


SUPPLY CHAIN RESILIENCE MEETS QUALITY MANAGEMENT

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ARTICLE INFO	ABSTRACT
<p>Article history:</p> <p>Received 01 September 2023</p> <p>Accepted 01 December 2023</p>	<p>Purpose: This study is aimed at supply chain resilience and quality management, which are critical in today's volatile global economy marked by various disruptions. The focus is on how these traditionally separate disciplines can be combined to enhance organizational performance.</p>
<p>Keywords:</p> <p>Supply Chain Resilience; Quality Management; Organizational Performance; Six Sigma; TQM; Risk Mitigation.</p>	<p>Theoretical framework: The theoretical framework revolves around the concepts of supply chain resilience, which includes elements like proactive risk assessment, adaptability, collaborative networks, strategic redundancies, and quality management principles. The research scrutinizes their interplay, revealing significant overlap and implications for organizational outcomes.</p>
	<p>Design/Methodology/Approach: An exploratory case study approach forms the core methodology, primarily utilizing secondary data to gain insights into real-world scenarios. This approach enables a deep understanding of the critical factors influencing supply chain resilience and the impact of quality management concepts on customer satisfaction and product/service quality in supply chain processes. The questionnaire is distributed to get insights into the company's practices.</p> <p>Findings: The findings indicate that integrating supply chain resilience with quality management leads to more sustained and improved organizational outcomes. A resilient supply chain is quicker to recover from disruptions, minimizing financial impacts. Concurrently, a steadfast focus on quality ensures customer satisfaction and loyalty. This integration offers synergistic benefits, contributing to operational efficiency, market competitiveness, and a more substantial brand reputation.</p> <p>Research, Practical & Social implications: The study provides insights into critical factors of supply chain resilience and their interconnections with quality management concepts. These insights can inform strategies for enhancing resilience and quality management in supply chains. Practically, the study offers a guide for organizations to adopt a unified approach that optimizes supply chain resilience and quality management. This approach is particularly relevant for organizations seeking to improve operational efficiency and customer satisfaction through better risk management and quality assurance processes. Socially, the study highlights the importance of resilient and high-quality supply chains in today's business landscape by maintaining Sustainable Developmental Goals.</p> <p>Originality/Value: This research highlights how resilience, characterized by adaptability and robust recovery in disruptive scenarios, and stringent quality management, crucial for meeting customer expectations, are fundamental in modern supply chains. The study emphasizes the importance of a risk management culture and the role of digital technologies in enhancing supply chain resilience, underscoring their vital contributions during crises like the COVID-19 pandemic. Thus, this work offers valuable insights into achieving more resilient and high-quality supply chains</p>

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in today's challenging business environment through the integration of Quality Management Tools.

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A RESILIÊNCIA DA CADEIA DE FORNECIMENTO ATENDE À GESTÃO DA QUALIDADE

RESUMO

Objetivo: Este estudo visa a resiliência da cadeia de abastecimento e a gestão da qualidade, que são críticas na volátil economia global de hoje, marcada por várias perturbações. O foco está em como essas disciplinas tradicionalmente separadas podem ser combinadas para melhorar o desempenho organizacional.

Enquadramento teórico: O enquadramento teórico gira em torno dos conceitos de resiliência da cadeia de abastecimento, que inclui elementos como avaliação proativa de riscos, adaptabilidade, redes colaborativas, redundâncias estratégicas e princípios de gestão da qualidade. A pesquisa examina minuciosamente sua interação, revelando sobreposições e implicações significativas para os resultados organizacionais.

Design/metodologia/abordagem: Uma abordagem exploratória de estudo de caso constitui a metodologia central, utilizando principalmente dados secundários para obter insights sobre cenários do mundo real. Esta abordagem permite uma compreensão profunda dos factores críticos que influenciam a resiliência da cadeia de abastecimento e o impacto dos conceitos de gestão da qualidade na satisfação do cliente e na qualidade do produto/serviço nos processos da cadeia de abastecimento. O questionário é distribuído para obter insights sobre as práticas da empresa.

Constatações: As conclusões indicam que a integração da resiliência da cadeia de abastecimento com a gestão da qualidade conduz a resultados organizacionais mais sustentados e melhores. Uma cadeia de abastecimento resiliente recupera mais rapidamente de perturbações, minimizando os impactos financeiros. Ao mesmo tempo, um foco constante na qualidade garante a satisfação e a fidelidade do cliente. Esta integração oferece benefícios sinérgicos, contribuindo para a eficiência operacional, competitividade no mercado e uma reputação de marca mais substancial.

