOS software aims to bring it to a stable structure by revising the model with new suggestions. Furthermore, AMOS guides the user with its understandable interfaces. In this thesis, IBM SPPS AMOS is utilized as it has so many superiorities on the statistical evaluations. SPSS is also used for the reliability analysis of the proposed models.

Within the scope of the thesis, a model is created by using visual templates in IBM SPSS Amos software for the analysis to be made using the SEM method. The relationship arrows are indicated with figures in the model in order to reveal the degree of relationship among the variables in the end of the analysis. Then, the file containing the results of the questionnaire is transferred to the program and the steps of the analysis are implemented to obtain realistic and reliable analysis data. When the analysis is run, it is first checked whether the model complies with the multivariate normality assumption. For this reason, tests for normality and outliers' options should be checked in the analysis properties tab. Note that the model must comply with the multivariate normality assumption to make accurate and consistent estimations.

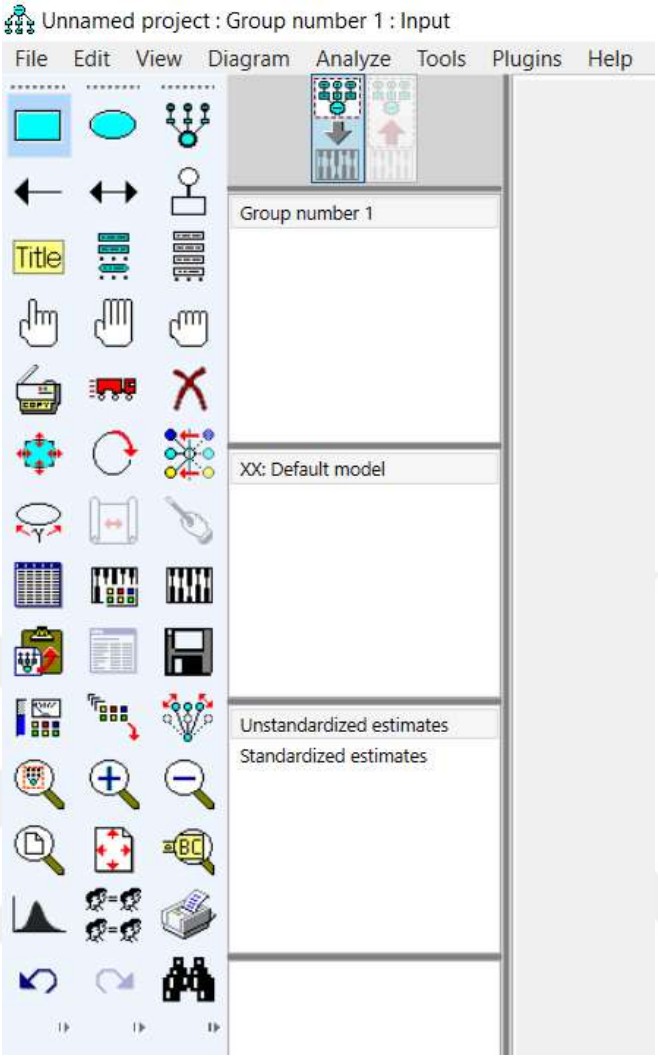

Figure 3.4 Main tools and symbols within the IBM Amos software

Here, univariate normality refers to the conformity of only one variable in the sample to the normal distribution. Multivariate normality, on the other hand, defines the conformity of all variables in the sample to the normal distribution (Gao et al, 2008). The most important assumption of SEM is that the data have a normal distribution (Kumar, 2015). In the next step, the significance values of the measurement model is examined. In other words, the significance levels of each latent and the observed variables depending on the latent variable are checked. The significance value (p) of the observed variables is less than 0.05, indicating that that observed variable is significant under the related latent variable.

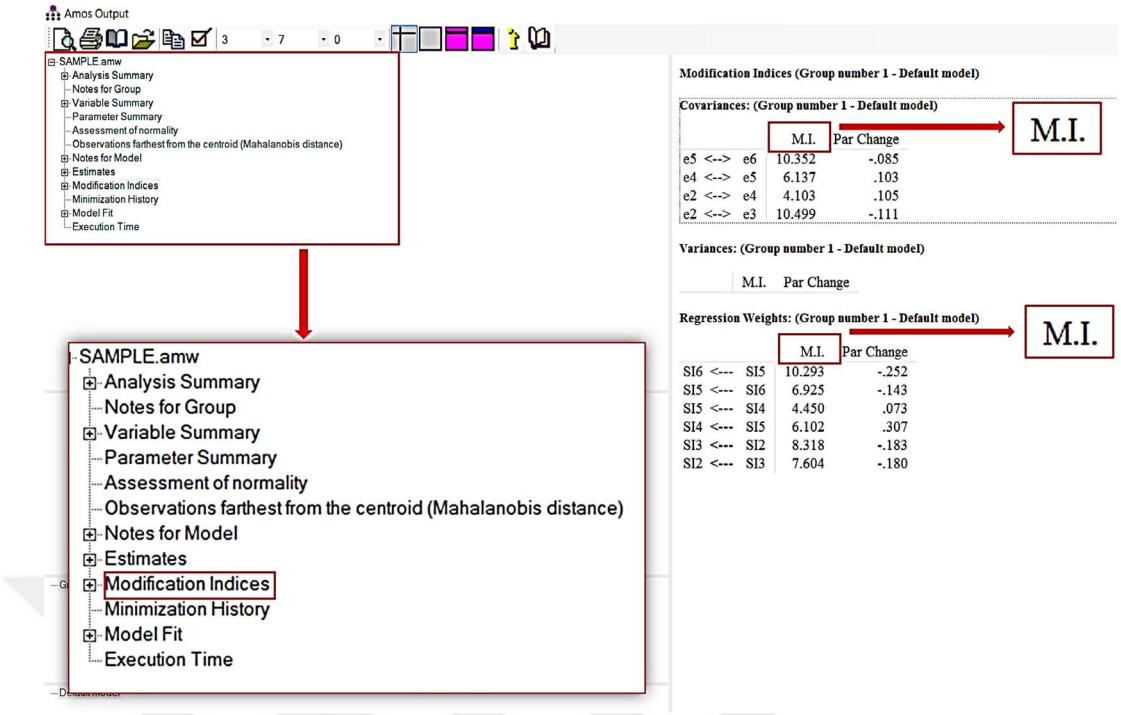

Figure 3.5 Modification indices obtained in the software

As a result of the analysis, the Amos software may offer various suggestions to make the model better and more compatible. These suggestions are located under the modification indices (MI) section on the analysis results page. If the MI value in the modification indices page is high, it means that there may be an intense relationship between those two parameters. At this point, the Amos software proposes to the researcher to establish a covariance relationship between those two parameters.

There is no general view that these recommendations should always be followed. Since the main purpose of the suggestions is to make the model better, suggestions that do not match the setup logic of the model and do not make the model more meaningful should not be implemented. It is recommended that the proposed modifications be applied when they are based on a theoretical justification. In addition, there are studies that suggest that modification proposals often fail to create the right model (Hox and Bechger, 1998). Therefore, starting from the highest MI value, suggestions should be evaluated through a logic filter.

Another point to be checked with the analysis is the fit indices of the model. Model fit indices express how well the model established with the SEM fits the data set. AMOS offers several goodness-of-fit measures to evaluate model fitting. The Chi-square (x^2) test is the most commonly used test of goodness of fit and forms the basis of other fit indices (Hoe, 2008). If the model is a perfect fit to the data, it is expected that the obtained value (*p-value*) will not be close to zero, that is, it will not be close to zero, i.e, it will not be significant. Contrary to the known significance test, we desire that the *p* value in the Chi-square (x^2) test is intended to be meaningless (Sümer, 2000). However, the Chi-square (x^2) value is very sensitive to the sample size, and the result is usually significant when large samples are used. Therefore, it is recommended to use the ratio of Chi-square over degrees of freedom instead of directly calculating the Chi-square (x^2) value for evaluation of model fit (Hoe, 2008). Although there is a widespread opinion that the Chi-square/Degrees of Freedom must be presented, there is no consensus on which of the remaining fit indices should be reported. Additionally, not all indices are expected to be used or reported (Alavi et al, 2020). Fit indices have different strengths and weaknesses. They can be sensitive to sample size, simplicity or complexity of the model, or size of the degrees of freedom. The approach that measures the discrepancy between the variance and covariance ratios of the actually observed and the designed-targeted model is the goodness of fit method (GFI). Goodness of fit method is less sensitive to the sample size compared to the Chi-square (x^2) method (Yaşlıoğlu, 2017). However, it still shows a tendency to reject in analyzes with small sample sizes.

Table 3.4 Fit indices used in AMOS software (Schermelleh and Moosbrugger, 2003: Byrne, 2010: İlhan and Çetin, 2014)

Fit Indices	**Perfect Fit Criterion**	**Acceptable Fit Criterion**
x^2/DF	$0 \leq x^2/DF \leq 2$	$2 \leq x^2/DF \leq 3$
AGFI	$0.90 \leq AGFI \leq 1.00$	$0.85 \leq AGFI \leq 0.90$
GFI	$0.95 \leq GFI \leq 1.00$	$0.90 \leq GFI \leq 0.95$
CFI	$0.95 \leq CFI \leq 1.00$	$0.90 \leq CFI \leq 0.95$
NFI	$0.95 \leq NFI \leq 1.00$	$0.90 \leq NFI \leq 0.95$
NNFI (TLI)	$0.95 \leq NNFI (TLI) \leq 1.00$	$0.90 \leq NNFI (TLI) \leq 0.95$
RFI	$0.95 \leq RFI \leq 1.00$	$0.90 \leq RFI \leq 0.95$

Table 3.4 Continues

IFI	$0.95 \leq IFI \leq 1.00$	$0.90 \leq IFI \leq 0.95$
RMSEA	$0 \leq RMSEA \leq 0.05$	$0.05 \leq RMSEA \leq .0.08$
SRMR	$0 \leq SRMR \leq 0.05$	$0.05 \leq SRMR \leq 0.10$
PNFI	$0.95 \leq PNFI \leq 1.00$	$0.50 \leq PNFI \leq 0.95$
PGFI	$0.95 \leq PGFI \leq 1.00$	$0.50 \leq PGFI \leq 0.95$
AIC	The model with the smallest value among those compared	
CAIC	The model with the smallest value among those compared	
ECVI	The model with the smallest value among those compared	

The fit criterion of the root mean square error of approximation (RMSEA) is an approach that expresses the degree of fit of the model to the data, and this approach takes into account the model size and sample size. The RMSEA value must be less than 0.05 for the convergence of proposed model to reality (Hox and Bechger, 1998). On the other hand, Comparative Fit Index (CFI) assumes that all latent variables are uncorrelated and compares the covariance matrix of the established model with this empty matrix. It is one of the most frequently used methods since it is less affected by the sample size (Hooper et al, 2008). Another measure of fit index is the root mean square residual (RMR). RMR is based on the calculating the square root of the difference between the residuals of a sample covariance matrix and an assumed covariance model. Interpretation of RMR becomes difficult when different indicator criteria are included in the collected data (Schermelleh et al, 2003). However, all survey questions in this study were scaled between 1 and 5. Therefore, the disadvantage of RMR is not applicable for this investigation and collected data set. In this thesis, commonly used fit indices given in Table 3.4 were examined and reported.

