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RESEARCH ARTICLE

The Mediating Effect of Uncertainty on the Impact of Information Technologies, Agility and Integration on Operational and Financial Performance[1]

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Abstract

The aim of the research is to draw attention to the integration of rapidly developing and changing information technologies into supply chain management and to test the dimensions of integration and agility. In addition, it is to analyze the effects on the performance of the enterprises and to make concrete suggestions according to the results obtained. For this purpose, the main mass of the research, which was conducted by applying a literature review, face-to-face interview, and a two-stage questionnaire, consisted of managers working in medium and large-scale enterprises operating in Istanbul. In research in supply chain management; The effects of information technologies, integration and agility on operational and financial performance are analyzed. In addition, the moderator effect of demand and technological uncertainty between integration and agility variables and operational performance has been examined. The reliability and validity analyzes of the research variables were examined using explanatory factor analysis and confirmatory factor analysis. Research hypotheses were tested using correlation analysis and structural equation modeling (path analysis). Based on the data obtained, there is a significant relationship between the other variables except for the information technologies and integration variables; It has been concluded that uncertainty creates a moderator effect only with its technological dimension.

Keywords: *Information Technologies, Integration, Agility, Uncertainty, Performance.*

Öz

Araştırmanın amacı hızla gelişen ve değişen bilgi teknolojilerinin tedarik zinciri yönetimine entegrasyonuna dikkat çekmek, entegrasyonun ve çevikliğin boyutlarını test etmektir. Ayrıca işletmelerin performansına etkilerinin neler olduğunu analiz ederek, elde edilen sonuçlara göre somut önerilerde bulunmaktır. Bu maksatla literatür taraması, yüz yüze görüşme, iki aşamalı anket uygulanarak yapılan araştırmanın ana kütlesini İstanbul'da faaliyet gösteren orta ve büyük ölçekli işletmelerde çalışan yöneticiler oluşturmuştur. Araştırmada tedarik zinciri yönetiminde; bilgi teknolojileri, entegrasyon ve çevikliğin operasyonel ve finansal performansa etkileri analiz edilmiştir. Ayrıca talep ve teknolojik belirsizliğin, entegrasyon ve çeviklik değişkenleri ile birlikte operasyonel performans arasındaki moderatör etkisi incelenmiştir. Araştırma değişkenlerinin güvenilirlik ve geçerlilik analizleri, açıklayıcı faktör analizi, doğrulayıcı faktör analizi kullanılarak incelenmiştir. Araştırma hipotezleri ise korelasyon analizi ve yapısal eşitlik modeli (yol analizi) kullanılarak test edilmiştir. Elde edilen verilerden yola çıkıldığında bilgi teknolojileri ve entegrasyon değişkenleri hariç diğer değişkenler arasında anlamlı bir ilişki olduğu; belirsizliğin sadece teknolojik boyutuyla moderatör etki yarattığı sonuçlarına ulaşılmıştır.

Anahtar Kelimeler: *Bilgi Teknolojileri, Entegrasyon, Çeviklik, Belirsizlik, Performans*

[1] ***This study was derived from Murat SAĞBAŞ Ph.D. thesis "The Impact of Information Technologies, Agility and Integration on Operational and Financial Performance in Supply Chain Management" which was supervised by Prof. Hüseyin İNCE.***

Introduction

The rapid development of technology and rapid and incredible developments in information technologies have removed the borders in the globalizing world and rebuilt the world under the umbrella of information societies that are in constant communication and competition with each other. With the rapid spread and cheapening of information technologies, people have had the opportunity to access information with personal computers in their homes and workplaces. It is possible to share information very cheaply by accessing another computer and data bank via the internet from anywhere in the world at any time. With the 21st century, the need for desktop computers in our homes or workplaces for information sharing is also disappearing. Even laptop technology has fallen behind due to the rapid development of smartphones and tablet computers.

If we evaluate the factors that businesses focus on and determine criteria for selection while integrating information technologies into their own structures, operational and financial performance comes first. Evaluating the concept of performance is not at all easy. A superficial analysis causes great losses for the business. In addition, in the competitive environment in the market, it remains in the background and its market share is lost. Our other two concepts in our research are integration and agility. If the best performance is to be achieved in supply chain management, the impact of information technologies, integration and agility on the chain should be well evaluated. Integration in the supply chain means that all the links in the chain have information and work simultaneously with the whole system, not just before and after it. Otherwise, it should be noted that a malfunction will affect the entire system and reduce performance. Partial successes in supply chain management are not enough for the system. A holistic success is required for performance. If we define agility under the umbrella of supply chain management, we can say that it is being able to respond to demands in the desired place and time, despite the changes in market and market conditions. Agility is one of the factors that businesses must have and develop under competitive market conditions in the supply chain. Non-agile organizations do not adapt to rapidly changing conditions and are doomed to extinction. The aim of the research is to draw attention to the importance of supply chain management in medium and large enterprises, to identify the deficiencies arising from existing practices in the planning, implementation and control stages of supply chain management and to reveal what should be done. In addition, for the success of supply chain management practices in universities; to emphasize that the supply chain management processes should be considered as a whole, to determine the extent to which the supply chain management process is affected by the performance of the enterprises and to make concrete suggestions by comparing them. Our country has been opened to international competition after 1980 and has accepted the conditions of global competition as a member of the World Trade Organization. Under these competitive conditions, companies entered into a great race to be the best. Mass production methods have become a thing of the past and customer satisfaction has come to the fore. With the awareness of the customers, the responsibilities of the enterprises have increased. Therefore, the factors affecting the performance of the enterprises have changed and increased. In this context, supply chain management, which has a great impact on the performance of enterprises, will be discussed in this study. The importance of information technologies in presenting a good and service to the consumer at the right time, place and conditions and its role in competitive conditions will be examined. In additon, this study aims to measure the superiority of the companies that integrate information technologies well into the supply chain network and constantly update them over other enterprises, as well as their optimal decision-making success in conditions of uncertainty. Success is the necessity of an agile decision-making mechanism and the existence of a

supply network that uses information technologies extensively and up-to-date for this mechanism.