Implicações de pesquisa, práticas e sociais: O estudo fornece insights sobre factores críticos da resiliência da cadeia de suprimentos e suas interconexões com conceitos de gestão da qualidade. Estas informações podem informar estratégias para melhorar a resiliência e a gestão da qualidade nas cadeias de abastecimento. Na prática, o estudo oferece um guia para as organizações adotarem uma abordagem unificada que otimize a resiliência da cadeia de abastecimento e a gestão da qualidade. Esta abordagem é particularmente relevante para organizações que procuram melhorar a eficiência operacional e a satisfação do cliente através de uma melhor gestão de riscos e processos de garantia de qualidade. Socialmente, o estudo destaca a importância de cadeias de abastecimento resilientes e de alta qualidade no cenário empresarial atual, mantendo os Objetivos de Desenvolvimento Sustentável.

Originalidade/valor: Esta pesquisa destaca como a resiliência, caracterizada pela adaptabilidade e recuperação robusta em cenários disruptivos, e a gestão rigorosa da qualidade, crucial para atender às expectativas dos clientes, são fundamentais nas cadeias de abastecimento modernas. O estudo sublinha a importância de uma cultura de gestão de riscos e o papel das tecnologias digitais no reforço da resiliência da cadeia de abastecimento, sublinhando as suas contribuições vitais durante crises como a pandemia da COVID-19. Assim, este trabalho oferece informações valiosas sobre como alcançar cadeias de abastecimento mais resilientes e de alta qualidade no desafiador ambiente de negócios atual, através da integração de ferramentas de gestão da qualidade.

Palavras-chave: Resiliência da Cadeia de Suprimentos, Gestão da Qualidade, Desempenho Organizacional, Seis Sigma, TQM, Mitigação de Riscos.

LA RESILIENCIA DE LA CADENA DE SUMINISTRO SE ENCUENTRA CON LA GESTIÓN DE CALIDAD

RESUMEN

Propósito: Este estudio tiene como objetivo la resiliencia de la cadena de suministro y la gestión de la calidad, que son fundamentales en la volátil economía global actual, marcada por diversas interrupciones. La atención se centra en cómo se pueden combinar estas disciplinas tradicionalmente separadas para mejorar el desempeño organizacional.

Marco teórico: El marco teórico gira en torno a los conceptos de resiliencia de la cadena de suministro, que incluye elementos como evaluación proactiva de riesgos, adaptabilidad, redes de colaboración, redundancias estratégicas y principios de gestión de calidad. La investigación analiza su interacción y revela importantes superposiciones e implicaciones para los resultados organizacionales.

Diseño/metodología/enfoque: un enfoque de estudio de caso exploratorio forma la metodología central, utilizando principalmente datos secundarios para obtener información sobre escenarios del mundo real. Este

enfoque permite una comprensión profunda de los factores críticos que influyen en la resiliencia de la cadena de suministro y el impacto de los conceptos de gestión de la calidad en la satisfacción del cliente y la calidad del producto/servicio en los procesos de la cadena de suministro. El cuestionario se distribuye para obtener información sobre las prácticas de la empresa.

Hallazgos: Los hallazgos indican que la integración de la resiliencia de la cadena de suministro con la gestión de la calidad conduce a resultados organizacionales mejores y más sostenidos. Una cadena de suministro resiliente se recupera más rápidamente de las interrupciones, minimizando los impactos financieros. Al mismo tiempo, un firme enfoque en la calidad garantiza la satisfacción y lealtad del cliente. Esta integración ofrece beneficios sinérgicos, contribuyendo a la eficiencia operativa, la competitividad del mercado y una reputación de marca más sustancial.

Implicaciones de investigación, Prácticas y Sociales: el estudio proporciona información sobre los factores críticos de la resiliencia de la cadena de suministro y sus interconexiones con los conceptos de gestión de la calidad. Estos conocimientos pueden informar estrategias para mejorar la resiliencia y la gestión de la calidad en las cadenas de suministro. En la práctica, el estudio ofrece una guía para que las organizaciones adopten un enfoque unificado que optimice la resiliencia de la cadena de suministro y la gestión de la calidad. Este enfoque es particularmente relevante para las organizaciones que buscan mejorar la eficiencia operativa y la satisfacción del cliente a través de una mejor gestión de riesgos y procesos de garantía de calidad. Socialmente, el estudio destaca la importancia de cadenas de suministro resilientes y de alta calidad en el panorama empresarial actual manteniendo los Objetivos de Desarrollo Sostenible.

Originalidad/Valor: esta investigación destaca cómo la resiliencia, caracterizada por la adaptabilidad y una recuperación sólida en escenarios disruptivos, y una gestión de calidad estricta, crucial para satisfacer las expectativas de los clientes, son fundamentales en las cadenas de suministro modernas. El estudio enfatiza la importancia de una cultura de gestión de riesgos y el papel de las tecnologías digitales para mejorar la resiliencia de la cadena de suministro, subrayando sus contribuciones vitales durante crisis como la pandemia de COVID-19. Por lo tanto, este trabajo ofrece información valiosa para lograr cadenas de suministro más resilientes y de alta calidad en el desafiante entorno empresarial actual mediante la integración de herramientas de gestión de calidad.

