



## RISK MANAGEMENT TOOLS IN THE ROAD TRANSPORTATION INDUSTRY WITH MEDIATION AND MODERATION ANALYSIS

Pervin Ersoy, Mustafa Tanyeri

1) Yasar University, Izmir, **Turkey**, 2) Dokuz Eylül University, Izmir, **Turkey**

**ABSTRACT. Background:** This study aims to shed light on risk-mitigating tools and strategies that can be used in third-party logistics (3PL) companies to increase performance. Risk and risk management tools are identified and classified according to the managers' feedback and the theoretical background. The most important risks for the road transportation industry are analyzed, their implications are discussed, and mitigating strategies are offered.

**Methodology:** The study used purposive sampling from international road freight forwarders that were members of the Association of International Forwarding and Logistics Service Providers (UTIKAD) or International Transporters' Association (UND). The data were collected by questionnaire method and analyzed with SPSS 22 and AMOS programs.

**Results:** The results show that the road transportation industry has important risks that managers have not effectively managed. According to the results, the main problems in 3PL companies are lack of coordination, lack of visibility, and poor service quality. The results support that delivery risk directly affects transportation quality and process risks.

**Originality** In this study, transportation-related risks are analyzed, showing their impact on a company's overall processes. Additionally, we examine whether the transportation quality creates a mediation effect or information sharing has a moderation effect on a company's process risks. Few studies exist on transportation risks and the role of mitigating strategies in reducing these risks, and this is also a limitation of our research from the risk perspective.

**Keywords:** risks, road freight transportation, transportation risks, risks of road freight transportation industry, mediation, moderation.

### INTRODUCTION

In the last decade, globalization and technology developments have increased competition in the international arena and companies have begun to look for new ways to reduce their risks. To compete effectively nationally or internationally, companies must seek new solutions for the business environment. Outsourcing is one tool that companies use in this competitive environment. Outsourcing activity in logistics has increased significantly over time. The main reason for logistics outsourcing is to reduce costs and risks, thereby increasing a firm's performance. Transportation is one of the most important services of a third-party logistics

(3PL) company. A firm's activities, partners, transfer volume, and number of employees directly affect the firm's performance, cost, profit, damage, and risks. Therefore, if a firm wants to manage and reduce its damage and risks, which have a direct effect on the firm's profitability and cost, it should add risk management tools for its processes. Many studies emphasize that risks are increasing in the supply chain context and mitigating strategies play an important role in managing supply chain risks [Wang et al., 2020a]. The modern concept of logistics dates to the second half of the twentieth century [Seyed-Alagheband et al., 2011]. Since the 2000s, logistics has become crucial for both industries and researchers and, thus, the field has expanded theoretically and practically. The

development of logistics necessitates that managers have a comprehensive and current vision of the logistics concept. Logistics is essential for dealing with problems related to the transportation of goods without delays or damage, the on-time delivery of goods, and consumers'/customers' satisfaction with the service. The variety of logistics and supply chain activities (e.g., transportation, warehousing, handling, packaging) increases the complexity of the process and the risks for good decision making. In outsourcing, firms should analyze whether logistics activities provide efficiency and benefit the company. The benefit and efficiency can be related to increasing a firm's performance and profit and/or reducing costs. Third-party logistics activities include both transportation and warehousing activities; 3PL companies are also involved with packaging, order management, inventory management, finance, information-related activities, and value-added activities for customers, such as door-to-door services and custom operations [Wu, Chaipiyaphan, 2019]. These activities allow companies to manage transportation, delivery, and quality problems. In many cases, outsourcing is a main strategic decision for organizations that increasingly focus on a limited number of core competencies. For example, firms generally engage in outsourcing to improve service quality, provide effective communications with suppliers, reduce costs, and coordinate activities. Well-defined outsourcing strategies or strategic collaborations with partners can increase the overall performance of the organizations [McIvor et al., 2009]. Some studies have shown that outsourcing in many European countries, Australia, the United States, and Japan is an important element for both public and private industries [Domberger, 1998]. Additionally, Gay and Eassinger [2000] show that outsourcing activities are important for reducing cost, increasing flexibility, having easy access to expertise, improving service quality, and focusing on the firm's main activities. Similarly, other studies have emphasized that outsourcing activities allow firms to focus on their core competencies, reduce logistics cost, increase flexibility in operations, improve productivity, access new technology and innovation, increase penetration into new markets, improve return