The study consists of six chapters. The theoretical framework for the study will be presented in the section following the introduction. Following that, the research hypotheses will be determined within the theoretical framework. The scales will be specified in the method section, as well as information on data collection. Data analysis will be performed, and the research hypotheses will be evaluated, in the data analysis and findings section. The research findings and recommendations for future studies will be presented in the final section. It is considered that the results of the study will make significant contributions to the practice and the literature.

Theoretical Framework

A supply chain is a network of facilities and possibilities consisting of the distribution of raw materials to semi-manufactured products (Rajaguru and Matanda, 2013:623). Every company that produces goods or services is bound to at least one supply chain (Autry et al., 2010: 3). How wide or narrow the supply chain is managed is directly related to which supply chain management is applied (Ganeshan et al., 1999: 4). According to Lambert et al. (1998:506) "Supply chain; It is the harmony observed between institutions that offer products and services to the market". Ganeshan et al. (1999); It defines supply chain as a network in which the finished product supply to the buyers with product supply functions has taken place. While Chopra and Meindl (2004: 2) define the supply chain as a network in which the finished product supply to the buyers is realized with the product supply functions, on the other hand, in order to meet the direct and indirect buyer demands, the supply chain is not only composed of producers and suppliers, but also transporters, warehousing service providers, retailers, buyers. and they define it as a chain that includes all other actors. Houlihan (1998) considers all activities in the supply chain as a single process and states that supply is a common goal shared by the units in the chain (Houlihan, 1988). When the main objectives of supply chain management are expressed; Increasing customer satisfaction, reducing cycle time, reducing inventory and inventory-related costs, reducing product errors, reducing operating costs are among the first activities, and the mechanisms and levels that businesses should establish in order to successfully carry out these activities have been determined by the Global Supply Chain Forum. These; customer relationship management (Crimea, 2001), customer service management (Keely et al., 2001; Çancı & Erdal, 2003), demand management (Kobu, 1999), order processing (Kotler et al., 1999; Croxton et al., 2001), manufacturing flow management (Doğruer, 2005), supplier relationship management (Sanders, 2005), purchasing, product development and commercialization, and returns (Çancı and Erdal, 2005). Eight processes defined by the members of the Global Supply Chain Forum are generally accepted (Özdemir, 2004). Although supply chain management differs among academics in definition, it can be defined as an indispensable system for businesses to respond to changing market conditions and to meet customers' demands and expectations. There are three types of approaches to supply chain management (Jones and Riley, 1985; La Londe et al., 1994; Mentzer et al., 2001); "supply chain management as a management philosophy", "supply chain management as business activities", "supply chain management as a set of management processes". Firms often reconsider their supply chain activities to meet their needs. The system that connects the company to its suppliers, distributors or customers is called the information system. Information technology infrastructure, which allows companies to provide supply chain management, is one of the ambiguous resource types. Information technology infrastructure is generally divided into two main groups: These are the technical and human infrastructure of information technologies. Managerial information technology capabilities generally depend on the relationship between people developed over the years (Patterson et al., 2004, p.12-13). Integration

increases in direct proportion to productivity and production. The effective integration of suppliers into the supply chain is a very important factor in gaining competitive advantage. The higher the integration between suppliers and customers, the greater the possible profitability. Supply chain integration can improve its performance by eliminating inefficiencies and instabilities, directing processes correctly, giving customers what they want, avoiding excessive inventory, and actively regulating demand (Agan, 2011:34). It is said that companies with strong customer relations have more integrated strategies. Market-oriented supply chains emphasize issues such as coordination and integration, which are supply chain tasks and activities, instead of sourcing and shipping a simple product (Faisal et al., 2008: 70-71). In the study of Prajogo and Olhager (2012) with companies for long-term suppliers, the important relationship between information technology capacities and information sharing with logistics integration has been revealed. Moreover, long-term supplier relationships have been expressed as direct and indirect effects on performance. Another factor that businesses should have and develop under competitive market conditions in the supply chain is agility. Although agility is especially related to the flexible production system, it has been conceptualized in the field of production (Nagel et al., 1999). While supply chain agility creates a competitive difference in the market environment, it also provides a long-term sustainable situational advantage for the organization (Lee, 2004). Its speed and efficiency in the agility of key suppliers and customers is defined as a capability for organizations (Wanger and Silveira-Camargos, 2012). Agility has a very important place in the supply chain management literature. Agility starts with the development of scales in the supply chain (Braunscheidel, 2005; Başkol, 2011). Market sensitivity, network integration, virtual integration and process integration are elements in the procurement framework (Van Hoek, et al., 2001: 126-147). It emerges as a successful exploration of elements such as agility, speed, flexibility, proactive innovation, quality and profitability in the rapidly changing market environment of reconfigurable resources during integration. Supply chain agility according to this market environment; supply chain planning, procurement and procurement in the supply chain, supply chain production, supply chain logistics and product delivery (Yao and Cartson, 2003: 95-102).

Research Hypotheses

With our research, which has six variables, ten different hypotheses have been established as a result of the literature evaluated within the theoretical framework. Frohlich and Westbrook (2001) as stated, the top-down and bottom-up information flow in the supply chain network is very important. Ensuring this flow of information flawlessly depends on the basic mechanisms (Sheu et al., 2006). These are information technology capacity, a good coordination platform, participation, problem solving activities and integration. The integrative relationship between information technologies and integration is available in the literature studies conducted so far. Daniel Prajogo (2011), in his study with companies with long-term suppliers, revealed the important relationship between information technology capacities and information sharing with logistics integration. Moreover, long-term supplier relationships have been expressed as direct and indirect effects on performance. In the studies of Bush (2001) there are findings supporting that information technologies affect supply chain integration. Although previous studies state that only the sub-concepts of information technologies, technical structure affects integration and do not evaluate the human dimension, it can now be stated that human and technical infrastructure together affect supply chain integration and there is a relationship between them.

H1: There is a positive relationship between information technologies and integration.