Palabras clave: Resiliencia de la Cadena de Suministro, Gestión de Calidad, Desempeño Organizacional, Six Sigma, TQM, Mitigación de Riesgos.

INTRODUCTION

The term "supply chain" was introduced in the early 1980s, defining an emerging management discipline that integrated logistics and operations management activities. Over time, supply chain management evolved, encompassing functions like quality management and supplier performance monitoring, all aimed at optimizing the flow of goods and services. As supply chains expanded globally to support diverse operations, recent world events underscored the unpredictable nature of our environment. Natural disasters, geopolitical tensions, terrorism, and industrial disputes demonstrated the potential to disrupt supply chain activities significantly. Enhancing supply chain velocity and efficiency relies on streamlining processes, reducing inbound lead times, and eliminating non-value-added time. In this context, resilience is defined as the system's ability to recover from disturbances and adapt to new conditions, emphasizing the significance of flexibility and adaptability.

THE RATIONALE OF THE STUDY

The study's rationale originates from the supply chain's vital role in modern organizations and the challenges of disruptions and uncertainties. Disasters, geopolitical events, economic fluctuations, and supplier issues can disrupt supply chain operations, leading to financial losses, customer dissatisfaction, and operational inefficiencies. Organizations must develop resilient supply chains that respond effectively and recover from unforeseen events. The primary objective of this research is to investigate the critical factors influencing supply chain resilience in the context of disruptions and uncertainties. By identifying these key factors, the study aims to provide valuable insights to supply chain managers, executives, and decision-makers, enabling them to proactively address vulnerabilities and enhance their supply chain's resilience. Furthermore, the study intends to examine the links and correlations between quality management concepts and supply chain resilience factors. Understanding how these two dimensions interact and influence each other is crucial for creating a unified approach that optimizes supply chain resilience and product/service quality.

RESEARCH OBJECTIVES

1. What critical factors influence supply chain resilience in disruptions and uncertainties?
2. What impacts do quality management concepts have on Supply Chain Resilience, Customer Satisfaction, Quality of Products and services in Supply Chain Processes?

RESEARCH SCOPE

This research paper will explore the critical relationship between supply chain resilience and quality management, providing insights into their interdependencies and showcasing how organizations can leverage these concepts to achieve sustained success in a rapidly changing business environment. This paper aims to contribute to the existing body of knowledge in supply chain and quality management disciplines by presenting real-world case studies and proposing a comprehensive framework. While an exploratory case study offers valuable insights, it has certain limitations. The findings may be context-specific and not easily generalizable to other settings. Additionally, the study's scope may be limited to a few organizations, restricting the overall diversity of perspectives.

LITERATURE REVIEW

The First Industrial Revolution, in the late 18th century, spearheaded a shift from handcrafted to machine-aided production, spurred predominantly by steam engines and mechanized textiles. While this period did not flaunt intricate supply chains, it sowed the initial seeds for organized production, inherently demanding simple logistics and quality assurance mechanisms. Advancing into the Second Industrial Revolution, the advent of electricity, assembly lines, and enhanced transportation notably widened production capabilities. It introduced systematic supply chain management to ensure consistent and expansive distribution of goods. Additionally, the surge in mass production instinctively indicated enhanced quality management protocols to safeguard and standardize manufacturing outputs.

The digital winds of the Third Industrial Revolution ushered in an era where computerization and internet connectivity began to weave through supply chains delicately, instigating the emergence of integrated logistics and the preliminary adoption of technology in quality assurance practices. The present embodiment of the Fourth Industrial Revolution, or Industry 4.0, presents a sophisticated tapestry where the physical and digital spheres coalesce, bringing forth technologies like the Internet of Things (IoT) and Artificial Intelligence (AI), which not only support supply chain transparency and agility but also elevate quality management to a predictive, proactive, and personalized paradigm.

