

Supply chain disruptions during COVID-19 pandemic: Key lessons from the pharmaceutical industry

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Purpose: This study extends previous research by exploring the key lessons learned by the pharmaceutical industry in South Africa from the COVID-19 pandemic supply chain disruptions.

Design/methodology/approach: Having embraced the interpretivist paradigm, 25 supply chain professionals were purposively selected on the basis of their experience and deep knowledge of the industry and interviewed using the semi-structured approach of interviews. A qualitative data analysis programme, ATLAS.ti (version 9.1), was used to analyse the transcripts.

Findings/results: Following thematic analysis, the following themes emerged from the primary data: supply networks, demand planning and management, supply chain coordination, inventory management, logistics management and local production.

Practical implications: It is crucial to build resilience in the design of pharmaceutical supply chains. A comprehensive demand management strategy and use of data analytics need to be adopted by pharmaceutical companies to improve demand visibility, responsiveness and supply chain resilience. The study also revealed the need for local production, as local skills and enterprises are being developed.

Originality/value: This study has extended the body of knowledge on the supply chain disruptions, particularly in the pharmaceutical industry by building on the studies that were conducted during COVID-19, many of which were not based on empirical data. It also points supply chain professionals in a direction which enables them to develop a disruption strategy while providing justification for policymakers to support investment in the development of the requisite skills for the pharmaceutical industry and the development of local production facilities.

Keywords: supply chain disruption; COVID-19; pharmaceutical industry; supply networks; supply chain coordination; logistics management; local production; demand planning and management; inventory management.

Introduction and background

As COVID-19 spread around the world in February 2020 and the number of cases increased in many countries, millions of people worldwide experienced terror and uncertainty (Kostev & Lauterbach, 2020). In an effort to stem the tide of rising infections, many economies were severely impacted as they implemented measures such as social distancing and mandated lockdowns (Statistics South Africa, 2020). Supply chain disruptions on such a scale caught industry and governments unaware (GPMB, 2019). In many countries, pharmaceutical supply chains (PSCs) were no exception as they experienced shortages of medical supplies, test kits and personal protective equipment (PPE), thereby threatening patient welfare and rendering healthcare systems more fragile (Gereffi, 2020). Supply chain disruptions caused by the COVID-19 pandemic compounded on the risks such as access to medicines, increased cost of operations, increased waste and reduced value, all of which were common in many PSCs (Moosavi et al., 2022).

Scheibe and Blackhurst (2018) had cautioned that owing to their size and complexity, PSC disruptions are likely to spread through the system and cause damage to more than one supply chain network. Azman and Jaafar (2018) observed that it is always important to identify factors that could disrupt supply chain efficiency and performance. According to McKinsey and Company (2022), despite 'progress over the past 12 months, many companies still lack a

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comprehensive picture of the risks lurking deep inside complex multitier supply networks'. There have been a number of studies which sought to investigate the COVID-19 implications on business. Some of those studies were conducted during the height of the pandemic itself. For example, a study by Meier and Pinto (2020) compared the two major world economies of the United States and China and explored the impact of COVID-19 pandemic on their supply chains. More studies were also conducted to determine the impacts of COVID-19 on the economies and supply chains (Magableh, 2021; Walmsley et al., 2021).

According to Kovács and Falagara Sigala (2021), studies on the COVID-19 have not scratched the surface, as it were, as further research is needed to explore the topic in the context of supply chain management (SCM). In this regard, Atkinson et al. (2020) concur that there is a need for more research into the responses of PSC disruptions. Recent studies by Chowdhury et al. (2021), Kovács and Falagara Sigala (2021) and Tirivangani (2021) explored how the pharmaceutical industry could mitigate supply chain disruptions caused by the COVID-19 pandemic. The first study was a review of literature, while the second one relied on the secondary data from previous studies and literature. Using empirical data from PSC professionals, this study aims to extend previous research by exploring the key lessons learned by the pharmaceutical industry in South Africa from the COVID-19 pandemic supply chain disruptions. To that end, the article is organised as follows: the first section reviews the relevant literature on the topic, followed by the section that explains the research design and methodology adopted in the study. Next, the study's empirical findings are presented and discussed. Finally, the article concludes by highlighting the contribution, making recommendations, acknowledging limitations and suggesting directions for further research.

