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18<sup>th</sup> edition of the Conference "Risk in Contemporary Economy",  
RCE2017, June 9-10, 2017, Galati, Romania

## Risk in Contemporary Economy

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<https://doi.org/10.18662/lumproc.rce2017.1.25>

*How to cite:* Ünğan, M. (2017). Relationship Between Supply Chain Risks: An Empirical Work. In S. Hugues, & N. Cristache (eds.), *Risk in Contemporary Economy* (pp. 293-303). Iasi, Romania: LUMEN Proceedings. <https://doi.org/10.18662/lumproc.rce2017.1.25>

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## Relationship Between Supply Chain Risks: An Empirical Work

Mustafa ÜNGAN<sup>1</sup>

### *Abstract*

*Supply chain risk management is turned out to be a critical function for organization around the globe as a consequence of change in technology, economic, environment of organizations. Most companies or organizations view supply chain risk as a disruption of the flow of products or services that meet their requirements and consequently reduce their performance. A literature review for this study indicates that relationship between supply chain risks and developing appropriate mitigation strategies is drawing the attention of practitioners and academics in recent years. However, there is a lack of studies in this field. This paper aims to contribute to fill this gap in the literature by exploring the relationships between supply chain risks in Nigeria. To this end, data were collected 82 companies operating in different industries. Correlation matrices and item to total correlations were used for the analysis. The results indicated that terrorist activity risk is the most perceived supply chain risk in Nigeria. It was also found that many companies can reduce the level of many supply chain risks with an optimum level of capacity and good planning. It is expected that the findings help supply chain managers and policy makers in their decisions.*

**Keywords:** *Supply chain, Risk, Supply chain risk management, Enterprise risk management.*

### 1. Introduction

Recent years have witnessed many disasters (e.g. Japanese earthquake) and economic crises that have created many problems for the supply chains of global companies. [1] These disasters and their aftermath have drawn the attention of academics and practitioners to the role of risk

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<https://doi.org/10.18662/lumproc.rce2017.1.25>

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management in supply chains. Supply chain risks are related to disturbances and interruptions of the flows within the goods- information and financial network, as well as the social and institutional networks. And, they may negatively affect the objective accomplishment of the individual company, respectively, the entire supply chain, in regards of end-user advantage, costs, time or quality. [2]

There are different classifications of supply chain risks in the literature [2, 3, 4]. For example, Demirkol [5] classified risks into four categories: supplier, operational, security and environmental. Supply chain risk management is described as an approach for the identification, assessment, control and monitoring of supply chain risks. [2, 6, 7] Supply chain risk management has a great influence on the relationship among supply chain partners and hence very important for a superior performance of the entire chain. For this reason, it has gained a great importance in recent years.

According to a Deloitte report published in 2013, although many firms are paying attention to risk management only few of them adequately understand and manage the relationship between risks. [8] Most firms manage risk in 'silos,' often ignoring risk interdependencies. However, companies should study and understand the relationships between risks for a better utilisation of production factors and successful configuration of their supply chain networks. [9] Many examples can be given for the relationship between risks. For example, the reliability of production and service would be seriously affected by a disruption of supply. Furthermore, it may undermine vendors' initiatives and enterprises' image, resulting in a declined market share. A deficient plan restricts production, which may result in production bottlenecks and excessive inventories. Mistakes of prediction on demands may either lead to loss of opportunities or excessive end-product inventory. [10] Another example is quality risk. Quality may influence supply chain operation in many ways. A low-level quality of components and parts in procuring process will decrease the outcome of production and affect consumer experience, which in turn would harm sales and image of the enterprise. Furthermore, it always increases the cost of warranty and after-sale service. [11]

Chopra and Sodhi [12] reported that individual risks are often interconnected, and this makes supply chain risk management difficult. As a result, actions that mitigate one risk can end up exacerbating another. For this reason, managers must build into their contingency plans ways to respond when risks become more or less likely with changes in their environment. This is important for supply chain design choices and resource deployment. For example, if a company predicts that distortion risks will

decrease and delay risks will increase, it might need to reconfigure supply chain designs from a reliance on excess capacity to a focus on increasing responsiveness. [12]

