

# Supply chain risks in the South African manufacturing sector



## Authors:

Rudzani Tshifhumulo<sup>1</sup>   
 Gert J. Heyns<sup>1</sup>   
 Peter J. Kilbourn<sup>1</sup> 

## Affiliations:

<sup>1</sup>Department of Transport and Supply Chain Management, School of Management, University of Johannesburg, Johannesburg, South Africa

## Corresponding author:

Gert Heyns,  
 gjheyns@uj.ac.za

## Dates:

Received: 10 May 2025  
 Accepted: 23 July 2025  
 Published: 30 Aug. 2025

## How to cite this article:

Tshifhumulo, R., Heyns, G.J. & Kilbourn, P.J., 2025, 'Supply chain risks in the South African manufacturing sector', *Journal of Transport and Supply Chain Management* 19(0), a1189. <https://doi.org/10.4102/jtscm.v19i0.1189>

## Copyright:

© 2025. The Authors.  
 Licensee: AOSIS. This work is licensed under the Creative Commons Attribution License.

## Read online:



Scan this QR code with your smart phone or mobile device to read online.

**Background:** Supply chain operations in many organisations are becoming vulnerable to increasing supply chain risks because of unforeseen events that can disrupt the flow of goods and services across the value chain.

**Objectives:** The primary objectives of this study were to determine the most significant supply chain risks in the South African manufacturing sector, to ascertain the effects of supply chain risks in the South African manufacturing sector and to determine the risk mitigation measures that the South African manufacturing sector employs to manage supply chain risks.

**Method:** A quantitative research design was used, and the philosophical paradigm for this study was positivism, with empirical data collected using a self-administered online questionnaire. Exploratory factor analysis, correlation analysis and regression analysis were employed to analyse the research data.

**Results:** The study's findings revealed that supply chain risks have a significant relationship to supply chain operations. The correlation analysis revealed a positive correlation between logistics risk, supply risk, financial risk and supply chain operations. In contrast, the findings suggested a weak relationship between environmental and demand risk in supply chain operations.

**Contribution:** Findings suggest that logistical, supply and financial risks are the most important supply chain risks affecting manufacturers in South Africa and should be prominently featured in risk mitigation strategies.

**Conclusion:** The findings of this study provide supply chain managers with a better understanding of supply chain risk and its effects on organisational operations.

**Keywords:** supply chain risks; supply chain operations; risk management; South African manufacturing sector; risk mitigation strategies.

## Introduction

Supply chain risks are undesirable, and mostly unpredictable disruptive events that have the potential to negatively impact supply chain operations and organisational performance (Simba et al. 2017). Organisational supply chain operations are exposed to disruptions caused by risk events such as extreme weather events, disease outbreaks and political instability (Parast & Subramanian 2021). Supply chain operations in many organisations are becoming vulnerable to increasing supply chain risks because of unforeseen events that can disrupt the flow of goods and services across the value chain. Kanike (2023) suggested that natural hazards, regulatory changes, technological failures, political unrest, a shortage of raw materials and transportation issues contribute to supply chain risks in the manufacturing industry.

Supply chain risk is defined as a potential event that can disrupt both the upstream and the downstream operations of a business (Truong & Hara 2019). Supply chain risks exist in business operations because of changes in demand, uncertain supply and changes in global trends (Junaid et al. 2020) and are influenced by rapid changes in the business environment and uncertainty factors such as geopolitical risk, poor supplier performance, natural hazards and economic risks (Dias, Hernandez & De Oliveira 2020). Supply chain risks include, but are not limited to, operational risks, environmental disasters, economic risks, geopolitical risks, logistics risks, pandemics, technological risks and societal risks (Dias et al. 2020; Parast & Subramanian 2021). Developments in the business landscape, such as growing globalisation, the development of new technologies and fluctuating supply and demand, have made managing supply chain risks increasingly essential for companies.

The South African manufacturing sector has recently experienced significant supply chain disruptions because of the coronavirus disease 2019 (COVID-19) pandemic (PWC 2020). A report compiled by Avenyo (2021) found that manufacturing sector output decreased by approximately 87% in 2020 because of the COVID-19 pandemic. Most companies could not manufacture goods because of the country's lockdown. A further issue affecting the manufacturing sector's output is equipment failure; for example, in December 2020, a South African oil refinery (Astron) lost 110000 barrels per day (bpd) of production because of an explosion (Ward & Roelf 2020). In April 2022, KwaZulu-Natal province experienced floods that affected many companies, such as Toyota South Africa's Durban plant, Sappi and others, especially those exporting their products through Durban and Richards Bay (Wesgro 2022). These disruptions caused a significant interruption in the manufacturing sector's value chain, and as a result, some manufacturing industries were exposed to supply chain risks. A study by Kanike (2023) alluded to the fact that natural hazards are detrimental to the supply chain network of the manufacturing sector. As a result, supply chain risk consequences could cause higher product prices, interruptions in the manufacturing process, decreased efficiency and reduced customer satisfaction (Kanike 2023). Supply risks can cause disruptions that can affect upstream and downstream businesses.

The South African manufacturing sector operates in a challenging environment characterised by uncertain supply, unpredictable demand and the effects of globalisation (Fazluddin, Ojijo & Godfrey 2022). These challenges pave the way for organisations' investment in resources to manage supply chain risk. According to Statistics South Africa (StatsSA 2021), the manufacturing sector ranks as the fourth largest industry and contributes roughly 13% to the South African gross domestic product (GDP). Furthermore, the South African manufacturing sector is directly interconnected with other sectors, including mining, transport, construction, agriculture and retail; hence, the supply chain interdependencies of this sector can easily be exposed to high volatility and uncertainty.

There are several types of supply chain risk in the manufacturing sector, such as demand, supply, operational, logistics and environmental risks (Ceryno, Scavarda & Klingebiel 2015). These types of supply chain risks vary from industry to industry and also depend on the location of an organisation. For example, manufacturing companies in Western Cape, Gauteng and KwaZulu-Natal provinces might have different logistical challenges because each province has a different transportation infrastructure. Certain supply chain risks pose potential ramifications for companies, including financial losses, operational difficulties or a halt in the company's activities (Fan & Stevenson 2018). If supply chain risks are not adequately managed, an organisation might experience increased supply chain disruptions (Parast & Subramanian 2021). Macroeconomic trends, such as globalisation, political instability, economic

downturns and logistics disruptions, have prompted supply chain professionals and organisational leaders to examine the range of supply chain vulnerabilities within an organisation and assess the potential risks (Gurtu & Johnny 2021). The possibility of these consequences should encourage company leaders to develop and adopt more effective supply chain risk solutions to mitigate those risks.