Within the scope of the thesis, each of fit indice was examined in detail and it we investigate whether the parameter estimates are statistically significant, or not. The findings are analyzed under the following headings, which are the main objectives of this research.

1- Determining the relationship of each latent variable with the observed variables underneath.

2- Investigation of the relationship among latent variables of *SI*, *CI, II*, and *ICT*.
3- Analyses on the effects of *SI*, *CI*, *II* and *ICT* on business performance.

CHAPTER FOUR

AN APPLICATION IN THE SUPPLY CHAIN MANAGEMENT

In this thesis, Structural Equation Modelling (SEM) method is utilized to determine the effects of supply chain strategies on business performance. SEM technique is a statistical method for prediction of cause-and-effect relevance among observed and unobserved variables in theories. The method has been used in many different fields such as social sciences, engineering, educational sciences, and marketing. The SEM model used in this research is a second level and five-factors model. The latent variables in the model are supplier integration (*SI*), customer integration (*CI*), internal integration (*II*), information-communication technology (*ICT*), and firm performance (*FP*). *SI*, *CI*, *II* and *ICT* are in the position of an exegenous variable. A covariance relationship was established with two-way arrows in order to analyze the relationship among the exogenous latent variables. These four exogenous latent variables have significant influence on the firm performance, which is an endogenous latent variable. Note that there are six observed variables under the exogenous latent variables and two observed variables under the endogenous latent variable. The observed variables are presented in Table 3.2 for each exogenous latent variable.

Figure 4.1 shows relationship among the observed variables, exogenous and endogenous latent variables. In the model, an error term is assigned to the endogenous latent variable of FP. Note that, one of the arrows from the observed variables must be fixed with a regression weight of one in order to run the model. Before testing the model, the analysis properties which will be performed are marked by selecting the standardized estimates, squared multiple correlations and tests for normality tabs in the analysis window.

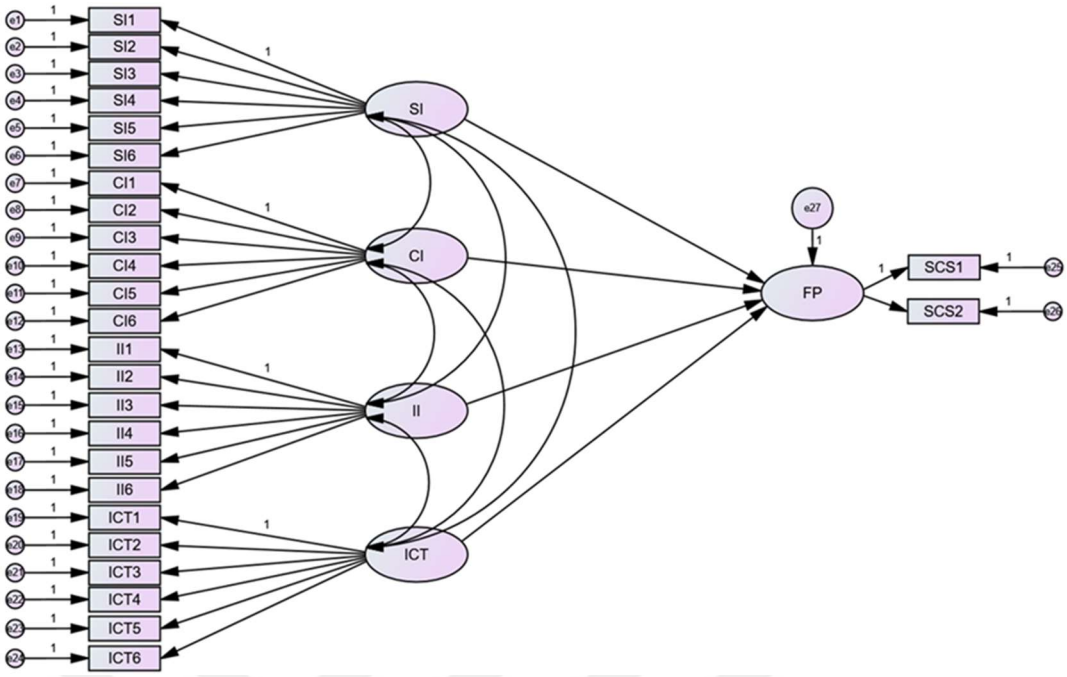

Figure 4.1 SEM model structure and relations between the variables

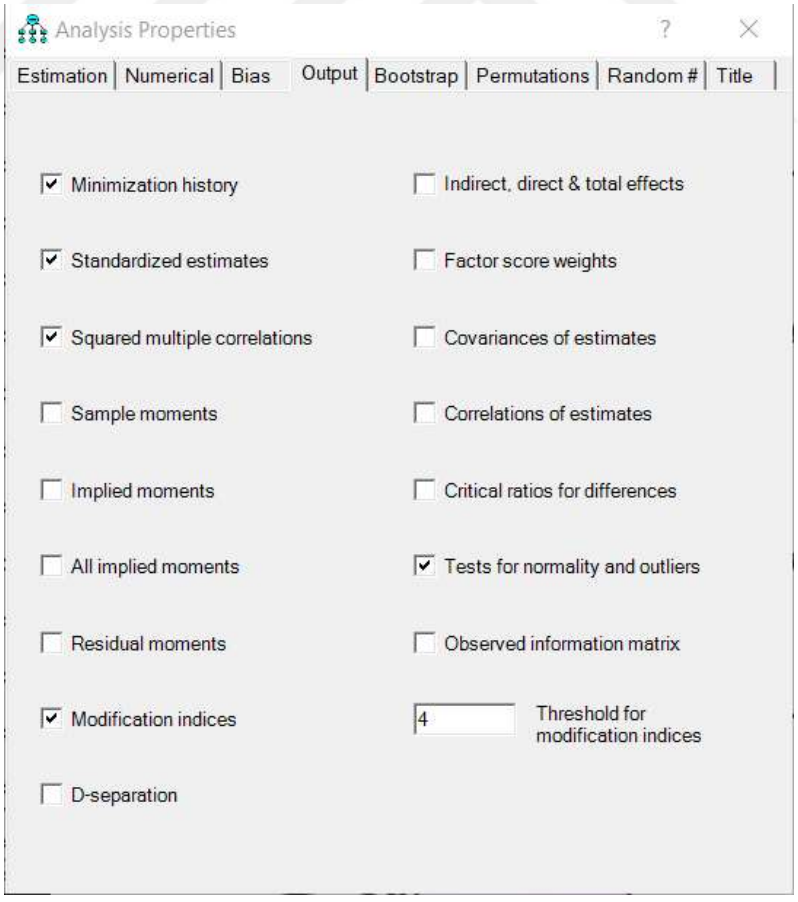

Figure 4.2 Selected analysis properties for the investigated SEM model

Minimization history is a default parameter which is used for logging the required iteration steps of investigated analysis. Unstandardized estimates are a default parameter within the analisis. Standardized estimation is selected as this option facilitate to interpret the effects among the variables. Squared multiple correlation measures each dependent variables' proportion of the variance within the model. Modification indices option offers various suggestions to increase fitting of the SEM model. Normality test option is selected to check whether the model complies with the multivariate normality assumption.

The path diagrams obtained after running the analysis are given below.

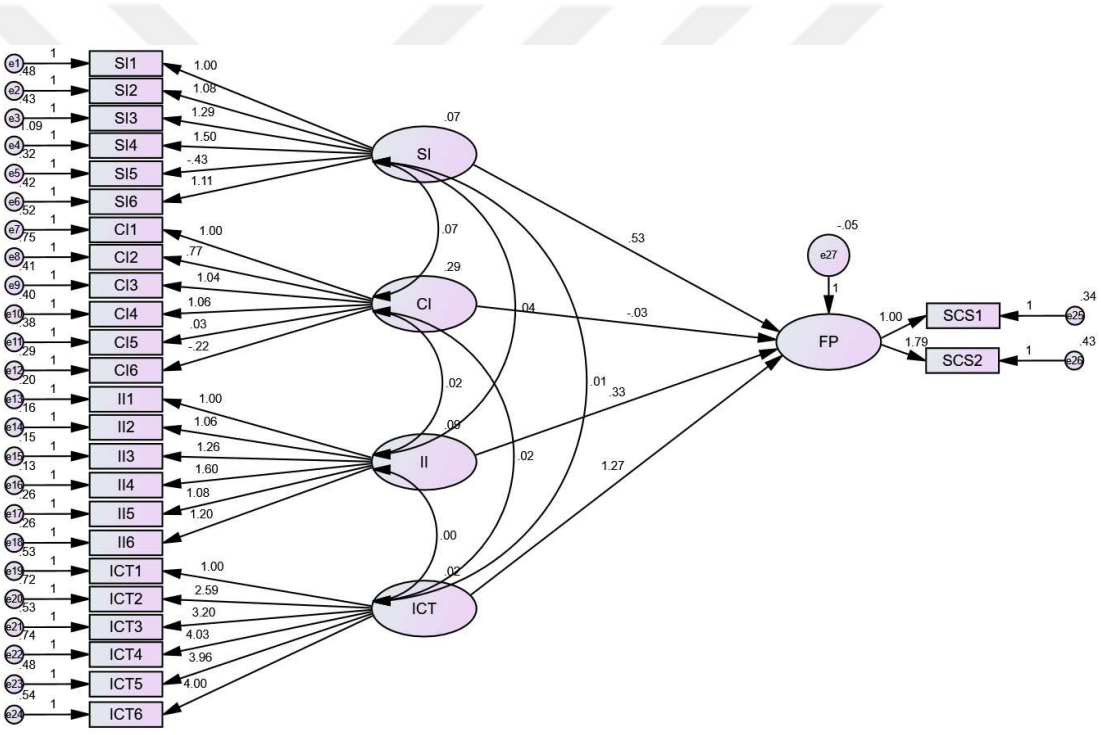

Figure 4.3 SEM results for unstandardized path

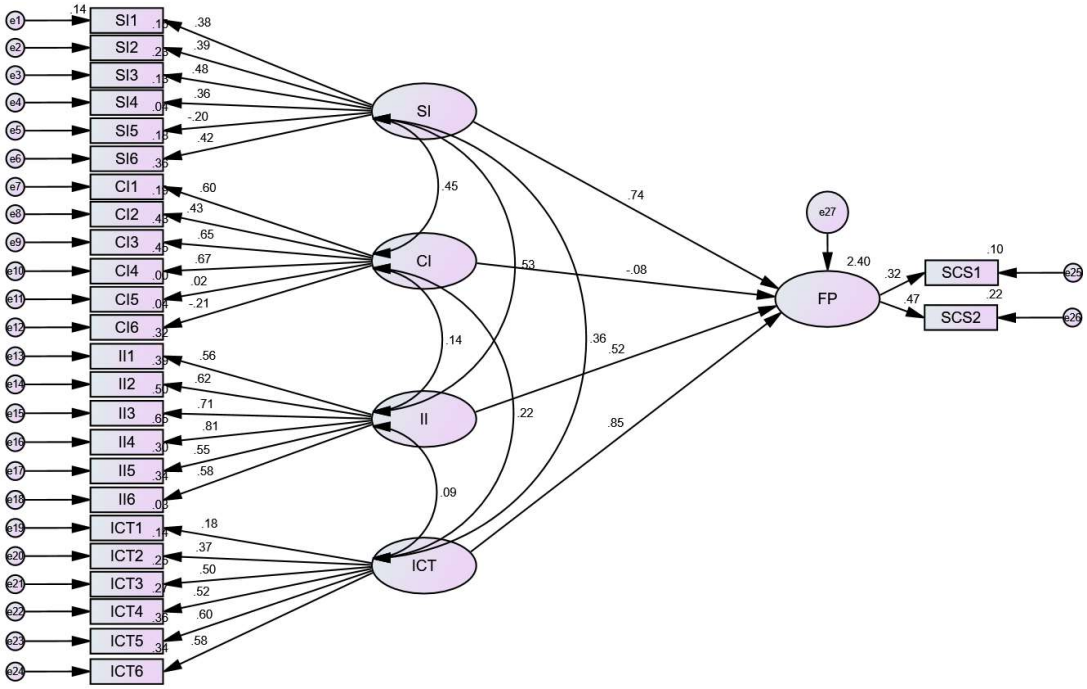

Figure 4.4 SEM results for standardized path

4.1 Multivariate Normality Test Results

It should be checked whether the model conforms to the multivariate normality assumption before model fit is tested. The previous investigations showed that the analyses provide consistent and accurate estimates when the assumption of multivariate normality is met. Therefore, it is very important to perform a normality test to obtain reliable results. The literature papers present that the skewness absolute value of the variables in a research model should be less than two, and the kurtosis absolute value must be less than seven for a sufficient multivariate distribution (West et al., 1995; Dölarslan and Özer, 2014; Kumar, 2015). Table 4.1 presents the findings obtained with multivariate normality test.

