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Abstract

Purpose: The aim of the study was to assess the influence of e-commerce integration on supply chain resilience in Sudan.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: The study found that E-commerce platforms facilitate real-time data exchange, allowing for better tracking of inventory levels, demand forecasting, and supply chain coordination. This enhanced visibility helps companies quickly adapt to disruptions, such as sudden changes in consumer demand or supply shortages. Furthermore, the digital nature of e-commerce enables companies to diversify their supplier base more easily, reducing dependence on any single source and mitigating risks associated with regional disruptions. Additionally, e-commerce integration supports more flexible logistics and distribution models, such as drop-shipping and last-mile delivery innovations, which can swiftly adapt to changing conditions. Overall, the digitalization and connectivity brought by e-commerce integration strengthen supply chain resilience by promoting more informed decision-making, increasing operational flexibility, and enhancing the ability to respond to unforeseen challenges.

Implications to Theory, Practice and Policy: Resource-based view (RBV) Theory, dynamic capabilities theory and transaction cost economics may be used to anchor future studies on assessing the influence of e-commerce integration on supply chain resilience in Sudan. In terms of practical implications, organizations should foster a culture of innovation, agility, and collaboration to support effective E-commerce integration initiatives. On the policy front, it is recommended to advocate for regulatory frameworks that support digital innovation, interoperability, and data security within E-commerce ecosystems.

Keywords: *E-commerce, Integration, Supply Chain, Resilience*

INTRODUCTION

Supply chain resilience refers to the ability of a supply chain to anticipate, respond to, and recover from disruptions effectively. Adaptability, on the other hand, involves the capacity of the supply chain to adjust and thrive in dynamic environments. In developed economies like the USA, there has been a growing emphasis on supply chain resilience and adaptability, particularly following significant disruptions like the COVID-19 pandemic. For example, a study by Ivanov (2018) highlights the importance of digital technologies in enhancing supply chain resilience, with statistics showing a 15% increase in the adoption of digital supply chain solutions in the USA since 2017.

Another example can be seen in Japan, where the 2011 earthquake and tsunami prompted a reevaluation of supply chain strategies. According to a report by Nishiguchi and Bebenroth (2019), Japanese companies have since increased their investment in redundancy and diversification strategies, resulting in a 20% decrease in supply chain disruptions in the past five years. These examples demonstrate how developed economies are proactively addressing supply chain challenges through technological advancements and strategic investments.

In developing economies like India, supply chain resilience has become a critical focus amid rapid economic growth and globalization. For instance, a study by Srivastava and Srivastava (2020) shows a 25% increase in supply chain investments in resilience-building measures such as inventory optimization and supplier diversification. Similarly, in Brazil, a report by da Silva (2021) notes a 30% rise in the adoption of supply chain risk management tools, indicating a growing awareness of resilience strategies among businesses.

In developing economies such as Brazil, the agricultural sector has been strategically focusing on enhancing supply chain resilience to navigate challenges posed by climate change impacts, market volatility, and transportation constraints. Santos (2020) discusses the concerted efforts undertaken by Brazilian agribusinesses to fortify their supply chains through sustainable practices, improved logistics infrastructure, and diversified supply sources. These initiatives have resulted in a notable 20% reduction in supply chain disruptions, reflecting the sector's adaptability and resilience in volatile market conditions. Moreover, the integration of digital technologies and data analytics has enabled Brazilian farmers to optimize production processes, mitigate risks, and ensure timely delivery of agricultural products to domestic and international markets.

In Vietnam, the manufacturing industry has experienced a paradigm shift towards resilience-driven strategies following challenges posed by trade disputes and supply chain disruptions. Nguyen (2021) highlights the proactive measures adopted by Vietnamese manufacturers, including a 25% increase in investments in supply chain technologies and risk mitigation measures. These investments have not only strengthened operational continuity but have also positioned Vietnam as a preferred destination for foreign investment due to its robust and adaptable supply chain ecosystem. Moreover, strategic collaborations between government agencies, industry players, and academia have facilitated knowledge sharing, innovation, and capacity building, further enhancing the resilience of Vietnam's manufacturing sector.

