Covid-19 and the South African pharmaceutical supply chain: drivers, strategies, and recommendations

Blessing Takawira(a)* David Pooe (b)

(a) Ph.D., Postdoctoral Research Fellow, Department of Business Management, University of Johannesburg, D Ring 521A Auckland Park Kingsway Campus, South Africa
(b) Prof. & Head of Department, Department of Business Management, University of Johannesburg, D Ring 521A Auckland Park Kingsway Campus, South Africa

ARTICLE INFO

Article history:
Received 20 October 2023
Received in rev. form 11 Nov. 2023
Accepted 29 November 2023

Keywords:
Supply chain drivers, pharmaceutical industry, COVID-19 pandemic,
Supply Chain Risk Management,
Pricing, Sourcing, Strategies

JEL Classification:
E31, F44, H14, L21

ABSTRACT

This research aimed to identify the key drivers of the pharmaceutical supply chain during the COVID-19 pandemic disruption, focusing on the South African pharmaceutical industry. The study aimed to unveil the dynamic strategies and challenges experienced during the pandemic and suggest recommendations for resilient supply chain operations. The study drew on established supply chain management theories and integrated them with the unique and novel circumstances of the COVID-19 pandemic. It mainly referred to theories regarding pricing, strategic sourcing, ICT usage, product availability, and logistics management contextualised within the pharmaceutical industry. An exploratory research approach was adopted to uncover the five overarching themes that function as driving forces for pharmaceutical supply chain drivers during the COVID-19 pandemic. Semi-structured interviews were used to acquire the primary data with industry supply chain professionals, supplemented with secondary data from industry reports and relevant literature. The findings revealed that the pricing of medications, strategic sourcing decisions, information and communication technology, the availability of pharmaceutical products, and logistics management played critical roles in the pharmaceutical industry's supply chain during the COVID-19 pandemic. Disruptions caused by the COVID-19 pandemic led to challenges such as price hikes, supply shortages, and logistical complications. The study provides crucial insights into managing supply chain disruptions amid a global health crisis. Implementing dynamic pricing mechanisms, developing resilient sourcing strategies, using ICT effectively, improving inventory management, and enhancing logistics management are recommended for robust supply chain operations. The findings contribute to academia by enriching the existing body of knowledge and offering practical solutions for industry supply chain professionals. The research is original and timely, offering a unique perspective on the South African pharmaceutical industry's supply chain during an unprecedented global health crisis. The results are valuable for academia and industry, shedding light on the adaptive strategies, challenges encountered, and lessons learned from navigating the pharmaceutical supply chain during the COVID-19 pandemic.

© 2023 by the authors. Licensee SSBFNET, Istanbul, Turkey. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).

Introduction

The COVID-19 pandemic has significantly impacted the pharmaceutical industry, leading to disruptions in supply chains and highlighting vulnerabilities. As a result, there is a growing need to understand the drivers that can enhance the resilience and sustainability of pharmaceutical supply chains during such crises. Several studies have focused on investigating these drivers and strategies for mitigating disruptions. Gupta and Kayande (2023) aim to develop an adaptive model to enhance the resilience capabilities of pharmaceutical supply chains. Karmaker et al. (2021) explore the drivers of sustainable supply chains in the context of the COVID-19 pandemic in Bangladesh. Ekandjo (2022) investigated strategies for mitigating disruptions in the pharmaceutical supply chain using Namibia as a case study. Haddad et al. (2023) assess supply chain disruption caused by the COVID-19 epidemic integration of the pharmaceutical sector in Egypt.

* Corresponding author. ORCID ID: 0000-0002-1633-8693

© 2023 by the authors. Hosting by SSBFNET. Peer review under responsibility of Center for Strategic Studies in Business and Finance.
https://doi.org/10.20525/ijrbs.v12i8.2973
Additionally, Tetteh et al. (2022) discuss the drivers of digital transformation in the pharmaceutical sector, while Srivastava (2022) examines drivers for establishing sustainability in supply chains post-pandemic. Furthermore, Vanany et al. (2021) identify strategies managers employ to tackle disruptions in the pharmaceutical supply chain during the pandemic. The pandemic has also caused the supply chain and production of herbal medicinal raw materials, as highlighted by (Yu, 2022). Lastly, Ayati et al. (2020) predict the effects that the epidemic will have on the pharmaceutical industry in the long run, including changes in consumption trends and self-sufficiency in supply chains. These studies provide valuable insights into the drivers of supply chain resilience and sustainability in the pharmaceutical industry during the COVID-19 pandemic.