Literature review

The pharmaceutical industry

The pharmaceutical industry is big business which contributes considerably to the world's economy and has a rising global presence. It is estimated that the global pharmaceutical industry is worth about \$1 trillion (Statista, 2020). The industry comprises four main segments, namely: (1) the innovative pharmaceutical industry, (2) the biopharmaceutical industry, (3) biologics and (4) the generic pharmaceutical industry. The pharmaceutical industry is one of the most innovative industries in the world (Bucalo & Jereb, 2017) and has been one of the world's most prosperous and lucrative sectors for the past few decades. According to Nedelcheva (2019), the industry's main activities start with the research phase, then the development phase, and finally the delivery of pharmaceutical drugs. By the 1990s, the South African pharmaceutical industry was already well established and had become the most rapidly growing and mature pharmaceutical industry in Africa, supplying both primary and secondary medicines through local and multinational firms (Viviers et al., 2014). The South African pharmaceutical

industry is the largest market for medicines in sub-Saharan Africa. According to Global Africa Network (2020), there are over 200 pharmaceutical firms in South Africa, valued at about R20 billion. The local manufacturing supplies about 70% of the pharmaceutical industry's demand with generic medicines accounting for 50% of the total market (Investsa, 2020). The private sector accounts for approximately 84% of the market with the public sector accounting for the rest (Maphumulo & Bhengu, 2019).

Pharmaceutical supply chains

Supply chain management is the management of all activities that are targeted at satisfying the end consumer (Chopra, 2020). It involves managing supply chain assets and products, information and fund flow to maximise total supply chain surplus (Chopra, 2020). It also involves managing upstream and downstream relationships with suppliers and customers to deliver superior customer value at low cost to the supply chain (Christopher, 2022). As alluded to earlier, PSCs are very complex, combining processes, organisations and operations involved in developing, designing and manufacturing useful pharmaceutical drugs (Singh et al., 2016). According to Amadi and Tsui (2019), a typical PSC process includes importation, registration, procurement and distribution of drugs and medical products, forming a significant component of the healthcare system.

According to Kapoor et al. (2018), the key stakeholders in this supply chain include multiple government agencies, hospitals, clinics, drug manufacturers, drug distributors, pharmacy chains, retailers, research organisations and regulatory boards such as the South African Health Products Regulatory Authority (SAHPRA). In the pharmaceutical industry, supply chain breakdowns can have a direct impact on the company's bottom line, but they can also have a direct impact on the health and well-being of patients (Yarason et al., 2019). A typical PSC can be illustrated in Figure 1.

As per Figure 1, the PSC commences with the manufacturer or supplier of raw materials, who supplies the necessary components for medication synthesis in accordance with the specific product requirements. Subsequently, the finalised products are conveyed to a distribution platform that oversees the storage and extensive dissemination to wholesalers and distributors. These intermediaries subsequently distribute the products to regional distributors, pharmacies and hospitals. During this procedure, financial transactions take place, and crucial demand and inventory data are exchanged. Medications are distributed to end users, usually patients through pharmacies or hospitals. The bidirectional exchange of information frequently occurs, and financial transactions can encompass intricate arrangements such as credit agreements, insurance policies and compensation measures, particularly inside healthcare establishments. A supply chain contains information on everything from facilities to inventory to transportation to