SUPPLY CHAIN RESILIENCE

Supply Chain Resilience (SCRes) refers to the ability of a supply chain to prepare for, respond to, and recover from disruptions while maintaining its essential functions and performance. The critical components of SCRes include (Shishodia et al., 2023) Vulnerability assessment, Risk management, Redundancy and Flexibility, Collaboration and Communication, Information Sharing, Resource Allocation, and Resilient Culture. These components are critical to maintain the supply chain's resilience and ensure it can withstand disruptions and recover quickly. Another perspective on supply chain resilience is the distinction between engineering resilience and social-ecological resilience (Wieland & Durach, 2021). This perspective emphasizes the need to consider both technical and social aspects of resilience. It suggests that supply chain resilience should not only focus on technical capabilities but also consider the social and ecological dimensions of the supply chain. (Thị et al., 2023) examined the impact of inbound logistics capabilities on supply chain resilience in the Vietnamese textile industry. They found that inbound logistics capabilities indirectly affect

supply chain resilience through dynamic supply chain capabilities. (Um & Han, 2020) found that implementing mitigating strategies can help organizations effectively manage uncertain events and improve supply chain resilience. This highlights the importance of proactive risk management and the adoption of strategies to mitigate potential disruptions. The study empirically shows risk control enhances logistics performance.(Yanginlar et al., 2023)

Supply chain managers are critical in ensuring supply chains become resilient. (Nikookar & Yanadori, 2021) The supply chain manager's social capital, human capital, and cognition have significance in building organizational supply chain resilience antecedents such as visibility, responsiveness, and flexibility. Supply chain alertness, which refers to the ability to detect and respond to disruptions, is another factor that contributes to supply chain resilience (Queiroz et al., 2022). Additionally, supply chain complexity, agility, and ambidexterity have positively impacted supply chain resilience (Aslam et al., 2020; Hussain et al., 2022; Liu & Chin, 2021). (Vijayakumar & Chandrasekar, 2022)Integrating innovative capabilities into the supply chain significantly improves firm performance in manufacturing MSMEs, enhancing manufacturing and marketing capabilities. The role of technology and digital transformation in improving supply chain resilience is also worth noting. Digital transformation, including blockchain technology, can improve supply chain resilience by increasing transparency, traceability, and trust in the supply chain. (Fang & Ge, 2023).

Case Studies on Supply Chain Disruptions and Resilience Strategies: Suez Canal Blockage

The blockage of the Suez Canal in 2021 significantly impacted global shipping and the economy. According to a report by the British Broadcasting Corporation, the obstruction of the canal disrupted approximately \$9.6 billion worth of goods daily (Duoming & Chin, 2022).This disruption caused supply chain delays and economic consequences for various industries. The disruption highlighted the vulnerability of global supply chains and the risks associated with relying on a single transportation route (Man-yin & Yin-cheung, 2021). The blockage of the canal overlapped with the COVID-19 pandemic, which had already been causing disruptions in global shipping patterns since early 2020 (Ruiz et al., 2022). These combined disruptions further exacerbated the challenges faced by the shipping industry and led to significant delays in the movement of goods. The economic impact of the Suez Canal blockage was substantial. The daily disruption of billions of dollars worth of goods had ripple effects throughout the global economy. Industries that heavily rely on timely delivery of goods, such as manufacturing

and retail, experienced supply chain delays and increased costs (Dirzka & Acciaro, 2022). The blockage also affected the availability of goods in various markets, leading to potential shortages and price increases (He et al., 2023). Additionally, the disruption caused financial losses for shipping companies, as they had to reroute vessels and deal with the backlog of ships waiting to pass through the canal (Verschuur & Koks, 2023). The blockage of the Suez Canal highlighted the vulnerabilities and risks associated with global shipping and supply chains. This gave rise to the idea of diversifying the transportation routes to mitigate the impact of future disruptions.

Case Studies on Supply Chain Disruptions and Resilience Strategies: Global Semiconductor Shortage

The semiconductor shortage in 2020-2021 affected various sectors, including the automotive industry, electronics, food and beverages, apparel, IT, and agriculture. (Khan et al., 2022). The semiconductor industry has been experiencing growth and advancement in chip development, but the shortage has highlighted the need for strategies to address the crisis. The optimization of manufacturing yield has become crucial in semiconductor operations due to the increasing cost of fabrication and global supply shortage situations (Jiang et al., 2021). In response to the shortage, strategies include adopting innovative strategies to mitigate supply chain disruptions, such as using data analytics for operational risk management and developing innovative manufacturing focusing on big data. Defect engineering and the construction of heterostructures with other semiconductors have been suggested to overcome the shortage (Liu & Chin, 2021).

Case Studies on Supply Chain Disruptions and Resilience Strategies: COVID-19 Vaccine Supply Chain Issues

COVID-19 vaccine delivery through cold chain logistics has grown to be a challenging operational task regarding timeliness and cost (Xue et al., 2022). Cold chain management is essential for maintaining the recommended storage and distribution temperature range of COVID-19 vaccines (Fahrni et al., 2022). COVID-19 vaccines require special end-to-end supply cold chain requirements, from manufacture and transportation to warehouses and healthcare facilities (Fahrni et al., 2022). COVID-19 vaccine distribution and logistics, including cold chain management and international coordination, to ensure the effective and efficient delivery of vaccines worldwide.

