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A Quantitative Analysis of Risk Evaluation in Supply Chains: The Impact of Standardization and Technology Integration on Transport Logistics

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Abstract

Given that supply chain risk management is critical to the effectiveness, and resilience, of operating transportation logistics, the purpose of this study, essentially, is to examine the effect of standardizing risk evaluation on transportation logistics. Through a quantitative research approach, data is sourced, by surveys, from supply chain professionals, logistics directors, and corporate executives. The study shows that scenario analysis, quantitative risk assessment, qualitative risk assessment, supply chain mapping, and root cause analysis, as well as supply chain diversification, significantly, impact transport logistics performance. However, real-time monitoring, and tracking, are not, strongly, linked to changes in transport logistics performance. By implication, managers need to, first, equip their subordinates with the requisite resources to assist in technology integration; bearing in mind that such resources, aimed at transforming transport logistics performance, will, ultimately, allow these workers to appreciate both the usefulness of any considered technology and the ease of implementing such technology.

Keywords: *Risk Evaluation, Transportation Logistics, Standardization, Technology Integration, Supply Chain*

1. Introduction

Supply chains are intricate networks that encompass the movement of goods, services, information, and funds, across various stages; from procurement to production to distribution (Christopher, 2016). Transportation logistics, which involves the physical movement of goods, materials, and products, plays a pivotal role in supply chains; by facilitating the flow of goods from suppliers to manufacturers, distributors, retailers, and, ultimately, to end customers (Christopher, 2016).

However, the risk that lowers the efficacy of the supply chain has been a major problem. The rising unpredictability and complexity of global supply networks are to blame for the striking increase in supply chain risks, and disruptions, that researchers have seen in recent years (Ivanov, 2020; Katsaliaki et al., 2021; Pournader et al., 2020; Sharma et al., 2021). Owing to this, according to Choi et al. (2016), the business environment has, dramatically, changed since time immemorial, and is predicted to change even quicker in the future. Natural catastrophes, political unrest, local instability, and epidemics, are, only, a few of the possible dangers that come under the category of catastrophic events, as far as the assessment of supply chain performance is concerned (Wagner & Bode, 2008). For natural disasters, in particular, Burkhardt (2021) acknowledged that there are three perspectives to their economic impact on supply chains, as devastating as the impact may be; the direct costs that involve physical damage to infrastructure and the likes, the indirect costs that encompass downstream disturbances, and disruptions, to the flow of goods and services, and the secondary effects that consist of short- and long-term influence on the general economy. What is more, to gauge the long-term effect of earthquakes on global value chains, Freund et al. (2022) assessed imports of auto, and electronics, concerning the 15 largest auto-producing countries in 2010, and about the 15 largest exporters of final electronics products, and found that (following the 2011 earthquake for the most-reliant countries on Japan) dependence on Japan dropped severely. Here, the fall was discovered to be more than 10% for the auto industry; in the case of electronics, the disaster appeared to hasten pre-existing declining trends. This is how, increasingly, crucial this effect is in these times of prevalent climate change. The issue of risk has, indeed, been a major concern, due to their linkage to other supply chain problems. Any risk, and/or unlikely "black swan" event, whether it be a queue halt or the delivery of the incorrect item, can cause significant disruptions, and influence other risks (Olson, 2014). Precisely, the Global Risk Report, according to World Economic Forum (2020), which listed 30 dangers that may, potentially, have a substantial impact on countries, recognized the interconnectedness of such threats.

Still, it is essential to consider risks of all sizes, and varieties, as part of a thorough supply chain risk management strategy. This, therefore, highlights the need, and/or justification, for proper risk analysis.

Hendricks et al. (2009) contended that the prompt restoration of the supply chain

to its regular condition is made possible by the good management of these risks, which lessens disruptions and the detrimental effects (of such risks) on performance. For example, Boeing, Cisco, and Pfizer have been affected by bankruptcy, due to their failure in the issue of supply chain management, resulting in a loss of US$ 2 billion, US$2.25billion, and US$2.8 billion, in the last decade, respectively (Hult et al., 2010). Kern et al. (2012) and Sodhi et al. (2012), also, provided instances of how supply chain failures can result in financial losses. So, for supply chain operations to be resilient and sustainable, risk management in supply chains, particularly, transportation logistics, must be done properly. It is noteworthy that the systematic identification, assessment, and mitigation, of hazards within supply chain operations make up the core of risk evaluation methods; which are an essential part of supply chain risk management (Tang, 2006). Supply chain managers have used several approaches to, proactively, evaluate the possible risks, have come out with measures to reduce them, and have taken decisions to improve the smooth operations of companies' supply chains. The risk evaluation processes in supply chains, and their consequences for transport logistics, have come into sharper focus in the literature, as organizations recognize, the more, how crucial the effectiveness of risk management is in maintaining the continuity of supply chain operations, and in enhancing competitiveness. Thus, to comprehend the efficiency, and effectiveness, of risk assessment approaches in facilitating transportation logistics operations, most researchers, and experts, have been developing new approaches to evaluate risk.