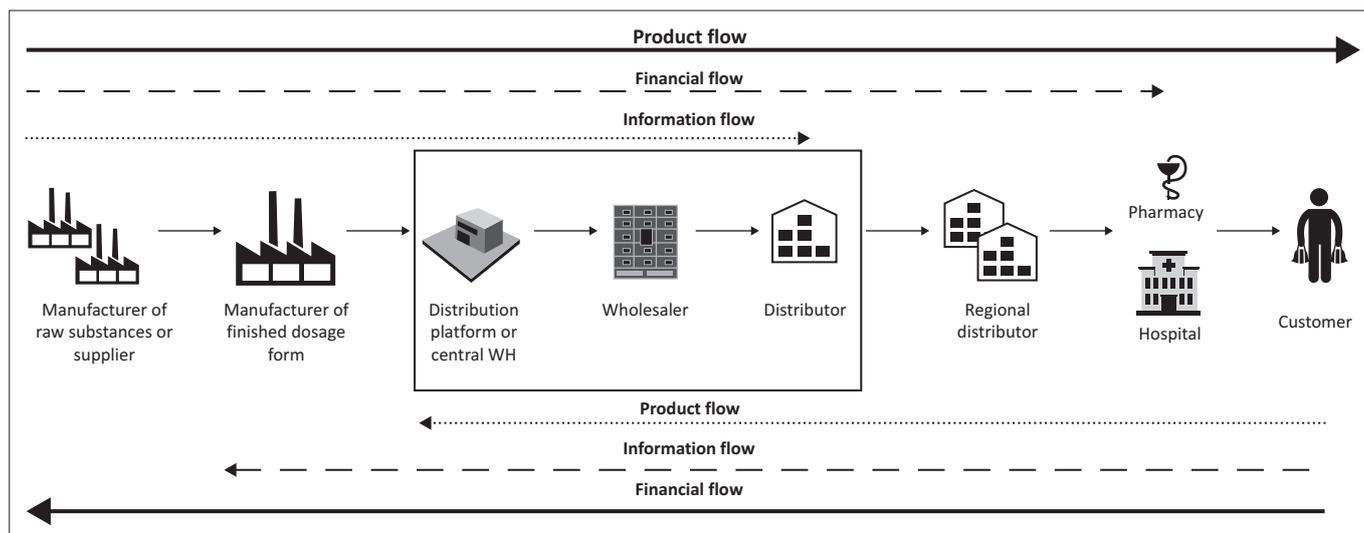


FIGURE 1: Pharmaceutical supply chain.

costs and prices (Chopra, 2020). Both patient and practitioner practices are central to pharmaceutical research and development (R&D), but supply chain (SC) analysis has emerged as a noteworthy avenue for investigation (Nematollahi et al., 2018). Channels for medication delivery are diverse and handled by parties including pharmaceutical companies and workers, logistics providers, hospitals, laboratories, clinicians, consumers and public entities, among others (Grujić et al., 2020).

Supply chain disruptions

Disruptions usually represent spontaneous occurrences of unpredictable duration (Sawik, 2019). Yet, Scheibe and Blackhurst (2018) describe supply chain disruption propagation as the spreading of the effects of disruption beyond the initial location of the disruption. Supply chain disruptions may occur as a result of natural events such as earthquakes or hurricanes or man-made events like wars, terrorist attacks or conflicts (ShakirUllah et al., 2016). In addition, fire or mechanical breakdown in a production facility, an unexpected surge in demand or a reduction in supply are other forms of supply chain disruptions (Gao et al., 2019).

When a disruption occurs in a firm, its effects are often felt throughout the supply chain. Supply chain disruptions significantly affect the short-term performance of the whole supply chain. Unlike other uncertainties, supply chain disruptions are very difficult to predict (Chopra, 2020). Alora and Barua (2019) state that supply chain disruptions reflect a firm's demand-and-supply mismatch. Supply chain disruptions occur when the normal flow of goods and materials within a supply chain is disturbed (Bui et al., 2021). Therefore, disruptions are unplanned events that may occur in the supply chain and affect the usual or expected flow of materials and components (Wicaksana et al., 2022). Externally induced disruptions are the most difficult to manage because these tend to affect supply chains the most (Wieteska, 2018).

Impact of COVID-19 disruptions on global supply chains

The COVID-19 pandemic had a significant and far-reaching influence on global supply networks, resulting in extensive disruptions and posing challenges to established operational practices. The global supply networks were exposed to vulnerability as firms and industries worldwide faced challenges such as lockdowns, travel restrictions and shifts in customer behaviour. In the initial stages of the pandemic, Magableh (2021) highlighted the phenomenon of global reliance on suppliers from a single source, particularly in countries heavily touched by COVID-19. This reliance led to bottlenecks that had far-reaching effects on sectors throughout the globe. The situation was further aggravated by logistical and transportation challenges caused by movement limitations, which presented significant barriers to the prompt delivery of both raw materials and completed items (Ivanov, 2020). The COVID-19 pandemic has brought to light the vulnerabilities associated with lean supply chain models, which prioritise cost-effectiveness and efficiency but may lack the necessary resilience to withstand disruptions (Queiroz et al., 2022). The aforementioned circumstances resulted in an increasing focus on the notion of supply chain resilience, which encompasses the capacity to anticipate, react to and recuperate from disturbances (Singh et al., 2021). The COVID-19 pandemic has not only caused significant disruptions to global supply chains in the short term, but also it carries ramifications for long-term supply chain strategies and regulations.