Although the increasing costs and speed of change of information technologies reach scary dimensions for companies, they have to be at a sufficient level to survive in a competitive environment. Its speed and efficiency in the agility

of key suppliers and customers is defined as a capability for organizations (Wanger & Silveira-Camargos, 2012). Thanks to this key, the business can enter the market more easily, hold on and advance. Literature studies show us that there is a positive effect between information technologies and agility (Bottani, 2010; Overby et al., 2006; Poweret et al., 2001; Swafford et al., 2008; Tallon & Pinsonneault, 2011; Yusuf et al., 2004; Zain, et al., 2003). Information technologies increase the speed in obtaining, processing and sharing information by companies (Vickery et al., 2010). In line with these studies, the relationship between information technologies and agility can be mentioned.

H2: There is a positive relationship between information technologies and agility.

The dynamic nature and continuous evolution of the supply chain presents interesting problems for effective system coordination. Supply chain members may not compete as independent members. Before the product is consumed by the end user, it passes through many business segments and adds value. Moreover, globalization, outsourcing and reduction in supply bases worsen uncertainty and increase risks in the supply chain. The supply chain is more prone to sudden disruptions (Yusuf et al., 2012). When the concepts of integration and agility are handled separately in increasing supply chain performance, it has been observed in the literature studies that they make positive contributions. It is seen that integration and agility variables affect each other depending on the performance criteria. It is considered that there is a relationship between integration and agility (Prajogo & Olhager, 2012; Chaudhuri, et al., 2018 p. 691).

H3: There is a positive relationship between integration and agility.

In order to achieve a high operational performance, the requirements of using the most appropriate parts in the system at the right time, place and manner should be determined. When these two concepts are examined under the title of supply chain management, it is also stated in the literature studies that there is a direct relationship between integration and operational performance. Yu et al. (2013)'s research revealed the relationships between financial performance, which is an important sub-dimension of performance and supplier integration, which is a sub-dimension of integration in 213 companies in the manufacturing sector in China. In Wong's (2011) study, he sees that supply chain integration has been examined under 3 main subheadings. These are internal integration, supplier integration, and customer integration. The firm's performance measures are distribution product pricing, product quality, and product flexibility. It is defined by Wong (2011) that there is a positive relationship between these three main integration factors and operational performance.

H4: There is a positive relationship between integration and operational performance.

In McKinsey's research, senior managers defined agility as being at the forefront over time and playing an important role in business success. According to the study, increased agility offers positive benefits such as higher earnings, satisfied customers and business employees, improved operational efficiency and faster time to market (McKinsey, 2006). The ability of businesses to integrate with the changing conditions of the markets is important in achieving and maintaining competitive advantage. The idea of adaptation to unpredictable situations and conditions has led to the development and increasing importance of agility, which is one of the last developing concepts of business strategies. Agility contributes significantly to the company's capabilities in maintaining operations and making profits in uncertain and unregulated markets. It accelerates the decision mechanisms that affect performance within organizations. Previous studies show that there is a direct relationship between operational performance and agility (Swafford et al., 2008; Yusuf and Adeleye, 2002). It has been observed that it contributes to firm performance, especially

when the supply chain agility speed of the firms is measured and the supply chain functions are adapted to the variables of the market (Swafford, 2008). It can be said that there is a relationship between agility and performance.

H5: There is a positive relationship between agility and operational performance.

In order to evaluate and measure performance, a given job must be completed and its result must be evaluated. Business performances are measured against financial and operational (non-financial) criteria. In operational measures, it can be divided into two directions. First, key competitive success factors such as quality, price, delivery, service and flexibility; second, internal indicators such as defect, schedule realization, and cost (Parahinski and Benton, 2004; Uğural, 2020). Financial performance, on the other hand, can be evaluated by the increase or decrease in operating earnings of the success experienced in operational performance. Parahinski and Benton (2004) discussed supplier performance in terms of critical success factors and determined the criteria as product quality, delivery performance, price, responsiveness to changing demands, service support and overall performance. Fawcett et al. (2007), on the other hand, used cost, quality delivery, flexibility and innovation factors as key factors related to supplier performance. When the operational and financial performance concepts are evaluated, it is defined that there are two different basic sub-dimensions of the performance variable in both concepts and there is a relationship between them.

H6: There is a positive relationship between operational performance and financial performance.

Prater et al. (2001), the supply chain takes place in an uncertain environment with customer demands on the one hand and demands from raw material suppliers on the other. Traditionally, attention has been focused on uncertainties in customer demand, but there are also uncertainties in the market. The quality and quantity of raw materials from external suppliers differ. With regular integration systems, the supply and demands of customers and suppliers in the market are fully met, and the uncertainty of the structure here puts customers and suppliers in a difficult situation. Uncertainty within the supply chain spreads, causing useless downtime and worthless practices. Mason-Jones and Towill (1999) stated that due importance should be given to reducing uncertainty for international competitive performance. Wong et al. (2011) investigated the effect of the possibility of environmental uncertainty on the relationship between supply chain integration and operational performance. While establishing the theoretical model in this research, internal integration, supplier integration and customer integration as sub-dimensions of integration; Distribution, product cost, product quality, product flexibility were used as sub-dimensions of performance. It has been determined in the study that uncertainty has a regulatory variable effect at high and low levels for integration and operational performance.

H7a: Demand uncertainty has a regulatory variable effect between integration and operational performance.
H7b: Technological uncertainty has a moderator effect between integration and operational performance.

The most important problem areas that businesses face in the 21st century are the changes, uncertainties and unexpected developments that occur in the environment in which they exist. Businesses are looking for new solutions to be successful under these changes and uncertainty factors. International competition, developing technology, changing and developing business and industry environment, consumer dissatisfaction have put businesses under pressure. Existing production methods and systems increase the efficiency and effectiveness of enterprises in the short run, but do not contribute to adapting to changing market conditions in the long run. The concepts of agile production and supply chain agility are defined as the way businesses should follow in order to provide the

desired performance under constant change and uncertainty in a competitive environment (Çetin and Altuğ, 2005).

Wong (2009) and Germain et al. (1994) tested that customers frequently change their orders every month, the operational performance of their suppliers cannot be predicted, factories frequently change their core product technologies, and competitive moves related to market promotions cannot be predicted. Uncertainty affects the agility and operational performance of the firm.