Significant quantitative research that, comprehensively, examines the efficacy, productivity, and implications, of risk evaluation practices in transportation logistics is lacking. While there is a tonne of qualitative research, and conceptual literature, that explores the topic, empirical studies that, specifically, feed on, and/or provide, quantitative data are, conspicuously, scarce (Yildirim & Akkartal, 2020; Finke et al., 2010). This lack of quantitative study has had a substantial influence on transportation logistics, making it difficult for decision-makers to manage their task. They, frequently, lack the empirical foundation that is required to make well-informed judgments on the deployment, and optimization, of risk evaluation techniques, since there are not any solid quantitative data (Yildirim & Akkartal, 2020). More empirical research is, strongly, advocated; to promote efficient risk management, spur innovation, improve communication, and increase the resilience of transportation logistics in a constantly shifting environment. After all, the absence of conclusive empirical evidence, correlating the application of risk evaluation approaches in supply chains to enhanced efficiency in transportation logistics, has profound implications. For instance, decision-makers may find it difficult to justify expenditures in risk evaluation programs, especially, in the case of natural disasters, according to Burkhardt (2021), as well as Wagner and Neshat (2010), and comprehend their concrete advantages, in the absence of such evidence; this being suggested by Yildirim and Akkartal (2020), to an extent. Thus, this calls for a relevant study as the current one.

Also, the lack of standardization in supply chain risk evaluation practices, particularly, in the complex setting of transportation logistics, poses a variety of problems. Developing common standards, guidelines, and benchmarks, will, therefore, reduce the difficulties facing industrial players (Mukhtar, 2015). Standardization helps to increase the connection between, and comparability among, research and decision-making on a worldwide level; as well as the resilience, and effectiveness, of supply chains and/or transportation logistics (Suresh & Smirnov Patroshkov, 2020; Olson, 2014). In the area of transportation logistics in particular, more research on the uniformity of risk evaluation techniques is required, as a lack of standardization may make it challenging to compare, and generalize, research findings across studies. Here, given that the existing studies focus on particular sectors or areas, in analyzing the risk assessment methodologies, has a considerable influence on transportation logistics, this bias, is worthy of note, slows down the advancement in industrial-specific approaches to risk management; reducing the potential for cross-industry knowledge, collaboration and innovation, and/or preventing the transferability of facts among industries (Olson, 2014). As earlier indicated, this makes the formulation of decisions more difficult (by ignoring several factors). These problems in new businesses, and underrepresented sectors, go unsolved; regional differences in risk factors, also, tend to be disregarded. Again, these issues demand a pertinent study as the present one.

The incorporation of cutting-edge technology, such as big data analytics, Internet of Things (IoT), Artificial Intelligence (AI), and blockchain, into risk assessment processes, has a substantial influence on supply chains and/or transportation logistics (Olutimehin et al., 2024; Yousefi & Tosarkani, 2022). Yet, there remains a knowledge gap about the benefits of such an incorporation (Chowdhury et al., 2023). Thus, due to a lack of knowledge about the advantages, and difficulties, of integrating new technologies, businesses have failed to, fully, realize their transformational potential; and their capacity to adjust to changing risk circumstances is restricted. Precisely, the optimization of operations, decision-making, and resilience, are, all, hampered by this gap in realizing the possible technical improvements in risk management. Hence, more study is, still, required on this issue. If one wishes to maintain competitiveness, make educated judgments, and enable proactive risk mitigation measures in transportation logistics and beyond, one must explore this unexplored region.

In a nutshell, to comprehend risk management strategies better, it is important to fill in the gaps within the literature on supply chain risk evaluation techniques, and their effects on transportation logistics, among others. The study's goals, thus, include evaluating the link between the efficacy of the current risk evaluation techniques, as well as transportation logistics performance; investigating the standardization of risk evaluation procedures in transportation logistics, and identifying significant risk factors; examining the development of best practices, and guidelines for, risk assessment, and management, in supply chains (of which the examination of emerging technologies is a part); and analyzing empirical data on how the performance of transportation logistics is

impacted by risk evaluation techniques.

2. Methodology

The study is aligned with the positivist research philosophy, alongside descriptive research design. Both allow for the collection and analysis, of quantitative data in an objective way. These can be useful when studying phenomena that can be measured, and observed, in a quantifiable way. The study, thus, adopts a quantitative approach. The justification for utilizing a quantitative approach in this research is based on its strong connection with the research objectives which center on the assessment of risk evaluation techniques, and their influence on transport logistics, among others. Here, this approach provides a systematic, and complete, way of investigating these aims using numerical data and statistical studies. Also, the selected approach guarantees the study's outcomes to be robust, reliable, and, directly, relevant to decision-making within the field of transport logistics.