Methodology

Research paradigm

A qualitative research approach with an interpretive paradigm was the most appropriate in addressing the aim of the study, namely, to explore the lessons learned by PSCs from the COVID-19 pandemic. As indicated by Brinkmann and Kvale (2018), qualitative research relies heavily on the art of interpretation.

Selection of participants

In this study, the perspectives of supply chain professionals within the South African pharmaceutical industry were considered insightful for the achievement of the objectives of the study. To this end, 25 supply chain professionals were purposively selected on the basis of their experience and deep knowledge of the industry. These participants came from the suppliers, primary pharmaceutical importers, drug manufacturers, drug distributors or wholesalers, pharmacy chains or corporates, independent retail pharmacies and pharmacies at government hospitals. Although 25 participants were interviewed, it was evident after the 22nd interview that data collection had reached saturation point, which is a point where no new ideas emerged. Their selection served the objectives of the study (Bougie & Sekaran, 2020). The researchers' knowledge of the pharmaceutical industries in South Africa enabled the researcher to approach high-profile individuals, including top management, to participate in the study. Data were collected by means of semi-structured interviews which were mainly conducted via the online platforms of Zoom, Skype and Microsoft Teams. Each interview was recorded with a digital voice recorder, following permission to record these proceedings from the participants. As noted by Brinkmann and Kvale (2018), the data obtained from the semi-structured interviews were transcribed in a voice-based format. The researcher used a digital voice recorder as a compliment to the digital voice recorder from the online platform. The recordings were then uploaded to a computer, where the audio files were converted to MP3s and saved. A Microsoft Word document containing the whole transcript of each interview was created.

Data analysis

A qualitative data analysis programme, ATLAS.ti (version 9.1), was used to analyse the transcripts. Firstly, the researcher coded the transcripts. The Results section shows the findings using verbatim quotes from participants. The punctuation in quotations has been modified to improve readability, and any phrases or words omitted from quotations have been noted with ellipses, where applicable. Secondly, thematic analysis was performed. To code and develop themes more comprehensively, the researcher used ATLAS.ti in the following phases: creating the project, adding documents, identifying relevant data segments, coding, writing memos and comments, analysing and querying data, developing models, visualising and generating the final report. The qualitative analysis and interpretation of the results were made once all data had been organised and coded. The key objective was to describe the solutions and comprehend them. A more in-depth look at the data helped the researchers find trends and establish overall themes.

In a process known as thematic analysis, the interview transcripts were read several times to deduce the main themes and topics emanating from it (Kiger & Varpio, 2020). According to Nowell et al. (2017), thematic analysis involves six steps: the initial step of familiarisation with the

data involves immersing oneself in the data to become familiar with the depth and breadth of the content. In this regard, the researcher became acquainted with the primary data by reading the transcripts many times until several patterns began to emerge (Gibbs, 2018). The initial codes were generated by identifying important features of the data that might be relevant to answering the research question and were coded for later stages of analysis. In the third step of searching for themes, codes were sorted into potential themes, which are collections of codes that appear to form a pattern. In the next step, themes were reviewed and refined. Then the themes were defined and named. Finally, the analytic narrative and data extracts were weaved together and contextualised in relation to existing literature.

Measures of trustworthiness

In this study, four features of trustworthiness were applied, namely, credibility, dependability, transferability and conformability. Credibility ensures that themes are accurately represented participants' experiences; dependability helps provide a clear description of their analytic process; transferability offers rich descriptions of findings so that others can judge their applicability in other settings; and confirmability ensures documenting the research process in detail for potential external audits (Nowell et al., 2017). In this study, the researchers rigorously adhered to ethical standards. Prior to conducting the study, ethical clearance was obtained to ensure that all processes aligned with the necessary ethical requirements to ensure the rights, dignity and well-being of all participants. Participants were given firm assurances regarding the confidentiality and anonymity of their personal information and other data collected throughout the course of the study. Each participant was assured of their right to withdraw at any point if they felt uncomfortable during the interview process.

Results

Table 1 reflects the study's participants and their brief profiles.