on investment, reduce company risks, and improve company performance [Browne, Allen, 2017, Knemeyer, Murphy, 2004]. Other important benefits of outsourcing activities are improved firm performance and effectiveness. By outsourcing some activities, firms can focus on their main activities, their various businesses, and their core competencies and reduce their overall risks [Lankford, Parsa, 1999]. Firms are generally interested in outsourcing their logistics activities to achieve cost efficiency and mitigate bad outcomes. Outsourcing strategies provide efficiency, time saving, and money saving [Lankford, Parsa, 1999; Knemeyer, Murphy, 2004]. Despite its advantages, outsourcing also carries risks related to, for example, loss of control [Bardi, Tracey, 1991]. Also, a long-term contract can lead to a lack of flexibility, difficulty in reversing decisions [Shrivastava, 1995], a lack of volume, rigid systems, no understanding of value, and loss of in-house expertise [Bardi, Tracey, 1991].

Risk and performance are directly related to these dimensions, which in turn directly affect a company's managerial organization, a supplier's quality, and an organization's control [Lonsdale, Cox, 2000]. Therefore, risk management strategies are important for companies to mitigate risks and increase overall performance and profit.

The most important risks for transportation industries are distribution risks; these risks relate to late delivery and lead time, among other concerns. Transportation quality risk is related to the defect rate, accidents, and similar circumstances, and process risk is related to production processes and product quality. Different criteria are used to evaluate suppliers' performance. Researchers generally highlight risks associated with quality, delivery, performance, warranty policy, reliability, product, satisfaction, price, and technical skills [Tracey, Tan, 2001]. Ho et al. [2010] emphasize that delivery, product quality, service quality, and managerial risks are critical criteria for the performance evaluation process.

Many studies have emphasized the importance of risks related to quality, delivery, and processes, taking different perspectives

and using different risks mitigating tools [e.g., Schoenherr et al., 2008; Sinrat, Atthirawong, 2013, Świerczek, 2019]. In this study, we limit the research to three types of risks that have the highest impact, as identified in the literature. The effects of delivery-related risks, process risks and transportation quality risks on a company's overall process risks are analyzed and recommendations are made to help companies reduce these risks.

Generally, studies in the literature have focused on supply chain-related risks; very few have investigated 3PL-related risks. Based on these gaps in the literature, this study aims to research and analyze 3PL-related risks and mitigating strategies that can be used to reduce the impact of these risks.

This paper continues with the following sections. In Section 2, we address the theoretical background of 3PL-related risks and the hypothesis development. Section 3 discusses the research method. Section 4 continues with analysis and results and Section 5 concludes the paper, details managerial implications, and suggests future research paths.

## **THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT**

Managing transportation risk, delivery risk, and quality-related risk is essential in supply chain processes. Agency theory concentrates on problems related to each other or to each member in the chain [Eisenhardt, 1989, Lassar, Kerr, 1996]. This theory emphasizes process coordination [Celly, Frazier, 1996], control [Anderson, Oliver, 1987], outsourcing [Bahli, Rvard, 2003], management [McMillan, 1990], supply chain [Zsidisin, Ellram, 2003], and managerial risk taking [Wiseman, Gomez-Mejia, 1998]. Additionally, quality-related problems represent another important risk that directly increases the supply chain process risks. Zsidisin and Ellram [2003] show that quality-related risks are generally related to suppliers, equipment, delivery failure, damage, or employee performance.