Table 4.1 The multivariate normality test results of the used methodology

Variable	Min	Max	Skew	c.r.	kurtosis	c.r.
SCS2	2	5	-0.689	-4.199	0.316	0.962
SCS1	2	5	-0.259	-1.581	0.494	1.505
ICT6	2	5	-0.339	-2.067	-0.623	-1.9

Table 4.1 continues

ICT5	2	5	-0.689	-4.202	-0.006	-0.018
ICT4	1	5	0.199	1.214	-1.136	-3.463
ICT3	1	5	-0.751	-4.579	0.44	1.343
ICT2	1	5	-0.447	-2.726	-0.502	-1.53
ICT1	2	5	-0.707	-4.307	0.183	0.558
II6	2	5	-0.727	-4.433	1.065	3.247
II5	2	5	-1.076	-6.561	1.897	5.784
II4	2	5	-0.664	-4.048	0.781	2.38
II3	3	5	-0.358	-2.185	-1.035	-3.154
II2	3	5	-0.954	-5.819	-0.283	-0.862
II1	2	5	-0.286	-1.741	0.119	0.363
CI6	1	3	-0.193	-1.178	-0.927	-2.825
CI5	1	3	-0.123	-0.75	-0.489	-1.491
CI4	2	5	-0.506	-3.082	-0.279	-0.851
CI3	1	5	-0.775	-4.726	0.395	1.205
CI2	1	5	-0.495	-3.015	-0.45	-1.372
CI1	1	5	-0.72	-4.387	0.073	0.224
SI6	2	5	-0.526	-3.208	0.327	0.996
SI5	1	3	0.293	1.788	-0.734	-2.237
SI4	1	5	-0.087	-0.531	-0.982	-2.992
SI3	2	5	-0.875	-5.334	0.405	1.235
SI2	2	5	-1.075	-6.551	1.517	4.623
SI1	1	5	-1.156	-7.05	2.654	8.089
Multivariate					37.125	7.265

Normality estimation techniques are used according to the skewness or kurtosis of the data set (Kumar, 2015). Skewness measures of the unsymmetrical degree of a distribution. Kurtosis presents the existence of samples in the middle of the distribution. The min and max columns represent the minimum and maximum scores in the survey questions. The critical ratio (*cr*) is calculated by dividing the skewness and kurtosis values each by its standard error. Dividing these parameters by its own error provides a statistic comparable to *z*.

Similar to Yılmaz and Varol (2015), Kline (2011) documents that if the normalized multivariate kurtosis (critical ratio) is greater than 8, the data set does not fit the multivariate normal distribution since the multivariate kurtosis is the critical value of a normality test. As a result of the multivariate normality test performed on the observed variables, the critical ratios value was calculated as 7.265. Therefore, with

the preliminary analysis, it is understood that the data set conforms to a multivariate normal distribution.

4.2 Evaluations of Significance Test Results

SEM results based on the supply chain management survey data were also evaluated in terms of the statictical significance. The significance value (p) measurements for the proposed model indicates that the relationship between *CI5* and *CI* was not significant since p is higher that 0.05. Table 4.2 shows the significance test results for all observed variables.

Table 4.2 Significance test results for the observed variables

Observed variables	Path	Latent variables	β_1	β_0	Standard error	Critical ratio	Significance value, p
SI1	<---	SI	0.379	1			
SI2	<---	SI	0.391	1.075	0.3	3.579	<0.001
SI3	<---	SI	0.476	1.295	0.329	3.934	<0.001
SI4	<---	SI	0.364	1.496	0.435	3.439	<0.001
SI5	<---	SI	-0.201	-0.426	0.188	-2.263	0.024
SI6	<---	SI	0.424	1.111	0.298	3.73	<0.001
CI1	<---	CI	0.596	1			
CI2	<---	CI	0.431	0.773	0.161	4.807	<0.001
CI3	<---	CI	0.653	1.037	0.167	6.227	<0.001
CI4	<---	CI	0.667	1.062	0.17	6.26	<0.001
CI5	<---	CI	0.024	0.027	0.091	0.298	0.066
CI6	<---	CI	-0.212	-0.218	0.084	-2.587	0.01
II1	<---	II	0.561	1			
II2	<---	II	0.622	1.056	0.152	6.929	<0.001
II3	<---	II	0.705	1.256	0.168	7.484	<0.001
II4	<---	II	0.807	1.595	0.199	8.002	<0.001
II5	<---	II	0.546	1.085	0.171	6.338	<0.001
II6	<---	II	0.585	1.204	0.181	6.648	<0.001
ICT1	<---	ICT	0.177	1			
ICT2	<---	ICT	0.37	2.593	1.248	2.077	0.038
ICT3	<---	ICT	0.498	3.196	1.471	2.172	0.03
ICT4	<---	ICT	0.524	4.033	1.846	2.184	0.029
ICT5	<---	ICT	0.599	3.963	1.793	2.211	0.027
ICT6	<---	ICT	0.581	4.001	1.814	2.205	0.027
SCS1	<---	FP	0.32	1			
SCS2	<---	FP	0.472	1.785	0.312	5.724	<0.001

β_0 and β_1 denote the unstandardized and standardized path coefficients, respectively. Here, non-standardized path coefficients mean the model estimation based on the raw data. On the other hand, standardized path coefficients are calculated by the standardization of the examined data set. Literature investigations show that using the standardized path coefficients are more meaningful for directly unmeasurable data sets (Kwan and Chan, 2011). Unstandardized path coefficients are more difficult to interpret. For this reason, standardized path coefficients are generally examined. Standard errors represent the precision of the parameter estimation. Standard errors that are too large or too small indicate low model fit, but there is no precise range for a large or small value (Bryne 2010). The critical ratio is found by dividing the parameter estimate by the standard error and distributed as a *z*-statistic (Byrne, 2010). In general point of view, parameters with a significance level of $p <$ 0.05 and critical ratio higher than 1.96 in absolute value are considered statistically significant (Khine, 2013). The observed variable *CI5* was removed from the model since there was no significant relationship between *CI5* and *CI.* The model was reconstructed to satisfy the significance value.