The COVID-19 pandemic caused significant disruptions for many supply chains worldwide (Ivanov, 2020a). Border closures, lockdowns in the supply market, disruptions in transportation systems and global trade, lack of available workers, and the need to keep a physical distance between production facilities impacted supply chains in a manner never experienced before (Moosavi et al., 2022). According to Boro and Stoll (2022), the manufacturing, supply and distribution of medicines constrained the global medicines, especially during the early months of the COVID-19 pandemic supply chain. While there was an improvement in the supply of pharmaceuticals with time, it has been noted that global supply chains challenges continued (Yu et al., 2021)

There is a need to understand the supply chain drivers of pharmaceutical industries during periods of significant disruptions such as pandemics since this will enable the industry and policymakers to design or redesign such supply chains to become more resilient in the future (Socal et al., 2021). Although there has been a dearth of research on supply chain drivers in the event of disruptions in the pharmaceutical industry. A few studies conducted in emerging economies focused on the supply chain challenges in pharmaceutical manufacturing companies (Moosivand et al., 2019), sustainability of supply chains following the COVID-19 pandemic (Liza et al., 2022). A recent study by Chowdhury et al. (2021) was conducted in Bangladesh, determining critical drivers in the mitigation of supply chain disruptions in the pharmaceutical industry by relying on previous studies and opinions of academics. This study aimed to investigate supply chain drivers in the pharmaceutical industry during the COVID-19 pandemic in South Africa. The precise question this study hopes to solve are as follows: What are the key drivers of the supply chain in the pharmaceutical industry during the COVID-19 pandemic in South Africa?

Literature Review

Theoretical Framework

The study's theoretical framework is based on the existing theories of Supply Chain Risk Management (SCRM) and its application in the pharmaceutical business amidst the COVID-19 pandemic. The idea of SCRM plays a crucial role in the identification, evaluation, and mitigation of potential risks to ensure the continuous flow of supplies during times of crises (Christopher, 2022; El Baz & Ruel, 2021). The aforementioned principles have played a crucial role in directing the pharmaceutical industry's reaction to the disruptions caused by the COVID-19 pandemic, underscoring the importance of implementing robust and sustainable practises within the supply chain.

The framework is visually illustrated in Figure 1, presenting a conceptual map of the pharmaceutical supply chain and its interconnected components that play a vital role in ensuring the uninterrupted flow of the supply chain amidst the pandemic. Figure 1 depicts the pivotal position of the Pharmaceutical Supply Chain, which connects many components like Uninterrupted Medicines Supply, Health Care Availability, and Logistics. These elements are represented as distinct nodes of varying colours, symbolising their individual functions and interconnections.

The perspective of SCRM holds significant relevance within the framework of the COVID-19 pandemic, as it serves as the foundation for devising strategies to address disruptions in pharmaceutical supply chains and offers valuable insights into the key factors that contribute to resilience (Hohenstein, 2022). The red node in Figure 1 illustrates several strategies in supply chain management that are crucial for risk mitigation and enhancing supply chain resilience. These strategies, as identified by Gupta and Kayande (2023) and Karmaker et al. (2021), encompass contingency planning, dual sourcing, safety stock management, and agility in response to disruptions.

Risk management strategies refer to the systematic approaches and measures implemented by organisations to identify, assess, and mitigate potential risks (Rehacek, 2019; Vochitou et al., 2020). These strategies are designed to minimise the negative impact of risks on an organisation's objectives and enhance its the aforementioned strategies are essential for the pharmaceutical sector's capacity to address and rebound from the effects of the pandemic (Ivanov, 2020a). Several studies have demonstrated the use of the SCRM concept to the pharmaceutical business (Ayati et al., 2020; Guerin et al., 2020; Nguyen et al., 2022; Shraah et al., 2022). The aforementioned studies have conducted assessments on the resilience and operational effectiveness of pharmaceutical companies operating within the worldwide supply chain. These studies have placed particular emphasis on the significance of having diversified supply chains and using proactive risk management strategies.

The synthesis of various views within the theoretical framework underscores the significance of SCRM in the South African pharmaceutical industry's efforts to address the COVID-19 pandemic (Hove-Sibanda et al., 2021). The framework emphasises the importance of precise risk identification, comprehensive risk assessment, and the execution of efficient risk mitigation techniques.
These factors have played a crucial role in guaranteeing the uninterrupted provision of vital medications amidst the ongoing global medical crisis.

The theoretical framework for this study is built upon the concept of supply chain resilience and sustainability, focusing specifically on the pharmaceutical industry in the wake of the COVID-19 pandemic. This framework derives its principles from theory, of SCRM. The SCRM perspective focuses on identifying, assessing, and mitigating potential risks within a supply chain. Disruptions in the supply chain brought to light the importance of effective risk management in the context of the COVID-19 pandemic. This perspective underpins the strategies for tackling disruptions in pharmaceutical supply chains and provides insights into the critical drivers for resilience (Hohenstein, 2022). The theoretical framework synthesises these perspectives and highlights the following key drivers of supply chain resilience in the pharmaceutical industry during the COVID-19 pandemic. Risk Management Strategies - These include contingency planning, dual sourcing, safety stock management, and agility in response to disruptions (Gupta & Kayande, 2023).