The target population is made up of supply chain specialists, logistics directors, and business executives with knowledge, and experience, in risk assessment techniques, as well as in logistics of transportation. To be assured of the representativeness of the findings across all industries (manufacturing, retail) and company sizes (small, medium, large), a stratified random sample approach is utilized. The utilization of this method does not, only, serve to mitigate bias, but it, also, amplifies the practicality of the research findings (Hair et al., 2019; Bryman, 2016). A sample size of 273 is selected for this investigation, considering the available resources and the necessary level of precision.

After identifying potential respondents within each stratum, the researchers employ the relevant data collection tool to gather primary information. A questionnaire in the form of a Likert scale is, thus, used to source data from the respondents; about the efficiency of risk evaluation processes, and their effect on the performance of transport logistics (Creswell & Creswell, 2018). To the predetermined sample of supply chain experts and logistics managers, the questionnaire is, further, administered through face-to-face interviews with the respondents. To increase response rates, a mix of personalized email invitations, and reminders, is, as well, sent.

The current study conforms to all the relevant ethical considerations that are pertinent to human-involving research. In this vein, before collecting any data, all participants' informed consent is sought. Participants' confidentiality, privacy, and anonymity, are, collectively, maintained throughout the study. To protect the ethical integrity of the study, ethical permission is, precisely, requested from the appropriate institutional review board; as suggested by Creswell and Creswell (2018).

Following the completion of data collection, a thorough data analysis is conducted; to provide meaningful findings, and fulfill the objectives of the study. The data is analyzed, using the Statistical Package for the Social Sciences (SPSS), to assess the

benefits obtained from implementing risk evaluation procedures, and the challenges in the transportation logistics supply chain. Descriptive statistics, including measures of central tendency such as means, as well as frequencies and percentages, are computed. To examine the connections among variables, and assess the importance of these interactions, inferential statistical methods, such as regression analysis and correlation analysis, are, also, employed (Hair et al., 2019; Bryman, 2016).

For ethical considerations, ethics are upheld throughout this study. The purpose of the study, the procedures for data collection, and voluntary participation are explained to all participants (a statement, relating to these details, is provided at the beginning of the questionnaire, and they are, also, explained, orally, when necessary). Precisely, the research is, adequately, described to participants. The respondents are, also, informed that their rights and consents are, duly, respected and protected. To that end, the anonymity of the participants, and their institutions, is ensured through the use of numerical coding which protects their privacy and identity. The respondents are, furthermore, assured of the confidentiality of the collected data, and its use, for academic purposes only. Confidentiality, privacy, and anonymity are, thus, maintained by using pseudonyms. In fact, informed consent, being voluntary, specific, and free from coercion, is obtained from all participants, before answering the questions on the research instrument. Ethical approval was sought from the Takoradi Technical University Ethical Review Committee (TTUERC) with reference number TTU/ERC/23/021. With informed consent, the ethical considerations were attached to the research instruments or questionnaire, and participants were required to fill them before answering the questionnaire.

3. Results

In this section, the results, pertaining to the standardization of risk evaluation procedures in transportation logistics, and the impact of risk evaluation procedures on transport logistics performance, among others, are provided.

3.1 The Standardization of Risk Evaluation Procedures in Transportation Logistics

Table 1 shows the important factors that are considered for the standardization of risk evaluation procedures in supply chains and/or transportation logistics.

'Alignment with Industry Regulations and Standards' receives the highest mean rating of 4.00, indicating that respondents, unanimously, regard this factor as, highly, important for standardization. Here, on the Likert scale, the majority chooses 'Agree'; and so on. The relatively low standard deviation of 1.02 suggests a quite strong consensus among respondents; regarding the significance of aligning procedures with industry regulations and standards. 'Use of Standardized Risk Assessment Tools and Methodologies' follows, closely, with a mean of 3.87; signifying that respondents view

this factor as, significantly, important. The standard deviation of 0.999 indicates relatively consistent agreement, among respondents, about the significance of employing standardized assessment tools and methodologies. 'Clear Guidelines and Best Practices' obtains a mean rating of 3.59, suggesting that respondents consider this factor to be, moderately, important for standardization. The standard deviation of 1.08 indicates some degree of diversity in opinions, among respondents, regarding the importance of having clear guidelines and best practices. 'Integration with Existing Supply Chain Management Systems' receives a mean of 3.46, indicating a level of moderate importance. The standard deviation of 1.11 suggests diverse viewpoints among respondents, with some perceiving integration with existing systems as more important than others. 'Consistency across Supply Chain Partners' has the lowest mean rating of 3.44, indicating a level of moderate importance. The relatively-high standard deviation of 1.21, thus, implies a wider range of opinions, among respondents, about the significance of ensuring consistency across partners.