In developing economies like Indonesia, supply chain resilience has emerged as a critical strategy due to the country's vulnerability to natural disasters and geopolitical uncertainties. A study conducted by Wibowo (2019) sheds light on the increasing emphasis placed by Indonesian businesses on fortifying their supply chains against disruptions. This focus is evident in the 30%

rise in the adoption of supply chain risk management practices, including scenario planning and alternative sourcing strategies. These measures are crucial for businesses operating in regions prone to earthquakes, tsunamis, and volcanic eruptions, as they enable organizations to anticipate potential disruptions and implement timely responses to safeguard their supply chains.

In Thailand, the tourism and hospitality sector has demonstrated a proactive approach towards addressing supply chain challenges to enhance resilience, particularly in the face of crises such as natural disasters and pandemics. Thongchai (2023) delves into the comprehensive strategies adopted by Thai businesses in this sector, which include the implementation of robust risk management frameworks encompassing contingency planning, supply diversification, and the digitalization of operations. These strategies have not only helped mitigate risks but have also contributed to a 30% decrease in supply chain disruptions over the past five years. This reduction in disruptions has been crucial in enabling Thai businesses in the tourism sector to recover swiftly from disruptions and maintain seamless service delivery for tourists, thereby bolstering the industry's overall resilience and adaptability.

Furthermore, in Mexico, the manufacturing industry has embraced a range of supply chain resilience strategies to mitigate disruptions arising from trade uncertainties and supply shortages. Martinez (2023) provides insights into the innovative approaches adopted by Mexican manufacturers, including the integration of agile manufacturing processes, the implementation of supply chain visibility tools, and the fostering of collaborative partnerships with suppliers. These initiatives have yielded tangible benefits, with a 20% improvement observed in on-time deliveries and a significant reduction in production downtime. These outcomes highlight the effectiveness of resilient supply chains in enhancing operational efficiency, reducing costs, and enhancing customer satisfaction within the Mexican manufacturing sector.

In Brazil, the renewable energy sector has been at the forefront of enhancing supply chain resilience to navigate challenges such as regulatory changes, market fluctuations, and technological advancements. Research by Silva (2021) delves into the strategies adopted by Brazilian renewable energy companies, which include investment in diversified sourcing strategies, integration of renewable energy technologies, and the establishment of strategic partnerships with local suppliers and stakeholders. These initiatives have led to a 25% reduction in supply chain disruptions and improved overall operational efficiency within the renewable energy sector, contributing significantly to Brazil's energy security and sustainability goals.

Turning to Egypt, the construction and infrastructure sector has undergone substantial transformations to bolster supply chain resilience and adaptability in the face of economic volatility, project delays, and supply chain disruptions. Mahmoud (2022) outlines the comprehensive approach taken by Egyptian construction firms, encompassing supply chain digitization, enhanced supplier collaboration, and risk mitigation strategies. As a result, there has been a notable 30% decrease in project delays and cost overruns, signaling the positive impact of resilient supply chains on project delivery timelines, cost management, and stakeholder satisfaction within Egypt's construction industry.

Additionally, in Bangladesh, the textile and garment sector has recognized the importance of supply chain resilience in mitigating risks associated with global market fluctuations, supply chain disruptions, and changing consumer preferences. Rahman (2023) highlights the adoption of sustainable sourcing practices, capacity-building initiatives for suppliers, and the integration of

digital supply chain technologies to enhance transparency and traceability. These efforts have not only strengthened resilience but have also positioned Bangladesh as a competitive player in the global textile market, attracting investments and fostering sustainable growth in the industry.

Similarly, in South Africa, the mining sector has been proactively investing in supply chain resilience to address challenges such as commodity price fluctuations, labor strikes, and regulatory changes. Moyo (2022) highlights the significant progress made in enhancing supply chain resilience within the mining industry. Over the past five years, there has been a notable 25% decrease in supply chain disruptions, attributed to improved collaboration with suppliers and the implementation of advanced forecasting technologies. These resilience-building efforts have not only minimized operational disruptions but have also enhanced the sector's ability to adapt to dynamic market conditions, ensuring sustainable growth and competitiveness in the global market.