There have been limited studies conducted on supply chain risks in South Africa. Specifically identifying the most significant supply chain risks and their effect in the South African manufacturing sector. Furthermore, very little research pertains to the mitigating strategies adopted by firms in the manufacturing sector. Niemann, Kotzé and Manny's (2018) study addressed supply chain risk identification and focused primarily on the textile industry, a manufacturing subcategory. The study by Simba et al. (2017) focused on a subcategory within the South African manufacturing sector by examining the effectiveness of implementing supply chain risk management to mitigate risk in the food and beverage industry. Limited studies examining supply chain risk have been conducted in the South African manufacturing sector; their study focused on limited sectors, such as small and medium industries, and eliminated larger companies. Hove-Sibanda, Motshidisi and Igwe (2021) conducted a qualitative study on the South African retail sector, which focused on supply chain risks or barriers that impede the efficiency of supply chain risk management. Meyer et al. (2019) conducted a qualitative study on supply chain risk in the South African third-party logistics industry. Van Nieuwenhuyzen, Niemann and Kotzé (2018) examined supply chain risk management strategies as mitigating factors of supply chain risk, focusing on the retail sector. Moshesh, Niemann and Kotze (2018) conducted a qualitative study on risk management and implementation challenges, particularly in the petrochemical industry. Despite the studies investigating supply chain risks in South Africa, there remains a research gap because these studies only focused on limited sectors, such as petrochemicals, third-party logistics, retail and transportation. Other critical industries that have been overlooked include: glass and non-metallic mineral products; iron and steel, nonferrous and other metal products and motor vehicles and transportation equipment. These industry subsectors account for 40% of South Africa's manufacturing sector (Stats SA 2021). Most South African studies conducted are qualitative, resulting in a research gap to investigate the effects of supply chain risks using a quantitative approach. Kanike (2023) and Parast and Subramanian (2021) proposed that further research should be conducted into supply chain risks in other countries to identify the most vulnerable subsectors. Because of the research gap identified, this study addressed the current gap in the body of knowledge by specifically identifying and assessing selected supply chain risks within the South African manufacturing sector.

Supply chain risks can cause disruptions in supply chains by creating market uncertainty in the supply and demand of goods, affecting the business environment and organisational performance. The manufacturing sector in South Africa is

experiencing declining profitability and limited growth (South African Reserve Bank [SARB] 2020). A decline in profitability is exacerbated by several factors, including economic downturns, business uncertainty and disruptions caused by supply chain risks (SARB 2020). Galanton (2019) emphasised the need to investigate and evaluate a range of supply chain risks, including but not limited to logistical, geopolitical, financial, operational, environmental, natural hazards, societal and technological risks. The aforementioned supply chain risks could be vulnerable to the South African manufacturing sectors and could impair the effectiveness of supply chain operations, thus necessitating the need to find a solution to the research problem.

This study aims to examine the relationship and interrelationship between supply chain risks and supply chain operations. In addition, this study sought to establish and evaluate supply chain risk management approaches used by the South African manufacturing sector to mitigate supply chain risks. The study sought to address the following supply research questions:

- *What are the most common supply chain risks affecting the South African manufacturing sector?*
- *What effects do supply chain risks have on supply chain operations in the South African manufacturing sector?*
- *What measures do the South African manufacturing sectors take to mitigate supply chain risks?*

To address the research questions, this study used the research objectives:

- To determine the South African manufacturing sector's most significant supply chain risks.
- To ascertain the effects of supply chain risks on the South African manufacturing sector
- To determine the risk mitigation measures the South African manufacturing sector employs to manage supply chain risks.

The study contributes to the existing body of knowledge concerning the management and mitigation of supply chain risk factors. More specifically, this study identifies the most significant supply chain risks relevant to the South African manufacturing sector. Furthermore, the study identifies the effect of these risks and determines the current risk mitigation measures employed by the sector. The research highlighted the significance of executing effective risk mitigation strategies to address supply chain risks. The research outcomes guide supply chain practitioners in comprehending the significant effects of supply chain risks on supply chain operations.

## Literature review

The purpose of this section is to introduce literature within the study context. This section reviews the literature relevant to this study. The literature review focuses on the following topics: manufacturing sector, supply chain management, supply chain risks, classification of supply chain risks, and supply chain risk management process.

The literature review aims to link the theoretical background to the research topic and explore relevant theories.

### Status of South African manufacturing sectors

Manufacturing is characterised as a sector with an economic multiplier because of its forward and backward linkages with the downstream and upstream sectors of the economy (SARB 2020). The manufacturing sector is critical to the country's economic development, contributing to export and employment growth (SARB 2020). The manufacturing sector is exposed to risks because of its interconnected supply chain networks. The South African manufacturing sector is exposed to various risk factors, such as exchange rate fluctuations, unreliable infrastructure, machinery breakdowns, unstable production, labour disputes and political instability, contributing to supply chain risk (Fazluddin et al. 2022). Managing supply chain risk across the manufacturing sector is critical as it reduces risk exposure and enables smooth coordination of supply chain processes across upstream and downstream (Kanike 2023).

Statistics South Africa classifies South Africa's manufacturing sector into 10 distinct industries: iron and steel, fast-moving consumer goods, textiles, wood products, petroleum and chemicals, glass, electrical machinery, Information and Communication Technology (ICT) equipment, automotive and furniture production (StatsSA 2021). In 2022, this sector played a significant role in the South African economy, contributing 13% to the overall GDP, 12% to formal employment and 42% to the export market (South African Instrumentation and Control [SAIMC] 2023). Notably, the glass, automotive, electrical machinery, fast-moving consumer goods, wood products, oil and gas and iron and steel sectors collectively comprise 70% of the entire manufacturing sector (StatsSA 2021). This study delved specifically into selected subsectors within the manufacturing industry, focusing on food and beverages; wood and wood products; petroleum, chemical products, rubber and plastic products; glass and non-metallic mineral products; electrical machinery, basic iron and steel, non-ferrous metal products and metal products and motor vehicles and transport equipment (StatsSA 2021).

### Supply chain management

Supply chain management is an integrated system that gives an organisation a holistic overview of its operations, supply, demand and customers (Hugos 2018). Supply chain management is a systematic process involving the seamless flow of material, information and services from suppliers to customers (Avelar-Sosa, García-Alcaraz & Castrellón-Torres 2014). The primary goal of supply chain management is to enable organisations to fulfil customer demands efficiently, minimising costs and reducing lead times. Avelar-Sosa et al. (2014) explained that supply chain management is the integration of business processes that link suppliers, manufacturers, wholesalers and retailers to allow the flow of goods and services to customers. According to the authors mentioned above, the supply chain management process

aims to integrate supply and demand operations across and within an organisation. The functions of supply chain management serve as facilitators, aiding organisations in overseeing the costs and quality of goods and services procured from suppliers. This section has provided a holistic overview of supply chain management in an organisation and highlighted why it is important for an organisation to have a supply chain management process. The following section discusses supply chain risks associated with supply chain management.

### Supply chain risks

Several researchers, including Abas et al. (2020), Wuni, Shen and Mahmud (2019) and Truong and Hara (2019), asserted that supply chain risks are events that could occur in the future and are likely to affect an organisation's supply chain operations. This study adopted the supply chain risk definitions proposed by Truong and Hara (2019), where supply chain risk is defined as an uncertain condition that disrupts an organisation's upstream and downstream operations. The supply chain risks definition is consistent with this study, which focused on the manufacturing sector from upstream to downstream systems.

### Classification of supply chain risks

Supply chain risk classification can play a significant role in organisations' determining appropriate supply chain risk strategies to manage risk effectively. Namdar et al. (2021) attested that risk identification and classification are essential for an organisation when determining an appropriate risk management plan to manage supply chain risk. Table 1 details the classification of supply chain risk drivers.

#### Logistics risk

Logistics risk occurs when goods and services are interrupted from the supplier to the manufacturer (Shahbaz, Rasi & Ahmad 2019a). Logistic risks can potentially disrupt upstream and downstream operations within an organisation by affecting the movement of goods or services from suppliers to manufacturers. In addition, logistics risk can occur in an organisation's internal and external supply chains and is triggered by damage to transport infrastructure, social and labour unrest, warehouse problems and process errors (Tse et al. 2016). The manufacturing sector faces several challenges because of transportation disruptions, including extended lead times for producing goods, higher supply chain costs and declining customer demands (Kanike 2023).