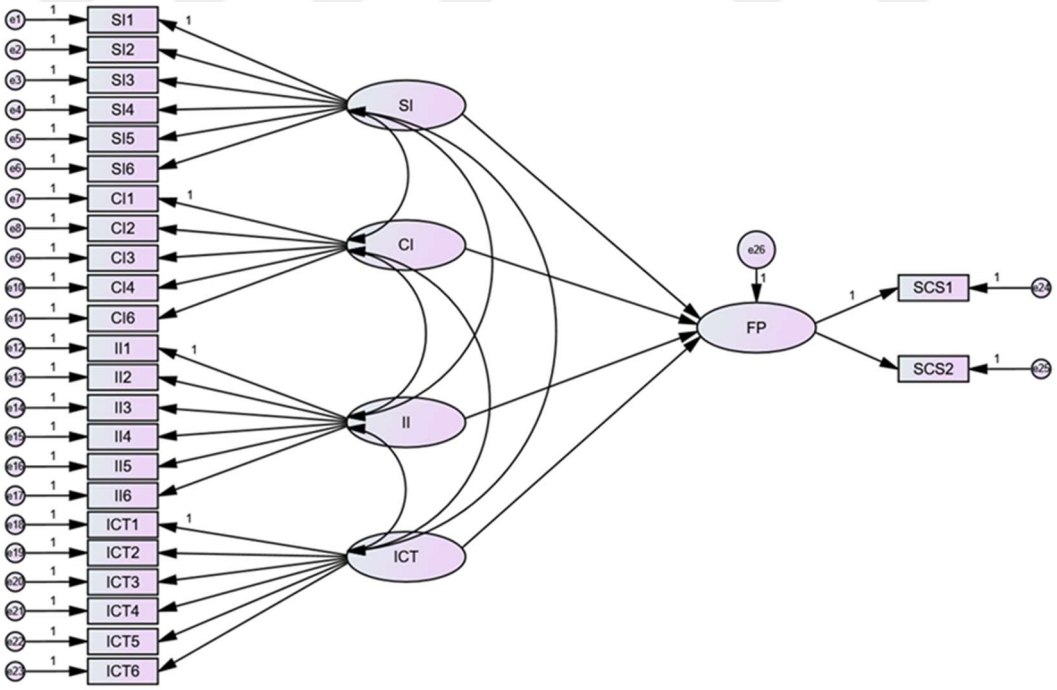

Figure 4.5 Re-constructed SEM model

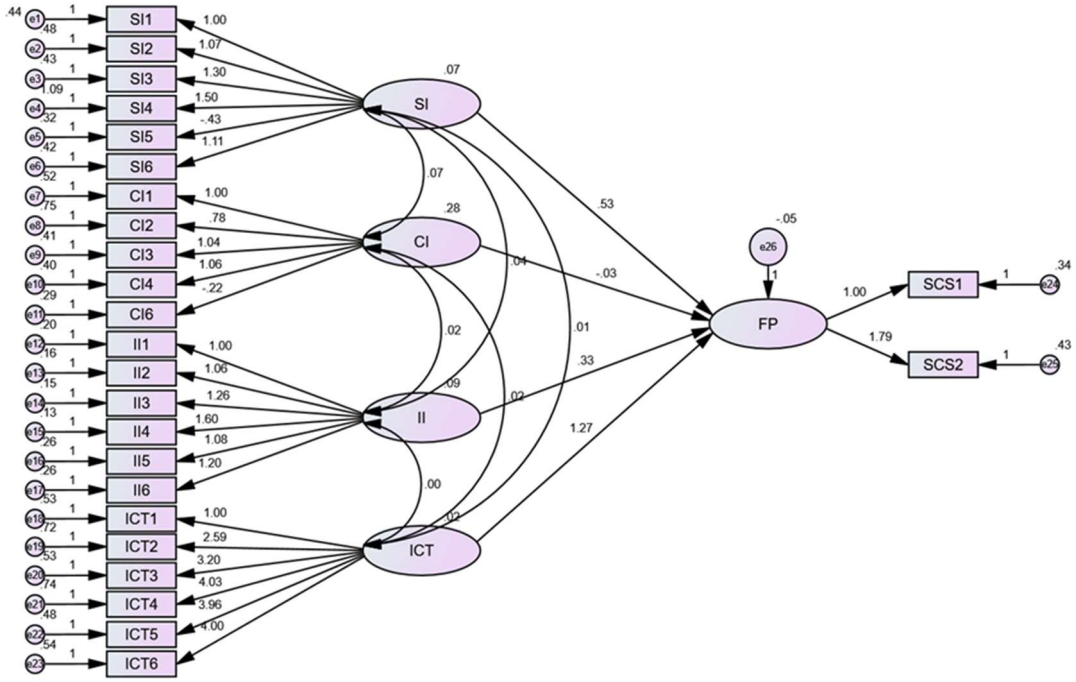

Figure 4.6 Re-constructed SEM model results for unstandardized path coefficients

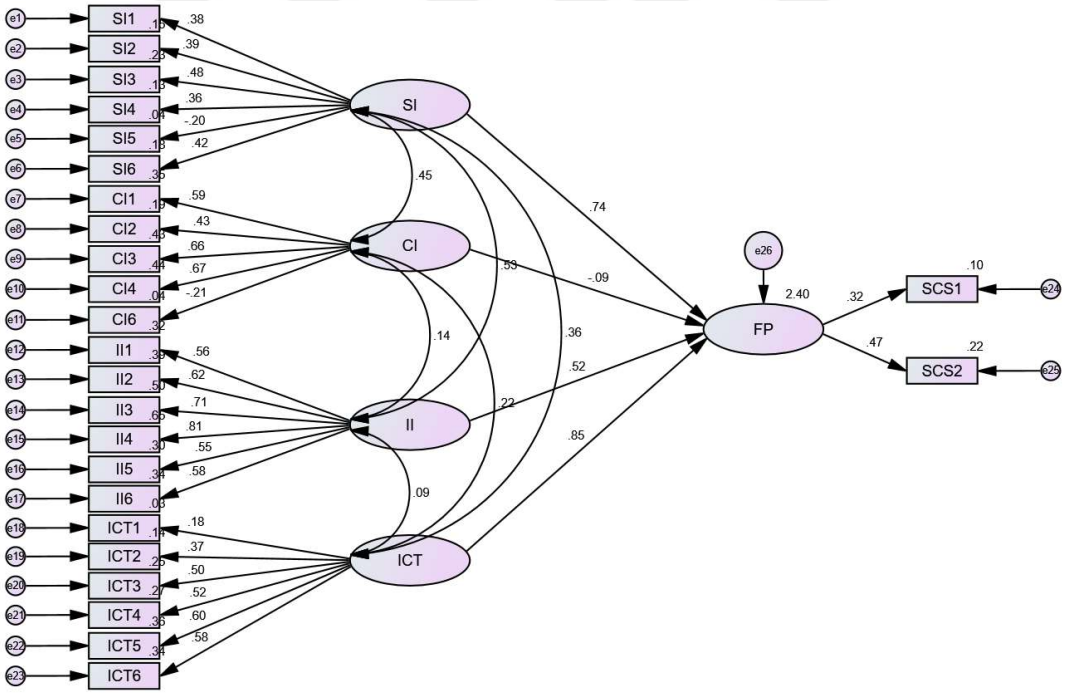

Figure 4.7 Re-constructed SEM model results for standardized path coefficients

Figure 4.5 presents the re-constructed SEM model and main relations between the investigated variables. Likewise, Figure 4.6 shows the results of unstandardized path

coefficients when the SEM model ran. On the other hand, standardized path coefficients are presented in Figure 4.7. Once the SEM model was re-constructed, the analyses are run again to observe the significance values. Table 4.3 presents the significance test results after the *CI5* revisions. When the analysis is run again and the *p* values are examined, it is seen that the analysis parameters are significant ($p < 0.05$). Note that multivariate normality value may change after modifications on the investigated SEM models.

Here, the multivariate normality value of the model was double-checked in the output segment when the *CI5* parameter was removed from the model and the analysis was redone. Table 4.4 shows the multivariate normality test results after the SEM re-construction. We aim to have a multivariate normality value less than eight, which was determined compatible with the literature studies using similar methodologies as we discussed in Section 4.1. It was observed that the multivariate normality value increased from 7.265 to 7.856. However, we proceeded with the re-constructed SEM model since it is within the desired normality limits.

Table 4.3 Significance test results of re-constructed SEM model

Observed variable	Path	Latent Variable	β_1	β_0	Standard error	Critical ratio	Significance value, *p*
SI1	<---	SI	0.379	1			
SI2	<---	SI	0.391	1.075	0.3	3.578	<0.001
SI3	<---	SI	0.477	1.296	0.329	3.937	<0.001
SI4	<---	SI	0.364	1.495	0.435	3.439	<0.001
SI5	<---	SI	-0.201	-0.426	0.188	-2.262	0.024
SI6	<---	SI	0.424	1.112	0.298	3.731	<0.001
CI1	<---	CI	0.594	1			
CI2	<---	CI	0.431	0.777	0.162	4.806	<0.001
CI3	<---	CI	0.655	1.044	0.168	6.219	<0.001
CI4	<---	CI	0.666	1.064	0.17	6.245	<0.001
CI6	<---	CI	-0.211	-0.218	0.085	-2.578	0.01
II1	<---	II	0.561	1			
II2	<---	II	0.622	1.055	0.152	6.928	<0.001
II3	<---	II	0.705	1.256	0.168	7.484	<0.001
II4	<---	II	0.807	1.595	0.199	8.002	<0.001
II5	<---	II	0.546	1.085	0.171	6.338	<0.001
II6	<---	II	0.585	1.205	0.181	6.649	<0.001
ICT1	<---	ICT	0.177	1			

Table 4.3 Continues

ICT2	<---	ICT	0.37	2.593	1.248	2.077	0.038
ICT3	<---	ICT	0.498	3.196	1.471	2.172	0.03
ICT4	<---	ICT	0.524	4.033	1.846	2.184	0.029
ICT5	<---	ICT	0.599	3.963	1.793	2.211	0.027
ICT6	<---	ICT	0.581	4.001	1.814	2.205	0.027
SCS1	<---	FP	0.32	1			
SCS2	<---	FP	0.472	1.785	0.312	5.723	<0.001

Table 4.4 The multivariate normality test results of re-constructed SEM model

Variable	Min	Max	Skew	c.r.	kurtosis	c.r.
SCS2	2	5	-0.689	-4.199	0.316	0.962
SCS1	2	5	-0.259	-1.581	0.494	1.505
ICT6	2	5	-0.339	-2.067	-0.623	-1.9
ICT5	2	5	-0.689	-4.202	-0.006	-0.018
ICT4	1	5	0.199	1.214	-1.136	-3.463
ICT3	1	5	-0.751	-4.579	0.44	1.343
ICT2	1	5	-0.447	-2.726	-0.502	-1.53
ICT1	2	5	-0.707	-4.307	0.183	0.558
II6	2	5	-0.727	-4.433	1.065	3.247
II5	2	5	-1.076	-6.561	1.897	5.784
II4	2	5	-0.664	-4.048	0.781	2.38
II3	3	5	-0.358	-2.185	-1.035	-3.154
II2	3	5	-0.954	-5.819	-0.283	-0.862
II1	2	5	-0.286	-1.741	0.119	0.363
CI6	1	3	-0.193	-1.178	-0.927	-2.825
CI4	2	5	-0.506	-3.082	-0.279	-0.851
CI3	1	5	-0.775	-4.726	0.395	1.205
CI2	1	5	-0.495	-3.015	-0.45	-1.372
CI1	1	5	-0.72	-4.387	0.073	0.224
SI6	2	5	-0.526	-3.208	0.327	0.996
SI5	1	3	0.293	1.788	-0.734	-2.237
SI4	1	5	-0.087	-0.531	-0.982	-2.992
SI3	2	5	-0.875	-5.334	0.405	1.235
SI2	2	5	-1.075	-6.551	1.517	4.623
SI1	1	5	-1.156	-7.05	2.654	8.089
Multivariate					38.656	7.856

4.3 Modification Indices

At the end of the analysis, various modification suggestions are presented to increase the fit of the SEM model. A high modification index value means that there may be an intense relationship between two variables. It is suggested to establish a covariance relationship between parameters having a high modification indice value. However, it is not recommended to make many changes in order to avoid numerical errors (Lei and Wu, 2007). Another critical point is that if the observed variable needs to be moved from one latent variable to another latent variable, the new location of the observed variable must be logical. Therefore, changes to be made should be based on strong theories. In other words, the modification to be made should be theoretically logical (Çapık, 2014). Suggestions that are incompatible with the model presented by the analysis should not be applied to the established model.

Table 4.5 Model results for the modification indices

Variable	Path	Variable	Modification Indices	Par Change
e2	<-->	e8	16.563	0.174
e2	<-->	e3	12.898	-0.117
e18	<-->	e19	12.713	0.152
e2	<-->	e17	12.02	-0.088
e5	<-->	e16	11.73	-0.069
e17	<-->	CI	11.502	0.073
e2	<-->	e10	10.676	-0.113
e16	<-->	e23	10.591	0.09
e4	<-->	e5	9.86	0.129
e3	<-->	e17	9.858	0.076
e7	<-->	e17	9.824	0.088
e17	<-->	ICT	8.449	-0.016
e11	<-->	e13	8.423	-0.045
e4	<-->	II	7.99	-0.063
e21	<-->	II	7.981	-0.054
e5	<-->	II	7.874	-0.034
e2	<-->	e15	7.398	0.055
e1	<-->	e10	7.063	-0.088
e13	<-->	e26	6.87	0.019
e18	<-->	II	6.795	0.04
e1	<-->	e22	6.784	-0.09
e19	<-->	e22	6.688	0.113
e10	<-->	SI	6.494	-0.039

Table 4.5 Continues

e9	<-->	e11	6.401	0.067
e15	<-->	e18	5.935	0.051
e3	<-->	e5	5.85	0.063
e10	<-->	e17	5.752	0.062
e8	<-->	e22	5.727	-0.108
e1	<-->	e7	5.694	0.086
e8	<-->	ICT	5.456	-0.022
e2	<-->	e4	5.36	0.118
e2	<-->	e7	5.341	-0.087
e13	<-->	e25	5.337	0.037
e5	<-->	SI	5.155	0.028
e4	<-->	e11	5.144	-0.088
e13	<-->	CI	5.114	-0.039
e4	<-->	e15	4.984	-0.068
e3	<-->	e18	4.793	0.074
e14	<-->	e17	4.681	-0.032
e14	<-->	ICT	4.644	0.009
e20	<-->	II	4.597	0.034
e11	<-->	e16	4.583	0.041
e11	<-->	e12	4.542	0.036
e5	<-->	e6	4.484	-0.054
e16	<-->	SI	4.467	0.024
e4	<-->	e7	4.425	-0.119
e13	<-->	e15	4.2	-0.024

Covariance relationships should be established starting from the highest modification indices value. Table 4.5 presents the SEM model results for the modification indices. In the table, the e2-e8 covariance, which was the first association with the highest modification indices value, is ignored because they aren't under the same factor. Considering that they should be under the same factor and the highest modification indices value, a covariance relationship is established between e2-e3, which has the latter highest modification indices value of 12.898. However, when the covariance relationship between e2 and e3 is established, the observed variable *SI5* under the supplier integration latent variable becomes meaningless. Similarly, when the covariance relationship is established between e18-e19, the observed variables under the latent variable of *ICT* become meaningless. At this point, no modification has been made since the modifications to be made wouldn't make the model better.