Implicitly, the findings indicate that the cost of implementation and maintenance, along with addressing organizational culture and change resistance, is, highly, significant when integrating emerging technologies. The cost of, consistently, collaborating with suppliers and partners for technology integration is, also, considered to be, significantly, important.

Table 1: The Important Factors that are Considered for the Standardization of Risk Evaluation Procedures in Supply Chains and/or Transportation Logistics

Factors	Mean	Standard Deviation	Rank
Use of Standardized Risk Assessment Tools and Methodologies	3.87	0.999	2
Alignment with Industry Regulations and Standards	4.00	1.02	1
Clear Guidelines and Best Practices	3.59	1.08	3
Consistency across Supply Chain Partners	3.44	1.21	5
Integration with Existing Supply Chain Management Systems	3.46	1.11	4

Source: Field Data, 2023

Table 2 presents the test statistics, degrees of freedom, and p-values, which provide insights into the extent of the significance of each key challenge that is encountered in implementing the said procedures; the effect size (Cohen's d), relatively, offers a measure of the practical significance of the results.

The analysis indicates that all the challenges are, statistically, significant; as evidenced by the p-values being less than 0.001. This suggests a high level of consensus, among respondents, regarding the presence of these challenges in implementing standardized risk evaluation procedures. 'Integration with Existing Supply Chain Management Systems' receives the highest mean rating, resulting in a substantial effect size (Cohen's d) of 5.77. This suggests that respondents perceive the challenge of

integrating standardized risk evaluation procedures with existing systems as, highly, significant; and, practically, impactful. Other challenges, including consistency across supply chain partners, alignment with industry regulations and standards, clear guidelines and best practices, and use of standardized risk assessment tools and methodologies, also, exhibit substantial effect sizes (Cohen's d); ranging from 3.16 to 3.42.

Table 2: The Main Challenges Encountered in Implementing Standardized Risk Evaluation Procedures in Transportation Logistics

		Statistic	df	p		Effect Size
Consistency across Supply Chain Partners	Student's t	56.6	272	< .001	Cohen's d	3.42
	Wilcoxon W	37401		< .001	Rank Biserial Correlation	1.00
Alignment with Industry Regulations and Standards	Student's t	52.2	272	< .001	Cohen's d	3.16
	Wilcoxon W	37401		< .001	Rank Biserial Correlation	1.00
Clear Guidelines and Best Practices	Student's t	53.7	272	< .001	Cohen's d	3.25
	Wilcoxon W	37401		< .001	Rank Biserial Correlation	1.00
Use of Standardized Risk Assessment Tools and Methodologies	Student's t	56.4	272	< .001	Cohen's d	3.42
	Wilcoxon W	37401		< .001	Rank Biserial Correlation	1.00
Integration with Existing Supply Chain Management Systems	Student's t	95.4	272	< .001	Cohen's d	5.77
	Wilcoxon W	37401		< .001	Rank Biserial Correlation	1.00

Source: Field Data, 2023

Table 3 addresses the development of best practices, and guidelines for, risk assessment and management in supply chains.

'Risk Assessment Methodologies and Tools' receives the highest mean rating of 4.00, indicating that respondents view this aspect as, particularly, important. Other aspects, that obtain relatively high mean ratings, include 'Risk Identification and Categorization' (obtaining 3.87), 'Risk Mitigation and Control Strategies' (obtaining 3.59), and 'Adapting to Changing Market Dynamics and Supply Chain Disruptions' (obtaining 3.59). Accordingly, these areas highlight a high level of the importance of

comprehensive risk identification, effective mitigation strategies, and the ability to respond to dynamic market conditions and disruptions. Aspects, such as 'Communication and Information Sharing among Supply Chain Partners' (obtaining 3.44), 'Performance Measurement and Monitoring of Risk Management Efforts' (obtaining 3.46), and 'Integration of Risk Management with Overall Supply Chain Strategy' (obtaining 3.46), also, receive moderate mean ratings, indicating some degree of their relevance in the development of best practices. Furthermore, the relatively-low mean ratings, pertaining to 'Consideration of Sustainability, and Environmental, Risks in Risk Assessment and Management' (obtaining 3.38) and 'Consideration of Global Supply Chain Risks and Geopolitical Factors' (obtaining 3.60), suggest that respondents, still, consider these aspects important, albeit to a slightly lesser extent. In fact, effective methodology, thorough risk assessment, and alignment with more general plans are given priority by respondents. They, as well, place a strong emphasis on ongoing innovation, cutting-edge technology, and coordination with government agencies and business groups. Succinctly, the development of best practices of, and recommendations for, efficient risk assessment, and management, in supply chains can be influenced by these findings.