Case Studies on Supply Chain Disruptions and Resilience Strategies: Personal Protective Equipment (Ppe)

The COVID-19 pandemic has caused significant disruptions in the supply chain of Personal Protective Equipment (PPE) worldwide (Rubashkin et al., 2023). The surge in demand for PPE overwhelmed existing supply chains, leading to shortages (Rubashkin et al., 2023). This shortage of PPE posed a tremendous challenge to the supply chain as healthcare organizations struggled to meet the increased demand (Zhang et al., 2021). During the pandemic, the healthcare supply chain crisis presented unique and complex challenges in delivering the right supplies to the right people at the right time (Zhang et al., 2021). The COVID-19 pandemic highlighted the fragility of the global health supply chain and the need for improved coordination and transparency (Klerk & Santaolalla, 2022). To address these challenges, companies in the manufacturing industry have been adopting Additive Manufacturing (AM), also known as 3D printing. Additive Manufacturing (AM) is seen as a viable option to handle disruptions and boost the resilience of the automotive supply chain. (Sheriff et al., 2021).

Case Studies on Supply Chain Disruptions and Resilience Strategies: Us-China Trade War

The US-China trade war and the imposition of tariffs have had significant impacts on the global supply chain, particularly in the manufacturing industry (Araz et al., 2020; Handfield et al., 2020; Zhan & Lu, 2021). These disruptions have been further exacerbated by the COVID-19 pandemic, leading to increased concerns about the resilience of supply chains and the need for strategies to mitigate disruptions (Frankowska et al., 2022; Paul & Chowdhury, 2020; Zhan & Lu, 2021). Supply chain disruptions in the manufacturing industry can arise from various factors, including raw material shortages, supplier failures, rising material prices, machine breakdowns, uncertain demand, inaccurate forecasts, order changes, and transportation failures. These disruptions can have far-reaching consequences, affecting the manufacturing industry and other sectors that rely on a stable supply chain (Wahdat & Lusk, 2022).

INTERCONNECTION BETWEEN SUPPLY CHAIN RESILIENCE AND QUALITY MANAGEMENT TOOLS

Supply chain integration involves coordinating and collaborating with various stakeholders in the supply chain, including suppliers, manufacturers, distributors, and customers (Tiwari, 2020). By integrating the supply chain, organizations can improve communication, visibility, and coordination, essential for effective risk management and response during disruptions (Siagian et al., 2021). Another critical factor in enhancing supply chain resilience is adopting risk management strategies. Risk management involves identifying potential risks, assessing their impact and likelihood, and implementing measures to mitigate or respond to them (Al-Ayed & Al-Tit, 2023). Risk management strategies include diversifying suppliers, developing alternative sourcing options, and implementing contingency plans (Obashi, 2021). By adopting flexible strategies such as agile manufacturing, just-in-time inventory management, and responsive logistics, organizations can better adapt to disruptions and maintain operations (Siagian et al., 2021).

QUALITY MANAGEMENT TOOLS

Quality management, as defined by the International Organization for Standardization (ISO), highlights the customer focus and emphasizes understanding and exceeding customer expectations. Quality management standards play a crucial role in ensuring the efficiency and effectiveness of organizations across various industries. Among the most widely recognized quality management standards are ISO 9001 and Six Sigma. ISO 9001 is a series of international standards that provide guidelines for quality management and assurance systems (Singh et al., 2020). Total Quality Management (TQM) is an integrated management philosophy continuously improving products and processes for better customer satisfaction (Cahyono et al., 2022). TQM focuses on quality and involves the participation of all members of an organization (Wulan & Azizah, 2021). It is centered on quality and aims for long-term success through customer satisfaction and benefits to all members of the organization and society (Danuri et al., 2021). On the other hand, Six Sigma is a methodology that focuses on reducing defects and improving process performance (Keleş, 2022). The integration of Lean and Six Sigma, known as Lean Six Sigma (LSS), combines the waste reduction principles of Lean with the defect reduction principles of Six Sigma (Scheller et al., 2018). This combination allows organizations to achieve operational excellence by eliminating waste, reducing defects, and improving overall efficiency (Mishra & Kaushik, 2023). Organizations can enhance the

resilience and sustainability of their supply chains by integrating digital technologies and adopting practices from the circular economy alongside implementing Kaizen and Lean methodologies.(Cherrafi et al., 2022). One approach to evaluate the resilience of supply chains is using Resilience Metrics. These metrics provide quantitative measures of the resilience of supply chains, allowing organizations to assess their current level of resilience and identify areas for improvement (Golan et al., 2020). They provide a standardized and objective way to measure and compare the resilience of different supply chains, enabling organizations to benchmark their performance and identify best practices (Wieland & Durach, 2021b).