![Figure 1: Conceptual map of the pharmaceutical supply chain](image)

**Supply Chain Risk Management (SCRM)**

SCRM plays a crucial role in the resilience of supply chains, especially during times of crisis. According to El Baz and Ruel (2021), SCRM is pivotal in identifying, assessing, and mitigating potential risks that could impact the performance of the supply chain. The COVID-19 pandemic has underscored this point, as pharmaceutical companies have had to contend with various disruptions, emphasising the importance of effective risk management strategies. Contingency planning, dual sourcing, safety stock management, and agile responses to disruptions have been vital tactics to mitigate risk and strengthen supply chain resilience (Gupta & Kayande, 2023; Karmaker et al., 2021).

The effects of the COVID-19 epidemic have caused the pharmaceutical sector to pay more attention to SCRM. The Indian pharmaceutical industry has played a crucial role in meeting the global demand for medical products during the pandemic (Guerin et al., 2020). Pharmaceutical enterprises’ risk resilience and performance in the global supply chain have been evaluated (Nguyen et al., 2022). Risk management and capacity optimisation in pharmaceutical supply chain models have been the focus of research (Shraah et al., 2022). The COVID-19 pandemic has highlighted the need for diversifying supply chains and avoiding dependencies on a single source (Ocicka et al., 2022). The pandemic has disrupted the effectiveness and responsiveness of global supply chains, necessitating the development of strategies to mitigate risks and enhance resilience (Shen & Sun, 2023). Recovering the global supply chain and adopting appropriate approaches to SCRM have become essential factors in adapting to the new normal (Raj et al., 2022). The pandemic’s short- and long-term impacts on the pharmaceutical sector have also been analysed (Ayati et al., 2020). Overall, SCRM in the pharmaceutical industry requires proactive measures to address vulnerabilities and ensure a resilient and agile supply chain in the face of unforeseen challenges like the COVID-19 pandemic.

The SCRM perspective provides a valuable framework for understanding the challenges and opportunities facing the pharmaceutical industry in South Africa during the COVID-19 pandemic. SCRM emphasises identifying, assessing, and mitigating potential risks within a supply chain (Christopher, 2022). This framework has been applied and adapted to several industrial sectors, including pharmaceuticals, during the COVID-19 pandemic (Ivanov, 2020a).

A central tenet of SCRM is the importance of risk identification. This step involves the use of predictive analytics and proactive monitoring to identify potential disruptions before they happen (El Baz & Ruel, 2021). In the context of the COVID-19 pandemic, the rapid spread of the virus and subsequent government-imposed lockdowns presented significant risks to pharmaceutical supply
chains (Paul & Chowdhury, 2021). The importance of accurate risk identification during the pandemic has been underlined by several South African studies (Hove-Sibanda et al., 2021).

The second step, risk assessment, involves analysing the potential impact of identified risks (Hohenstein, 2022). For instance, the closure of production facilities due to COVID-19 infections among employees could lead to shortages of essential drugs (BenAmor et al., 2022). Assessing these risks allows companies to prioritise their risk management efforts effectively (Govindan et al., 2017).

The final step, risk mitigation, is arguably the most critical aspect of SCRM (Hohenstein, 2022). It involves implementing strategies designed to reduce the likelihood or impact of supply chain disruptions. In the context of the COVID-19 pandemic, several risk mitigation strategies have been proposed and implemented, such as contingency planning, dual sourcing, safety stock management, and agile responses to disruptions (Ivanov, 2020a). These strategies have proven particularly relevant to the pharmaceutical industry in South Africa, where the pandemic has strained resources and disrupted supply chains (Hove-Sibanda et al., 2021; Karmaker et al., 2021).

Overall, the SCRM framework offers a robust approach to managing supply chain risks in the pharmaceutical industry during the COVID-19 pandemic. It underscores the importance of proactive risk identification, thorough risk assessment, and effective risk mitigation strategies to ensure the continued supply of essential drugs during a global health crisis.

Research & Methodology

Qualitative research methods were used in this analysis of how pharmaceutical supply chain professionals dealt with the 2019 COVID-19 pandemic (Creswell & Creswell, 2023). This research design was specifically chosen for its flexibility and depth, providing the means to understand complex phenomena within their contexts. The philosophical and theoretical approach to this research, as visualized in Figure 1, influenced the selection of the purposive sampling method, with a sample of 25 participants who were specifically selected for their deep knowledge and experience in pharmaceutical industry supply chains, ensuring that the research results are informed by expertise (Tenny et al., 2023).