Shifting focus to Kenya, the agricultural sector has undergone significant transformations aimed at improving supply chain resilience and adaptability in response to changing market dynamics and climate variability. Kamau (2022) sheds light on the multifaceted approach adopted by Kenyan agricultural businesses, which includes the widespread adoption of climate-smart agriculture practices, substantial investments in infrastructure such as cold storage facilities and efficient transportation networks, and the integration of digital platforms for enhanced market access and real-time information sharing. As a result of these concerted efforts, there has been a notable 25% increase in agricultural productivity alongside a corresponding reduction in post-harvest losses. This positive outcome underscores the pivotal role of resilient supply chains in not only ensuring food security but also contributing to economic stability and sustainable growth in Kenya.

Furthermore, in sub-Saharan economies such as Nigeria, supply chain resilience has gained traction due to challenges like infrastructure limitations and political instability. Study by Adesida (2018) underscores the role of collaboration among stakeholders in enhancing resilience, with a 15% increase in public-private partnerships aimed at improving supply chain infrastructure in the region. These examples illustrate the evolving landscape of supply chain resilience and adaptability across diverse economic contexts.

Degree of E-commerce Integration refers to the extent to which electronic commerce (e-commerce) is integrated into an organization's overall business operations and strategies. This integration can vary significantly, and four key degrees can be identified: basic integration, transactional integration, strategic integration, and transformative integration. Basic integration involves using e-commerce primarily for online transactions, such as selling products through a website. Transactional integration extends beyond basic transactions to include functionalities like online payment systems, order tracking, and customer support Chen & Zhang (2018). Strategic integration goes further by aligning e-commerce with broader business strategies, such as incorporating e-commerce data into supply chain planning and decision-making processes. Transformative integration represents the highest degree, where e-commerce is deeply ingrained in all aspects of the organization, driving innovation, agility, and customer-centricity across the supply chain.

Linking these degrees of e-commerce integration to supply chain resilience and adaptability reveals crucial connections. For instance, basic integration may provide a starting point for digitalizing certain supply chain functions, but it may not fully leverage e-commerce capabilities for resilience and adaptability. Transactional integration enhances supply chain visibility and

responsiveness, allowing businesses to better track orders, manage inventory, and address customer needs promptly, thereby contributing to supply chain resilience Kim, & Lee (2022). Strategic integration enables organizations to harness e-commerce data for predictive analytics, risk management, and optimized decision-making, leading to more agile and adaptive supply chains. Lastly, transformative integration fosters a culture of continuous innovation and collaboration, enabling businesses to proactively anticipate disruptions, rapidly pivot strategies, and enhance overall supply chain resilience and adaptability.

Problem Statement

In today's dynamic business environment, the integration of E-commerce technologies into supply chain management has become increasingly prevalent. However, there remains a need to comprehensively understand the impact of E-commerce integration on supply chain resilience. While previous studies have explored aspects of E-commerce integration and its effects on supply chain performance, there is a gap in the literature regarding the specific mechanisms through which E-commerce integration influences supply chain resilience in the context of recent technological advancements and market dynamics (Kim, 2022; Wu & Liu, 2023). Additionally, with the rapid evolution of digital technologies and the growing complexity of global supply chains, there is a pressing need to investigate how different degrees of E-commerce integration, ranging from basic transactional functions to transformative strategies, contribute to enhancing supply chain resilience (Chen & Zhang, 2018; Gao & Li, 2019). Therefore, this study aims to address these gaps by examining the influence of E-commerce integration on supply chain resilience and identifying key factors and strategies that enable organizations to build resilient and adaptable supply chains in the digital era.

Theoretical Framework

Resource-Based View (RBV) Theory

Originated by Wernerfelt in 1984 and further developed by Barney in 1991, RBV focuses on the strategic management of resources and capabilities within an organization. RBV suggests that competitive advantage stems from the unique resources and capabilities possessed by a firm. In the context of E-commerce integration and supply chain resilience, RBV can help understand how firms' internal resources such as technological infrastructure, data analytics capabilities, and human capital contribute to building resilient supply chains. An organization's ability to leverage E-commerce technologies effectively and integrate them seamlessly into supply chain operations can be seen as a key resource for enhancing resilience (Barney, 1991).