QUALITY ASSURANCE IN THE PRODUCTION PROCESS

Quality assurance plays a crucial role in supplier selection and evaluation. It ensures that the selected suppliers meet the required quality standards and can consistently deliver high-quality products or services. Several factors are considered in the supplier evaluation and management process, including supplier quality, certification, facilities, continuous improvement, and physical distribution (Salam & Khan, 2018). Direct integration of supplier quality plays a pivotal role in elevating an organization's competitive edge. Concurrently, integrating internal quality processes not only directly contributes to competitive performance but also indirectly amplifies this effect by strengthening the quality integration of suppliers (Zhang et al., 2021). Ensuring compliance and certifications throughout the supply chain is crucial for various industries, including food, agriculture, fashion, and pharmaceuticals. Compliance measures are necessary to prevent fraud, forgery of certificates, and content changes during production (Sung et al., 2022). Certification systems ensure quality food management and safety standards from farm to fork (Arshad et al., 2023). They help to identify products approved for certified production throughout the supply chain (Sheriff et al., 2021).

Traceability is another critical aspect of ensuring compliance and certifications in supply chains. It allows for identifying and tracking products and their components throughout the supply chain (Hinkes & Peter, 2020). Traceability systems ensure deforestation-free supply chains and can be integrated with certification systems (Hinkes & Peter, 2020). Blockchain technology has been identified as a potential solution for enhancing supply chain traceability and transparency (Azevedo et al., 2023; Wang et al., 2019). It can provide decentralized and trustful assurance of provenance, chain of custody, and traceability functionalities (Azevedo et al., 2023). Quality control in production processes involves various techniques and tools. Statistical process control (SPC) is frequently used to monitor, control,

analyze, manage, and improve products and processes using statistical methods (Soekesi et al., 2021). Control charts, a standard SPC tool, play a vital role in assessing the quality of a product (Lestari & Rahmat, 2018). Additionally, using quality control tools, such as Ishikawa diagrams and Pareto charts, can help to identify failures in the production process and reduce defective products (BOERIU & Canja, 2021). Six Sigma is another commonly used tool in product quality control. It focuses on improving product quality, effectiveness, and efficiency by following the DMAIC (Define, Measure, Analyze, Improve, Control) approach. By using Six Sigma, companies can reduce defective parts, production time, and errors, ultimately leading to higher customer satisfaction (Syamsul et al., 2022).

DATA AND METHODOLOGY

We have employed a mixed method approach via a questionnaire sent to 80 purposively selected professionals. Combining scaled, multiple-choice, and open-ended questions, the survey yielded 56 valid responses, offering diverse insights into the intersection of supply chain resilience and quality management. To analyze the data further, Pearson's correlation coefficient was utilized for hypothesis testing, particularly to assess the strength and direction of relationships between key variables within supply chain resilience and quality management.

RESEARCH QUESTIONS

RQ1: To examine the organization's strategies and practices to integrate supply chain resilience and quality management into a unified approach.

RQ2: To analyze the interconnections and relationships between supply chain resilience elements and quality management tools in the unified approach.

HYPOTHESES

H1: Organizations that use advanced risk assessment techniques are more likely to adopt quality management principles.

H2: Higher levels of proactive risk assessment in organizations are associated with a more significant impact of resilience and quality management integration in supply chain operations.

RESULTS AND DISCUSSION EXPLORATORY STUDIES

SURVEY ANALYSIS

Table 1: Means and Standard deviation of the Constructs used in the Form

Constructs	N= 56	Mean	Std. Deviation
Proactive Risk Assessment		0.96	0.187
Risk Assessment Techniques		2.34	1.379
Risk Mitigation Strategies		2.48	1.335
Supplier Collaboration		1.00	.000
Collaborative Efforts with Suppliers		2.27	1.286
SC Diversification Approaches		1.93	1.024
Impact of Resilience and Quality Management Integration		0.95	0.227
Presence of Quality Management Principles		1.00	.000
Quality Management Principles Adopted		3.23	0.831
Alignment of Resilience Strategies and Quality Management		2.41	1.187
Impact of Quality Management on Supply Chain		2.61	0.928
Tracking of Customer Satisfaction Levels		1.00	.000
Methods to Measure Customer Satisfaction		2.71	1.124
Perception of Supply Chain Resilience and Quality Relationship		1.30	0.685
Priority of Quality Management Practices		1.23	0.572