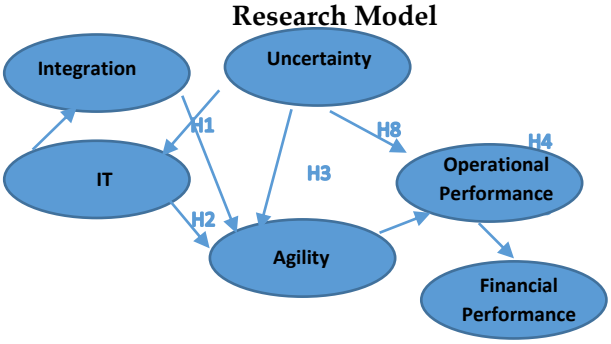
H8a: Demand uncertainty has a moderator effect between agility and operational performance.

H8b: Technological uncertainty has a moderator effect between agility and operational performance.

Method

In this part of the study, the population and sampling process used in the research, the research model, the data collection method, the determination of the research variables, the research hypotheses, the analysis of the data, and the development of the survey questions are mentioned. In the study, which will be carried out in line with the stated purposes, it has been tried to contact 1500 businesses operating in the food, furniture, white goods, electronics, clothing, and weaving sectors operating in the province of Istanbul, using e-mail, telephone and face-to-face interview methods. About 300 of these businesses responded to the survey. However, the study continued with the questionnaire data of 200 companies, which were filled in appropriately from the feedback provided.

Research Model



Scales

This study was applied to middle and senior managers of 200 companies in Istanbul between January-July 2014. Ethics committee report was not requested by the university related to the research. It was shaped as a result of the survey titled "The impact of information technologies, integration and agility on the operational and financial sector in supply chain management". In order to measure the effect of information technologies on supply chain management, five questions were asked to the participants. In these questions, it has been tried to determine at what scale the suppliers use information technologies in their communication with each other, product orders, invoicing, product loading and monitoring stages. The questions are taken from the study in the article by Prajogo and Olhager (2012). In supply chain management, five questions about integration were asked to the participants. In these questions, information sharing between suppliers and customers and the dimensions of this information sharing were asked in general. The level of information sharing was tried to be revealed with questions about sensitive information sharing and confidential information sharing. The questions are taken from the study in the article by Patricia M. Swafford (2008). seven questions about agility in the supply chain were asked to the participants. These questions generally wanted to measure production time, product development cycle, distribution capacity, improving delivery reliability, and responding to changing market needs. Related questions are taken from article in Sharon E. DeGroote (2013). Sixteen questions about performance were asked to the participants. In these questions, questions were used to measure the comparison of the return on investment with the competitors, the presentation of the product and service to the market before the competitors, the response to customer complaints before the competitors, the fact that the market share is higher than the competitors, the level of profitability, the growth rate and the comparison of the market value of the company with the competitors.

Related questions are taken from the study in the article by Prajogo and Olhager (2012).

Sampling and Data Collection Tool

The universe of this research consists of middle and senior managers of medium and large enterprises operating in the province of Istanbul in Turkey. In the study carried out within the scope of the survey, it was tried to apply a survey to 1500 enterprises by e-mail and face-to-face. The questionnaire was answered appropriately by 200 enterprises. Some of the enterprises did not want the name of the enterprise, the number of employees and annual profit figures to be disclosed in the data related to the survey. This request was also taken into account. The obtained data were transferred to the SPSS program and prepared for data analysis. Questionnaire method was used as data collection method in the research. The questionnaire is an observation tool consisting of a group of questions that the people to be informed can read and answer. Some of our surveys were conducted via e-mail and some of them were made face-to-face. In the first part of the questionnaires prepared for the research, questions about demographic information were asked. In the second part of the questionnaire, "Five-point Likert Scale" for information technology, agility, performance and uncertainty variables (1-Strongly disagree, 2- Disagree, 3-Undecided, 4-Agree, 5-Strongly Agree; 1= Very little; 2 = Little; 3= Moderate; 4= Too Much; 5= Too Much). For the integration variable, "Five-Likert Scale" (1-Definitely Insufficient, 2-Inadequate, 3-Undecided, 4-Sufficient, 5-Absolutely Sufficient) was used with different options. In the preparation of the scales, importance was given to the fact that the sources were up-to-date and generally accepted in the international arena. The studies of Prajogo and Olhager (2012), Patricia M. Swafford (2008) and Sharon E. DeGroote (2013) were used in the preparation of the survey questions. The reliability and validity analyzes of the research variables were examined using explanatory factor analysis and confirmatory factor analysis. Research hypotheses were tested using correlation analysis and structural equation modeling (path analysis).

Data Analysis and Findings

First of all, the demographic characteristics of the participants were examined, and before testing the research hypotheses, reliability and validity analyzes of the scales used were made. In order to perform reliability and validity analyzes, firstly, Exploratory Factor Analysis (EFA) was performed, then confirmatory factor analysis (CFA) was performed to investigate whether the scales have discriminant and concordant validity. Explanatory factor analysis was done with the help of SPSS. Structural equation model was created to perform confirmatory factor analysis and AMOS 4.0 structural equation software was used for this. In order to examine the relationship between the variables that make up the research model, correlation analysis and pathanalysis, and whether the hypotheses are supported or not, were examined with the structural equation model.

Demographic features

In this study, the number of employees in the companies of the participants who answered the questionnaire, the activity period of their companies and the fields of activity of their companies were examined and summarized. In Table 1, it is seen that 56% of the companies participating in the research have 250 or more employees. According to these data, when the distribution of the companies participating in the research according to their activity period is examined, it is seen that the number of companies operating for 15 years or more (18.5%) is low. The fact that 12% of the respondents are in the industrial sector shows that there are few operators in sectors that require large capital and R&D. It should not be forgotten that the industrial sector is large and strong, and it will also create a resource for other sectors.