Dynamic Capabilities Theory

Introduced by Teece, Pisano, and Shuen in 1997, Dynamic Capabilities Theory emphasizes an organization's ability to adapt, learn, and innovate in response to changing environments. This theory is highly relevant to the influence of E-commerce integration on supply chain resilience as it highlights the importance of agile and adaptive capabilities in managing disruptions and uncertainties. E-commerce integration provides firms with opportunities to develop dynamic capabilities such as real-time data visibility, supply chain agility, and rapid decision-making, which are essential for building resilient supply chains in today's fast-paced business landscape (Teece, Pisano & Shuen, 1997).

Transaction Cost Economics (TCE)

Proposed by Coase in 1937 and further expanded by Williamson in the 1970s, TCE focuses on the costs associated with transactions within economic systems. TCE suggests that firms choose governance structures based on minimizing transaction costs, which can include costs related to information asymmetry, coordination, and opportunistic behavior. In the context of E-commerce integration and supply chain resilience, TCE can help analyze how firms make decisions regarding outsourcing, vertical integration, or partnership models to reduce transaction costs and enhance supply chain flexibility and responsiveness (Williamson, 1979).

Empirical Review

Chen and Zhang (2018) investigated the impact of E-commerce integration on supply chain resilience in the manufacturing sector. The purpose of their research was to analyze how firms' adoption of E-commerce technologies affects their ability to recover from disruptions and maintain operational continuity. The study used survey data collected from 200 manufacturing companies across different industries. The findings revealed a positive correlation between E-commerce integration and supply chain resilience. Firms that had integrated E-commerce reported faster recovery times during disruptions and lower overall disruption costs compared to those with less integrated systems. This suggests that the strategic integration of E-commerce technologies into supply chain operations plays a crucial role in enhancing resilience and minimizing the impact of disruptions. Based on their results, Chen and Zhang recommended that organizations prioritize E-commerce integration as part of their supply chain management strategies to enhance resilience. They also highlighted the importance of ongoing monitoring and evaluation of E-commerce integration efforts to identify areas for improvement and optimization.

Gao and Li (2019) explored the transformative integration of E-commerce and supply chain management in a multinational retail company. The primary aim of their study was to understand how strategic E-commerce initiatives contribute to building a resilient supply chain. The researchers conducted interviews with key stakeholders within the company and analyzed relevant documents to gather qualitative data. The findings highlighted the strategic advantages of transformative E-commerce integration, including improved supply chain visibility, agility, and responsiveness. The company's investment in advanced E-commerce technologies allowed it to monitor and adapt to market changes more effectively, reducing vulnerability to disruptions. Gao and Li emphasized the importance of strategic planning and organizational readiness for E-commerce integration to achieve resilience goals successfully. They recommended that organizations develop comprehensive E-commerce strategies aligned with supply chain objectives, invest in training and development to build digital capabilities, and foster a culture of innovation and adaptability.

Kim and Lee (2022) examined the strategic integration of E-commerce in supply chain management practices across multiple industries. The study aimed to identify best practices and challenges in leveraging E-commerce for supply chain resilience. They used surveys to gather quantitative data from a sample of organizations and conducted in-depth interviews with supply chain professionals to gather qualitative insights. The findings indicated that organizations that strategically integrated E-commerce into their supply chains experienced greater resilience. Specifically, they were better equipped to manage inventory effectively, forecast demand accurately, and implement risk mitigation strategies. The study highlighted the importance of

aligning E-commerce integration efforts with overall supply chain strategies and business objectives. Kim and Lee emphasized the need for continuous monitoring and adaptation of E-commerce strategies to address evolving market dynamics and maintain resilience over time. They recommended that organizations invest in technologies that enable seamless E-commerce integration, develop robust supply chain strategies, and foster collaboration and knowledge sharing across functional areas to enhance resilience and competitive advantage.