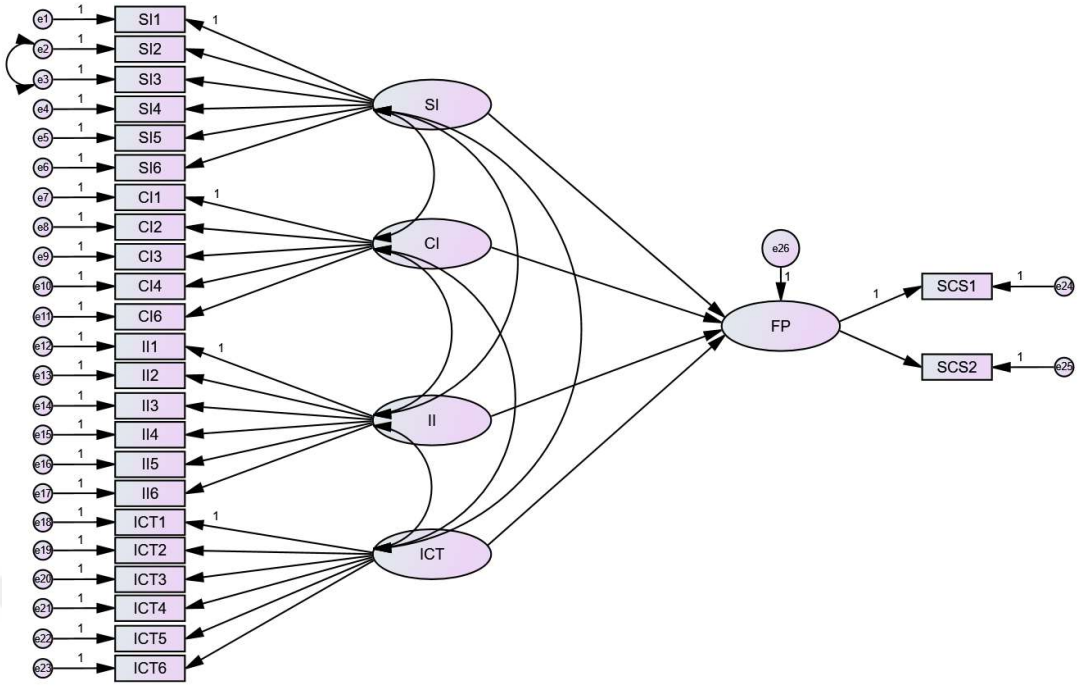

Figure 4.8 Model results for the modification indices

Table 4.6 Significance test results for the observed variables after establishing the covariance relationship between e2 and e3

Observed variable	Path	Latent variable	β_1	β_0	Standard error	Critical ratio	Significance value, p
SI1	<---	SI	0.387	1			
SI2	<---	SI	0.519	1.402	0.352	3.977	<0.001
SI3	<---	SI	0.583	1.555	0.372	4.184	<0.001
SI4	<---	SI	0.415	1.676	0.432	3.879	<0.001
SI5	<---	SI	-0.097	-0.201	0.166	-1.21	0.226
SI6	<---	SI	0.412	1.06	0.275	3.861	<0.001
CI1	<---	CI	0.588	1			
CI2	<---	CI	0.432	0.786	0.164	4.787	<0.001
CI3	<---	CI	0.661	1.063	0.172	6.183	<0.001
CI4	<---	CI	0.667	1.076	0.174	6.197	<0.001
CI6	<---	CI	-0.207	-0.217	0.086	-2.528	0.011
II1	<---	II	0.561	1			
II2	<---	II	0.622	1.056	0.152	6.925	<0.001
II3	<---	II	0.706	1.258	0.168	7.486	<0.001
II4	<---	II	0.809	1.6	0.2	8.005	<0.001
II5	<---	II	0.543	1.08	0.171	6.312	<0.001
II6	<---	II	0.584	1.203	0.181	6.639	<0.001
ICT1	<---	ICT	0.174	1			
ICT2	<---	ICT	0.371	2.641	1.288	2.05	0.04
ICT3	<---	ICT	0.499	3.253	1.52	2.141	0.032

Table 4.6 Continues

ICT4	<---	ICT	0.523	4.093	1.902	2.152	0.031
ICT5	<---	ICT	0.601	4.037	1.854	2.177	0.029
ICT6	<---	ICT	0.58	4.061	1.87	2.172	0.03
SCS1	<---	FP	0.322	1			
SCS2	<---	FP	0.469	1.762	0.304	5.799	<0.001

4.4 Investigations on Fit Indices

Another point to be checked with the analysis is the fit indices of the structural equation model. Fit indices statictically describe how well the data fit the model. As a result of an analysis, it may be seen that although the factor loads of the items give a good value, sometimes the fit indices cannot reach the normal values (Çapık, 2014). There are many fit indices to evaluate the fit of the model. The Chi-square (x^2) test is generally accepted as the most general fit statistic. Contrary to the known significance test, the significance value (p) is intended to be meaningless in the Chi-square (x^2) test (Sümer, 2000). If the model fit is perfect, it is expected to obtain a significance value which isn't close to zero. Note that Chi-square (x^2) value is very sensitive to the sample size and the result is usually significant when working with large samples. For this reason, it is recommended to base the Chi-square (x^2) value divided by the degrees of freedom (x^2/DF) instead of directly evaluating the Chi-square (x^2) value and the model fit (Hoe, 2008). Although there is a widespread opinion that x^2/DF must be presented, there is no consensus on which of the remaining fit indices should be reported.

Table 4.7 Evaluation of fit indices for the proposed SEM model (Çapık, 2014; İlhan and Çetin, 2014)

Fit Indices	Explanation	Perfect Fit Criteria	Acceptable Fit Criteria	Calculated Value	Result
x^2/DF	Chi Square / Degrees of Freedom	$0 \leq x^2/DF \leq 2$	$2 \leq x^2/DF \leq 3$	2.030	Accepted
GFI	Goodness of Fit	$0.95 \leq GFI \leq 1.00$	$0.90 \leq GFI \leq 0.95$	0.848	Close the range
CFI	Comparative Fit Index	$0.95 \leq CFI \leq 1.00$	$0.90 \leq CFI \leq 0.95$	0.759	Close the range
RMR	Root Mean Square Residual	$0 < RMR < 0.05$	$0.05 < RMR < 0.08$	0.045	Accepted
RMSEA	Root Mean Square Error Approximation	$0 \leq RMSEA \leq 0.05$	$0.05 \leq RMSEA \leq 0.08$	0.068	Accepted

Limit values of the commonly used fit indices and the model data obtained as a result of the analysis are given in Table 4.7. The results indicate that proposed model is in good agreement with the data set as the x^2/DF, root mean square residual (RMR) and root mean square error approximation (RMSEA) values are in the acceptable range. Even if the goodness of fit (GFI) and comparative fit index (CFI) values are out of the range, these values are very close to the acceptable range. Main criterum in SEM investigations is to satisfy the x^2/DF and to keep it within the acceptable range. According to the calculated x^2/DF value, SEM structure represents the collected data set in an accurate and reliable way.

4.5 Impact of the Supply Chain Strategies on Business Performance

The standard error, critical ratio and significance value of the observed variables should be examined before making statistical evaluations. The main purpose here is to obtain reliable analysis results by establishing a correct model with all variables. In this thesis, questionnares of the main supply chain strategies form the observed variables. Note that supplier integration (*SI*), customer integration (*CI*), internal integration (*II*), information-communication technology (*ICT*) has six observed variables for each supply chain strategy, while firm performance (*FP*) has two six observed variables. The reliability and validity tests of the structural equation model of this second level-five factors analysis have been carried out. According to Şencan (2005), reliability means robustness and validity means conformity. For instance, a shoe is suitable if it is made according to our foot measurement, it is not suitable if it is larger or smaller. Likewise, here the robustness term represents the reliability. It is expected that the measurement studies should be reliable and valid. It is desired to determine whether the measurement tools are accurate and whether they really measure what it aims to measure with the validity analysis in quantitative research. On the other hand, reliability analysis aims to test whether the result is reproducible (Golafshani, 2003).

In this study, confirmatory factor analysis (CFA) method was used to analyze structural validity. It was analyzed by establishing a SEM model with maximum

likelihood, which is the default estimation method of Amos. According to the obtained model fit results, the Chi-square over degrees of freedom (x^2 / DF) value was found to as 2.03. Root mean square error of approximation (RMSEA) value was calculated as 0.068. The results obtained prove that the model fit is achieved. Therefore, the structural validity of the model seems to be provided.

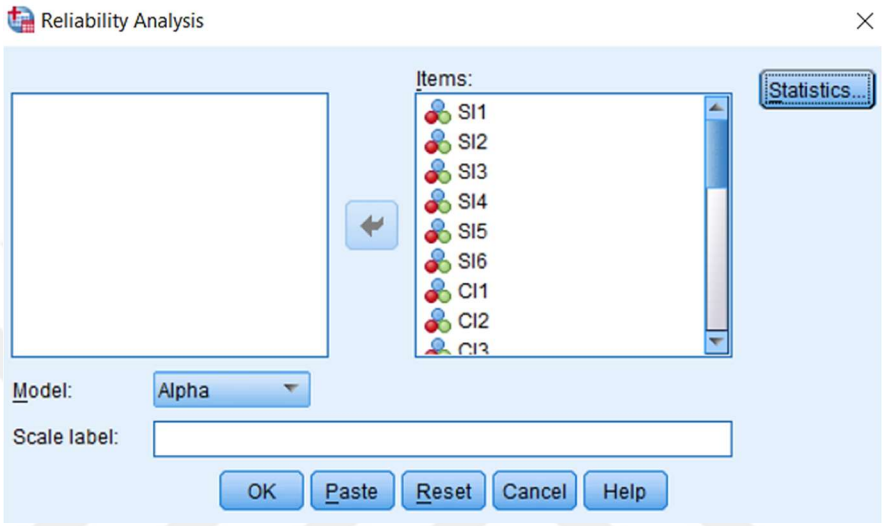

Figure 4.9 IBM SPSS screenshot for Cronbach's alpha method

In this thesis, Cronbach's alpha method within the IBM SPSS software was used for reliability analysis (Fig. 4.9). Cronbach's alpha reveals the internal consistency of the research. There may be a Cronbach's alpha value for each item in the questionnaire, or an average Cronbach's alpha value can be calculated for overall items. The α value calculated based on all the items expresses the total reliability of the questionnaire (Kılıç, 2016). However, a disadvantage of Cronbach's alpha is that this value is very sensitive to the number of questions within the questionnaire. Therefore, adding questions to the study can increase the Cronbach's alpha value (Gagnon et al, 2017). The literature shows that the Cronbach's alpha value, which has a range between 0 and 1, must be at least 0.70, or above (Som et al., 2019; Daneshvar et al., 2020; Danese and Romano, 2011; Cheng and Chaudhuri, 2016). As a result of the analysis, the Cronbach's alpha value was found as 0.723. Reliability is ensured because the obtained value is above the desired alpha limits.