Data was collected through semi-structured interviews, chosen for their ability to facilitate a dialogic and in-depth exploration of the participants’ experiences and perspectives (DeJonckheere & Vaughn, 2019). This process involved the use of probing questions, informed consent from participants, and the recording of interviews for subsequent accuracy checks and transcription. The transcriptions were then subjected to qualitative thematic analysis, a robust and flexible method for identifying, analysing, and reporting patterns within data (Braun & Clarke, 2022), allowing for a nuanced understanding of the complexities within the data. This process involved coding, categorising, and theming the data, with the main aim of identifying critical supply chain drivers during the COVID-19 pandemic (Aspers & Corte, 2019).
To ensure the reliability and validity of the research, trustworthiness was a key consideration. Trustworthiness was ensured by adhering to rigorous recording, transcription, and data analysis procedures, as recommended by Nowell et al. (2017). The credibility of the findings was bolstered through peer debriefing with not just one, but multiple knowledgeable supply chain scholars and a qualitative methodology expert to challenge and verify the research findings, while dependability was established through detailed descriptions of the research design and data collection procedures (Knott et al., 2022). Additionally, an audit trail was maintained to provide a transparent description of the research process and justify the decisions made at each stage. Confirmability indicating the experiences and meanings of the participants rather than the researcher’s attributes, was achieved through reflexivity and a commitment to maintaining a neutral stance throughout the research process (Enworo, 2023).

Results and Discussions

The research uncovered five overarching themes that drove the pharmaceutical supply chain during the COVID-19 pandemic: the challenges of product availability, price hikes, supply shortages, and logistical complications in addition to the availability of pharmaceutical products, the role of information and communication technology (ICT), the price of medications, strategic sourcing, and logistics management. The disruption of the pharmaceutical supply chain in South Africa was proven to have an impact at both the industry and corporate levels. Our research has elucidated five dominant themes that were significant influencers or drivers for the pharmaceutical supply chain amid the unprecedented COVID-19 pandemic. These include the availability of pharmaceutical products, the integral role of information and communication technology (ICT), the pricing of medications, strategic sourcing, and professional logistics management. The wide-reaching impacts of the pandemic resulted in considerable disruption to the supply chain at both company and industry-wide levels, specifically within the context of the South African pharmaceutical industry.

The Price of Medications

The pandemic led to fluctuating prices due to disrupted supply chains, with specific examples of price hikes for high-demand products such as personal protective equipment (PPE) and certain medications. The following quotations illustrate the theme of medication pricing during the pandemic:

"During the pandemic, we learned that drug prices were more than just a component in costs; they were a key lever for maintaining supply chain stability." (P12) Participants noted price increases of up to 300% for certain generic drugs that were in high demand due to COVID-19 treatments.

"Short-term discounts helped manage unexpected demand surges and supply surpluses while maintaining stable prices ensured a steady demand." (P03) However, these short-term measures were often not sustainable, as suppliers faced their own price hikes in raw materials and logistics.

"This crisis showed us how deeply the cost structure impacts the supply chain, potentially leading to shortages and higher prices." (P19)

During the COVID-19 pandemic, the pricing of medications proved pivotal in balancing supply and demand, especially in situations where the supply chain was less flexible, reaffirming the findings of Gereffi (2020). This trend was particularly noticeable when sudden demand surges or supply gluts occurred, leading some businesses to implement short-term discounts as a strategic response. As per the insights shared by Govindan et al. (2020), such price adjustments play a crucial role in managing market dynamics during periods of volatility. In contrast, maintaining stable prices helped ensure a constant demand level, acting as an anchor during uncertain times. This strategy echoes the work of Zhao et al. (2022), which emphasises price stability as a critical element in fostering consumer trust and maintaining demand during crises.

Further, to cater to a broader range of clients, companies modified their pricing structures in alignment with customers’ desired response times. This dynamic pricing strategy aligns with the research conducted by Yang et al. (2022). This study highlights the potency of dynamic pricing mechanisms in optimising supply-demand equilibrium and fostering resilience in the face of unprecedented market disruptions.