Improving information sharing by using risk management tools to reduce process-related risks and to develop closer relationships with suppliers is also part of this theory. Agency theory focuses on problems with partners and reducing the associated risks [Eisenhardt, 1989, Lassar, Kerr, 1996]. From the risk management perspective, the main purpose of this theory is to reduce misinformation or information asymmetries, align objectives, and encourage closer supplier relations [Zsidisin, Ellram, 2003]. All these efforts aim to reduce the impact of supply chain-related risks. Therefore, in our research, the theoretical reasoning in the interactions among transportation quality, delivery, and process risks is backed up by a well-established theoretical foundation.

### **Delivery Risks and Transportation Quality Risks**

Delivery risks are associated with product damage, product loss, wrong delivery, or delivery to a wrong address. Wrong deliveries related to quantity include failures, demand problems, or irregular supplies [Zsidisin, 2003]. These types of risks cause transportation quality problems. Similarly, if firms' delivery risk decreases, the quality of transportation increases [Tuncel and Alpan, 2010]. Delivery and transportation risks are companies' main concerns. Transportation quality and delivery are important for companies to ensure that customers receive products in proper condition [Ghavamifar et al., 2018]. Delivery problems like wrong or late deliveries not only cause financial losses, but they also result in reduced product quality, loss of prestige in the eyes of customers, damage to property and equipment, suppliers, and the wider public, and delivery delays [Ahlert et al., 2009, Waters, 2011, Beneke et al., 2015]. Prior findings and rationales lead to our first hypothesis:

H<sub>1</sub>= Delivery risks increase transportation quality risks.

## **Delivery Risks, Transportation Quality Risks, and Process Risks**

The process starts when a customer orders something from the manufacturer and continues with delivery of the order. If all aspects of the process are in place (e.g., product availability, transportation, operations), the purchase process activities can start. The main concerns with the delivery process are delivery risks and transportation quality risks, both of which are important for transporting products in the desired condition [Tuncel, Alpan, 2010]. The risks involving this process include, in particular, consumers' fear that the product will be damaged during transportation. For this reason, it is important to manage the delivery process effectively and to select a suitable delivery system to reduce delivery- or process-related risks [Shi et al., 2014]. These risks especially relate to internal processes, distribution failures, or poor transportation quality [Sreedevi, Saranga, 2017]. Process risks arise when the delivery of goods or services is slow, delayed, irregular, or incorrect [Zhao et al., 2013] because the delivery process includes high uncertainty and high unreliability [Frohlich and Westbrook, 2002]. Delivery and operation risks can affect all transportation movements, as well as the quality of the process [Waters, 2011]. Delivery-related risks and transportation quality risks affect all process activities (e.g., sales, delivery, company reputation, operations, costs) [Garvey et.al, 2015; Globerman, Storer, 2015; Mesa-Arango, et. al., 2016].

Transportation quality affects all aspects of the supply chain (e.g., late delivery, disruption, flow interruption, product quality) [Zhen et.al., 2016]. These transportation quality problems cause operations breakdowns, lost sales, late delivery, and reputation problems [Garvey et al., 2015]. This confirms that transportation is an important dimension of supply chain operations and processes. Supply chain disruptions may cause problems such as, inability to meet customer requirements, stock outs, long lead times, and increasing costs [Svensson, 2000]. Risk in the supply chain may cause unexpected problems such as capacity problems, accidents, quality related problems or natural disasters at the supplier

side [Yang, Yang, 2010, Blackhurst et al., 2005]. Globerman and Storer [2015] emphasized that transportation quality plays an important role in supply chain and process efficiency.

Giunipero and Eltantawy [2004] stressed that "transportation disruption caused a great risk and, if severe, could cripple the entire supply chain". Houshyar et al. [2013] argued that transportation disruption may cause a decrease in supply chain performance as it may result in delay production and late deliveries, leading to loss sales. Prior findings and rationales lead to our second and third hypotheses:

H<sub>2</sub>= Delivery risks increase process risks.