Table 1. Demographic Characteristics Table

Number of Employees	Frequency	Ratio (%)	Cumulative Percentage (%)
0-50	55	27,5	27,5
50-100	42	21	48,5
100-250	47	23,5	72
250 and more	56	28	100
TOTAL	200	100	
Duration of Year	**Frequency**	**Ratio (%)**	**Cumulative Percentage (%)**
1-5 year/years	62	31	31
6-10 years	78	39	80
11-15 years	23	11,5	81,5
16-20 years	17	8,5	90
21 years and more	20	10	100
TOTAL	200	100	
Sector of the Company	**Frequency**	**Ratio (%)**	**Cumulative Percentage (%)**
Industry	12	6	6
Service	37	18,5	24,5
Agriculture	13	6,5	31
Other	138	69	100
TOTAL	200	100	

Reliability and Validity Analysis

Explanatory and confirmatory factor analysis was performed for validity analysis. First, explanatory factor analysis was performed and it was examined whether the data set formed the concepts to be measured or not. Explanatory factor analysis allows researchers to obtain the least possible number of factors with the variables in the data set. Thus, the factors obtained have a clear and distinct meaning. The purpose of this method is to obtain different components for a group of variables (indicators). Before starting the factor analysis, the suitability of the data set was examined. For this, Kaiser-Meyer-Olkin (KMO) sample adequacy statistics and Bartlet sphericity test were applied. KMO sample adequacy value was analyzed by making 2 groups. It was found as 0.748 and 0.798. This seems to be much higher than the recommended 0.50 (Hair et al., 1998). In addition, it is statistically significant at the 1% significance level of the Bartlet test of Sphericity ($\chi 2$ (55) = 1941.45 and $\chi 2$ (190) = 4066; $p < 0.01$) (Hansen and Bush, 1999). These results show that the sample is suitable for factor analysis. Our goal is; "Principal Components Analysis" was used together with the "Explanatory Factor Analysis" method because it is to determine the indicators (questions) that make up the information technologies, integration, agility, operational and financial performance factors (concepts) and to calculate composite values. 12 indicators were eliminated because they did not load on a factor and did not meet the criterion of having a factor load equal to or greater than 0.50, loaded on more than one factor (factor load on other factors-cross-loading-cross-loading) was 0.40 or higher. Principal-component factor analysis (with varimax rotation) was applied with the remaining 31 indicators as a result of the process described above. Factor loads of all indicators are above 0.50 and cross-loading is below 0.30. Factor analysis results (factor loadings and total explained variance) are shown in Table 2-3. As seen in Table 2-3, the indicators constitute the appropriate scales. In addition, construct validity is available since all factor loads are greater than 0.50.

Table 2. Results of Explanatory Factor Analysis

Results of Explanatory Factor Analysis			
Expressions	**Component**		
	IT	**Integration**	**Agility**
IT1	0.723		
IT2	0,839		
IT3	0,854		
Integration 1		0,921	
Integration 2		0,917	
Integration 4		0,844	
Integration 5		0,816	
Agility 4			0,789
Agility 5			0,819
Agility 6			0,932
Agility 7			0,763
Eigenvalues	2,048	3,459	2,885
Explained Variance (%)	18,622	31,450	26,225

Varimax rotation was used with principal component analysis. Total explained variance 76,297%

Table 3. Results of Explanatory Factor Analysis

Results of Explanatory Factor Analysis				
Expressions	**Component**			
	1	**2**	**3**	**4**
Perf1	0,691			
Perf2	0,847			
Perf3	0,545			
Perf8	0,547			
Perf9	0,811			
Perf10	0,797			
Perf11	0,605			
Perf5		0,886		
Perf6		0,924		
Perf7		0,746		
Perf16		0,791		
Uncertainty5			0,831	
Uncertainty6			0,896	
Uncertainty7			0,898	
Uncertainty8			0,574	
Uncertainty9				0,696
Uncertainty10				0,773
Uncertainty11				0,830
Uncertainty12				0,810
Uncertainty13				0,817
Eigenvalues	4,031	3,710	2,983	3,615
Explained Variance(%)	20,157	18,552	14,913	18,077

Varimax rotation was used with principal component analysis. Total Explained Variance 71,700%

In addition, to investigate the validity of the scales in detail, the data set was subjected to confirmatory factor analysis. Confirmatory factor analysis was used to examine construct validity (convergent validity and convergent validity). AMOS structural equation modeling software was used to perform confirmatory factor analysis. The measurement model consists of 7 factors (latent variable) and does not constitute only one latent variable of the indicators. It is seen that 12 indicators obtained using Maximum Likelihood Management are loaded on the relevant factors. This confirms the unidimensionality of the concepts and provides strong empirical evidence about the validity of the scales (Anderson & Gerbing, 1988). Construct validity consists of two parts: concordance and discriminant validity. Concordance validity, high t values of factor loadings obtained as a result of confirmatory factor analysis with the help of structural equation model (Akgün et al., 2007) indicate that there is concordance validity (Akgün et al., 2007). If all factor loadings are at least 2 times its standard error, the scale is considered to have convergent validity. As seen in Table 4, the smallest t-test value (critical ratio) is 6.917, which is much higher than 2. This information obtained shows that the indicators measure the concept effectively (Anderson & Gerbing, 1998). The value of the measurement model was obtained as $\chi 2(219)$ 821.51. Also, $\chi 2$/sd(degrees of freedom) is equal to 3.751. Since this value is close to the threshold value of 3, the measurement model is suitable. Since the chi-square statistic is sensitive to sample size, secondary fit indices were also examined to test the fit of the model. As a result, it was seen that the measurement model and the data were quite compatible with each other. Fit indices – comparative fit index (CFI) = 0.883, incremental fit index (Incrimental Fit IFI) = 0.884 and the root mean square error of approximate errors (Root Mean Square Error of Approximation, RMSEA) = 0.098. This shows that the overall fit of the measurement model is good. In the light of all this information, it was concluded that the scales (concepts) had convergent validity. Take, for example, the convergent validity of the concept of "integration". As seen in Table 4, the t-test values of the 4 indicators (questions) that make up the concept of "integration" are between 13,774 and 44,449. Since these values are very high, the concurrency validity of this concept is high. The t-test values of other concepts are given in Table 4. According to these results, it can be seen in Table 4 that all concepts have congruent validity.