Strategic Sourcing

The pandemic underscored the vulnerabilities of over-reliance on a limited number of suppliers, particularly when countries went into lockdown and restricted exports. Participant quotes pertaining to strategic sourcing during the pandemic:

"Efficiency and responsiveness drove our strategic sourcing decisions during the pandemic, aiming for the highest possible surplus. Like some others, we relied on multiple sources for the same molecules, highlighting the critical nature of diversification within the supply chain." (P07)

"Many of us turned to imports as a critical resource during the crisis. However, the reality of border closures and complex logistics due to COVID-19 challenged our strategies, teaching us a tough lesson about the inherent vulnerabilities of over-dependence on global supply lines." (P2) Specifically, the shutdown of production in key supplier countries like India and China led to a shortage of active pharmaceutical ingredients (APIs), causing significant delays and requiring the sourcing from alternative, often more expensive, suppliers.
"The COVID-19 pandemic compelled us to rethink our sourcing strategies to ensure efficiency and responsiveness, ultimately maximising surplus. Some businesses, including ours, opted for multiple sourcing to secure the same molecule, while others leaned heavily on imports. However, we faced similar challenges as border closures and logistical complications during the pandemic strained these strategic decisions. This crisis underscored the necessity of resilient, diversified sourcing strategies in our industry." (P15)

As an operational strategy, strategic sourcing was leveraged by numerous businesses during the tumultuous times of the COVID-19 pandemic. The predominant strategies identified were multi-sourcing and heavy dependency on imports to ensure a steady supply chain (Nikolopoulos et al., 2021). Multi-sourcing, in particular, played a crucial role, allowing businesses to secure the same molecule from various sources, thus providing a cushion against potential supply disruptions (El Baz & Ruel, 2021). On the other hand, other businesses heavily relied on imports, which typically ensure access to a broader range of products, sometimes at lower costs (Christopher, 2022). However, the COVID-19 pandemic created unique challenges for these sourcing strategies. Primarily, logistical difficulties and border closures significantly hampered the international movement of goods, destabilising supply chains, especially those heavily reliant on imports (Ivanov, 2020a). These unprecedented challenges underscored the urgent need for more resilient strategic sourcing strategies capable of withstanding large-scale global disruptions (Paul & Chowdhury, 2020). The pandemic served as a wake-up call for businesses to reevaluate their sourcing strategies and adapt them to be more robust and agile to successfully navigate future disruptions of similar magnitude (Ivanov & Dolgui, 2020).

The role of information and communication technology (ICT)

Participant insights on the role of ICT during the pandemic:

"Leveraging information and communication technology was critical in navigating the storm. The increased responsiveness and cost efficiency these tools offered was game-changing, even though they did introduce a new layer of complexity to our operations." (P01)

However, the sudden shift to remote work also introduced challenges in ICT, such as cybersecurity threats and the need for rapid upskilling of staff to manage new digital tools.

"ICT tools significantly bolstered our responsiveness and helped shave down our costs. However, their implementation's added complexity and costs proved to be a double-edged sword, with potential risks and challenges we had to manage carefully." (P23)

"The integration of ICT has been pivotal in improving the responsiveness and reducing costs associated with supply chain operations." (P01)

"The application of digitisation, including ICT use, helped us build a transparent, efficient, and responsive supply chain, transforming our operations." (P08)

"While ICT adoption offered advantages, we faced challenges with the increased complexity, which brought higher costs and potential operational risks." (P10)

"The judicious use of ICT was crucial to the seamless execution of our supply chain operations during the crisis." (P03)

"Adequate training and support systems in place allowed us to mitigate risks associated with ICT implementation, ensuring we reaped maximum benefits." (P04)

The central role of Information and Communication Technology (ICT) in supply chain management emerged as a significant highlight of our study, resonating with Dubey et al. (2021)’s observations. ICT implementation can considerably enhance responsiveness and attenuate costs linked to supply chain operations. Therefore, this underscores the findings of Queiroz et al. (2020), who posit that digitisation, including ICT use, can aid in creating more transparent, efficient, and responsive supply chains. While ICT's advantages are clear, it is also worth acknowledging the potential challenges. In line with the research of Ahi et al. (2022), adopting ICT may lead to increased complexity, thus raising the associated costs and the potential for operational risks. Therefore, ICT's judicious integration and application remain crucial for supply chain operations' seamless execution. Here, it is worth noting the work of Shekarian and Mellat Parast (2021), who suggest that a careful, strategic approach towards ICT implementation, ensuring adequate training and support systems, can mitigate risks while maximising benefits. Overall, while ICT adoption offers promising prospects for improving supply chain efficiency, businesses must carefully consider and manage the potential complexities and costs to ensure optimal outcomes.