H<sub>3</sub>= Transportation quality risks increase process risks.

Transportation quality problems and risks arise from delays or unavailability of the product, in either inbound or outbound activities [Sheffi et al., 2003]. Transportation risks cause delays in the final delivery or the production delivery stages [Prakash et al., 2020]. Transportation risk directly affects customer satisfaction and quality of service; therefore, improving transportation quality with risk analysis tools plays an important role in processes [Christopher, Holweg, 2011].

## **Mediation and Moderation Effects**

Sharing correct, reliable, relevant and timely information between members defined as information sharing [Ramanathan, 2013]. It is characterized by frequency, reliability, content, and validity [Neumann, Segev, 1979]. Shared information helps members to coordinate and standardize their activities to work together [Sodhi, Son, 2009]. Shared information among members can be related to strategic, operational or tactical plans and decisions [Huang et.al., 2003]. In addition, information sharing is an important tool for reducing process disruptions [Craighead et al., 2007, Sodhi, Tang, 2012], cost [Kahn et al., 2016], transparency [Jüttner, 2005], and supply chain visibility [Christopher, Lee, 2004]. Sharing risk and information with supply chain

members has a significant and positive impact on a company's operational performance [Fan et al., 2017; Wang, et al., 2020b]. Lee and Lee's [2019] framework shows the importance of information sharing as a mediation between trust and long-term relationships, but without any analysis or results.

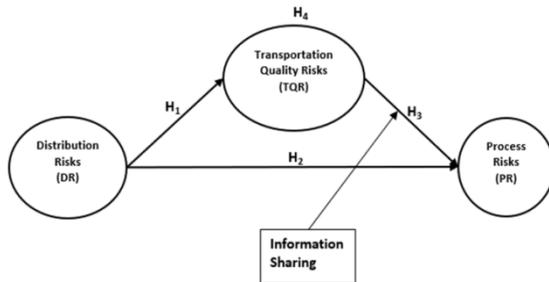


Fig. 1. Research Model

Our fourth hypothesis is as follows:

H<sub>4</sub>= Transportation quality risks mediate delivery risks and process risks.

On time delivery is vital for satisfying production needs and reducing inventory cost. Delivery is evaluated via the differences between the planned and occurred arrival times [Li, Zeng, 2016]. Proper delivery conditions are important to customer satisfaction and product or production quality; quality risks can be related to the product or production process [Sinrat, Atthirawong, 2013]. These quality problems can increase a company's process risks. Information-related risks (e.g., product, quality, demand, cost, delivery) are extremely sensitive elements because information is directly related to a firm's performance [Min. et.al, 2007]. Additionally, information sharing between supply chain members plays an important role in a company's relationships. However, very few articles in the literature have examined the relationship between risk and information sharing, and the moderator effect of information sharing has not yet been studied.

## RESEARCH METHOD

### Sample and Data Collection

The proposed model validates with utilized a cross-sectional survey approach in this study empirically. The study used purposive sampling from international road freight forwarders that were members of the Association of International Forwarding and Logistics Service Providers (UTIKAD) or International Transporters' Association (UND). The questionnaire was pre-tested with three logistics managers and five general managers who worked in highly reputable international logistics companies to ensure the quality and validity of the questionnaire. The pilot survey was conducted using face-to-face interviews and pre-tested with 60 international road transportation firms' managers. The questions used for the pre-test and the participants' answers were analyzed with confirmatory factor analyses and some questions were deleted from the survey based on pre-test analyses. Final data were collected from 151 managers, executives, and logistics managers who were members of UTIKAD or UND. According to the survey results, the respondents' gender distribution was male dominated at 81.46%, with 18.54% being female. As predicted, the logistics industry is male dominated. Participants' position in the 3PL firms were Manager (35.8%), General Manager (25.2%), and Logistics Manager (18.5%). These three types of managers represented approximately 80% of all survey respondents. Generally speaking, well-educated managers answered the survey. To eliminate the impact of other factors on delivery and process risks, it is important to control factors such as firm size and experience. Two control variables were used in this research. Firm size and number of years doing business were selected as control variables. Firm size and experience are often used as control variables, with different results.