Wu and Liu (2023) investigated the transactional integration of E-commerce and its impact on supply chain resilience in the logistics sector. The primary objective was to assess how E-commerce transactions influence supply chain performance and resilience. The researchers collected data from a sample of logistics companies and analyzed transactional data related to E-commerce activities. The findings indicated that firms with higher levels of transactional E-commerce integration reported improved supply chain visibility, reduced lead times, and better collaboration with suppliers. These improvements contributed to enhanced resilience by enabling faster response times to disruptions and increased operational efficiency. The study underscored the importance of transactional E-commerce integration in improving supply chain resilience and suggested that organizations prioritize investments in digital platforms, data analytics capabilities, and collaborative technologies to strengthen resilience and competitiveness in the logistics sector.

Zhang and Wang (2018) examined the evolution of E-commerce integration practices and their impact on supply chain resilience in the retail sector. The study utilized archival data from a panel of retail companies over several years and supplemented it with interviews with industry experts to track changes in E-commerce adoption and resilience strategies. The findings showed that firms that continuously updated their E-commerce capabilities and strategically integrated them into supply chain operations were better able to adapt to market disruptions and maintain operational continuity. The study highlighted the importance of ongoing investments in E-commerce technologies and strategic alignment with supply chain objectives to enhance resilience in the retail sector. Zhang and Wang emphasized the need for agility, flexibility, and responsiveness in E-commerce integration efforts to navigate dynamic market conditions and ensure long-term resilience and competitiveness.

Huang and Chen (2019) explored the influence of E-commerce platform choice on supply chain resilience in the e-retail industry. The researchers compared the resilience outcomes of firms using proprietary E-commerce platforms versus those using third-party platforms. They conducted in-depth case studies and analyzed data on supply chain disruptions, response times, and overall resilience measures. The findings indicated that firms with proprietary E-commerce platforms had greater control over their supply chains, leading to higher levels of resilience compared to those relying on third-party platforms. Huang and Chen highlighted the strategic advantages of proprietary platforms in enabling customization, integration, and control over data and processes. They recommended that organizations carefully evaluate their E-commerce platform choices and consider factors such as platform capabilities, scalability, and alignment with supply chain objectives to enhance supply chain resilience and competitiveness in the e-retail industry.

Li and Zhang (2023) assessed the impact of E-commerce logistics integration on supply chain resilience in the fast-moving consumer goods (FMCG) sector. The researchers surveyed a sample of FMCG companies and collected data on E-commerce logistics integration practices, supply chain performance metrics, and resilience indicators. The findings highlighted the importance of real-time data sharing, collaborative planning, and flexible logistics networks in building resilient

supply chains in the FMCG industry. Li and Zhang emphasized the need for integrated E-commerce logistics systems that enable seamless coordination, visibility, and responsiveness across the supply chain. They recommended that FMCG companies prioritize investments in E-commerce logistics integration technologies, develop collaborative partnerships with logistics providers, and implement agile supply chain practices to improve resilience and adaptability in a dynamic market environment.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

RESULTS

Conceptual Gap: While the studies by Chen and Zhang (2018) and Wu and Liu (2023) provide quantitative insights into the impact of E-commerce integration on supply chain resilience, there is a conceptual research gap in understanding the underlying mechanisms and processes that drive this relationship. Future research could focus on exploring the specific strategies, capabilities, and technologies within E-commerce integration that contribute most significantly to supply chain resilience. This could involve in-depth case studies or qualitative analyses to uncover the nuanced aspects of E-commerce integration that lead to improved resilience outcomes.

Contextual Gap: The studies by Gao and Li (2019), Kim and Lee (2022), and Huang and Chen (2019) predominantly focus on specific industry contexts such as retail and e-retail. There is a contextual research gap in understanding how E-commerce integration impacts supply chain resilience across diverse industries and sectors. Future research could adopt a comparative approach to examine variations in E-commerce integration strategies, challenges, and outcomes across different industry contexts. This could provide valuable insights into industry-specific factors that influence the effectiveness of E-commerce integration in enhancing supply chain resilience.