Source: *Own Survey by SPSS 29 (2023)*

In surveying our analysis reveals significant trends. A standout finding is the concentration of Supply Chain Resilience Rating scores around 4, signifying strong resilience and highlighting strategic prioritization in supply chain operations. This is complemented by the broad adoption of proactive risk assessments, with 96% of organizations participating (Mean = 0.96, Std. Deviation = 0.187), emphasizing the importance placed on forecasting and mitigating potential risks. Diversity in risk assessment techniques (Mean = 2.34, Std. Deviation = 1.379) suggests organizations tailor their risk strategies to specific needs. Supplier collaboration, with all organizations reporting engagement (Mean = 1.00, Std. Deviation = 0.000), indicates a move toward more integrated supply chain partnerships. The variation in the depth of these collaborations (Mean = 2.27, Std. Deviation = 1.286) reflects differing approaches to working with suppliers. Furthermore, organizations strongly commit to quality management principles (Mean = 3.23, Std. Deviation = 0.831), with most prioritizing quality standards and practices (Mean = 1.23, Std. Deviation = 0.572). The perceived positive link between supply chain resilience and quality (Mean = 1.30, Std. Deviation = 0.685) underlines an awareness of their joint impact on customer satisfaction, further evidenced by unanimous tracking of customer satisfaction (Mean = 1.00, Std. Deviation = 0.000). Overall, the data recognizes the value of proactive risk management, collaborative supply chain models, and a robust quality management focus.

Table 2: Correlation Matrix of Supply Chain Management Practices

Variable	Proactive Risk Assessment (PRisk)	Risk Assessment Techniques (RATec)	Risk Mitigation Strategies (RMStr)	SC Diversification Approaches (SCDiv)	Collaborative Efforts with Suppliers (CEfS)	Impact of Resilience and Quality (IRQ)
(PRisk)	1.00	-.232	-.091	-.076	.098	.382*
(RATec)	-.232	1.00	.276*	.266*	.249	-.194
(RMStr)	-.091	.267*	1.00	.325*	.618*	-.166
(SCDiv)	-.076	.266*	.325*	1.00	.349*	-.076
(CEfS)	.098	.249	.618*	.349*	1.00	.078
(IRQ)	.382*	-.194	-.166	-.076	.078	1.000

Note: * $p < .05$, ** $p < .01$. PRisk = Proactive Risk Assessment; RATec = Risk Assessment Techniques; RMStr = Risk Mitigation Strategies; SCDiv = SC Diversification Approaches; CEfS = Collaborative Efforts with Suppliers; Impact of Resilience and Quality (IRQ)

Source: *Own Survey by SPSS 29 (2023)*

In our study, we explored two hypotheses within the context of supply chain management, focusing on the roles of risk assessment and quality management. The findings from the correlation analysis offer substantial insights into these hypotheses.

Hypothesis 1 proposed that organizations using advanced risk assessment techniques are more likely to adopt quality management principles. The correlation analysis supports this hypothesis to some extent. While the direct relationship between advanced risk assessment techniques and the adoption of quality management principles was not explicitly measured, the positive correlation between risk assessment techniques and risk mitigation strategies ($\rho = 0.267$, $p < 0.05$) and supply chain diversification ($\rho = 0.266$, $p < 0.05$) indirectly supports the notion. These correlations suggest that a comprehensive approach to risk assessment is integral to effective risk management and supply chain resilience, which are critical components of quality management principles.

Hypothesis 2 suggested that higher levels of proactive risk assessment in organizations are associated with a more significant perceived impact of resilience and quality management integration in supply chain operations. The statistical analysis strongly supports this hypothesis, as evidenced by a significant positive correlation between proactive risk assessment and the integration of resilience and quality management (Spearman's $\rho = 0.382$, $p < 0.01$). This finding underscores the critical importance of proactive risk assessment in enhancing supply chain robustness and its integration with quality management practices.

Additionally, the study found a strong association between collaborative efforts with suppliers and risk mitigation strategies ($\rho = 0.618$, $p < 0.01$). This emphasizes the importance of supplier relationships in risk management, a crucial aspect of proactive risk assessment and quality management. Furthermore, the significant positive correlation between supply chain