#### Supply risk

Supply risk is an event whereby a supplier fails to fulfil its requirements to deliver goods or services as per the agreed lead time (Van Nieuwenhuyzen et al. 2018). Numerous studies revealed that supply risks occur because of supplier operations inefficiency, poor product or service quality and logistics delays (Parast & Subramanian 2021; Sarker et al. 2016). Higher product and service quality is proven to have a

**TABLE 1:** Drivers of supply chain risk.

Classifications	Risk drivers	Sub-risk drivers	Authors
External risks	Logistics risk	Infrastructure damage	Çikmak and Urgan (2022);
		Labour disputes	Rogers et al. (2016)
		Warehouse problems	
		Process errors	
		Custom clearance problems	
	Supply risk	Transport delays	
		Supplier insolvency	Abdel-Basset and Mohammed (2020);
		Price fluctuations	Rangel, De Oliveira and Leite (2015)
		Production capacity constraints	
		Supplier efficiency	
Financial risk	Supplier selection failure		
	Supplier location		
	Exchange rate fluctuations	Chowdhury et al. (2019);	
	Interest rate	Truong and Hara (2018a)	
	Inflation rate		
Environmental risk	Credit risk		
	Fail to reduce cost		
	Earthquake, Floods, Pandemic	Blos et al. (2016);	
	Energy crisis	Rangel et al. (2015)	
	Political instability		
Internal risks	Operational risk	Design changes	Abdel-Basset and Mohamed (2022);
		Labour disputes	Cunha, Ceryno and Leiras (2019)
		Capacity constraints	
	Process risk	Machine failure	Chen, Sohal and Prajago (2013);
		Changes in product variety	Gunessee and Subramanian (2020);
		Break of IT equipment	Parast and Subramanian (2021)
	Demand risk	Demand uncertainty	Çikmak and Urgan (2022);
		Market changes	Rangel et al. (2015);
		Inaccurate demand forecast	Truong and Hara (2018b)
	Technology Risk	Demand variability	
IR 4.0, 5.0, etc		Hove-Sibanda et al. (2021)	
		Advancements in technology	

Note: Please see the full reference list of the article, Tshifumulo, R., Heyns, G.J. & Kilbourn, P.J., 2025, 'Supply chain risks in the South African manufacturing sector', *Journal of Transport and Supply Chain Management* 19(0), a1189. <https://doi.org/10.4102/jtscm.v19i0.1189>, for more information.

IT, Information technology.

significant impact on reducing supply risks within supply chain operations. This implies that suppliers should always aim to produce superior products and service quality to remain competitive and meet customers' demands (Nel & Simon 2020).

A recent study conducted by Duong et al. (2022) outlined global supply risk as a result of product recall because of quality problems, for example, the Robert Bosch case, which caused supply disruption in automotive industries and production losses in companies, such as Audi and BMW. In addition, supply risk would significantly impact outbound logistics or the inflow of materials; as a result, this could negatively affect the performance of the supply chain.

#### Financial risk

A financial risk is an event within supply chains that could affect a supplier financially and cause an inability to produce

goods or services for its market (Shahbaz et al. 2019b). Financial risk can negatively affect supplier finances by increasing operating expenses, decreasing supplier cash flows, lowering profit margin and influencing credit risk (Ghadge et al. 2021). Various metrics are used to measure supplier finances, including profitability, liquidity and operational efficiency. According to Shahbaz et al. (2019b) and Ghadge et al. (2021), financial risk is not limited to an organisation's financial performance but also affects the supply chains of an organisation. Zainal Abidni and Ingirige (2018) argued that there is still a need to validate finance risk factors, such as exchange rate, price and cost, if they affect supply chains.

### Environmental risk

Environmental risk is an uncontrolled event within the supply chains of an organisation (Rangel et al. 2015). According to Parast (2020), environmental risks are caused by floods, droughts, hurricanes, tornadoes, heat waves, earthquakes or pandemics. Environmental risks significantly threaten the supply chain because they affect both demand and supply. Dohale et al. (2022) list the COVID-19 pandemic as one environmental risk, and they mentioned how extreme weather has led to supply chain disruptions and worldwide economic downturns. In 2022, the KwaZulu-Natal province experienced excessive flooding, which damaged transport, electricity and water infrastructure. The estimated damage to the infrastructure and economy was R25 billion (The Durban Edge 2022). As a result of the KwaZulu-Natal floods, the manufacturing and retail trade industry sector's export of finished goods and imports of goods were disrupted because of the limited capacity available at the Durban harbour and damage to the rail and road infrastructure (The Durban Edge 2022).

According to Kilpatrick and Barter (2020), the COVID-19 pandemic caused significant disruption in global supply chain operations, including the interruption of materials flow from suppliers to production facilities, which resulted in some industry shutdowns. The supply of goods and services has been significantly impacted by the COVID-19 pandemic as manufacturing facilities experienced major disruptions (Dohale et al. 2022). Hou and Zhao (2021) proposed that future research is needed to examine the significant impact of environmental risks across different industries; this study focused primarily on the South African manufacturing sector.

### Demand risk

Demand risk refers to an event caused by demand fluctuations and uncertainty of products or services (Duong et al. 2023). According to Parast and Subramanian (2021), demand risk is unavoidable because customer needs differ and demand is unpredictable. Sreedevi and Saranga (2017) hypothesised that demand risks are the primary contributor to risk in the supply chain. Organisations are exposed to demand risk because of the interconnected nature of supply chains. Truong and Hara (2018b) argued that demand risks are focused on

downstream activities in the supply chain, such as demand variability, market competition and customer insolvency. The occurrence of these risks causes disruptions, and businesses might be unable to forecast market demand accurately.

The supply chain operations of an organisation would be negatively affected by the occurrence of demand fluctuation, which in turn promotes the existence of demand disruption and later becomes a demand risk. Demand risks in an organisation are attributed to uncertainties in the demand for products or services (Negahban & Smith 2016). Demand uncertainties might be associated with changes in financial market conditions, the latest technology developments and competition in the marketplace.

### Supply chain risk management

Supply chain risk management is described as a collaborative strategy between supply chain practitioners and other stakeholders to implement solutions to detect and reduce supply chain risks across businesses while ensuring business continuity and profitability (Hudnurkar et al. 2017). Gurtu and Johny (2021) defined supply chain risk management as a systematic approach that aims to recognise, evaluate, rank, mitigate and monitor risks that can disrupt an organisation's supply chain network.

The primary purpose of supply chain risk management is to identify sources of risk and propose alternative risk mitigation plans to overcome the risks. Supply chain risk management encourages organisations to ensure the continuity and reliability of the supply of goods and services. Mouloudi and Evrard Samuel (2022) suggested that managing supply chain risk is imperative; as a result, organisations must implement or adopt different risk management approaches to mitigate supply chain risks. This has resulted in many organisations planning for the risks and implementing contingency plans to cover those supply chain risks. Fan and Stevenson (2018) suggested a five-step approach when dealing with supply chain risks, namely: risk identification, risk assessment, risk evaluation, risk mitigation and risk monitoring. De Oliveira et al. (2017) suggested that the supply chain risk management process revolves around three steps: risk identification, risk estimation to quantify the magnitudes of the risk and risk evaluation to determine the level of acceptability. There are similarities in the supply chain risk management processes mentioned above, especially concerning the emphasis in the first step on risk identification and assessment.

## Research methods and design

This article aims to ascertain the main supply chain risks and propose risk mitigation strategies to overcome these risks. To address the research questions and objectives, a positivist philosophical paradigm was followed. Saunders, Lewis and Thornhill (2023) ascertained that positivist philosophy is associated with quantitative research because it employs

structured data collection and interpretation of the data. Therefore, a quantitative methodology was used for this study. A deductive approach is suitable for this study because the research design focuses on evaluating theory against collected data (Taherdoost 2022).