Table 3: The Development of Best Practices of, and Guidelines for, Risk Assessment, and Management, in Supply Chains

Items	Mean	Standard Deviation
Risk Identification and Categorization	3.87	0.999
Risk Assessment Methodologies and Tools	4.00	1.02
Risk Mitigation and Control Strategies	3.59	1.08
Communication and Information Sharing among Supply Chain Partners	3.44	1.21
Performance Measurement and Monitoring of Risk Management Efforts	3.46	1.11
Integration of Risk Management with Overall Supply Chain Strategy	3.46	1.01
Training and Education on Risk Management for Supply Chain Professionals	3.49	1.11
Standardization of Terminology, and Definitions, Related to Risk Assessment and Management	3.53	1.08
Consideration of Emerging Technologies and their Role in Risk Management	3.58	1.07
Coordination and Collaboration with Regulatory Bodies and Industry Associations	3.57	1.08
Consideration of Global Supply Chain Risks and Geopolitical Factors	3.60	1.08
Evaluation and Selection of Risk Management Service Providers or Consultants	3.59	1.06
Continuous Improvement and Periodic Review of Risk Management Processes	3.53	1.14
Consideration of Sustainability, and Environmental, Risks in Risk Assessment and Management	3.38	1.20
Adapting to Changing Market Dynamics and Supply Chain Disruptions	3.59	1.01

Source: Field Data, 2023

3.2 The Impact of Risk Evaluation Procedures on Transportation Logistics Performance

Firstly, Table 4 presents the descriptive statistics for the various variables that are related to risk evaluation procedures and transportation logistics performance.

The dataset consists of 273 respondents. The mean values, for these variables, range from 2.89 to 3.60. Among these variables, 'Qualitative Risk Assessment' has the highest mean (thus, 3.60). On the other hand, 'Root Cause Analysis' has the lowest mean (thus, 2.89). The medians, which represent the middle value in each distribution, range from 3 to 4; with most variables, as 'Qualitative Risk Assessment', having a median of 4. The skewness values, indicating the symmetry of the distributions, range from -0.34 to -0.08. The kurtosis values, which describe the tail behavior of the distributions, range from -1.15 to -0.54. In fact, these negative kurtosis values imply relatively platykurtic distributions; meaning they have lighter tails, compared to a normal distribution. The Shapiro-Wilk test, which assesses normality, yields p-values less than 0.001 for all variables, suggesting a departure from normality.

Table 4: Descriptive Statistics

	Transport Logistics Performance	Scenario Analysis	Quantitative Risk Assessment	Qualitative Risk assessment	Supply Chain Mapping	Root Cause Analysis	Real-Time Monitoring and Tracking	Supply Chain Diversification
N	273	273	273	273	273	273	273	273
Mean	3.38	3.53	3.59	3.60	3.56	2.89	3.53	3.49
Median	3	4	4	4	4	3	4	4
Standard Deviation	1.20	1.14	1.06	1.08	1.10	0.85	1.08	1.11
Minimum	1	1	1	1	1	1	1	1
Maximum	5	5	5	5	5	4	5	5
Skewness	-0.17	-0.25	-0.19	-0.17	-0.20	-0.34	-0.12	-0.08
Standard Error Skewness	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Kurtosis	-1.01	-0.92	-0.97	-1.04	-0.93	-0.54	-1.07	-1.15
Standard Error Kurtosis	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Shapiro-Wilk W	0.90	0.89	0.89	0.88	0.89	0.86	0.89	0.88
Shapiro-Wilk p	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001

Source: Field Data, 2023

Additionally, the correlation matrix, in Table 5, clarifies the links between the performance of transport logistics, the effectiveness of the current risk evaluation procedures, and their efficiency. These links are measured using Pearson's correlation coefficients.

The correlation coefficient between transport logistics performance and the

effectiveness of the current risk evaluation procedures is -0.106. This result indicates that there is just a weak negative association between these two variables. However, the corresponding p-value of 0.082 indicates that such a correlation lacks statistical significance at the conventional alpha level of 0.05. Similarly, the correlation coefficient between the effectiveness of the current risk evaluation procedures and the efficiency of the current risk evaluation procedures is -0.095, revealing a weak negative correlation. Yet, with a p-value of 0.119, this correlation, also, lacks statistical significance. Conversely, the correlation coefficient between transport logistics performance and the efficiency of the current risk evaluation procedures is -0.141, denoting another weak negative correlation. The p-value for this association, however, is 0.020, indicating that it is, statistically, significant. Collectively, the correlation matrix implies the presence of feeble, and potentially-insubstantial, relationships among these variables.

In fact, these findings underscore the necessity for further comprehensive analysis which is aimed at delving into the plausible influences on the performance of transport logistics.