4.5.1 Relationship of Each Latent Variable with the Observed Variables

Table 4.8 presents the SEM model results between the observed variables and the latent variables. The significance value results show that there is a meaningful relationship between the observed and latent variable as the $p < 0.05$ in any case. In addition, the critical ratio for each observed variable is higher than 1.96 which means that the model gives good agreement with the findings. The standardized path coefficients indicate the direction of relationship between the observed variables and supply chain integration strategies. The results are obtained for both standardized (β_1) and unstandardized (β_0) path coefficients. Path coefficients reveal that there is a significant and negative relationship between *SI5* and supplier integration, and between *CI6* and customer integration. Furthermore, the results given in Table 4.8 show that one unit increase in *SI5* decreases *SI* by 0.201 units. Likewise, one unit increase in *CI6* decreases *CI* by 0.211 units. It was seen that *SI3* "We must help our suppliers improve their processes so that they better meet our needs." has the greatest impact on supplier integration while the *SI5* "Over-dependence on suppliers can pose a risk to the firm in the long run." has the least impact (β_1 = 0.477 for *SI3*, and β_1 = -0.201 for *SI5*).

Table 4.8 Overall evaluation of the observed variables

Observed variable	Path	Latent variable	β_1	β_0	Standard error	Critical ratio	Significance value, *p*
SI1	<---	SI	0.379	1			
SI2	<---	SI	0.391	1.075	0.3	3.578	<0.001
SI3	<---	SI	0.477	1.296	0.329	3.937	<0.001
SI4	<---	SI	0.364	1.495	0.435	3.439	<0.001
SI5	<---	SI	-0.201	-0.426	0.188	-2.262	0.024
SI6	<---	SI	0.424	1.112	0.298	3.731	<0.001
CI1	<---	CI	0.594	1			
CI2	<---	CI	0.431	0.777	0.162	4.806	<0.001
CI3	<---	CI	0.655	1.044	0.168	6.219	<0.001
CI4	<---	CI	0.666	1.064	0.17	6.245	<0.001
CI6	<---	CI	-0.211	-0.218	0.085	-2.578	0.01
II1	<---	II	0.561	1			
II2	<---	II	0.622	1.055	0.152	6.928	<0.001
II3	<---	II	0.705	1.256	0.168	7.484	<0.001
II4	<---	II	0.807	1.595	0.199	8.002	<0.001

Table 4.8 Continues

II5	<---	II	0.546	1.085	0.171	6.338	<0.001
II6	<---	II	0.585	1.205	0.181	6.649	<0.001
ICT1	<---	ICT	0.177	1			
ICT2	<---	ICT	0.37	2.593	1.248	2.077	0.038
ICT3	<---	ICT	0.498	3.196	1.471	2.172	0.03
ICT4	<---	ICT	0.524	4.033	1.846	2.184	0.029
ICT5	<---	ICT	0.599	3.963	1.793	2.211	0.027
ICT6	<---	ICT	0.581	4.001	1.814	2.205	0.027
SCS1	<---	FP	0.32	1			
SCS2	<---	FP	0.472	1.785	0.312	5.723	<0.001

Most dominant effect on the customer integration is *CI4* "Involving the customer in processes (such as design) allows the customer to spend more time and effort to contribute more to the product/service." with β_1 = 0.666, and *CI6* "Customer integration causes the manufacturer to be limited to incremental innovation efforts only." with β_1 = -0.211 has only a slight effect. On the other hand, parameter *II4* "Companies improve response time and information processing capabilities by internal integration." has the most obvious impact on internal integration, while the *II5* "-If the departments do not work in sync, the business will face financial and operational loss." has the least impact (β_1 = 0.807 for *II4*, β_1 = 0.546 for *II5*). *ICT5* "As a result of technology, continuous accessibility by the customer positively affects the performance of employees/businesses (fast communication with smart phones, calling-mailing." is the most dominant factor on the supply chain management strategy of information-communication technologies with β_1 = 0.599. *ICT1* "Companies that follow technology closely during the pandemic period have increased their competitiveness (digital meetings, remote work, etc.)" is the most ineffective factor with β_1 = 0.177. The results indicate that *SCS2* "Internal abilities such as employee productivity, ability to process information, fast access to information and readiness for future actions are directly related to company performance." has dominant impact on firm performance whereas the *SCS1* "Parameters such as competitiveness, quality, responsiveness, customer satisfaction, and profitability are important criteria in measuring company performance." slightly effects the business performance (β_1 = 0.472 for *SCS2*, β_1 = 0.32 for *SCS1*).

4.5.2 Determining the Effects of Supply Chain Strategies on Each Other

In this thesis, the relationship between the four main supply chain strategies of supplier integration (*SI*), custormer integration (*CI*), internal integration (*II*), and information-communication technologies (*ICT*) are also examined in detail. Table 4.9 presents the statistical results for the relationship in between the investigated latent variables.

Table 4.9 The effect of the latent variables on the other variables

Latent variable	Path	Latent variable	β_1	β_0	Standard error	Critical ratio	Significance value, p
SI	<-->	CI	0.449	0.065	0.022	2.994	0.003
SI	<-->	II	0.533	0.044	0.013	3.396	<0.001
SI	<-->	ICT	0.36	0.013	0.007	1.742	0.081
CI	<-->	II	0.139	0.022	0.015	1.528	0.127
CI	<-->	ICT	0.217	0.015	0.01	1.564	0.118
II	<-->	ICT	0.091	0.004	0.004	0.919	0.358

As a result of the investigations on relationships among the supply chain management strategies, the following hypotheses are concluded:

H1: Supplier integration is positively related to customer integration.
A significant relationship is found between supplier integration and customer integration ($p < 0.05$). The impact factor of the *SI* and *CI* is 0.449 for one unit increase.

H2: Supplier integration is positively related to internal integration.
A significant relationship is found between supplier integration and internal integration ($p < 0.05$). The impact factor of the *SI* and *II* is found 0.533 units.

H3: Supplier integration is positively related to information and communication technologies.
There is no significant relationship between supplier integration and information and communication technologies ($p > 0.05$).

H4: Customer integration is positively related to internal integration.

There is no significant relationship between customer integration and internal integration ($p > 0.05$).

H5: Customer integration is positively related to information and communication technologies.

There is no significant relationship between customer integration and information and communication technologies ($p > 0.05$).

H6: Internal integration is positively related to information and communication technologies.

There is no significant relationship between internal integration and information communication technologies ($p > 0.05$).

Table 4.10 Hypothesis results- Part 1

Hypothesis		Adopted / rejected
H1	Supplier integration → Customer integration	Adopted
H2	Supplier integration → Internal integration	Adopted
H3	Supplier integration → Information and communication and technologies	Rejected
H4	Customer integration → Internal integration	Rejected
H5	Customer integration → Information and communication and technologies	Rejected
H6	Internal integration → Information and communication and technologies	Rejected

4.5.3 Determining the Effects of SI, CI, II and ICT on Firm Performance

One of main objective of this thesis is to determine the relationship between the supply chain management strategies and business performance. Table 4.11 documents the analysis results of the relationship between firm performance (endogenous latent variable) and supplier chain management strategies of *SI*, *CI*, *II*, and *ICT* (exogenous variables). The results given in Table 4.11 indicate that there is a significant relationship between *FP*, *SI, II*, and *ICT* as the significance factor is lower than the acceptable limit ($p < 0.05$). However, when the relationship between *FP* and *CI* is

examined, the significance value is greater than 0.05. Therefore, there is no significant relationship detected between the firm performance and customer integration.

Table 4.11 Impact of the supply chain management strategies on business performance

Endogenous latent variable	Path	Exogenous latent variable	β_1	β_0	Standard error	Critical ratio	Significance value, p
FP	<---	SI	0.742	0.532	0.217	2.454	0.014
FP	<---	CI	-0.087	-0.032	0.056	-0.564	0.573
FP	<---	II	0.518	0.333	0.117	2.834	0.005
FP	<---	ICT	0.852	1.273	0.613	2.078	0.038

As a result of the effects of supply chain management strategies on firm performance, the following hypotheses are concluded:

H7: There is a positive relationship between firm performance and supplier integration.
There is a significant relationship between firm performance and supplier integration ($p < 0.05$). We see that one-unit increase in supplier integration strategy provides a positive 0.742-unit increase on firm performance.

H8: There is a positive relationship between firm performance and customer integration.
There is no significant relationship between firm performance and customer integration ($p > 0.05$).

H9: There is a positive relationship between firm performance and internal integration.
There is a significant relationship between firm performance and internal integration ($p < 0.05$). The internal integration has a positive 0.518-unit effect on the firm performance.

H10: There is a positive relationship between firm performance and information and communication technologies.
There is a significant relationship between firm performance and information and communication technologies ($p < 0.05$). We see that *ICT* has the most dominant impact on the firm performance with $\beta_1 = 0.852$.

Table 4.12 Hypothesis results- Part 2

Hypothesis		Adopted / rejected
H7	Supplier integration → Firm performance	Adopted
H8	Customer integration → Firm performance	Rejected
H9	Internal integration→ Firm performance	Adopted
H10	Information and communication and technologies → Firm performance	Adopted

CHAPTER FIVE

CONCLUSION

Supply chain is a critical network providing effective relationships among the suppliers, custormers, internal facilities, and companies. This inevitable network contributes to reducing manufacturing cost, increasing service efficiency, and business performance. At this point, supply chain management strategies have crucial impact to obtain an effective supply chain network between the customers, suppliers, and business itself. In the literature, various supply chain management strategies have been examined and reported in terms of the effects on manufacturing cost and business performance. Literature survey showed that custormer integration, supplier integration, internal integration, and information-communication technologies are the most common, valid, and effective supply chain management strategies that affect the business performance. Therefore, these four supply chain management methods were determined as the main strategies affecting the business performance. The custormer integration, supplier integration, internal integration, and information-communication technologies are abbreviated by *CI*, *SI*, *II*, and *ICT*, respectively.

In this thesis, all supply chain management strategies have six observed variables to obtain a comprehensive data set by questionnaire. Izmir Ataturk Industrial Cluster is determined as investigated population which contains 508 large-sized firms. The minimum sample size is calculated via modified Cochran's formula, and the calculations showed that it should be at least 219 firms to obtain meaningful data set with 95% confidence interval. The questionnaire was conducted via Google Forms, and all survey data were logged and reprocessed in the IBM SPSS Amos sofware. Survey questions are determined compatible with the industrial applications and literature. The questionnaires were applied to the managers or lead engineers of the investigated companies. In the first part of the questionnaire, a brief explanation of the questionnaire was added to inform the reader. Afterwards, three personal questions were listed: e-mail address, company name, and position. This mandatory section enabled to be distinguished the survey data coming from the same company. The

remaining sections consist of questions to examine the effects of supply chain strategies on firm performance. Table 3.2 presents the questionnaire details for the main supply chain management strategies and firm performance.