The target population group for this research was supply chain practitioners in the following positions but not limited to: senior managers, planners, production schedulers, buyers, procurement specialists, sourcing specialists, procurement managers, category managers, supply chain managers, demand managers, head of procurement, chief procurement officers and other supply chain professionals working in the South African manufacturing sector. The target manufacturing sector included companies that operate in any of South Africa's nine provinces. The targeted participants were in a position to provide meaningful responses to the questionnaire. Various databases, including LinkedIn, email address lists of participants working within selected manufacturing sectors, and the Chartered Institute of Procurement and Supply (CIPS) South Africa database, were used.

This study's sample size was determined using Raosoft statistical software to estimate the minimum sample size. The Raosoft statistical software calculated a sample size of 377 based on an estimated population size of 20000 (because of an indeterminate population size), a 95% confidence level, a 50% response distribution rate and a 5% margin of error. Reliability tests were conducted to test whether the collected data and procedure used were consistent if another researcher repeated the data analysis. The following reliability tests were performed: Cronbach's alpha coefficient ( $\alpha$ ) to measure consistency of results and inter-item correlation to assess relationships between items. This study utilised construct validity as a measurement tool to determine the relationship between the constructs and the trustworthiness of the research findings. For this study, internal validity assisted in establishing whether the relationship between research variables existed.

The research instrument, a structured self-administered online questionnaire, was developed through a review of relevant literature. The questionnaire consisted of four separate segments, with the first section asking questions regarding general information about the respondents and the organisations they work for; the second section included questions to obtain perspectives on the supply chain risk factors currently challenging supply chain operations in the South African manufacturing sector; the third section asked questions about supply chain operations and the fourth section requested information regarding the risk mitigation strategies used by supply chain operations in the South African manufacturing sector.

To analyse the collected data, SPSS (Statistical Package for the Social Sciences) version 29 was used. In this study, descriptive statistics were utilised to explain and summarise frequency tables, variables and their interpretations. An

inferential statistical analysis, which includes correlation, regression and factor analysis, was conducted.

## Ethical considerations

As this study involved humans completing an online questionnaire, all participants were informed that their data would remain confidential and would be used for academic purposes. This study complied with all ethical requirements set out by the University of Johannesburg. Ethical clearance was issued by the Research Ethics Committee of the Department of Transport and Supply Chain Management (TSCMREC) (reference number: 2023-TSCM013) from the University of Johannesburg (UJ). The participants were informed that their participation was entirely voluntary and that they could withdraw at any time.

## Results and discussion

### Demographic analysis

The majority of respondents worked in three industry sectors, namely: petroleum, chemicals, rubber and plastic products (21.1%); food and beverages (17.8%) and motor vehicles and transport equipment (14.4%). A report published by Statistics SA (2021) stated that the most dominant sectors in the South African economy, in terms of employment, were the above-mentioned sectors, indicating that the respondents were representative of the South African manufacturing sector. Most of the respondents (73%) indicated that they have a postgraduate qualification, and 26% held undergraduate degrees, indicating that the respondents have the necessary skills and knowledge, adding to the credibility of their responses.

**TABLE 2:** Respondent profile.

Variable	Frequency	%
<b>Level of education</b>		
Undergraduate (Diploma, Bachelor)	24	26.67
Postgraduate (Honours Degree, Master's, PhD)	68	73.33
<b>Manufacturing subsectors</b>		
Petroleum, chemicals, rubber and plastic products	19	21.10
Food and beverages	16	17.80
Motor vehicles and transport equipment	13	14.40
Basic iron and steel, non-ferrous metal and metal products	10	11.10
Electrical machinery	7	7.80
Wood and paper products	6	6.70
Glass and non-metallic mineral products	3	3.30
Other (please specify)	16	17.80
<b>Company annual turnover</b>		
R0–R200 million	14	16.00
R201–R500 million	18	20.00
More than R501 million	58	64.44
<b>Company manufacturing location</b>		
Gauteng	56	62.2
KwaZulu-Natal	14	15.60
Mpumalanga	8	8.90
Eastern Cape	4	4.40
Western Cape	3	3.30
Northern Cape	2	2.20
Limpopo	1	1.10
North West	1	1.10
Free State	1	1.10

The research findings further revealed that most respondents (64%) stated that their company's annual turnover exceeded R501 million. This indicates that the majority of respondents worked for larger companies. Respondents from medium and small companies were 20% and 16%, respectively. Furthermore, the results showed that most respondents indicated that their organisations operate in Gauteng, KwaZulu-Natal and Mpumalanga Provinces. The findings corresponded with the Statistics SA (2021) report, suggesting that Gauteng, KwaZulu-Natal and the Western Cape provinces are the primary locations for manufacturing hubs in South Africa. A summary of the demographic information of the respondents is shown in Table 2.

## Supply chain risk measurements

For this study, reliability analysis was performed to measure the internal consistency of the research questionnaire. Table 3 shows a reliability summary analysis of the supply chain risk constructs for this study. The Cronbach's alpha value ( $\alpha$ ), ranging from 0.673 to 0.777, was recorded, which indicates an acceptable internal consistency. An alternative reliability scales were used to assess the reliability of the questionnaire was assessed using inter-item correlation; the result ranged from 0.292 to 0.404, falling between the permissible range of 0.2 and 0.4 (Pallant 2020). In addition, the corrected item-total correlation was performed with a

**TABLE 3:** Scale reliability.

Construct	Items	Cronbach's alpha ( $\alpha$ )	Inter-item correlation	Corrected item-total correlation
Environmental risk	-	0.67	0.29	-
	ER1	-	-	0.55
	ER2	-	-	0.33
	ER3	-	-	0.48
	ER4	-	-	0.44
	ER5	-	-	0.34
Demand risk	-	0.73	0.35	-
	DR1	-	-	0.36
	DR2	-	-	0.68
	DR3	-	-	0.52
	DR4	-	-	0.52
	DR5	-	-	0.38
Supply risk	-	0.65	0.27	-
	SR1	-	-	0.35
	SR2	-	-	0.40
	SR3	-	-	0.43
	SR4	-	-	0.51
	SR5	-	-	0.34
Logistic risk	-	0.71	0.34	-
	LR1	-	-	0.47
	LR2	-	-	0.35
	LR3	-	-	0.62
	LR4	-	-	0.51
	LR5	-	-	0.45
Financial risk	-	0.78	0.41	-
	FR1	-	-	0.64
	FR2	-	-	0.59
	FR3	-	-	0.50
	FR4	-	-	0.67
	FR5	-	-	0.38

ER, environmental risk; DR, demand risk; LR, logistic risk; FR, financial risk.

value ranging from 0.334 to 0.672, which was within the acceptable range (Junaid & Syed 2020). Therefore, no items were deleted.