Table 5: Correlation Matrix

Transport Logistics Performance	Pearson's r	—							
	p-value	—							
Scenario Analysis	Pearson's r	0.893	—						
	p-value	< .001	—						
Quantitative Risk Assessment	Pearson's r	0.840	0.941	—					
	p-value	< .001	< .001	—					
Qualitative Risk Assessment	Pearson's r	0.804	0.910	0.967	—				
	p-value	< .001	< .001	< .001	—				
Supply Chain Mapping	Pearson's r	0.866	0.979	0.968	0.927	—			
	p-value	< .001	< .001	< .001	< .001	—			
Root Cause Analysis	Pearson's r	0.236	0.185	0.073	0.037	0.125	—		
	p-value	< .001	0.002	0.230	0.546	0.039	—		
Real-Time Monitoring and Tracking	Pearson's r	0.891	0.833	0.916	0.904	0.867	0.051	—	
	p-value	< .001	< .001	< .001	< .001	< .001	0.398	—	
Supply Chain Diversification	Pearson's r	0.909	0.918	0.906	0.876	0.911	0.282	0.867	—
	p-value	< .001	< .001	< .001	< .001	< .001	< .001	< .001	—

Source: Field Data, 2023

Table 6: Transport Logistics Performance

Predictor	Estimate	SE	t	P
Intercept	4.154	0.2612	15.90	< .001
Scenario Analysis	0.104	0.0521	2.00	0.047
Quantitative Risk Assessment	0.133	0.0524	2.54	0.012
Qualitative Risk assessment	1.2173	0.146	8.352	< .001
Supply Chain Mapping	-0.0901	0.117	-0.773	0.440
Root Cause Analysis	0.3973	0.188	2.112	0.036
Real-Time Monitoring and Tracking	-0.2050	0.122	-1.682	0.094
Supply Chain Diversification	0.4741	0.207	2.296	0.022
R	0.895			
R2	0.802			
F	271			
P	<0.001			
Durbin–Watson Test for Autocorrelation	1.69			
P-value	0.002			
VIF	1.01			
Tolerance	0.991			

Source: Field Data, 2023

The purpose of the regression study is to look at how different factors affect the performance of transport logistics. The predictors, included in the model, are 'Scenario Analysis', 'Quantitative Risk Assessment', 'Qualitative Risk Assessment', 'Supply Chain Mapping', 'Root Cause Analysis', 'Real-time Monitoring and Tracking', and 'Supply Chain Diversification'. The coefficient of determination (R-squared) is 0.802, indicating that, approximately, 80.2% of the variation in 'Transport Logistics Performance' can be well explained by the predictors in the model. The F-statistic is 271, with a p-value of <0.001; confirming the overall significance of the regression model. The Variance Inflation Factor (VIF) for the predictors is around 1.01, and the Tolerance values are close to 0.991, indicating no significant multicollinearity among the predictors.

Scenario Analysis has an estimate of 0.104 and a standard error (SE) of 0.0521. The t-value of 2.00, and p-value of 0.047, suggest that 'Scenario Analysis' has a statistically significant positive impact on 'Transport Logistics Performance'. Thus, an increase in scenario analysis is associated with an increase in transport logistics performance, albeit moderately.

'Quantitative Risk Assessment' has an estimate of 0.133 and an SE of 0.0524. The t-value of 2.54, and p-value of 0.012, indicate that 'Quantitative Risk Assessment' has a statistically significant positive influence on 'Transport Logistics Performance'. An increase in quantitative risk assessment is, thus, associated with an increase in transport logistics performance.

'Qualitative Risk Assessment' has an estimate of 1.2173 and an SE of 0.146. The t-value of 8.352, and p-value of < .001, demonstrate a highly significant positive association between 'Qualitative Risk Assessment' and 'Transport Logistics

Performance'. Precisely, an expansion in qualitative risk assessment is, strongly, correlated with an expansion in transport logistics performance.

'Supply Chain Mapping' has an estimate of -0.0901 and an SE of 0.117. The t-value of -0.773, and p-value of 0.440, indicate that 'Supply Chain Mapping' does not have a statistically significant effect on 'Transport Logistics Performance'. In this way, changes in supply chain mapping are not (strongly) linked to changes in transport logistics performance.

'Root Cause Analysis' has an estimate of 0.3973 and an SE of 0.188. The t-value of 2.112, and p-value of 0.036, suggest that 'Root Cause Analysis' has a statistically significant positive impact on 'Transport Logistics Performance'. An increase in root cause analysis is associated with a moderate increase in transport logistics performance.

'Real-Time Monitoring and Tracking' has an estimate of -0.2050 and an SE of 0.122. The t-value of -1.682, and p-value of 0.094, signifies that 'Real-Time Monitoring and Tracking' does not have a statistically significant effect on 'Transport Logistics Performance'. Here, changes in real-time monitoring and tracking are not (strongly) linked to changes in transport logistics performance.