Geographical Gap: The studies by Chen and Zhang (2018), Gao and Li (2019), and Wu and Liu (2023) primarily focus on the impact of E-commerce integration on supply chain resilience within specific geographical regions or sectors. There is a geographical research gap in understanding how regional differences, regulatory environments, and market dynamics influence the relationship between E-commerce integration and supply chain resilience. Future research could adopt a global perspective to compare and contrast E-commerce integration practices and resilience outcomes across different regions and economies. This could provide valuable insights into the contextual factors that shape the effectiveness of E-commerce integration strategies in building resilient supply chains on a global scale.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The influence of E-commerce integration on supply chain resilience is a multifaceted and critical area of research with significant implications for businesses operating in today's dynamic and interconnected global markets. Through a comprehensive analysis of empirical studies and

theoretical frameworks, several key conclusions can be drawn regarding this influence. Firstly, E-commerce integration plays a pivotal role in enhancing supply chain resilience by improving visibility, agility, and responsiveness across the supply chain network. Studies such as those by Chen and Zhang (2018), Gao and Li (2019), and Wu and Liu (2023) have consistently demonstrated a positive correlation between E-commerce adoption and faster recovery times during disruptions, lower overall disruption costs, and improved collaboration with suppliers. These findings underscore the strategic value of leveraging E-commerce technologies to build resilient supply chains capable of adapting to unforeseen challenges and disruptions.

Secondly, the transformative impact of E-commerce integration extends beyond operational efficiencies to strategic advantages such as enhanced market adaptability, customer responsiveness, and competitive advantage. Research by Kim and Lee (2022) and Huang and Chen (2019) highlights how organizations that strategically integrate E-commerce into their supply chains experience greater resilience, better inventory management, and effective risk mitigation strategies. This strategic alignment of E-commerce initiatives with supply chain objectives is crucial for organizations seeking to navigate complex market dynamics and sustain long-term competitiveness. Furthermore, the evolution of E-commerce integration practices, as observed in longitudinal studies like that of Zhang and Wang (2018), underscores the importance of continuous innovation, adaptation, and alignment with evolving market trends. The dynamic nature of E-commerce technologies necessitates ongoing investments, monitoring, and evaluation to ensure that integration efforts remain effective in enhancing supply chain resilience over time.

In conclusion, the evidence from empirical studies and theoretical frameworks highlights the transformative impact of E-commerce integration on supply chain resilience, emphasizing the strategic imperative for organizations to prioritize digitalization, innovation, and strategic alignment within their supply chain management strategies. By leveraging the opportunities presented by E-commerce technologies and best practices, organizations can build agile, responsive, and resilient supply chains capable of thriving in an increasingly competitive and disruptive business landscape.

Recommendations

The following are the recommendations based on theory, practice and policy:

Theory

To advance theoretical understanding, it is recommended to conduct further research on the specific mechanisms and processes within E-commerce integration that significantly contribute to supply chain resilience. This entails exploring the role of advanced analytics, AI-driven decision-making, blockchain technology, and IoT devices in enhancing supply chain visibility, agility, and responsiveness during disruptions. Additionally, developing and validating theoretical frameworks that integrate concepts from supply chain management, digital transformation, and resilience theory would provide a deeper understanding of the underlying dynamics at play. These efforts would contribute significantly to enhancing the theoretical foundations of E-commerce integration and supply chain resilience.

Practice

In terms of practical implications, organizations should foster a culture of innovation, agility, and collaboration to support effective E-commerce integration initiatives. This involves investing in

training and development programs to build digital capabilities among employees and encouraging cross-functional collaboration between supply chain, IT, and marketing departments. Implementing robust risk management strategies that leverage E-commerce data analytics and real-time monitoring tools to identify potential disruptions, assess their impact, and proactively mitigate risks is also crucial. Developing contingency plans and response protocols ensures rapid and effective responses during crises or unforeseen events, enhancing overall supply chain resilience in practice.

Policy

On the policy front, it is recommended to advocate for regulatory frameworks that support digital innovation, interoperability, and data security within E-commerce ecosystems. Engaging with policymakers to address legal and regulatory barriers that may hinder seamless E-commerce integration across supply chains, such as data privacy regulations, cross-border trade restrictions, and cybersecurity concerns, is essential. Collaborating with industry associations, standardization bodies, and government agencies to develop industry-wide best practices, guidelines, and certifications for E-commerce integration and supply chain resilience is also beneficial. Encouraging knowledge sharing, benchmarking, and peer learning among organizations will drive continuous improvement and industry-wide resilience initiatives, ultimately contributing to a more robust and resilient supply chain ecosystem at the policy level.

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