Table 4. Confirmatory Factor Analysis Table

Confirmatory Factor Analysis Results				
Variable and Questions	**Non-standardized Factor Loads**	**Standard Factor Loads**	**S.E.**	**C.R.**
IT				
IT1	0,862	0,536	0,125	6,917
IT2	1,163	0,785	0,151	7,721
IT3	1	0,78	_a	_b
Integration				
Integration 1	1	0,992	_a	_b
Integration 2	0,963	0,966	0,022	44,449
Integration 4	0,683	0,679	0,245	15,32
Integration 5	0,675	0,672	0,049	13,774
Agility				
Agility4	1	0,773	_a	_b
Agility5	0,893	0,809	0,062	14,312
Agility6	0,979	0,916	0,062	15,871
Agility7	0,697	0,652	0,064	10,96
Demand Uncertainty				
Uncertainty5	1	0,771	_a	_b
Uncertainty6	1,778	0,994	0,125	14,185
Uncertainty7	1,743	0,969	0,124	14,09
Uncertainty8	0,847	0,502	0,112	7,567
Technological Uncertainty				
Uncertainty10	1	0,735	_a	_b
Uncertainty11	1,055	0,701	0,086	12,268
Uncertainty12	1,172	0,895	0,091	12,916
Uncertainty13	0,847	0,774	0,064	11,825
Financial Performance				
Perf5	1	0,975	_a	_b
Perf6	0,88	0,891	0,036	24,378
Perf7	0,81	0,803	0,05	16,316
Perf16	0,924	0,806	0,049	19,017
Operational Performance				
Perf2	1	0,813	_a	_b
Perf3	0,727	0,621	0,07	10,334
Perf8	0,999	0,673	0,084	11,906
Perf9	0,667	0,603	0,064	10,496

Note: SE stands for standard error from non-standard solution.

The _a t-values (critical ratio) were calculated using the non-standard solution.

All are statistically significant (different from zero) at a significance level of 0.01.

The factor _b was calculated as 1 for the purpose of estimating the load.

Convergent validity ensures that elements of a concept do not conceptually overlap with elements of other concepts. To examine the discriminant validity of a scale (concept), the mean extracted variance (Averege Variance Extracted, AVE) is compared with the squares of the correlation coefficients of other scales (concepts). If the scale's AVE value is greater than the square of the correlation coefficients with other scales, it is concluded that the scale provides discriminant validity (Fornell & Larcker, 1981). As seen in Table 5, the AVE value of each concept is greater than the square of the correlation coefficients. Therefore, it is concluded that the scales have discriminant validity.

The Confirmatory Factor Analysis results given in Table 4 show that all concepts were measured in accordance with the theory. Composite reliability (CR) coefficients of all scales (concepts) were found to be greater than the recommended threshold value of 0.70. Except for the operational performance variable, the average extracted variance (AVE) coefficients were found to be well above the recommended threshold value of 0.50 (Fornel and Larcker, 1981). These coefficients are given in Table 5. The conclusion of whether the measurement model (Structural Equation Model created to perform Confirmatory Factor Analysis) is appropriate is reached by using primary and secondary fit indices. As mentioned before, these indices are higher than the desired values. After ensuring the reliability and validity of the concepts, composite scores were created for each concept by using the indicators (items) constituting that concept to measure the concepts. In other words, a new variable was created and labeled by taking the averages of the indicators that make up each concept. For example, the concept of "Agility" was formed by taking the average of the 4 indicators that make up the concept of "Agility". The reliability of the scales was examined using the Cronbach Alpha reliability coefficient and the Composite Reliability coefficients. As seen in Table 5, the Cronbach Alpha reliability coefficient and Composite Reliability coefficients of all scales were found to be much higher than the threshold value of 0.70 (Akgün et al., 2007). This shows that the reliability of the scales is high.

Testing Research Hypotheses

Correlation and structural equation modeling were used to test the hypotheses. Correlation is the coefficient showing the strength of the linear relationship between two variables. If the

correlation coefficient is statistically significant, it is said that there is a relationship between the two variables. The correlation coefficient takes values between -1 and +1; the greater the absolute value of the correlation, the stronger the relationship between the variables (Newbold, 2009). When the correlation coefficients showing the linear relationships between the variables are examined, it is seen that there is a correlation at the 0.01 significance level (p<0.01) between the variables (See Table 5).

Table 5. Correlation Coefficients

Correlation Coefficients									
Variables	**Average**	**Standad Deviation**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1.IT	4,2574	,51699	1.00						
2.Integration	3,4251	,88294	,046	1.00					
3. Agility	3,7581	,61493	,139*	,521**	1.00				
4.Demand Uncertainty	3,0781	,79306	-,102	,206**	,175**	1.00			
5.Techno Uncertainty	3,9061	,69227	,015	,499**	,393**	,362**	1.00		
6.Financial Performance	3,7482	,58007	,117	,557**	,407**	,137*	,283**	1.00	
7.Operational Performance	3,7627	,48696	,094	,648**	,463**	,164*	,398**	,789**	1.00
Cronbach Alfa			0,732	0,918	0,863	0,859	0,857	0,791	0,943
Composite Reliability (CR)			0,748	0,748	0,870	0,878	0,860	0,926	0,775
Average Variance Extracted (AVE)			0,504	0,714	0,629	0,657	0,608	0,760	0,460

Structural equation model (SEM) was used to test the hypotheses in the research model. Structural equation models (SEM) is a statistical technique used to test causal relationships between observed and unobserved (latent) variables. It is a systematic tool used especially in social sciences (such as psychology, sociology, business) to evaluate the relations between variables and to test theoretical models. SEM uses the assumption that there is a causality structure between the set of latent variables and that latent variables can be measured through observed variables (Joreskog & Sörbom, 2001). Table 6; It illustrates the relationships between IT, Integration, Agility and Performance. It is seen that there is no relationship between information technologies and integration (β=0.05, p>0.05). Therefore, the H1 hypothesis was not supported. There is a positive relationship between information technologies and agility, supporting the H2 hypothesis (β=0.12, p<0.05). The H3 hypothesis, on the other hand, shows that there is a positive relationship between the independent variables of integration and agility (β=0.52, p<0.01). The H5 hypothesis (β=0.17, p<0.01), which examines the relationship between agility and operational performance, is supported. In our last hypothesis, H6, it can be stated that there is a strong positive relationship (β=0.79, p<0.01) between operational performance and financial performance.