## ANALYSIS AND RESULTS

Analyses of the measurement and structural model of our research follow Anderson and Gerbing's [1988] procedures. All items in the

model distribution risks, transportation quality risks, and process risks load with a high alpha coefficient, greater than 0.5, and all eigenvalues are greater than 1.00; thus, the results fulfill the convergent validity criteria. Items with a low alpha coefficient (lower than 0.70) and loading related to dependent and independent variables are rejected. The measurement items load with their respective construct and factor loadings range from 0.70 to 0.90, providing convergent validity of the theoretical constructs. The average variance extracted (AVE) value of the construct is greater than the recommended value of 0.50 [Bagozzi et al., 1981], so the model construct shows strong convergent validity. Composite reliability (CR) values of each construct are greater than 0.85, which shows that all measurement scales demonstrate high reliability [Nunnally and Bernstein, 1994]. Distribution risk (DR) and transportation quality risk (TQR) scales are adapted from Ersoy [2014] and the process risk (PR) scale is adapted from Ersoy [2014] and Moeinzadeh and Hajfathaliha [2009].

Amos 24 is applied to verify the internal consistency and reliability of the measurement model and to check factor structures using Confirmatory Factor Analysis (CFA) and relationships between the dependent and independent variables. The total variance explained with these three constructs is greater than 75%. The measurement model's CFA results show a good fit to our three-factor solution ( $\chi^2/df= 1.52$ , CFI= 0.991, IFI= 0.991, TLI= 0.981, NFI= 0.975, and RMSEA=0.042), and the fit indexes show a good fit for our model [Hu and Bentler, 1999]. Table A in the appendix, displays detailed information on the constructs, Cronbach's alpha, composite reliability, and average variance extracted. Correlations among the constructs are shown in Table B (in the appendix). The AVE values

of all constructs are greater than the correlation among all constructs, for this reason discriminant validity is provided among the constructs [Fornell, Larcker, 1981]. The Harman's one-factor test conducted by performing factor analysis on the items of the dependent and independent variables and designed questionnaire with separating dependent and independent variables [Podsakoff, et al., 2003]. The unrotated solutions yield three factors with eigenvalues greater than 1.0 and explain 59.34% of the total variance. Single factor loading accounts for less than 35% of the total explained variance [Malhotra et al., 2006]. The single factor model fit indices are very poor ( $\chi^2/df= 8.804$ , GFI= 0.67, CFI= 0.68, IFI=0.70, TLI=0.69, RMSEA=0.304). The results show that common method bias is not an issue in this research.

### Hypotheses Testing and Results

The structural model and model fit indices tested with using Amos 24. The model indices are a good fit ( $\chi^2/df= 2.582$ , CFI= 0.97, IFI= 0.98, TLI= 0.96, NFI= 0.97, RMSEA=0.052) and the structural model is acceptable. Table 1 shows the estimated results of the hypothesized model. H<sub>1</sub> and H<sub>2</sub> address distribution risk (DR), which affects transportation quality risk and process risk. For H<sub>1</sub>, the result ( $\beta=0.3354$ ,  $p=0.0000$ ) shows that distribution risk has a positive effect on transportation risk; thus, H<sub>1</sub> is supported. Similarly, a positive relationship exists between distribution risk and transportation quality ( $\beta=0.3501$ ,  $p=0.0000$ ); thus, H<sub>2</sub> is supported. Hypothesis 3 addresses the effects of transportation quality risk on a company's process risk; transportation quality risk has a positive and significant effect on process risk ( $\beta=0.4459$ ,  $p=0.0000$ ), and H<sub>3</sub> is supported.