## Exploratory factor analysis

Exploratory factor analysis was used to measure the relationship between constructs. The results shown in Table 3 display a summary of the rotated factor correlation matrix. The correlation coefficient matrix was set at a minimum value of 0.5. Hair et al. (2010) classified correlation coefficients as 0.3 (minimum), 0.4 (important) and 0.5 (significant). The results for supply chain risk showed that all items loaded above 0.5. Parallel analysis

**TABLE 4:** Exploratory factor analysis results.

Variable	Items	Component		
		1	2	3
<b>Factor 1: Logistics and supply risk</b>				
SR5	Limited supplier production capacity reduces supplier output and intensifies the risk associated with supply chain operations.	0.68	-	-
LR4	Supply chain disruption because of rail delays increases supply chain risk.	0.67	-	-
LR5	Operational port challenges and ageing of infrastructure raises supply chain risk in an organisation	0.63	-	-
LR3	Road infrastructure damage disrupts supply chain operations within an organisation and intensifies supply chain risk.	0.62	-	-
LR2	Delays caused by customs clearance of goods at the harbour disrupt the supply chain operations and increase supply chain risk.	0.60	-	-
SR4	Reliance on a single supplier increases supply chain risk.	0.55	-	-
LR1	Road freight incidents and hijackings disrupt supply chain operations within an organisation and escalate supply chain risk.	0.54	-	-
SR3	Supplier financial failure increases supply chain risk.	0.53	-	-
<b>Factor 2: Financial risk</b>				
FR2	Fluctuations in exchange rates harm supplier finances and escalate supply chain risk.	-	0.82	-
FR1	Fluctuations in interest rates harm supplier and company finances and intensify supply chain risk.	-	0.80	-
FR3	Changes in accounting and tax laws affect supplier finances and heighten risk within supply chain operations.	-	0.63	-
FR4	An adverse supplier credit profile hampers suppliers' ability to improve finances and escalates supply chain risk.	-	0.77	-
<b>Factor 3: Environmental risk</b>				
ER1	Labour disputes, including strikes, non-payment and government minimum wage rate rises, increase supply chain risk.	-	-	0.76
ER3	Risk associated with natural hazards, such as floods and pandemics, heightens supply chain risk.	-	-	0.73
ER4	Changes in government regulations, such as B-BBEE, increased customs duties and trade barriers, positively contribute to supply chain risk.	-	-	0.66
ER2	Risk arising from political instability positively increases supply chain risk.	-	-	0.60
Eigenvalue	-	3.95	2.19	1.77
% variance explained	-	24.7	38.42	49.53

Note:  $n = 90$  and  $\alpha = 0.642$  for the three-factor solution.

ER, environmental risk; DR, demand risk; LR, logistic risk; FR, financial risk; B-BBEE, Broad-Based Black Economic Empowerment.

was employed to ascertain the number of factors to retain, resulting in a three-factor solution derived from actual data with eigenvalues exceeding those of the simulated dataset.

The three factors discovered through exploratory factor analysis confirmed the theoretical factors discussed in this study. Component 1 denoted supply chain and logistics risks, Component 2 represented financial risks and Component 3 referred to environmental risks. The results shown in Table 4 display summary factor loading, with all correlation coefficients exceeding 0.50.

## Correlation analysis

This study measures the relationship between dependent variables (supply chain operations) and independent variables (environmental, demand, supply, logistics and financial risk). Correlation analysis is a measurement tool that assesses the degree and direction of relationships between dependent and independent variables (Pallant 2020). There are three methods for measuring coefficient correlation: Pearson's correlation, Kendall's tau-b ( $\tau_b$ ) and Spearman's correlation coefficient ( $\rho$ ) (Gogtay & Thatte 2017). The dataset for this study was not normally distributed, and variables were ordinal; therefore, a non-parametric test, Spearman's correlation coefficient, was calculated. Table 5 presents the means, standard deviations and the intercorrelation analysis for supply chain risk and operations.

The study found a significant ( $p < 0.001$ ) relationship between logistics risk and supply chain operations. In addition, the correlation coefficient ( $r = 0.64$ ) indicated a strong relationship between the dependent and independent variables. Supply risk was the second highest variable recorded, with a significant value of  $p < 0.001$ , indicating a substantial

**TABLE 5:** Spearman's rank correlation coefficient.

Variables	M	SD	ER	DR	SR	LR	FR	SCO
Environmental risk (ER)	20.81	3.18	1	0.44**	0.24*	0.36**	0.30**	0.25*
Demand risk (DR)	21.06	2.79	-	1	0.49**	0.50**	0.54**	0.41**
Supply risk (SR)	21.74	2.60	-	-	1	0.55**	0.42**	0.60**
Logistic risk (LR)	22.16	2.34	-	-	-	1	0.32**	0.64**
Financial risk (FR)	19.96	3.02	-	-	-	-	1	0.50**
Supply chain operations (SCO)	21.14	2.68	-	-	-	-	-	1

SD, standard deviation; M, mean.

\*,  $p < 0.05$ ; \*\*,  $p < 0.01$ .

**TABLE 6:** Supply chain operations: Coefficients.

Variable	Unstandardised coefficients		Standardised coefficients: $\beta$	$t$	Sig.	Collinearity statistics	
	$\beta$	SE				Tolerance	VIF
(Constant)	1.46	2.23	-	0.65	0.51	-	-
Environmental	-0.06	0.07	-0.08	-0.87	0.39	0.77	1.3
Demand	-0.03	0.1	-0.03	-0.3	0.76	0.52	1.94
Supply	0.21	0.1	0.21	2.15	0.03	0.62	1.62
Logistics	0.53	0.11	0.46	4.86	< 0.001	0.64	1.57
Financial	0.27	0.08	0.30	3.32	< 0.001	0.69	1.44

Note: Dependent variable: Operations.

VIF, variance inflation factor;  $\beta$ , beta; SE, standard error.

relationship between supply risks and supply chain operations. It is supported by a positive and strong relationship between supply risks and supply chain operations ( $r = 0.6$ ). Financial risks and supply chain operations results had a significant relationship ( $p < 0.001$ ), while  $r = 0.5$  indicated a moderate correlation between the variables (Gogtay & Thatte 2017). The findings showed that logistical, supply and financial risks have a significant relationship with supply chain operations in South Africa's manufacturing sector.

## Regression analysis

The multiple regression analysis was used to determine the relationship between dependent and independent variables. Table 6 shows the beta coefficient for the model, which included three variables with significant values less than  $p = 0.05$ : logistics, financial and supply risk. However, this model made environmental and demand risks insignificant because their  $p$  values were greater than 0.05.

The study's findings were consistent with those of Parast and Subramanian (2021), who found that logistics, supply and financial risk significantly affect supply chain operations. According to the findings, environmental and demand risks had the least significant effect on supply chain operations. This study's findings differ markedly from those of Tse et al. (2016), who discovered that demand risk significantly affects supply chain operations.

## Theoretical implications

This study added to the existing supply chain risk theory and had practical implications for the South African manufacturing sector. The research findings make a significant contribution to an existing theory of supply chain risks and their effects on supply chain operations. The research data showed that logistics risks were the most important element influencing supply chain operations, followed by financial and supply risks. The research findings supported previous theories and conclusions that logistics, supply and financial risks significantly impacted supply chain operations (Ngo et al. 2023). However, the research findings differ markedly from the conventional idea that environmental risk is the most important component of supply chain risk. While Tarei, Thakkar and Nag (2018) posit that environmental risk is the most important factor influencing supply chain operations, Ngo et al. (2023) claimed that environmental risk does not add

much to supply risk compared to other risks, which coincided with this study's findings.

The findings indicated a positive correlation between supply chain risks and supply chain operations. The findings identified three supply chain risks (logistics, supply and financial) that correlated highly with supply chain operations. In contrast, environmental and demand risks did not significantly influence supply chain operations. This study verified earlier research by Parast and Subramanian (2021), which found that logistics, supply and financial risks significantly influence supply chain operations. The findings support existing literature, suggesting that risk mitigation measures are implemented by selecting appropriate mitigation plans based on the type of risk the organisation is exposed to (Chang, Ellinger & Blackhurst, 2015). Furthermore, the research findings supported the literature indicating that supply chain professionals should consider the likelihood of risk before implementing appropriate risk mitigation plans (Dohale et al. 2022). The research findings also supported the theory that failure to manage supply chain risk had a significant effect on supply operations and increased vulnerability to other risks (Gurtu & Johny 2021). Furthermore, the research findings supported existing theory, pointing out that implementing appropriate risk mitigation strategies allowed organisations to manage supply chain operations.