Fit indices were used to test the fit of the established structural equation model. Fit indices $\chi2(7) = 4.736$; $\chi2/df = 1.184$; comparative fit index (CFI) = 0.998, incremental fit index (IFI) = 0.998, and root mean square error of approximation (Root Mean Square Error of Approximation, RMSEA) = 0.137. These results show that the established model is suitable. The linear relationships between the variables are measured by the correlation coefficient. However, in some cases, if the correlation coefficient is also affected by another variable or variables, it is not sufficient to explain this relationship. However, other variables in the model that are thought to be related to these may have an effect. "Path Analysis" developed by Sewal Wright was used when it was desired to find the parts arising from the relationship related to other variables in the correlation coefficient calculated between the variables (Orhan and Okut, 1993). Path analysis results are shown in Table 6. Except for the H1 hypothesis, our other hypotheses were supported as a result of our analysis.

Table 6. Results of Hypothesis Tests

Hypothesis	**Link**	**Path**	**Value**	**Result**
H1	Information technologies	→	Integration	0,05	Not supported
H2	Information technologies	→	Agility	0,12*	Supported
H3	Integration	→	Agility	0,52**	Supported
H4	Integration	→	Operational Performance	0,56**	Supported
H5	Agility	→	Operational Performance	0,17**	Supported
H6	Operational Performance	→	Financial Performance	0,79**	Supported

Path coefficients are standardized. *p< 0, 05; **p < 0,01

$\chi2$ (7) = 4,736	R^2(Integration)= 0,002
CFI = 0,998	R^2(Agility)= 0,285
IFI =0,998	R^2(Operational Performance) = 0,441
$\chi2$/df = 3,006	R^2(Financial Performance) = 0,623
RMSEA = 0,137	

For hypotheses H7 and H8, multiple hierarchical regression analysis was used to examine the moderating effect of integration and agility on operational performance with demand and technological uncertainty. Due to the multicollinearity problem, demand and technology uncertainty, integration and agility are transformed around the mean. When the VIF values were examined, no multivariate problem was found (VIF<10). According to Anderson's suggestion; R2 is compared to the regression equation with the cross product of the equation without R2 and the cross product with R2 (where incremental R2 is significant relative to the interaction). The results show that a significant explanation of variance (p≤0.05) was added to the operational performance model in Table 7 by including the interaction conditions in the hierarchical regression. However, the interaction-induced incremental R2 is statistically insignificant in model 2 (p>0.10). As shown in Table 7, the coefficients of interaction conditions are positively correlated with the moderating effect of high level of technology uncertainty and integration only.

Table 7. Results of Hierarchical Regression Analysis (Moderator Effect of Environmental Uncertainty)

	The Dependent Variable	
	Operational Performance	
	Model 1	**Model 2**
Integration	0,511**	0,587**
Agility	0,281**	0,217**
Demand Uncertainty	-0,002	0,009
Technological Uncertainty	0,065	0,090
Integration * Demand Uncertainty		-0,053
Integration * Technology Uncertainty		0,207**
Agility * Demand Uncertainty		-0,060
Agility * Technology Uncertainty		-0,109
R2	0,494	0,527
R2 adj	0,485	0,511
ΔR2	0,494	0,033
F	56,602	4,009

*Note: Regression coefficients are standardized. *p<0.05, **p<0.01*

The hypotheses and their support status are as follows.

Hypothesis Link Method Result

Table 8. Results of All Hypothesis Tests

H1	Information Technologies	→	Integration	YEM	Not supported
H2	Information Technologies	→	Agility	YEM	Supported
H3	Integration	→	Agility	YEM	Supported
H4	Integration	→	Operational Performance	YEM	Supported
H5	Agility	→	Operational Performance	YEM	Supported
H6	Operational Performance	→	Financial Performance	YEM	Supported
H7a	Integration Under Demand Uncertainty	→	Operational Performance	HRA	Not supported
H7b	Integration Under the Effect of Technological Uncertainty	→	Operational Performance	HRA	Supported
H8a	Agility Under Demand Uncertainty	→	Financial Performance	HRA	Not supported
H8b	Agility Under the Impact of Technological Uncertainty	→	Financial Performance	HRA	Not supported

Evaluation of Research Hypotheses

The results do not show that information technologies have a positive effect on integration (Table 6). The results obtained in the Path Analysis were not supported because they were not found to be significant. In the studies of Bush (2001), there are findings supporting that information technologies affect supply chain integration. In addition, in the study of Prajogo and Olhager (2012), the important relationship of information technology capacities and information sharing with integration has been revealed. In our study, however, this relationship was not found. The most important reason for different results may be to consider information technologies and integration multidimensionally. If these components are handled separately, different results can be obtained. In addition, differences between countries may cause this result. The results show that information technologies have a positive effect on agility (Table 6). The results obtained in the Path Analysis were found to be significant and supported. Literature studies also show us that there is a positive effect between information technologies and agility (Bottani 2010; Overby et al., 2006; Poweret et al., 2001; Cooper et