As soon as the survey data successfully collected, a structural equation model was constructed and statistically evaluated via the significance test, fit indices, critical ratios, and modification indices. The perfect and acceptable limits of each statistical test were determined with the help of literature investigations and these limits are shared in the thesis. Once the proposed structural equation model is statistically within the acceptable limits of significance test and fit indices, the analyses were initiated to obtain the relationships between the observed variables, exogenous latent variables (*CI*, *SI*, *II*, and *ICT*) and endogenous latent variable (*FP*). Within the scope of the thesis, the results of relationships between the supply chain management strategies, survey questions, and firm performance are documented. The main findings are as follows:

- There is a significant relationship between the firm performance and exogenous latent variables of supplier integration, internal integration, information-communication technologies as the significance factor is comparatively lower than 0.05 ($p < 0.05$).
- Information and communication technologies has the most dominant impact on the firm performance with $\beta_1 = 0.852$.
- The results indicate that there is a significant and positive relationship between supplier integration and internal integration ($\beta_1 = 0.533$).
- Likewise, supplier integration and customer integration have a positive relationship, yet the impact is slightly less than with the internal integration ($\beta_1 = 0.449$).
- Path coefficients revealed that there is a significant but negative relationship between *SI5* and supplier integration, and between *CI6* and customer integration.

The concept of this study can be extended by integrating other minor supplier chain

management strategies such as justice and social factors, company culture, and top management support. Findings of this study are able to be utilized for future investigations. The data set and results can be compared with different sample sizes or another industrial cluster to determine the quantitative and regional effects.

REFERENCES

Amini, A., & Alimohammadlou, M. (2021). Toward equation structural modeling: an integration of interpretive structural modeling and structural equation modelling. *Journal of Management Analytics*, *8*(4), 693-714.

Alavi, M., Visentin, D.C., Thapa, D.K., Hunt, G.E., Watson, R., & Cleary, M. (2020). Chi-square for model fit in confirmatory factor analysis. *Wiley Journal of Advanced Nursing*, *76*(9), 2209–2211.

Akinyode, B., F. (2016). The use of structural equation modeling (SEM) in built environment disciplines. *Research on Humanities and Social Sciences*, *6*(6), 109-120.

Alolayyan, M. N., Alyahya, M. S., Hijazi, H., & Hijazi, H. (2022). The development and validation instrument for the cognitive medical errors: structural equation modeling approach. *Qual Quant,* 56, 3831–3847.

Alvarez, J. S., Pedrosa, I., Lozana, L. M., Cueto, E. G., Cuesta, M., & Muniz, J. (2018). Using reversed items in likert scales: A questionable practice. *Psicothema*, *30*(2), 149-158.

Ariadi, G., Sumiati, S., & Rohman, F. (2021). The effect of lean and agile supply chain strategy on financial performance with mediating of strategic supplier integration & strategic customer integration: Evidence from bottled drinking-water industry in Indonesia. *Cogent Business & Management, 8*(1).

Bae, Y. H. & Yeom, H. A. Structural Equation modeling of person-centered nursing in hospital nurses. *Healthcare*, *10*, 514.

Balinado, J.R.O, & Young, M.N. (2020). The impact of technology on service supply chain of Toyota dasmarinas-cavite: A comparative study. *IEEE 7th International Conference on Frontiers of Industrial Engineering,* 13-17.

Bayyurt, N. (2011). İşletmelerde performans değerlendirmenin önemi ve performans göstergeleri arasındaki ilişkiler. *Journal of Social Policy Conferences, 53*, 577-592.

Bıçakçı, P.S., & Üreten, S. (2017). Tedarik zinciri yönetimi uygulamalarının zincir performansı üzerindeki etkileri: Bir uygulama. *Gazi University Journal of Faculty of Economics and Administrative Sciences*, *19*(1), 367-386.

Boon, S. (2009). The role of information technology and supply chain integration on production cost performance. *Proceedings of the 2009 IEEE IEEM,* 1464-1468.

Boston, W. (2017). *BMW Slows Some Production Due to Parts Shortage From Supplier Bosch.* https://www.wsj.com/articles/bmw-slows-some-production-due-to-parts-shortage-from-supplier-bosch-1496071360.

Buzduga, I. (2020). Performance measurement using performance indicators within the company. *The USV Annals of Economics and Public Administration, 20*(1), 174-180.

Byrne, B.M. (1994). *Structural equation modeling with EQS and EQS/Windows: Basic consepts, applications, and programming* (1 st ed.). Sage Publications.

Byrne, B.M. (2010). *Structural equation modeling with Amos* (2nd ed.). Routledge.

Carlsson, M., & Hamrin, E. (2002). Evaluation of the life satisfaction questionnaire (LSQ) using structural equation modelling (SEM). *Quality of Life Research, 11*, 415-425.

Cao, Y., Zhao, K., Yang, J., & Xiong, W. (2015). Constructing the integrated strategic performance indicator system for manufacturing companies. *International Journal of Production Research, 53*(13), 4102-4116.

Chavez, R., & Yu, W., Gimenez, C., Fynes, B., & Wiengarten, F. (2015). Customer integration and operational performance: The mediating role of information quality. *Decision Support Systems, 80*, 83-95.

Chatterjee, S., Rana, N.P. & Dwivedi, Y.K. (2022). Assessing consumers' co-production and future participation on value co-creation and business benefit: an F-P-C-B Model Perspective. *Information Systems Frontiers, 24,* 945–964.

Chen, H., Mattioda, D.D., & Daugherty, P.J. (2007). Firm-wide integration and firm

performance. *The International Journal of Logistics Management*, *18*(1), 5-21.

Cheng, Y., & Chaudhuri, A. (2016). Interplant coordination, supply chain integration, and operational performance of a plant in a manufacturing network: a mediation analysis. *Supply Chain Management: An International Journal, 21*(5), 550-568.

Cheung, W., Chiang, A., Sambamurthy, V., & Setia, P. (2018). Lean vs. Agile Supply Chain: The Effect of IT Architectures on Supply Chain Capabilities and Performance. *Pacific Asia Journal of the Association for Information Systems, 10*(1).

Chin, W.W., Peterson, R.A., & Brown, S.P. (2014). Structural Equation Modeling in Marketing: Some Practical Reminders. *Journal of Marketing Theory and Practice. 16*(4), 287-198.

Colin, M., Galindo, R., Hernández, O. (2015). Information and communication technology as a key strategy for efficient supply chain management in manufacturing SMEs. *Procedia Computer Science, 55,* 833–842.

Cui, A.S., Griffith, D.A., & Cavusgil, S.T. (2005). The influence of competitive intensity and market dynamism on knowledge management capabilities of multinational corporation subsidiaries. *Journal of International Marketing, 13*(3), 32-53.

Çapık, C. (2014). Geçerlilik ve güvenilirlik çalışmalarında doğrulayıcı faktör analizinin kullanımı. *Anadolu Hemşirelik ve Sağlık Bilimleri Dergisi, 17*(3), 196-205.

Çiğdem, Ş., & Erdoğan, S. (2019). Tedarik zinciri ve ürün inovasyonu ilişkisi: İlk 1000 sanayi firması üzerinde bir çalışma. *GAÜN İktisadi ve İdari Bilimler Dergisi, 1*(1), 51-79.

Danese, P., & Romano, P. (2011). Supply chain integration and efficiency performance: a study on the interactions between customer and supplier integration. *Supply Chain Management: An International Journal, 16*(4), 220–230.

Daneshvar, M., Razavi Hajılagha, S. H., Tupenaıte, L., & Khoshkheslat, F. (2020). Effective factors of implementing efficient supply chain performance. *Technological and Economic Development of Economy, 26*(4), 947–969.

Das, S. and Canel, C. (2022), Linking manufacturing and competitive strategies for successful firm performance: a review and reconceptualization, *Journal of Strategy and Management*, 1755.

Demirdöğen, S. (2021). Tedarik zincirinde bilgi entegrasyonunun işletmelerinin operasyonel performansları üzerine etkisi: İmalat işletmeleri üzerine bir araştırma. *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi, 35*(3), 1021-1046.

Dölarslan, E., Ş., & Özer, A. (2014). Hizmet Kalitesi, Tatmin ve Güvenin Daha Fazla Ödeme Eğilimi Üzerindeki Etkileri. *Anadolu University Journal of Social Sciences, 14*(1), 31-58.

Duhaylongsod, J.B., & Giovanni, P. (2018). The impact of innovation strategies on the relationship between supplier integration and operational performance. *International Journal of Physical Distribution & Logistics Management, 46*(2), 156-177.

Enkel, E., Kauch, C., & Gassmann, O. (2005). Managing the risk of customer integration. *European Management Journal, 23*(2), 203-213.

Erkorkmaz, Ü., Etikan, İ., Demir, O., Özdamar, K., & Sanisoğlu, S.Y. (2013). Doğrulayıcı faktör analizi ve uyum indeksleri. *Türkiye Klinikleri J Med Sci, 33*(1), 210-223.

Errassafi, M., Abbar, H., & Benabbou, Z. (2019). The mediating effect of internal integration on the relationship between supply chain integration and operational performance: Evidence from Moroccan manufacturing companies. *Journal of Industrial Engineering and Managament*, *12*(2), 254-273.

Eslami, M.H., Jafari, H., Achtenhagen, L., Carlbäck, J., & Wong, L. (2021). Financial performance and supply chain dynamic capabilities: the Moderating Role of Industry 4.0 technologies. *International Journal of Production Research*, 1-18.

Feng, T., Li, T., Sun, L., Wang. D. (2013). External involvement and operational performance: The mediating role of internal integration. *Chinese Management Studies, 7*(3), 488-507.

Feyissa, T.T., Sharma, R.R.K, Lai, K. (2018). The impact of the core company's strategy on the dimensions of supply chain integration. *International Journal of Logistics Management*, *30*(1), 231–260.

Franceli, J.C., & Turri, S.N.Z. (2021). Adoption factors of enabling I4.0 technologies and benefits in the supply chain. *Computer Science & Information Technology,* 81-96.

Füller, K., Weking, J., Böhm, M., & Krcmar, H. (2019). Leveraging customer-integration experience: A review of influencing factors and implications. *Communications of the Association for Information Systems*, *44*(4).

Gagnon, R. J., Stone, G. A., & Garst, B. A. (2017). Beyond composite scores and cronbach's alpha: Advancing methodological rigor in recreation research. *Journal of Outdoor Recreation, Education, and Leadership, 9*(4), 383–402.

Ganbold, O., Matsui, Y., & Rotaru, K. (2019). Effect of information technology-enabled supply chain integration on firm's operational performance. *Journal of Enterprise Information Management, 34*(3), 948-989.

Gao, S., Mokhtarian, P. l., & Johnston, R. A. (2008). Nonnormality of data in structural equation models. *Transportation Research Record: Journal of the Transportation Research Board,* 116–124.

Gimenez, C., & Ventura, E. (2005). Logistics-production, logistics-marketing and external integration: Their impact on performance. *International Journal of Operations & Production Management, 25*(1), 20-38.

Golafshani, N. (2003, December). Understanding reliability and validity in qualitative research. *The Qualitative Report, 8*(4), 597-607.

Güçlü, İ., & Karakaş, Y.E. (2018). Tedarik zinciri yönetimi düzeyi ve inovasyon eğilim ilişkisi üzerine Sinop ilinde bir araştırma. *İçtimaiyat Sosyal Bilimler Dergisi, 2*(2), 80-88.

Gyampah, K.A., Boakye, K.G., Famiyeh, S., & Adaku, E. (2020). Supplier integration, operational capability and firm performance: an investigation in an emerging economy environment. *Production Planning and Control, 31*(13), 1128-1148.

Hamali, S., Prihandoko, D., Kurniawan, S., and Ramdhani, R. (2020). The effects of supply chain information integration on organizational performance in food small industry. *Management Science Letters, 10*, 695-702.