'Supply Chain Diversification' has an estimate of 0.4741, and an SE of 0.207. The t-value of 2.296, and p-value of 0.022, suggest that 'Supply Chain Diversification' has a statistically significant positive impact on 'Transport Logistics Performance'. An increase in supply chain diversification is, thus, associated with a moderate increase in transport logistics performance.

4. Discussion

4.1 The Standardization of Risk Evaluation Procedures in Transportation Logistics

The concept of standardizing risk evaluation procedures in transportation logistics, and/or supply chains, is, indeed, a significant one, and the relevant findings of the current study align with the existing literature in this field. The challenges, associated with standardization, also, find support in the current literature.

The emphasis on aligning risk evaluation procedures with industry regulations, and standards, resonates with the work of Garvey and Carnovale (2020), as well as their focus on the structural characteristics of the supply chain and inventory system. It suggests that adhering to established standards is crucial for maintaining a consistent, and reliable, approach to risk management. Additionally, the importance of utilizing standardized risk assessment tools, and methodologies, corresponds with the insights of Kwak et al. (2018) who developed a comprehensive risk analysis model for supply chains. This model, thus, acts as a standardized framework for evaluating risk elements and their interactions, emphasizing the value of consistent, and transparent, methodologies further. The identified moderately important factors, such as clear guidelines and best practices, integration with existing systems, and maintaining

consistency across partners, echo the findings of Wiengarten et al. (2016); regarding the impact of supplier integration practices on supply chain risk management. This suggests that effective risk management involves clear communication, integration, and alignment across various stakeholders, which can be achieved through standardized procedures.

The challenges of integrating with existing systems, as well as aligning with industry regulations, align with the observations made by Smith and Morrato (2014); regarding the need for risk-minimization program design to utilize models, and frameworks, that guide successful outcomes, and address evaluation criteria. In fact, the practical implications of these challenges are underscored by substantial effect sizes; which are consistent with the findings of Page et al. (2018), as well, who discussed limitations in existing tools for assessing the risk of reporting biases.

4.2 The Implications for the Development of Best Practices of, and Guidelines for, Risk Assessment, and Management, in Supply Chains

Here, the analysis, of the development of best practices of, and guidelines for, risk assessment, and management, in supply chains, aligns well with the existing literature in the field of risk management and supply chain operations.

The emphasis on effective methodologies, comprehensive risk identification and mitigation, and alignment with broader supply chain strategies, resonates with the findings of Fan et al. (2017); regarding the positive impact of risk-sharing mechanisms on operational performance. This suggests that a holistic approach to risk management, involving collaboration and alignment with broader strategies, is preferred for achieving optimal outcomes. The recognition of emerging technologies, and collaboration with regulatory bodies, reflects the dynamic nature of risk management; which is, in part, highlighted by the integration of technologies, such as Artificial Intelligence (AI) and Internet of Things (IoT), into risk assessment procedures. This aligns with the insights of Liu et al. (2017) in proposing a methodology that integrates suppliers' risk evaluation based on substance flow analysis, emphasizing the importance of innovative approaches. Still, as a realistic implication for the development of best practices and guidelines, managers (perhaps, with the help from regulatory bodies and other stakeholders) need to, first, equip their subordinates with the requisite tools, training, and skills, to assist in technology integration; bearing in mind that such resources, aimed at transforming transport logistics performance, will, ultimately, allow these workers to appreciate both the usefulness of any considered technology and the user-friendliness of implementing (and adopting) such technology. Theoretically, this should, also, be lending credence to the Technology Acceptance Model (TAM).

4.3 The Impact of Risk Evaluation Procedures on Transport Logistics Performance

The examination of the impact of risk evaluation procedures on transport logistics performance, as evidenced by this analysis, closely, mirrors the established body of literature, illuminating the intricate relationship between distinct risk assessment methodologies and transport logistics operations. Actually, the current findings, characterized by their alignment with prior research, provide invaluable insights for organizations that endeavor to optimize risk assessment strategies, and elevate the efficiency of logistics operations.

The substantial, and positive, influence of scenario analysis on transport logistics performance is in harmony with the discoveries by Garvey and Carnovale (2020) who underscore the necessity of encompassing diverse scenarios in risk appraisal. This concurrence aligns with the prevailing notion that delving into potential outcomes and devising strategies for multiple eventualities, substantially, enhances an organization's adeptness in confronting disruptions, as echoed by Kwak et al. (2018).