Table 1. Structural Model Results

Hypothesis	Hypothesis path	Proposed Effect	p Value	Path coefficient	Results
H <sub>1</sub>	Distribution Risk → Transportation Quality Risk	Positive	0.0000	0.3354	Supported
H <sub>2</sub>	Distribution Risk → Process Risk	Positive	0.0000	0.3501	Supported
H <sub>3</sub>	Transportation Quality Risk → Process Risk	Positive	0.0000	0.4459	Supported

## Mediation and Moderation Analysis

Researchers use mediation analysis to understand how an independent variable (X) affects a dependent variable (Y) with or without an extra variable. To measure the mediation effect of transportation quality risk as formulated in H<sub>4</sub>, the recommended bootstrapping bias-corrected confidence interval procedure in structural equation modeling is applied [Preacher and Hayes, 2008]. Using AMOS 24, we apply 2,000 samples to obtain the confidence intervals. This procedure generated 95% confidence intervals, Table 2 describes the mediation effect results and shows a significant indirect

effect of distribution risk on process risk through transportation quality risk, supporting H<sub>4</sub> ( $\beta=0.4996$ ,  $p<0.0000$ ). Thus, transportation quality-related risks may increase a company's process risks. With a third variable, strength of the relationship between dependent and independent variables, the moderation effect occurs [Preacher et al., 2007]. H<sub>5</sub> addresses the moderation effect of information sharing on transportation quality risks and process risks ( $\beta=0.0327$ ,  $p<0.0000$ ). The result shows that sharing information through the delivery process may help companies reduce their process risks.

Table 2. Moderated Mediation Analysis Results

Hypothesis	Paths	Variable	Variable Type	Direct with mediator/moderator ( $\beta$ )	Direct without mediator/moderator ( $\beta$ )	p-value	Boot 95% CI		Relation Type	Proposed Effect	Results
							LL	UL			
H <sub>4</sub>	DR → PR	TQR	Mediator	0.4996	0.3501	p<0.000	0.3993	0.6000	Mediation	Positive	Supported
H <sub>5</sub>	TQR → PR	Information Sharing	Moderator	0.0327	0.4459	p<0.001	0.0124	0.0541	Moderation	Positive	Supported

Notes. CI= Confidence Interval; LL= Lower Limit; UL= Upper Limit

## CONCLUSIONS

The structural model and moderated mediation result tables show the results of our research. The results support that delivery risk directly affects transportation quality and process risks. Therefore, companies should manage their distribution options, delivery frequencies, packaging lines, and storage accordingly. Additionally, transportation quality risks directly affect a company's process risks. For this reason, companies should improve their transportation quality with additional employee seminars and training, thereby improving their service quality and solving routing problems via software. The mediation result shows that transportation quality problems directly increase process risks. Thus, improving their transportation quality may help companies improve their processes. The moderation effect

demonstrates that sharing information during the delivery process or increasing transparency between members helps to reduce process-related risks.

Similarly, Piltan and Sowlati [2015] showed that monitoring the performance of partnerships directly affects whole process performance. This research empirically analyzed the relationship between a firm's delivery and transportation quality risks and their impact on the firm's process risks. In which conditions these risks can be mitigated is the main concern of this study. The researchers found a limited number of studies on transportation risks and the role of mitigating strategies for reducing these risks. Delivery risks always affect a firm's internal and external logistics activities [Sreedevi, Saranga, 2017]. To reduce delivery, product, or time problems, companies can develop new strategies such as routing, employee training, and enhancing communication between chain

members. New solutions and strategies are inevitable in this competitive environment.