Heller, F.K. (2017). *Technological innovation applied to Walmart and Tesco's supply chain.* MSc Thesis, University of Lisbon, Lisbon.

Hoe, S. L. (2008). Issues and Procedures in Adopting Structural Equation Modeling Technique. *Journal of Applied Quantitative Methods, 3*, 76-83.

Hooper, D., Coughlan J., & Mullen2, M. R. Structural equation modelling: Guidelines for determining model fit. *Electronic Journal of Business Research Methods*, *6*(1), 53-60.

Hox, J. J., & Bechger, T. M. (1998). An introduction to structural equation modeling1" *Family Science Review, 11*, 354-373.

Hride, F. T., Ferdousi, F., & Jasimuddin, S. M. (2022). Linking perceived price fairness, customer satisfaction, trust, and loyalty: A structural equation modelling of Facebook-based e-commerce in Bangladesh. *Global Business and Organizational Excellence, 41*(3), 41– 54.

Huo, B. (2012). The impact of supply chain integration on company performance: an organizational capability perspective. *Supply Chain Management: An International Journal, 17*(6), 596–610.

Hvolby, H.H., Trienekens, J., & Steger-Jensen, K. (2007). Buyer–supplier relationships and planning solutions. *Production Planning & Control, 18*(6), 487–496.

İlhan, M., & Çetin, B. (2014). Lisrel ve Amos programları kullanılarak gerçekleştirilen yapısal eşitlik modeli analizlerine ilişkin sonuçların karşılaştırılması. *Journal of Measurement and Evaluation in Education and*

Psychology, *5*(2), 26-42.

Jacobs, F.R. & Chase, R.B. (2014). *Operations and Supply Chain Management.* (14th Global Edition), Berkshire: McGraw-Hill Education.

Ju, K., Park, B., Kim, T. (2016). Causal relationship between supply chain dynamic capabilities, technological innovation, and operational performance. *Management and Production Engineering Review, 7*(4), 6–15.

Khine, M. S., Ping, L. C., Cunningham, D. (2013). Application of Structural Equation Modeling in Educational Research and Practice. In. Khine, S.M (Ed.), *Application of Structural Equation Modeling in Educational Research and Practice*. *14*.

Kline, R. B. (2011). *Principles and Pracitce of Structural Equation Modeling.* The Guilford Press.

Kılıç, S. (2016, April). Cronbach'ın alfa güvenirlik katsayısı. *Journal of Mood Disorders, 6*(1), 47-48.

Kumar, S. (2015). Structure equation modeling basic assumptions and concepts: A novices guide. *Asian Journal of Management Sciences, 3*(7), 25-28.

Kwan J.LY., Chan W. (2011). Comparing standardized coefficients in structural equation modeling: a model reparameterization approach. *Behaviour Research Methods*, *43,* 730-745.

Lahane, S., Kant, R., & Shankar, R. (2020). Circular supply chain management: A state-of-art review and future opportunities. *Journal of Cleaner Production, 258*, 120859.

Lei, P. W., & Wu, Q. (2007). Introduction to structural equation modeling: Issues and practical considerations. *Educational Measurement: Issues and Practice,* 33-43.

Llewelyn, T. (2016, August). *The Sky's the Limit: Domino's Announces Partnership with Flirtey for CAA-Approved Drone Deliveries.* https://www.dominos.com.au/inside-dominos/media/aug-2016-the-sky-s-the-

limit-dominos-announces-partnership-with-flirtey-for-caa-approved-drone-deliveries.

Makransky, G., & Lilleholt, L. (2018). A structural equation modeling investigation of the emotional value of immersive virtual reality in education. *Education Tech Research Dev, 66*, 1141-1164.

Marek, S., Schuh, G., & Stich, V. (2020). Identification of multidimensional key performance indicators for manufacturing companies. *IEEE Technology and Engineering Management Conference (TEMCON).*

Nanjundeswaraswamy, T.S., & Divakar, S. (2021). Determitaion of sample size and sampling methods in applied research. *Proceedings on Engineering Sciences, 3*(1), 25-32.

Nosratabadi, S., Mosavi, A., Shamshirband, S., Kazimieras, Zavadskas, E., Rakotonirainy, A., & Chau, K.W. (2019). Sustainable business models: a review. *Sustainability, 11*, 1663-1692.

Öztemiz, H.H., Karaa, İ.E. (2018). Lojistik firmalarında performans ölçümü: Tek skorlu dengelenmiş skor kart ve Markov zincileri analizi. *Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 19*(2), 249-286.

Pado, G. (2017). Müşteri entegrasyonunun firma perforansı üzerindeki etkileri. *Uluslararası Bilimsel Araştırmalar Dergisi, 2*(2), 296-307.

Polat, M. (2018). Eğitim bilimlerinde PLS-SEM yaklaşımının kullanılabilirliği ve bir uygulama. *Social Science Studies Journal*, *4*(25), 5325-5337. http://dx.doi.org/10.26449/sssj.994

Rajaguru, R., & Matanda, M.J. (2019). Role of compatibility and supply chain process integration in facilitating supply chain capabilities and organizational performance. *Supply Chain Management: An International Journal, 24*(2) 301–316.

Riley, J.M., Klein, R., Miller, J., & Sridharan, V. (2015). How internal integration, information sharing, and training affect supply chain risk management capabilities. *International Journal of Physical Distribution & Logistics*

Management, 46(10), 963-980.

Ro, Y.K., Liker, J.K., & Fixson, S.K. (2007). Modularity as a Strategy for Supply Chain Coordination: The Case of U.S. Auto. *IEEE Transactions on Engineering Management, 54*, 172-189.

Saengchai, S., & Jermsittiparsert, K. (2019). The mediating role of supplier network, the moderating role of flexible resources in the relationship between lean manufacturing practices and the organizational performance. *Humanities & Social Sciences Reviews, 7(3),* 720-727.

Schermelleh, E.K., Moosbrugger, E.H. (2003). Evaluating the fit of structural equation models: Tests of Significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online*, *8*(2), 23-74.

Shou, Y., Hu, W., Kang, M., Li, Y., & Park. Y.W. (2018). Risk management and firm performance: the moderating role of supplier integration. *Industrial Management & Data System, 118*(7), 1327-1344.

Som, J.O., Cobblah, C., & Anyigba, H. (2019). The effect of supply chain integration on supply chain performance. *Proceedings of the Ninth International Conference on Engaged Management Scholarship,* 1-27.

Song, W., Ming, X., & Xu, Z. (2013). Risk evaluation of customer integration in new product development under uncertainty. *Computers & Industrial Engineering, 65* (3), 403-412.

Sümer, N. (2000). Yapısal eşitlik modelleri: Temel kavramlar ve örnek uygulamalar. *Türk Psikolojileri Yazıları*. *3*(6), 49-74.

Suvacı, B. (2016). Sosyal bilimler veri tabanında yayımlanan lojistik ve tedarik zinciri makalelerinin bibliyometrik profili. *Süleyman Demirel Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 25*, 263-281.

Şekercioğlu, G. (2009). *Çocuklar için benlik algısı profilinin uyarlanması ve faktör yapısının farklı değişkenlere göre eşitliğinin test edilmesi* [Unpublished doctoral dissertation]. Ankara University.

Şencan, H. (2005). *Sosyal ve davranışsal ölçümlerde güvenilirlik ve geçerlilik* (1 st ed.). Seçkin yayınları.

Tabachnick B. G., & Fidel, L. S. (2001). *Using multivariate statistics* (4th edition). Allyn&Bacon, Inc.

Taherdoost, H., Sahibuddin, S., & Jalaliyoon, N. (2022). Exploratory factor analysis; concepts and theory. *Advances in applied and pure mathematics, 27,* 375-382.

Tarka, P. (2017). An overview of structural equation modeling: its beginnings, historical development, usefulness and controversies in the social sciences. *Qual Quant, 52*, 313-354.

Toker, K., & Pınar, R.I. (2019). The mediating role effect of internal integration between long term relationship with suppliers and customers and business performance in Turkey ICI 500 enterprises. *Brazilian Journal of Operations & Production Management, 16*, 592-604.

Wu, I., & Chiu, M. (2018). Examining supply chain collaboration with determinants and performance impact: Social capital, justice, and technology use perspectives". *International Journal of Information Management, 39*, 5–19.

Xie, G., Jiang, F., & Liu., S. (2022). Price competition, experiential quality and online marketing decisions of a tourism supply chain. *Journal of China Tourism Research*.

Yaşlıoğlu, M.M. (2017). Sosyal bilimlerde faktör analizi ve geçerlilik: Keşfedici ve doğrulayıcı faktör analizlerinin kullanılması. *Istanbul University Journal of the School of Business*, *46*, 74-85.

Yeh, T.M., Pai, F.Y., & Wu, L.C. (2020). Relationship stability and supply chain performance for SMEs: From internal, supplier, and customer integration perspectives. *Mathematics, 8* (11), 1902.

Yıldız, B., & Sayın, B. (2020). Tedarik zinciri müşteri entegrasyonunun firma performansı üzerindeki etkisinde ürün inovasyon kapasitesinin aracı rolü. *Çankırı Karatekin Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *10* (1), 319-348.

Yılmaz, V., & Çelik, H.E. (2009). *Lisrel ile yapısal eşitlik modellemesi 1.* Pegem Akademi.

Yılmaz, V., & Dalbudak, Z.İ. (2018). Aracı değişken etkisinin incelenmesi: Yüksek hızlı tren işletmeciliği üzerine bir uygulama. *International Journal of Management Economics and Business*, *14*(2).

Yılmaz, V., & Varol, S. (2015). Hazır yazılımlar ile yapısal eşitlik modellemesi: AMOS, EQS, LISREL. *Dumlupınar University Journal of Social Sciences, 44*, 32.

Yu, W. (2015). The effect of IT-enabled supply chain integration on performance. *Production Planning & Control, 26* (12), 945–957.

Yu, K., Luo, B.N., Feng, X., & Liu, J. (2018). Supply chain information integration, flexibility, and operational performance. *The International Journal of Logistics Management, 29*(1), 340-364.

Yu, Y., Huo, B., & Zhang, Z. (2021). Impact of information technology on supply chain integration and company performance: evidence from cross-border e-commerce companies in China. *Journal of Enterprise Information Management, 34*(1), 460-489.

Yuen, K. F., & Thai, Van, V. (2016). The influence of supply chain integration on operational performance, a comparison between product and service. *The International Journal of Logistics Management, 28*(2), 444-463.

Yüreğir, O.H., & Nakıboğlu, G. (2007). Performans ölçümü ve ölçüm sistemleri: Genel bir bakış. *Ç.Ü. Sosyal Bilimler Enstitüsü Dergisi. 16* (2), 545-562.

Zhang, H. (2022). *Structural equation modeling.* (1 st ed.). Models and Methods for Management Science.

Zhang, M., Lettice, F., Chan, H.K., & Nguyen, H.T. (2018). Supplier integration and firm performance: the moderating effects of internal integration and trust. *Production Planning & Control, 29* (10), 802-813.

Zhou, R. H. (2022). Research on influencing factors of supply chain trust and

commitment based on transaction cost and social exchange theory. *Open Journal of Social Sciences*, *10*, 530-548.

Zhu, Q., Krikke, H., Caniëls, M.C.J., & Wang, Y. (2016). Twin-objective supply chain collaboration to cope with rare but high impact disruptions whilst improving performance. *The International Journal of Logistics Management,* 28 (2), 488-507.