### Managerial implications

The findings would assist supply chain experts and managers in understanding the effects of supply chain risk and developing appropriate risk management plans to reduce risk in South Africa's manufacturing sector. The findings indicated a strong relationship between supply chain risk and supply chain operations. However, the findings showed that not all supply chain risks significantly affect supply chain operations; thus, supply chain professionals and managers must be aware of the various types of risks in an organisation. The research findings have practical implications for supply chain experts and managers adopting or executing various risk mitigation strategies to reduce supply chain risk in the South African manufacturing sector. The research findings are also significant for supply chain experts to understand what types of supply chain risk might emerge during supply chain operations and how to create an adequate risk mitigation plan.

The findings indicated that most South African manufacturing organisations take steps to manage supply chain risk by implementing a variety of measures to reduce supply chain risk, including:

- Developing and prioritising a business continuity plan;
- Applying inventory control measures;
- Conducting supplier audits and supplier performance measures;
- Implementing a supply risk management process and

- Adhering to international and local standards and codes when procuring materials or services to lessen supply chain risk.
- Noteworthy environmental risk (lack of importance), its potential impact – doing business globally – in contrast to the global focus on sustainability

### Limitations of the study and recommendations for further research

A main limitation of the study is that it only collected responses from supply chain experts working specifically in the manufacturing sector, which might limit the ability to determine whether other industries share similar supply chain risks in South Africa.

As demonstrated in the research findings, not all sectors were adequately covered by the data acquired, making it difficult to generalise findings across all sectors of the South African economy. Also, the research questionnaire did not address additional internal risks, such as operational and process risks, covered in the literature chapter. This led to the generation of research data that were not normally distributed, suggesting that non-parametric correlation analysis was more appropriate than parametric analysis for this dataset. The study was conducted from 24 April 2024 to 10 July 2024, resulting in a shorter timeframe for participants to complete the survey, thus reducing the chances of obtaining a higher response rate.

Future research should look into adopting mixed research techniques to gain more comprehensive research findings by comparing outcomes from different research approaches. There is an opportunity to broaden the research target sample and explore other sectors and regions, allowing researchers to determine whether the effect of various risks on supply chain risk is similarly shared across sectors. Further research is needed to explore contemporary global developments such as geopolitical tensions (e.g. conflict in the Middle East and the volatility in global trade tariffs) and their impact on supply chain operations.

### Recommendations

This study was limited to supply chain risks, including environmental, logistics, financial, demand and supply risks. It is recommended that future studies be conducted to expand on determining other supply chain risks that might affect the South African manufacturing sector. The study showed that logistics, financial and supply risks are the most significant supply chain risks affecting the South African manufacturing sector. However, supply chain experts must be cognisant of various supply chain risks as organisational supply operations are exposed to different risks depending on the organisation's location. The findings indicated a strong correlation between supply chain risks (logistics, supply and financial) and supply chain operations. Supply chain professionals are advised to establish comprehensive risk mitigation strategies to reduce exposure

to risks affecting supply chain operations. Moreover, risk mitigation measures must be periodically reviewed as supply chain risks evolve.

## Conclusion

This study investigated the relationship between supply chain risks and supply chain operations. It also assessed the supply chain risk management strategies that the South African manufacturing sector uses to mitigate risk. The study's findings showed that logistical, supply and financial risks significantly correlate with supply chain operations, implying that these specific risks are the most important supply chain risks affecting manufacturers in South Africa and should feature more prominently in their risk mitigation strategies. The research findings indicated that environmental and demand risks had the least significant impact on supply chain operations.

Based on the research findings, it is evident that supply chain risks cannot be overlooked, and as such, supply chain professionals must implement effective risk mitigation strategies. The factor analysis model had three factors retained, suitable for reliability and validity analysis. This study's findings significantly contribute to existing supply chain risk theories and practical applications. Finally, the study's findings emphasised the importance of implementing effective risk mitigation strategies when managing supply chain risks.

## Acknowledgements

The authors are grateful to the Department of Transport and Supply Chain Management for granting permission to conduct this research.

## Competing interests

The author, P.J.K., serves as an editorial board member of this journal. P.J.K. has no other competing interests to declare. The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

## Authors' contributions

R.T. contributed to conceptualisation, draft preparation, methodology, analysis and visualisation. G.J.H. and P.J.K. were responsible for conceptualisation, supervision, review and editing. All authors have read and agreed to the published version of the manuscript.

## Funding information

The authors received no financial support for the research, authorship and/or publication of this article.

## Data availability

The data that support the findings of this study are available on request from the corresponding author, G.J.H.

## Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors, or that of the publisher. The authors are responsible for this article's results, findings, and content.