## 2. Problem Statement

Even though there is a good deal of empirical and conceptual research that deals with supply chain risk management (e.g. [3], [6], [7], [13], [14]), there has been little research about the relationship between supply chain risks (e.g. [2], [15], [16]). A formal and structured approach should be adopted to risk management as suggested by researchers (e.g., [16], [17]). On the other hand, Colicchia and Strozzi (2012) indicated that there is a need for a comprehensive and dynamic approach to supply chain risk management. [18]

Tools and analytical techniques have been designed to support the risk analysis in the fields of management science and operations research. These tools have guided the decision makers. Analytical hierarchy process (e.g., [19]), multi-stage influence diagram (e.g., [20]), Monte Carlo approach (e.g., [21]), interpretive structural modelling (e.g., [22]), partial least square method (e.g., [23]) and several other methods have been utilized by academics to test models for supply chain risk assessment.

Micheli [24] proposed a decision framework which identifies and describes the main elements of the supply chain risk management and the relationships among these elements. Lee [25] presented a scheme for large engineering project risk management using a Bayesian belief network and applied it to the Korean shipbuilding industry. These authors explored the relationships among risks are the very beginning, and significant basis in the decision-making process of risk management Shin [26] proposed a risk assessment approach that considers the inter-relationship between supply chain risks and the structure of network at the same time. To reduce the impact of the supply chain risk and enhance the flexibility of transportation route finding during the product delivery, the authors propose a way to model the risk propagation and how to integrate it with the supply chain network using Bayesian Belief Network.

Phofl [2] made a structural analysis of potential supply chain risks. This author demonstrate how interpretive structural modelling supports risk managers in identifying and understanding interdependencies among supply chain risks on different levels (e.g. 3PL, first-tier supplier, focal company, etc.). Similarly, Diabat [22] created a model which analyses the various risks involved in a food supply chain with the help of interpretive structural modelling. The model shows that the macro level risk, demand management

risk, supply management risk and information management risk have both strong driver power and dependence power and thus linkage elements. These risks can thus be considered as unstable risks and the actions taken on them may affect other risks. On the other hand, this author found that the product/service management risk is an autonomous element.

Ghadje [16] applied systems thinking concepts in modelling supply chain risks and developed and tested a framework for supply chain risk Management using an industrial case study. The systems approach for modelling supply chain risks predicts the failure points along with their overall risk impact in the supply chain network.

### **3. Research Questions/Aims of the research**

A literature review for this study indicated that relationship between supply chain risks are under-researched and no research was found in the Nigerian context. Therefore, this study was undertaken as a first step to identify the relationship between supply chain risks. More specifically, this study has two research questions:

1. What is the perceived importance of supply chain risks in Nigeria?
2. Is there any relationship between supply chain risks?

### **4. Research Methods**

Companies operating in different sectors in Nigeria was targeted for this study. These companies comprise service, manufacturing, oil and gas, information technology, mining, production, logistics, E-commerce, extracting companies, etc. Intentional sampling was used to decide the companies to be included in the study. The survey form was sent to 500 companies. Data collection started at the end of October 2016 and ended at the end of January 2017.

*A total of 88 questionnaires were filled out and collected. 6 of them were excluded from the study due to missing information. Thus, 82 questionnaires were subject to analysis. The response rate was found to be 16,4%. This rate is similar to the other survey-type studies. For the analysis, descriptive statistics, correlation matrices and item-total correlation statistics were used.*

*The items in the questionnaire was categorized into four: supplier risk, operational risk, security risk, and environmental risk. Supplier risk items include on time delivery, the desired amount of delivery, quality, knowledge sharing, and right supplier selection.*

*Operational risk items comprise machine breakdown, insufficient capacity, planning, inventory (unnecessary or excess inventory), and employee. Security risk consists of information technology, terrorist activity, fire, and accidents. Finally, environmental risk items include economic, increasing raw material cost, and demand. For each type of risk, respondents were asked to indicate its likelihood on a 5- point (1: very low, 2: small, 3: neither low nor high, 4: high, 5: very high). The questionnaire was designed in a way in which respondent would fill without the interference of the researcher.*

## 5. Findings

The mean and standard deviations of the risks are given in Table 1. As it can be seen from the table, terrorist activity, the desired amount of delivery, and on time delivery risks are the highest perceived risks. On the other hand, the lowest perceived risks are inventory, employee, and right supplier selection. The values of standard deviations indicate that there is a great variation among the responses.