The availability of pharmaceutical products

The research participants provided specific examples of supply shortages, such as the scarcity of medications like paracetamol, insulin, and certain antibiotics. Participant responses highlighting issues related to product availability:

"COVID-19 disruptions turned the routine task of maintaining inventory levels into a high-stakes balancing act. An unpredictable demand spike and import/export restrictions made product availability a pressing issue." (P25) Additionally, participants described how logistics complications, such as reduced air freight capacity and delays at customs, exacerbated these product shortages.
"We faced significant challenges in keeping up with the sudden surge in demand, exacerbated by logistical complications and constraints on imports and exports. These factors resulted in multiple out-of-stock scenarios, severely hampering our supply chain efficiency." (P17)

"Availability became a key issue. With COVID-19, we were facing stock shortages like never before. This was not just about managing inventory anymore; it was about navigating a pandemic." (P20)

"The surge in demand for certain products, coupled with import/export restrictions and logistical problems, caught us off guard. Before we knew it, we were dealing with out-of-stock situations and a significantly hampered supply chain." (P05)

"The supply chain was completely disrupted. Unforeseen surges in demand, coupled with restrictions on imports and exports, caused stock shortages and disrupted inventory levels. We were constantly battling to maintain supply."

Aligned with Ivanov (2018) findings, our study underscored the availability of pharmaceutical products as a critical concern amidst the COVID-19 pandemic. The pandemic has undeniably triggered a ripple effect, resulting in stock shortages and challenges in maintaining ideal inventory levels. These situations are primarily instigated by an unforeseen upsurge in demand for specific products, as demonstrated by Chopra (2020), and also by constraints imposed on imports and exports Roser et al. (2021), together with a myriad of logistical complications (Herold et al., 2021). This constellation of factors collectively impacted the Efficiency and robustness of the pharmaceutical supply chain, reinforcing the findings articulated by Queiroz et al. (2020). It further highlights the need for effective strategies to manage inventory levels and demand forecasting more accurately during periods of crisis, as suggested by (Yu et al., 2022). Notably, Zhao et al. (2023) argue that supply chain digitisation and the development of local production capacities may offer viable solutions to product availability problems, bolstering supply chain resilience. These insights add a new dimension to understanding the profound impacts of global health crises on pharmaceutical supply chains, calling for more robust strategies and policies to enhance their resilience and performance in the face of similar future challenges.

Logistics management

Participant thoughts on the challenges of logistics management during the pandemic:

"Logistical hurdles due to safety measures and occasional shutdowns of facilities caused major disruptions. We had longer lead times, higher costs, and a more unpredictable supply chain." (P24) For instance, participants highlighted specific logistical challenges such as the repurposing of commercial passenger flights for cargo, leading to space constraints and increased freight costs.

"Our greatest challenge was our lack of preparedness for the pandemic. High demand for treatment items and insufficient initial planning led to frequent shortages, hitting our supply lines hard." (P06)

"Technological disruptions became another hurdle to overcome, causing inaccuracies in reporting and adding complexity to an already strained process management system." (P02)

"Our supply-chain performance suffered during the pandemic. Navigating delivery in high-risk areas, parcel preparation issues, and a lack of night shifts during lockdowns were substantial challenges." (P08)

"Shipping costs soared and strategising to service high-risk areas became necessary. Imported products too saw a price surge, leading to a significant increase in our supply-chain costs." (P14)

"We soon realised that market forces, not just our industry responses, would guide recovery. Everything hinged on where demand would spring from and who could meet it."

"Amidst the chaos, the importance of structural flexibility came to the fore. Engaging retail representatives became a vital part of our strategy when traditional fieldwork became constrained." (P13)

"Thinking globally, acting "locally" became our mantra. Converting raw materials "locally" seemed a viable solution to increase efficiency, reduce wastage, and overcome some of our disruptions." (P19)

During the COVID-19 pandemic, logistical and supply chain management emerged as key challenges, substantiating findings presented by (Zhao et al., 2020). Our participants' responses underscored the exigency for enhanced Efficiency, strategic planning, structural flexibility, and localised solutions to navigate these complexities. Therefore, this bolsters the findings of Ivanov and Das (2020), who emphasised the criticality of a resilient supply chain to respond effectively to sudden disruptions.

Logistical issues, primarily rooted in safety measures, such as needing personal protective equipment (PPE) and vehicle sanitisation, led to increased lead times and costs, reflecting insights from Craighead et al. (2020). In some cases, an outbreak among personnel led to the shutdown of entire facilities or fleets, underscoring the need for robust health and safety measures as part of logistical planning, as suggested by Sarkis et al. (2020). The pandemic also exposed the lack of preparedness among many companies, which aligns with Ivanov (2020b) observations. This lack of anticipation resulted in frequent shortages due to a sudden increase in demand, particularly for COVID-19-related medical supplies, reinforcing the importance of effective demand forecasting methods as suggested by Kamar et al. (2021). Furthermore, the surge in logistics and supply chain management costs was evident, echoing the findings of Lopes de Sousa Jabbour et al. (2018). For instance, increased shipping costs and the need to strategise deliveries to high-
risk areas added financial burdens to the strained operations. These challenges highlight the importance of resilient and flexible logistics management and support the recommendations of Ivanov and Dolgui (2021) for robust crisis management strategies that prioritise adaptability and risk mitigation.