## References

- Abas, M., Khattak, S.B., Habib, T. & Nadir, U., 2022, 'Assessment of critical risk and success factors in construction supply chain: A case of Pakistan', *International Journal of Construction Management* 22(12), 2258–2266. <https://doi.org/10.1080/015623599.2020.1783597>
- Abdel-Basset, M. & Mohamed, R., 2020, 'A novel plithogenic topsis-critic model for sustainable supply chain risk management', *Journal of Cleaner Production* 247, 119586. <https://doi.org/10.1016/j.jclepro.2019.119586>
- Avelar-Sosa, L., García-Alcaraz, J.L. & Castrellón-Torres, J.P., 2014, 'The effects of some risk factors in the supply chains performance: A case of study', *Journal of Applied Research and Technology* 12(5), 658–668. <https://doi.org/10.1080/00207543.2015.1047975>
- Avenyo, E.K., 2021, 'Innovations and firm performance in Sub-Saharan Africa', Doctoral thesis, University of Maastricht, viewed 15 July 2023, from <https://cris.maastrichtuniversity.nl/en/publications/innovations-and-firm-performance-in-sub-saharan-africa-empirical->
- Blos, M.F., Hoefflich, S.L., Dias, E.M. & Wee, H.M., 2016, 'A note on supply chain risk classification: Discussion and proposal', *International Journal of Production Research* 54(5), pp. 1568–1569. <https://doi.org/10.1080/00207543.2015.1067375>
- Ceryno, P.S., Scavarda, L.F. & Klingebiel, K., 2015, 'Supply chain risk: Empirical research in the automotive industry', *Journal of Risk Research* 18(9), 1145–1164. <https://doi.org/10.1080/13669877.2014.913662>
- Chang, W., Ellinger, A.E. & Blackhurst, J., 2015, 'A contextual approach to supply chain risk mitigation', *International Journal of Logistics Management* 26(3), 642–656. <https://doi.org/10.1108/IJLM-02-2014-0026>
- Chen, J., Sohal, A.S. & Prajogo, D.I., 2013, 'Supply chain operational risk mitigation: A collaborative approach', *International Journal of Production Research* 51(7), 2186–2199. <https://doi.org/10.1080/00207543.2012.727490>
- Chowdhury, N.A., Ali, S.M., Mahtab, Z., Rahman, T., Kabir, G. & Paul, S.K., 2019, 'A structural model for investigating the driving and dependence power of supply chain risks in the readymade garment industry', *Journal of Retailing and Consumer Services* 51(C), 102–113. <https://doi.org/10.1016/j.jretconser.2019.05.024>
- Çıkmak, S. & Urgan, M.C., 2022, 'Supply chain risks and mitigation strategies in turkey automotive industry: Findings from a mixed-method approach', *Supply Chain Forum: An International Journal* 25(1), 75–95. <https://doi.org/10.1080/16258312.2022.2060694>
- Cunha, L., Ceryno, P. & Leiras, A., 2019, 'Social supply chain risk management: A taxonomy, a framework and a research agenda', *Journal of Cleaner Production* 220, 1101–1110. <https://doi.org/10.1016/j.jclepro.2019.02.183>
- De Oliveira, U.R., Marins, F.A.S., Rocha, H.M. & Salomon, V.A.P., 2017, 'The ISO 31000 standard in supply chain risk management', *Journal of Cleaner Production* 151, 616–633. <https://doi.org/10.1016/j.jclepro.2017.03.054>
- Dias, G.C., Hernandez, C.T. & de Oliveira, U.R., 2020, 'Supply chain risk management and risk ranking in the automotive industry', *Gestão & Produção* 27(1), pp. 1–21. <https://doi.org/10.1590/0104-530X3800-20>
- Dohale, V., Ambilkar, P., Gunasekaran, A. & Verma, P., 2022, 'Supply chain risk mitigation strategies during COVID-19: Exploratory cases of "make-to-order" handloom saree apparel industries', *International Journal of Physical Distribution & Logistics Management* 52(2), 109–129. <https://doi.org/10.1108/IJPDLM-12-2020-0450>
- Duong, A.T.B., Vo, V.X., Do Sameiro Carvalho, M., Sampaio, P. & Truong, H.Q., 2022, 'Risks and supply chain performance: Globalization and COVID-19 perspectives', *International Journal of Productivity and Performance Management* 72(7), 1962–1986. <https://doi.org/10.1108/IJPPM-02-2023-0104>
- Fan, Y. & Stevenson, M., 2018, 'A review of supply chain risk management: Definition, theory, and research agenda', *International Journal of Physical Distribution & Logistics Management* 48(3), 205–218. <https://doi.org/10.1108/IJPDLM-01-2017-0043>
- Fazluddin, S., Ojijo, V. & Godfrey, L., 2022, 'Manufacturing and the circular economy. A more competitive South African manufacturing sector through a circular economy', CSIR, viewed 8 August 2023, from [https://www.circulareconomy.co.za/wp-content/uploads/2022/04/Manufacturing\\_Report-CE-Opportunities.pdf](https://www.circulareconomy.co.za/wp-content/uploads/2022/04/Manufacturing_Report-CE-Opportunities.pdf)
- Galanton, N., 2019, 'Impact of supply chain on increasing environment value', *Economica* 14(117), 19–31. <https://doi.org/10.53486/econ.2021.118.019>
- Ghadge, A., Jena, S.K., Kamble, S., Misra, D. & Tiwari, M.K., 2021, 'Impact of financial risk on supply chains: A manufacturer-supplier relational perspective', *International Journal of Production Research* 59(23), 7090–7105. <https://doi.org/10.1080/00207543.2020.1834638>
- Gogtay, N. & Thatte, U., 2017, 'Principles of correlation analysis', *The Journal of the Association of Physicians of India* 65, pp. 78–81.
- Gunessee, S. & Subramanian, N., 2020, 'Ambiguity and its coping mechanisms in supply chains lessons from the COVID-19 pandemic and natural disasters', *International Journal of Operations & Production Management* 40(7/8), 1201–1223. <https://doi.org/10.1108/IJOPM-07-2019-0530>