**Table 1:** Descriptive statistics

Risk	Mean	Standard Deviation
On time delivery	3,40	0,93
The desired amount of delivery	3,44	0,97
Quality Risk	3,09	1,02
Knowledge sharing risk	3,20	0,94
Right supplier selection risk	2,86	0,98
Machine break down risk	3,14	0,92
Insufficient capacity risk	3,35	0,89
Planning risk	3,16	0,99
Inventory risk	2,75	1,01
Employee risk	2,80	1,08
Information technology risk	3,39	0,90
Terrorist activity risk	3,53	1,15

Risk of fire	2,94	1,04
Risk of accidents	2,96	0,91
Economic risk	3,02	1,11
The risk of increasing raw material costs	2,99	1,02
Demand risk	2,98	0,94

To identify the relationship among the supply chain risks, first, a correlation table (See Table 2) including all of the variables was first created. As it can be seen in the table, there are 135 correlation pairs. 42 of the pairs are significant at 0, 01 and 27 of the pairs are significant at 0,05. On the other hand, 66 of the pairs are non-significant. More than half of the risks are significantly correlated to each other.

The highest correlations are found between economic risk and the risk of increasing raw material prices ( $r=0,665$ ), increasing risk of raw material prices and demand risk ( $r=0,614$ ), accident risk and employee risk ( $r=0,58$ ), accident risk and fire risk ( $r=0,573$ ), planning risk and insufficient capacity risk ( $r=0,553$ ), on-time delivery risk and the desired amount of delivery risk ( $r=0,524$ ), the desired amount of delivery risk and quality risk ( $r=0,479$ ), on time delivery risk and quality risk ( $r=0,475$ ), insufficient capacity risk and employee risk ( $r=0,474$ ) and machine breakdown risk and insufficient capacity risk ( $r=0,457$ ).

The lowest correlations are found between risk of accidents and the desired amount of delivery risk ( $r=0,000$ ), economic risk and inventory risk ( $r=0,008$ ), inventory risk and machine breakdown risk ( $r=0,011$ ), inventory risk and demand risk ( $r=-0,014$ ), risk of increasing raw material prices and inventory risk ( $r=-0,016$ ), knowledge sharing risk and terrorist activity risk ( $r=0,020$ ), terrorist activity risk and machine breakdown risk ( $r=0,032$ ), and the desired amount of delivery risk and economic risk ( $r=0,036$ ).

**Table 2:** Correlations among the types of risks

	OD	DAD	QR	KS	RSS	MBD	IC	PR	IR	ER	IT	TA	FR	AR	ECO	IRMC	DR
OD	1,000																
DAD	0,524**	1,000															
QR	0,475**	0,479**	1,000														
KS	0,128	0,194	0,315*	1,000													
RSS	0,297*	0,443**	0,445**	0,556**	1,000												
MBD	0,325**	0,090	0,317*	0,102	0,243	1,000											
IC	0,350**	0,166	0,372**	0,430**	0,297*	0,457**	1,000										
PR	0,329**	0,416**	0,395**	0,325*	0,294*	0,309*	0,553**	1,000									
IR	0,200	0,173	0,070	0,237	0,096	0,011	0,403**	0,420**	1,000								
ER	0,245	0,151	0,246	0,228	0,151	0,312*	0,474**	0,405**	0,260*	1,000							
IT	0,152	0,135	0,126	0,063	0,053	0,176	0,185	0,380**	0,162	0,054	1,000						
TA	0,317*	0,265*	0,287*	0,020	0,071	0,032	0,081	0,141	0,097	0,302*	0,316*	1,000					
FR	0,342**	0,223	0,414**	0,144	0,087	0,181	0,425**	0,338**	0,324*	0,395**	0,045	0,328**	1,000				
AR	0,077	0,000	0,341**	0,274*	0,200	0,227	0,363**	0,278*	0,230	0,580**	-0,062	0,164	0,573**	1,000			
ECO	0,144	0,036	0,091	0,099	0,104	0,417**	0,352**	0,207	0,008	0,391*	0,304*	0,135	0,164	0,353**	1,000		
IRMC	0,218	0,156	0,230	0,168	0,147	0,427**	0,421**	0,280*	-0,016	0,275*	0,309*	0,172	0,132	0,246	0,665**	1,000	
DR	0,265*	0,391**	0,175	0,312*	0,434**	0,228	0,379**	0,415**	-0,014	0,317*	0,262*	0,174	0,170	0,229	0,408**	0,614**	1,000