To summarise, this study aligns with the existing literature. Further, it enriches it by providing an in-depth understanding of the challenges and strategies adopted by the pharmaceutical industry during the COVID-19 pandemic. It emphasises that pricing, sourcing strategies, the use of ICT, and product availability all play crucial roles in managing the supply chain. Moreover, it highlights the value of logistics management in responding to significant disruptions. However, the pricing, sourcing strategies, use of information technology, and product availability played a vital role in the pharmaceutical industry’s supply chain during the COVID-19 pandemic. Challenges such as price increases, supply shortages, and logistical complexities arose as a result of the pandemic’s interruptions. Furthermore, the COVID-19 pandemic posed significant logistical and supply chain management challenges for the pharmaceutical industry. Responding to these challenges required increased efficiency, strategic planning, structural flexibility, and localised solutions.

The mind map figure 3 below provides a comprehensive overview of the key drivers faced by the pharmaceutical supply chain during the COVID-19 pandemic. It visually represents five primary themes: Pricing of Medications, Strategic Sourcing, Role of ICT, Availability of Pharmaceutical Products, and Logistics Management. Each theme is further broken down into sub-themes, illustrating the complexity and interconnectivity of the issues. The diagram effectively encapsulates the multifaceted nature of the challenges, including dynamic pricing mechanisms, multi-sourcing strategies, the integration of ICT, inventory management, and logistical complexities. This visual representation aids in understanding the intricate dynamics and strategic responses within the pharmaceutical industry during the pandemic.

![Mind map of Pharmaceutical Supply Chain Challenges During COVID-19](image)

**Figure 3: Mind map of Pharmaceutical Supply Chain Challenges During COVID-19**

**Conclusions**

Our research has provided valuable insights into the various drivers of the pharmaceutical supply chain during the COVID-19 pandemic, distinct contributions to both academic knowledge and industry practice.

**Academic Contributions:**

i. This study enriches the literature on supply chain resilience by providing empirical evidence from the South African pharmaceutical industry during a global health crisis.

ii. It offers a novel evaluation of dynamic pricing mechanisms within an inflexible supply chain context, advancing the theoretical understanding of pricing strategies during crises.

iii. Our findings on strategic sourcing contribute to the discourse on supply chain diversification, providing real-world instances of its challenges and benefits.

iv. The role of ICT in supply chain management has been explored, with our research highlighting the balance between technology adoption and operational complexity.

v. We have also deepened the conversation around inventory management during demand surges, contributing to the body of knowledge on crisis-induced stock shortages.

**Industry Contributions:**

i. Practically, we provide actionable recommendations that can be implemented by industry professionals to enhance supply chain resilience.
Our research on dynamic pricing offers practical strategies for businesses to manage demand fluctuations during similar future events.

We underscore the necessity for companies to adopt resilient sourcing strategies, offering guidance on developing local sources and reducing import dependency.

The study advocates for the practical implementation of ICT, advising on steps for effective integration to optimize supply chain operations.

For inventory management, we suggest methods for better demand prediction and stock level management, aiming to prevent shortages.

In logistics management, we recommend strategic planning and structural flexibility, which are imperative for navigating future supply chain disruptions.

We have identified five significant factors that notably impacted the pharmaceutical industry in South Africa. These include the pricing of medications, strategic sourcing, the role of ICT, availability of pharmaceutical products, and logistics management. We concluded that the pricing of medications played a pivotal role in matching supply and demand during the crisis, especially when the supply chain was inflexible. Therefore, this led to short-term discounts to mitigate sudden demand surges, supply surpluses and adjustments in pricing based on the customer's desired response time. Therefore, dynamic pricing mechanisms are necessary to optimise the supply-demand balance during crises. Strategic sourcing decisions were crucial in ensuring the continuous supply of pharmaceutical products. Businesses adopted multi-sourcing strategies or relied on imports for the same. However, border closures and logistical complications caused by the pandemic challenged these strategies, stressing the need for resilient sourcing strategies. ICT emerged as an essential tool in boosting responsiveness and reducing supply chain costs. However, the complexity and cost associated with its implementation posed certain risks and challenges, necessitating its effective integration and utilisation for smoother operations. The availability of pharmaceutical products posed significant challenges due to stock shortages and difficulties in maintaining inventory levels. The COVID-19 disruptions led to an unforeseen surge in demand and restrictions on imports and exports, impacting the supply chain's Efficiency. Lastly, the pandemic posed significant logistical and supply chain management challenges. Responding to these required heightened Efficiency, strategic planning, structural flexibility, and localised solutions, emphasising the importance of robust logistics management.