- Gurtu, A. & Johny, J., 2021, 'Supply chain risk management: Literature review', *Risks* 9(16), 1–16. <https://doi.org/10.3390/risks9010016>
- Hair, J., Black, B., Babin, B. & Anderson, R., 2010, *Multivariate Data Analysis: A Global Perspective*, Pearson Education, Harlow.
- Hou, J. & Zhao, X., 2021, 'Toward a supply chain risk identification and filtering framework using systems theory', *Asia Pacific Journal of Marketing and Logistics* 33(6), 1482–1497. <https://doi.org/10.1108/APJML-05-2020-0342>
- Hove-Sibanda, P., Motshidisi, M. & Igwe, P.A., 2021, 'Supply chain risks, technological and digital challenges facing grocery retailers in South Africa', *Journal of Enterprising Communities* 15(2), 228–245. <https://doi.org/10.1108/JEC-05-2020-0104>
- Hudnurkar, M., Deshpande, S., Rathod, U. & Jakhar, S.K., 2017, 'Supply chain risk classification schemes: A literature review', *Operations and Supply Chain Management: An International Journal* 10(4), 182–199. <https://doi.org/10.31387/oscm0290190>
- Hugos, M., 2018, *Essentials of Supply Chain Management*, John Wiley & Sons, New Jersey.
- Junaid, M. & Syed, M.W., 2020, 'Construction of index system for risk assessment in supply chains of automotive industry', *International Journal of Supply Chain Management* 9(4), 2–26.
- Junaid, M., Xue, Y., Syed, M.W., Li, J.Z. & Ziaullah, M., 2020, 'A neutrosophic AHP and topsis framework for supply chain risk assessment in automotive industry of Pakistan', *Sustainability* 12(1), 18–20. <https://doi.org/10.3390/su12010154>
- Kanike, U.K., 2023, 'Factors disrupting supply chain management in manufacturing industries', *Journal of Supply Chain Management Science* 4(1–2), 1–24. <https://doi.org/10.18757/jscms.2023.6986>
- Kilpatrick, J. & Barter, L., 2020, *COVID-19: Managing supply chain risk and disruption*, viewed 20 August 2022, from <https://www.deloitte.com/global/en/services/risk-advisory/analysis/covid-19-managing-supply-chain-risk-and-disruption.html>.
- Meyer, A., Niemann, W., Uys, G., Beetge, D. & Niemann, W., 2019, 'An exploration of supply chain risk management in the South Africa third-party logistic industry', *Acta Commercii – Independent Research Journal in the Management Sciences* 19(1), 1–13. <https://doi.org/10.4102/ac.v19i1.612>
- Moshesh, R., Kotzé, T. & Niemann, W., 2018, 'Enterprise risk management implementation challenges: A case study in a petrochemical supply chain', *South African Journal of Industrial Engineering* 29(4), 230–244.
- Mouloudi, L. & Evrard Samuel, K., 2022, 'Critical materials assessment: A key factor for supply chain risk management', *Supply Chain Forum* 23(1), 53–67. <https://doi.org/10.1080/16258312.2021.2008771>
- Namdar, J., Torabi, S.A., Sahebjamnia, N. & Nilkanth Pradhan, N., 2021, 'Business continuity-inspired resilient supply chain network design', *International Journal of Production Research* 59(5), 1331–1367. <https://doi.org/10.1080/00207543.2020.1798033>
- Negahban, A. & Smith, J.S., 2016, 'The effect of supply and demand uncertainties on the optimal production and sales plans for new products', *International Journal of Production Research* 54(13), 3852–3869. <https://doi.org/10.1080/00207543.2016.1157274>
- Nel, J.D. & Simon, H., 2020, 'Introducing a process for radical supply chain risk management', *International Journal of Business Performance Management* 21(1–2), 149–165. <https://doi.org/10.1504/IJBPM.2020.106120>
- Ngo, V.M., Quang, H.T., Hoang, T.G. & Binh, A.D.T., 2023, 'Sustainability-related supply chain risks and supply chain performances: The moderating effects of dynamic supply chain management practices', *Business Strategy and the Environment* 33(2), 839–857. <https://doi.org/10.1002/bse.3512>
- Niemann, W., Kotzé, T. & Mannya, K., 2018, 'Global sourcing risk management approaches', *Southern African Journal of Entrepreneurship and Small Business Management* 10(1), 1–15. <https://doi.org/10.4102/sajesbm.v10i1.141>
- Pallant, J., 2020, *SPSS survival manual: A step by step guide to data analysis using IBM SPSS*, Routledge, London.
- Parast, M.M. & Subramanian, N., 2021, 'An examination of the effect of supply chain disruption risk drivers on organizational performance: Evidence from Chinese supply chains', *Supply Chain Management: An International Journal* 26(4), 548–560. <https://doi.org/10.1108/SCM-07-2020-0313>
- Parast, M.M., 2020, 'The impact of R&D investment on mitigating supply chain disruptions: Empirical evidence from U.S. firms', *International Journal of Production Economics* 227, 107671. <https://doi.org/10.1016/j.ijpe.2020.107671>
- PWC, 2020, *Thinking through the possible economic consequences of COVID-19 for South Africa*, PWC, viewed 20 July 2023, from <https://endeavor.co.za/wp-content/uploads/2020/04/PWC-Economic-Consequences-of-COVID19-for-South-Africa.pdf>.
- Rangel, D.A., De Oliveira, T.K. & Leite, M.S.A., 2015, 'Supply chain risk classification: Discussion and proposal', *International Journal of Production Research* 53(22), 6868–6887. <https://doi.org/10.1080/00207543.2014.910620>
- Rogers, H., Srivastava, M., Pawar, K.S. & Shah, J., 2016, 'Supply chain risk management in India – Practical insights', *International Journal of Logistics Research and Applications* 19(4), 278–299. <https://doi.org/10.1080/13675567.2015.1075476>
- Sarker, S., Engwall, M., Trucco, P. & Feldmann, A., 2016, 'Internal visibility of external supplier risks and the dynamics of risk management silos', *IEEE Transactions on Engineering Management* 63(4), 451–461. <https://doi.org/10.1109/TEM.2016.2596144>
- Saunders, H., Lewis, P. & Thornhill, A., 2023, *Research methods for business students*, Pearson, London.
- Shahbaz, M.S., Rasi, R.Z.R.M. & Ahmad, M.D.F.B., 2019a, 'A novel classification of supply chain risks: Scale development and validation', *Journal of Industrial Engineering and Management* 12(1), 201–218. <https://doi.org/10.3926/jiem.2792>
- Shahbaz, M.S., Sohu, S., Khaskhelly, F.Z., Bano, A. & Soomro, M.A., 2019b, 'A novel classification of supply chain risks: A review', *Engineering, Technology & Applied Science Research* 9(3), 4301–4305. <https://doi.org/10.48084/etasr.2781>
- Simba, S., Niemann, W., Kotzé, T. & Agigi, A., 2017, 'Supply chain risk management processes for resilience: A study of South African grocery manufacturers', *Journal of Transport and Supply Chain Management* 11(1), a325. <https://doi.org/10.4102/jtscm.v11i0.325>
- South African Instrumentation and Control (SAIMC), 2023, *SA's manufacturing sector must increase 4IR tech adoption*, SAIMC, viewed 11 February 2024, from <https://www.instrumentation.co.za/20294r>.
- South African Reserve Bank (SARB), 2020, *South African Reserve Bank occasional bulletin of economic notes*, SARB, viewed 04 May 2024, from <https://www.resbank.co.za/content/dam/sarb/publications/occasional-bulletin-of-economic-notes/2024/occasional-bulletin-of-economic-notes-combined-2401-01.pdf>.
- Sreedevi, R. & Saranga, H., 2017, 'Uncertainty and supply chain risk: The moderating role of supply chain flexibility in risk mitigation', *International Journal of Production Economics* 193, 332–342. <https://doi.org/10.1016/j.ijpe.2017.07.024>
- Statistics South Africa (StatsSA), 2021, *Manufacturing industry: Production, 2021*, Statistics South Africa, viewed 07 April 2023, from <https://www.statssa.gov.za/publications/Report-30-02-04/Report-30-02-042021.pdf>.
- Taherdoost, H., 2022, 'What are different research approaches? comprehensive review of qualitative, quantitative, and mixed method research, their applications, types, and limitations', *Journal of Management Science & Engineering Research* 5(1), 53–63. <https://doi.org/10.30564/jmserv.v5i1.4538>
- Tarei, P.K., Thakkar, J.J. & Nag, B., 2018, 'A hybrid approach for quantifying supply chain risk and prioritizing the risk drivers', *Journal of Manufacturing Technology Management* 29(3), 533–569. <https://doi.org/10.1108/JMTM-10-2017-0218>
- The Durban Edge, 2022, *Initial results-April 2022 KZN flood economic impact on Durban*, The Durban Edge, viewed 08 March 2023, from <https://economy.edge.durban/data-story/initial-results-april-2022-kzn-flood-economic-impact-on-durban>.
- Truong, H.Q. & Hara, Y., 2018a, 'Risks and performance in supply chain: The push effect', *International Journal of Production Research* 56(4), 1369–1388. <https://doi.org/10.1080/00207543.2017.1363429>
- Truong, H.Q. & Hara, Y., 2018b, 'Supply chain risk management: Manufacturing and service-oriented firms', *Journal of Manufacturing Technology Management* 29(2), 218–239. <https://doi.org/10.1108/JMTM-07-2017-0145>
- Truong, H.Q. & Hara, Y., 2019, 'The push effect of risks on supply chain performance: Service-oriented firms', *Business Process Management Journal* 25(7), 1734–1758. <https://doi.org/10.1108/BPMJ-12-2017-0343>
- Tse, Y.K., Matthews, R.L., Hua Tan, K., Sato, Y. & Pongpanich, C., 2016, 'Unlocking supply chain disruption risk within the Thai beverage industry', *Industrial Management & Data Systems* 116(1), 21–42. <https://doi.org/10.1108/IMDS-03-2015-0108>
- Van Nieuwenhuyzen, M., Niemann, W. & Kotzé, T., 2018, 'Supply chain risk management strategies: A case study in the south african grocery retail industry', *Journal of Contemporary Management* 15(1), 784–882, viewed 01 June 2022, from <https://hdl.handle.net/10520/EJC-154b71f06c>.
- Ward, R. & Roelf, W., 2020, *Blast-rocked South African oil refinery shut down for investigations*, Reuters, viewed 05 June 2022, from <https://www.reuters.com/article/us-engen-refinery/explosion-at-south-african-oil-refinery-in-durban-idUSKBN28E0SR>.
- Western Cape Tourism, Trade and Investment Promotion Agency (WESGRO), 2022, *Economic impact of flooding in KwaZulu-Natal*, WESGRO, viewed from [https://www.wesgro.co.za/uploads/files/Wesgro-Research\\_Economic-Impact-of-Flooding-in-KZN\\_2022.05.pdf](https://www.wesgro.co.za/uploads/files/Wesgro-Research_Economic-Impact-of-Flooding-in-KZN_2022.05.pdf).
- Wuni, I.Y., Shen, G.Q.P. & Mahmud, A.T., 2019, 'Critical risk factors in the application of modular integrated construction: A systematic review', *International Journal of Construction Management* 22(2), 133–147. <https://doi.org/10.1080/15623599.2019.1613212>
- Zainal Abidin, N.A. & Ingirige, B., 2018, 'The dynamics of vulnerabilities and capabilities in improving resilience within Malaysian construction supply chain', *Construction Innovation* 18(4), 412–432. <https://doi.org/10.1108/CI-09-2017-0079>