OD: On time delivery; DAD: The desired amount of delivery; QR: Quality; KS: Knowledge sharing; RSS: Right supplier selection; MBD: Machine break down; IC: Insufficient capacity; PR: planning; IR: Inventory; ER: Employee; IT: Information technology; TA: Terrorist activity; FR: Fire; AR: Accidents; ECO: Economic risk; IRMC: Increasing raw material costs; Demand

\*\*significant at 0,01; significant at 0,05



In addition to the correlation matrix, each risk's total correlation with all other risks is also analysed. For this purpose, item-total correlation table was created (See Table 3). In the table, it can be seen that insufficient capacity risk (0,662) has the highest item-total correlation score while planning (0,617) and demand risk (0,565) follow the insufficient capacity risk. The lowest scores for item-total correlations are for inventory risk (0,261), Information technology risk (0,278) and terrorist activity risk (0,364).

**Table 3:** Item-total correlations

Type of risk	Item-total correlation
Insufficient capacity	0,662
Planning	0,617
Demand	0,565
The risk of increasing raw material costs	0,556
Employee	0,541
Quality	0,531
On time delivery	0,502
Fire	0,494
Risk of accidents	0,476
Economic risk	0,469
Machine breakdown risk	0,434
Right supplier selection risk	0,427
The desired amount of delivery	0,416
Knowledge sharing risk	0,408
Terrorist activity risk	0,364
Information technology risk	0,278
Inventory risk	0,261

## 6. Discussions

A pilot test on two supply chain managers was conducted to test and improve the reliability of the data collection methods. The validity of this

study was enhanced by ensuring that the study sample is representative. The pilot test also helped to promote the validity of the study by providing the question measure what they are intended to measure. The sample size is the limitation of this research. It should be noted that it is quite difficult to get responses from African companies. Poor infrastructure (e.g. internet connection) in some countries was an obstacle to collect data. Some companies refuse to respond to the online survey. A lot of managers did not take their time in reading emails while some refuse to give to respond to it cause of confidentiality.

## 7. Conclusions

This study is intended to fill a gap in the literature as there was no empirical research on the relationship between supply chain risks in Nigeria. Results indicate that many supply chain risks are significantly correlated to each other.

The results show that Nigerian companies face a moderate level of supply chain risks. However, high standard deviations indicate that different companies perceive risks differently. Nigeria's development as a developing country is attracting a lot of investors across the globe, but a lot of investors are still sceptical of investing due to the vulnerability to risk in the region.

There are important implications of this study for the supply chain managers and policy makers. Knowing the perceived level of risks, supply chain managers can develop risk reduction strategies or, if a risk is inevitable, they can develop appropriate mitigation strategies. For example, with a good planning or working with an optimum level of capacity, supply chain managers can also manage the other risks such as machine breakdown, right supplier selection, knowledge sharing, quality, on-time delivery, inventory, employee, IT, terrorist activity, fire, accident, increasing cost of raw materials, and demand. On the other hand, selection of right supplier will lead to reduction in the risks of on-time delivery, the desired amount of delivery, quality, knowledge sharing, inventory control, planning, and demand.

Policymakers can also use the findings of this study in their decision making. For example, if terrorist activity risk can be reduced via tight security measures, on time delivery, desired amount of delivery, quality, planning, employee, IT and fire risks can also be reduced. Also, reducing the economic risk will lead to a reduction in employee, IT, increasing prices of raw materials, demand, insufficient capacity, machine breakdown, and accident risks.

As indicated above, this study is only the first steps in the supply chain risk management (i.e., only risk interconnectedness were identified). It is recommended that future studies can focus on identifying the causal relationship between supply chain risks with a larger samples sizes and develop appropriate risk reduction and mitigation strategies.

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