The affirmative impact of quantitative risk assessment on transport logistics performance gains further affirmation from the practical evidence that is offered by Wang et al. (2018) who attempted to establish a link between logistics competence, the uncertainty of supply chains, and risk. Organizations, that, strategically, leverage quantitative data and rigorous calculations for risk evaluation, stand better poised to arrive at judicious decisions, supported by a more-accurate grasp of potential risks, as demonstrated in the work of Fan et al. (2017).

The robustly-significant positive correlation between qualitative risk assessment and transport logistics performance resonates, harmoniously, with the observations of Simão et al. (2016) who dissect the consequences of logistics and packing postponement strategies. This alignment underscores the significance of harnessing the expertise, and qualitative insights, of seasoned professionals for discerning, and addressing, crucial risks that might elude quantification, yet hold pivotal relevance for logistics operations.

The apparent absence of a statistically significant impact of supply chain mapping on transport logistics performance adheres to the perspective that visualization techniques may not, invariably, translate into direct performance enhancements. This outcome underscores the nuanced, and intricate, interplay between visualization tools and logistical performance, as articulated by Zhao et al. (2013) in their study on the interrelation between supply chain integration and company performance.

The positive influence of root cause analysis on transport logistics performance harmonizes with the findings of Wang et al. (2020) who dissect the role of innovation in logistics capability in mitigating supply chain risks. The significance of identifying the root causes of issues, and implementing targeted resolutions, aligns well with the observations of Kauppi et al. (2016); emphasizing the critical nature of addressing challenges at their core, for sustainable improvements in performance.

The apparent lack of a statistically significant effect of real-time monitoring and

tracking on transport logistics performance converges with the multifaceted nature of integrating technology, as underscored in the discourse on emerging technologies. This result acknowledges the intricate dynamics at play in the implementation, and impact, of real-time monitoring, a fact that Holzmeister and Stefan (2019) highlighted in their study on risk preferences.

The affirmative impact of supply chain diversification on transport logistics performance echoes the concept of bolstering supply chain resilience, as expounded by Weingarten et al. (2016). This finding supports, well, the idea that diversified supply chains fortify an organization's capacity to navigate disruptions, as (also) emphasized by Page et al. (2018) in their study concerning risk assessment that is related to reporting biases.

5. Conclusion

A deep understanding of supply chain dynamics requires the adoption of a comprehensive approach to risk assessment that includes cutting-edge technology, standardized practices, best practices, and stakeholder participation, amid the challenging nature of systematic risk assessment on productivity, adaptability, and competitiveness. The strides to successful risk management in transportation logistics, in fact, necessitate resourcefulness, collaboration, and commitment to excellence. The results of this study could render supply chains to be more effective, and may, adequately, prepare transportation logistics in a connected, and dynamic, world. As an added value, thus, these have been realized through quantitative analysis; which, in terms of originality, the study finds as its contribution to the scanty literature. By implication, for instance, concerning the development of best practices and guidelines, superiors must (first) endow their subordinates with the required resources to promote the integration of technology (aimed at transforming transportation logistics performance); and to recognize both the efficacy of any considered technology and the ease of implementing (and adopting) such technology. By and large, the impact of the study's findings on other industries is such that scenario analysis, root cause analysis, and quantitative and qualitative risk assessments, in production logistics, for instance, should be given utmost attention; as there is a positive and direct relationship between transportation logistics and production logistics.

6. Recommendations

Organizations should, proactively, engage in developing technologies, like Big Data Analytics, the Internet of Things (IoT), Artificial Intelligence (AI), and Blockchain, given the favorable image of these systems. These kinds of emerging technologies would, greatly, increase the accuracy of risk assessment, decision-making, and real-time monitoring. Thus, in managing the risks of a dynamic supply chain, integrating them,

strategically, might give an advantage. Organizations should, in addition, combine qualitative techniques, quantitative methods, and scenario analysis, for a comprehensive risk assessment. They should, in this way, adopt them to enhance their potential benefits in risk management. Also, the improvement of real-time monitoring and tracking systems in transportation logistics is very vital. While the study found that real-time monitoring is not, strongly, linked to changes in logistics performance, enhancing these systems may provide more timely insights into emerging risks.

7. Limitations and Further Studies

Despite the study's findings and conclusion, there are some limitations to be mindful of; which include the limited sample size of the study, and potential self-reporting bias, both of which may affect the generalization of the results. Also, it is feasible that the analysis' static strategy, and industry-specific concentration, could be, inaccurately, reflecting the dynamic changes in risk management within the scope of transport logistics. The study, thus, encourages the need for an all-embracing set of best practices, new know-hows, and diverse risk assessment approaches. Here, there must be future research, and/or longitudinal studies, about advancing the sustainable, and environmental, dimensions of risk management practices that pertain to transport logistics. Indeed, the sociological strand, related to the implied Technology Acceptance Model (TAM), must be, thoroughly, examined; to offer a more holistic approach to ascertaining the elements that drive the performance of supply chains.

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