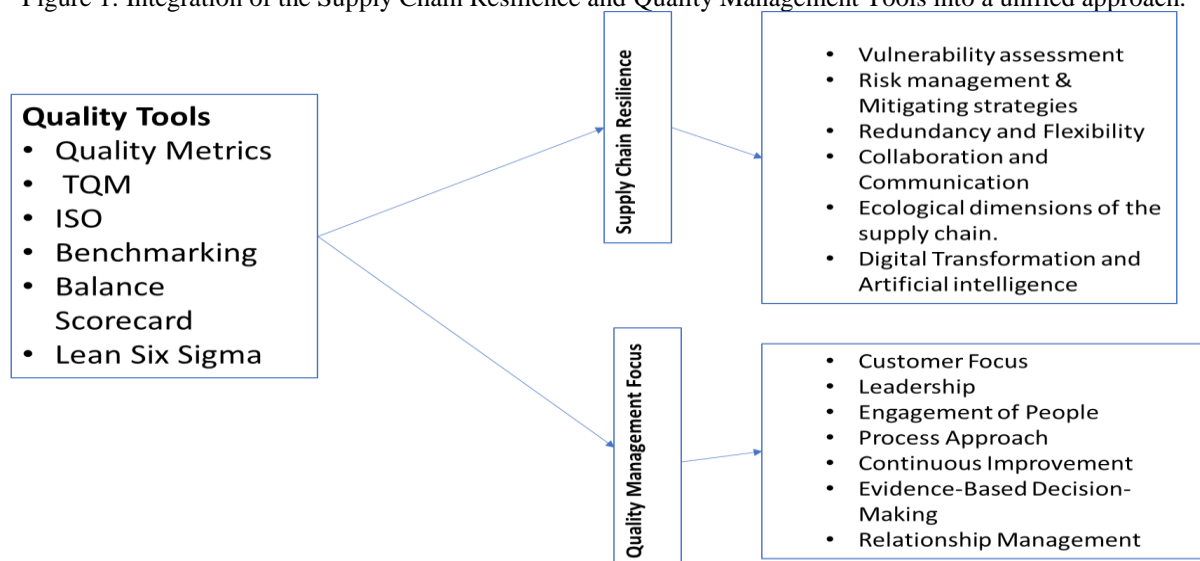
diversification approaches and the alignment of resilience and quality management strategies ($\rho = 0.440$, $p < 0.01$) aligns with second Hypotheses, indicating that diversified supply chains tend to integrate resilience and quality management more effectively. The most compelling evidence comes from the observed influence of quality management practices within organizations on the perception of the supply chain resilience-quality relationship ($\rho = 0.874$, $p < 0.01$). This high correlation indicates a strong awareness and integration of quality management in supply chain resilience strategies, directly supporting second Hypotheses.

CONCLUSION

Supply chain resilience and quality management are two pivotal pillars of effective supply chain management. Resilience, defined as the ability to persist, adapt, or transform in the face of change, is essential for navigating the complexities and uncertainties of today's business landscape. It encompasses the readiness to prevent and mitigate disruptions and the capacity to respond swiftly and recover robustly when disruptions occur. On the other hand, quality management is fundamental in ensuring that products and services consistently meet or surpass customer expectations regarding reliability, performance, and other essential attributes. Ultimately, fostering resilient supply chains demands a risk management culture within organizations. Successful initiatives like Collaborative Planning, Forecasting, and Replenishment (CPFR) in the fast-moving consumer goods (FMCG) industry improve supply chain intelligence by enhancing risk profile visibility. Numerous factors have been identified as influential in enhancing supply chain resilience. These include data analytics capability, organizational flexibility, social capital, human capital, and the cognitive abilities of supply chain managers. The global COVID-19 pandemic has further emphasized the critical importance of supply chain resilience, with research highlighting the vital role of factors such as supply chain visibility, responsiveness, and flexibility during crises. Supply chain risk management is closely intertwined with resilience, and this study has revealed that it affects resilience, often facilitated by innovative technologies like the Internet of Things (IoT). Furthermore, digital technologies and the ongoing digital transformation process have emerged as powerful enablers for improving supply chain resilience by facilitating better information sharing, coordination, and decision-making. Notably, the aspect of quality management, ensuring that products and services consistently meet high standards, is an indispensable part of the supply chain equation. It is essential to acknowledge that quality management is a core consideration that should run through all aspects of supply chain operations, contributing to

customer satisfaction and overall supply chain resilience. Below is the integrated model of the Supply chain resilience and the quality management tools. In conclusion, the statistical significance of these correlations provides empirical support for the critical role of proactive risk assessment and quality management in supply chain strategies. These findings are instrumental for practitioners aiming to enhance supply chain resilience and quality management, validating the proposed hypotheses and laying the groundwork for further research.

Figure 1: Integration of the Supply Chain Resilience and Quality Management Tools into a unified approach.



Source: Prepared by the Authors (2023)

FUTURE RESEARCH DIRECTIONS

Future research should focus on: 1) Examining the causal effects of proactive risk assessment on quality management adoption through longitudinal studies or randomized control trials. 2) Investigating the mediating role of strategy alignment in supply chain resilience using structural equation modeling. 3) Analyzing the relationship between quality management prioritization and customer satisfaction via regression analysis. 4) Studying the reciprocal influence of quality management on supply chain outcomes and vice-versa through longitudinal data analysis. 5) Evaluating the impact of external factors like industry type on aligning resilience strategies and quality management with regression and correlation tests. 6) Comparing various methodologies for measuring customer satisfaction to assess their influence on the perceived relationship between supply chain resilience and quality management.

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