### Managerial Implications

The research findings will help company managers form a new perspective to mitigate their delivery-related risks. First, the findings show that delivery-related risks can include mitigating distribution varieties, training employees, selecting alternative routes, and improving transportation services. Increasing flexibility during the delivery process or choosing alternative routes can help managers mitigate delivery-related risks. Additionally, managers can reduce distribution uncertainty, lead time, and systems problems by increasing process transparency and flexibility. These solutions not only reduce existing risks but also develop better service quality and long-run company sustainability. Our results provide alternative solutions for companies to identify their risks and reduce their potential impact. As seen from the results, process risks are directly related to transportation quality and delivery problems; for this reason, managers should focus on these problems to improve the company's overall performance and reduce its potential losses.

### Limitations and Future Research

Despite its important findings, as with any study, several limitations arise from our research design. In this study, we limited risks to delivery, transportation, and process risks. Other supply chain risks can be used in future studies to find new mitigating strategies. In this study, we used information sharing as a moderator; in future studies, other control variables such as age, education level, and gender can be used and control as a moderator. On the other hand, dependent variables like service-related risks or procurement-related risks can be used as a mediator and their impacts can be analyzed. This study was conducted on road freight transportation and, specifically, 3PL firms. The study can also be applied to industries to define their specific risks. For generalization of the findings, the solutions can be tested in different industries and countries.

### ACKNOWLEDGMENTS AND FUNDING SOURCE DECLARATION

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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## Appendix

Table A. Individual Constructs and Validity Measures

Author/s	Construct	Item	Cronbach Alpha	AVE	CR	Construct Reliability ( $\alpha$ )
Ersoy, P. (2014)	Distribution and Delivery Risks	Distribution network variety increases a company's delivery-related risk	0.790	0.668	0.889	0.834
		Delivery problems (e.g., frequency of delivery) increase a company's delivery-related risk	0.858			
		Network variety increases a company's delivery-related risk	0.848			
		Packaging line variety increases a company's delivery-related risk.	0.771			
Ersoy, P. (2014); Moeinzadeh & Hajfathaliha (2009)	Process Risks	Distribution uncertainty increases a company's process-related risk	0.813	0.679	0.894	0.858
		Problems with system integration increase a company's process-related risk	0.865			
		Lack of process visibility increases a company's process-related risk	0.841			
		Lead time problems increase a company's process-related risk	0.774			
Ersoy, P. (2014)	Transportation Quality Risks	Lack of education seminars for employees increases a company's transportation quality-related risks.	0.815	0.682	0.865	0.767
		Routing problems or choosing the wrong route increases a company's transportation quality-related	0.833			
		Complaints about transportation service increase a company's transportation quality-related risks	0.829			

Note: Likert scale: 1 = Completely disagree; 7 = Completely agree

GFI= 0.977

CFI=0.991

IFI= 0.991

NFI= 0.975

TLI=0.981

RMSEA= 0.042

$\chi^2/df = 39,612/26 = 1.52$

Table B. Correlations and Descriptive Statistics

Construct	Mean	Std. Dev.	Distribution Risks	Transportation Quality Risks	Process Risks
Distribution Risks	3.49	0.98	1		
Transportation Quality Risks	3.34	0.99	0.344	1	
Process Risks	3.42	0.95	0.492	0.547	1

Pervin Ersoy ORCID ID: <https://orcid.org/0000-0001-8196-0158>

Business School, Department of Logistics Management

Institution: Yasar University, Izmir, Turkey

Universite Cad., No: 35, Bornova, Izmir, 35500, Turkey

e-mail: [pervin.ersoy@yasar.edu.tr](mailto:pervin.ersoy@yasar.edu.tr)

Mustafa Tanyeri ORCID ID: <https://orcid.org/0000-0001-8606-6358>

Faculty of Business, Department of Business Administration

Institution: Dokuz Eylül University, Izmir

Doğuş Cad. 207/A Tınaztepe Yerleşkesi, Buca, Izmir, 35390, Turkey

e-mail: [mustafa.tanyeri@deu.edu.tr](mailto:mustafa.tanyeri@deu.edu.tr)