al., 1997; Swafford et al., 2008; Tallon and Pinsonneault, 2011; Yusuf et al., 2004; Zain et al., 2003). Information technologies increase the speed in obtaining, processing and sharing information by companies (Vickery et al., 2010). In line with these studies, the relationship between information technologies and agility can be mentioned. This relationship was also found in our study. It shows that integration has a positive effect on agility (Table 6). The results obtained in the Path Analysis were found to be significant and supported. When the concepts of integration and agility are handled separately in increasing supply chain performance, it has been observed in literature studies that they make positive contributions. It is seen that integration and agility variables affect each other depending on the performance criteria. In literature studies, it is thought that there is a relationship between integration and agility. This relationship was also found in our study. Analyzes show that integration has a positive effect on operational performance (Table 6). The results obtained in the Path Analysis were found to be significant and supported. In the study of Prajogo and Olhager (2012), information integration and material flow and the effect of supply chain partners on operational performance were investigated. According to data and research, there is an important relationship between integration and operational performance. In Wong (2011)'s study, we see that supply chain integration has been examined under three main subheadings. These are internal integration, supplier integration and customer integration. The firm's performance measures are distribution, product pricing, product quality, and product flexibility. It is defined by Wong (2011) that there is a positive relationship between these three main integration factors and operational performance. The positive relationship in previous studies was also observed in our study. As a result of the study, it was determined that agility has a positive effect on operational performance. The results obtained in the Path Analysis were found to be significant and supported. Many studies show that there is a direct relationship between operational performance and agility (Swafford et al., 2008; Yusuf and Adeleye, 2002; Acar vd., 2021). It has been observed that it contributes to firm performance, especially when the supply chain agility speed of the firms is measured and the supply chain functions are adapted to the variables of the market (Swafford, 2008). It can be said by examining the literature studies that there is a relationship between agility and performance. This relationship was also found in our study. The results show that operational performance has a positive effect on financial performance (Table 6). The results obtained in the Path Analysis were found to be significant and supported. Parahinski and Benton (2004) discussed supplier performance in terms of critical success factors and determined the criteria as product quality, delivery performance, price, responsiveness to changing demands, service support and overall performance. Fawcett et al. (2007) used cost, quality delivery, flexibility and innovation factors as key factors related to supplier performance. When the operational and financial performance concepts are evaluated, it is defined in previous literature studies that there are two different basic sub-dimensions of the performance variable in both concepts and there is a relationship between them. This relationship was also found in our study. As a result of the analysis, the regulatory variable effect of demand and technology uncertainties between integration and operational performance; Technological uncertainty was determined for the regulator variable, but not for demand uncertainty. Wong et al. (2011) investigated the effect of the possibility of environmental uncertainty on the relationship between supply chain integration and operational performance. In his research, Wong et al. (2011) while establishing a theoretical model, internal integration, supplier integration and customer integration as sub-dimensions of integration; Distribution, product cost, product quality, product flexibility were used as sub-dimensions of performance. Wong et al., which has been found to have high and low levels of regulatory variable impact for uncertainty, integration and operational performance. (2011), it was also determined in the study. In our study, our hypothesis about demand uncertainty, which is one of the sub-dimensions of uncertainty, was supported, but our hypothesis

about technology uncertainty was not supported. The most important reason for the different result may be to consider integration and operational performance multidimensionally. If the integration variable and the sub-dimensions of the operational performance variable are handled separately, different results can be obtained. In addition, differences between countries may cause this result. The results do not show that demand and technology uncertainties have a regulatory variable effect between agility and operational performance. When the literature studies are examined, it is said that this relationship exists. Wong (2009) and Germain et al. (1994) tested that customers frequently change their orders every month, the operational performance of their suppliers cannot be predicted, factories frequently change their core product technologies, and competitive moves related to market promotions cannot be predicted. It is seen in the existing literature studies that uncertainty affects the relationship between agility and operational performance. In our study, however, this relationship was not found. The most important reason for the different result may be to consider agility and operational performance multidimensionally. In addition, differences between countries may cause this result.

Conclusion And Recommendations

In this section, in the light of the findings obtained as a result of the analyzes, the following conclusions were reached, and various suggestions were made to middle and senior managers and researchers who will conduct future research. In this study, medium and large-scale companies operating in the province of Istanbul were examined, in supply chain management; The effects of information technologies, integration and agility on operational and financial performance were investigated.

First of all, no relationship was found between information technology applications and supply chain integration in the research. During the evaluation of the research hypotheses, necessary evaluations were made regarding why this relationship was not determined. When the literature studies are evaluated, it is seen that there is a significant relationship between the two variables (Prajogo & Olhager, 2012). It is also evaluated that innovations and developments in information technologies are not followed closely by companies and accurate cost analyzes are not made in businesses. The point of view that the budget to be allocated to information technologies will reduce other costs in the future has not yet been formed by the managers. Second, the strong relationship between agility and integration is demonstrated by companies. The only way to keep up with the qualitative and quantitative changes in customer demands in changing market conditions is with an agile and integrated supply network and management (Prajogo and Olhager, 2012; Chaudhuri, et al., 2018 p. 691). Finally, with this research, companies; It does not give the necessary importance to information technologies, does not allocate sufficient resources for information technologies, does not see information technologies as a part of supply chain management, but considers it as an additional cost, integration of information technologies with integration only takes place at the planning stage and difficulties are faced in implementation, the concept of integration in supply chain management is a holistic concept. It has been determined that it is considered only as communication between the previous and next supply network elements, not with a view. It has been revealed that operational performance will increase with an agile and integrated supply chain management. The strong relationship between operational performance and also financial performance has been demonstrated. There is a regulatory variable effect between supply chain integration and operational performance in environmental uncertainty (Wong et al., 2011).

According to the results of the literature study and analyzes carried out within the scope of the research, in order for company managers to be more successful and to catch up with market competition conditions; the inclusion of information technologies in all of the company's supply chain management processes, giving the

necessary importance to information technologies, allocating the necessary budget for the follow-up and integration of information technologies, revealing the importance of agility in the supply chain flow in all activities, integration not for two interconnected elements of the system, but for the whole system. It is suggested that the integration should be provided simultaneously, the integration should be followed from a central system and the necessary controls should be made from a single center, the relations between performance, integration and agility factors should be correctly perceived in order to minimize the negative effects of uncertainty, and technological and demand uncertainty should be correctly defined by the companies.

As for the suggestions for further research, it can be said that a different study can be done by considering the sub-dimensions of the information technologies, integration and agility variables used in the study model. The sub-dimensions of the uncertainty moderator variable, demand and technological uncertainty, have already been used in our study. To this can be added the concept of market uncertainty. The effect of information technologies on operational performance can be investigated. The relationship between the information technologies variable and the information sharing variable can be examined. Flexibility and risk can be added to the model as independent variables. In addition, the effects of these concepts on the model and other variables can be investigated. The relationship between information technologies and the concept of innovation can also be examined in future studies.

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