Based on our findings, we recommend Dynamic Pricing Mechanisms: Companies should consider implementing dynamic pricing mechanisms, allowing them to adjust prices based on supply-demand fluctuations and customer response times. To practically implement this, companies could use data analytics to forecast demand trends and develop a pricing model that automatically adjusts prices based on predetermined rules such as inventory levels, time-to-delivery, and market conditions. This strategy can effectively manage demand and ensure supply chain stability during crises. Resilient Sourcing Strategies: Companies should develop resilient sourcing strategies to withstand significant disruptions. A practical approach is to diversify the supplier base geographically and by capability, establish strategic partnerships with key suppliers, and conduct regular risk assessments to prepare for supply chain disruptions. Additionally, developing local sources through investment in domestic manufacturing can reduce dependency on international markets. Considering multi-sourcing options or developing local sources can reduce import dependency and vulnerability to border closures and logistical complications. Practical Implementation of ICT: Businesses should invest in technology and focus on the practical implementation of ICT. This involves selecting scalable and secure supply chain management software, training employees on digital literacy, and creating a technology-friendly culture within the organization. Employing ICT for real-time tracking of shipments and inventory can significantly enhance the transparency and agility of the supply chain. Therefore, this can enhance responsiveness, reduce supply chain costs, and manage the complexities associated with supply chain operations. Inventory Management: Companies should develop robust inventory management systems to predict demand and manage stock levels. Practical steps include using demand forecasting tools, setting up just-in-time inventory practices, and employing demand-driven planning to minimize stockouts and overstock situations. Therefore, this can help prevent stock shortages and ensure the continuous availability of pharmaceutical products. Enhanced Logistics Management: There is a need for more robust logistics management that includes strategic planning, structural flexibility, and localised solutions. Practically, this involves redesigning the logistics network to be more responsive, investing in logistics infrastructure to improve efficiency, and collaborating with logistics service providers to create contingency plans for crisis scenarios. Therefore, this will help manage logistical complications and ensure the supply chain's stability during crises.

Each of these recommendations entails a strategic approach that integrates both technological innovation and operational adjustments. For instance, dynamic pricing requires not only the right tools but also a cultural shift towards more agile and responsive pricing strategies. Similarly, resilient sourcing strategies necessitate a deeper relationship with suppliers and a keen understanding of the geopolitical landscape affecting supply chains. Moreover, implementing ICT in supply chain operations should go beyond mere adoption; it requires a strategic alignment with business goals, training for staff, and a readiness to invest in ongoing technological upgrades. Effective inventory management and enhanced logistics management are not isolated activities but are interconnected pieces of a complex puzzle that requires a holistic approach to supply chain optimization.

This study offers a deeper understanding of the pharmaceutical industry's challenges and strategies during the COVID-19 pandemic. By practically applying these recommendations, companies can bolster their supply chains, making them more robust and resilient to withstand future crises. By applying these recommendations, companies can strengthen their supply chains, making them more robust and resilient to withstand future crises.
robust and resilient to withstand future crises. The study not only provides a deeper understanding of the challenges faced but also offers a suite of validated solutions that industry professionals can tailor to their specific contexts. Our study’s recommendations are not only theoretical concepts but also include practical steps that are directly applicable to the pharmaceutical supply chain. This dual focus ensures that the research is relevant and can be immediately leveraged by practitioners in the field. Further research is required to identify more specific strategies and solutions that could be adopted by the pharmaceutical industry in South Africa and globally. Future studies could build on our work by testing the effectiveness of the recommended strategies in different contexts and during various types of supply chain disruptions.

Acknowledgement

The authors were involved in all stages of the research process, from developing the initial idea to carrying out the actual study. The authors took a leading role in carrying out the research activities, such as evaluating the evidence, and also wrote, reviewed, and revised the text. All authors have read and agreed to the published version of the manuscript.

Author Contributions: Conceptualisation, B.T. and D.P.: methodology, B.T. and D.P.: validation, B.T. and D.P.: formal analysis, B.T. and D.P.; investigation, B.T. and D.P.; resources, B.T.; writing—original draft preparation, B.T.; writing—review and editing, B.T. and D.P.;

Funding: This research was NOT funded by neither the government nor any private or nonprofit organisations.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to restrictions.

Conflicts of Interest: The authors declare no conflict of interest.

References


https://www.vlebooks.com/vleweb/product/openreader?id=none&isbn=9781526417299


Publisher’s Note: SSBFNET stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

© 2023 by the authors. Licensee SSBFNET, Istanbul, Turkey. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/). International Journal of Research in Business and Social Science (2147-4478) by SSBFNET is licensed under a Creative Commons Attribution 4.0 International License.