Table 1 shows the depth of experience and expertise among the participants who mainly come from manufacturing, distribution and retail parts of the South African PSCs. The participants were mainly based in the KwaZulu-Natal, Gauteng and the Western Cape provinces of South Africa, which are the main centres of economic activity in the country. The participants' experience ranges from 6 to 30 years in SCM, making their insights invaluable.

Themes

The primary data collected by means of the semi-structured interviews needed analysis. Following thematic analysis, the following themes emerged from the study: supply networks, demand planning and management, supply chain

TABLE 1: Participants' profile.

ID	Position	Years of experience	Player/actor/category	Province
P01	Owner/chief executive officer (CEO)	30	Drug manufacturer	KwaZulu-Natal
P02	Chief executive officer (CEO)	19	Drug distributor or wholesaler	Gauteng
P03	Chief executive officer (CEO)	20	Independent retail pharmacy	Western Cape
P04	Chief operating officer (COO)	28	Drug distributor or wholesaler	KwaZulu-Natal
P05	Procurement and planning manager	6	Pharmaceutical supplier	Gauteng
P06	Regional sales manager	15	Primary pharmaceutical importer	Kwazulu-Natal
P07	Sales manager	25	Drug manufacturer	Gauteng
P08	Professional sales representative	24	Primary pharmaceutical importer	KwaZulu-Natal
P09	Sales manager	19	Drug manufacturer	KwaZulu-Natal
P10	Sales representative	20	Pharmaceutical supplier	KwaZulu-Natal
P11	Sales representative	25	Drug manufacturer	KwaZulu-Natal
P12	Sales representative	30	Drug manufacturer	KwaZulu-Natal
P13	Sales representative	12	Primary pharmaceutical importer	KwaZulu-Natal
P14	Business analyst	10	Pharmaceutical supplier	Gauteng
P15	Sales representative	23	Drug distributor or wholesaler	KwaZulu-Natal
P16	Supply chain team lead	12	Drug manufacturer	Gauteng
P17	Supply chain professional	21	Pharmaceutical supplier	Gauteng
P18	Senior supply and demand planner	7	Drug manufacturer	Gauteng
P19	Responsible pharmacist	10	Retail pharmacy	Gauteng
P20	Supply chain specialist	9	Drug manufacturer	Gauteng
P21	Demand planner	6	Drug manufacturer	Gauteng
P22	Demand planning lead	16	Drug manufacturer	Gauteng
P23	Supply chain planner	7	Drug distributor or wholesaler	Gauteng
P24	Supply chain professional	24	Drug manufacturer	Western Cape
P25	Demand manager	14	Drug manufacturer	Gauteng

TABLE 2: Emerged themes.

Theme no.	Theme identity
1	Supply chain networks
2	Demand planning and management
3	Supply chain coordination
4	Inventory management
5	Logistics management
6	Local production

coordination, inventory management, logistics management and local production. Table 2 presents a categorisation of the themes that emerged from the primary data.

Theme 1: Supply chain networks – Key lessons

According to the participants, the first disruptions to SCM were largely attributed to the industry changes and transformations in supply chain networks brought about by the COVID-19 pandemic. In this regard, a few participants expressed the following sentiments:

'One of the challenges will be when the airports are locked down, or the ports are closed. That's a problem that nobody seems to know and be able to manage appropriately. The impact was terrible initially because we had massive delays, which have been sorted out now; there is no issue.' (P13)

'I think the delivery side of things was affected severely in terms of delivery standard times because capacity from transport service providers made it impossible for our goods to go through from the point of origin to the end of consumption. Hence, they also are affecting the lead times that delivery standard lead times that we are used to before COVID-19.' (P16)

'The first global lockdown caused movement disruptions. There was limited movement of goods into and outside of the country.' (P17)

For Theme 1, the most important discoveries are that the COVID-19 pandemic disrupted the distribution networks and global supply networks. Participants also pointed out that changes in lead times, delays and variations in the availability of medicine in the pharmaceutical industry resulted from COVID-19 restrictions. That said, there was consensus that the supply chain network should be valued. Yet, the COVID-19 pandemic exposed the industry's lack of resilience, with sophisticated networks failing from minor network outages to the absence of accessibility. The importance and role of supply chain networks are stressed in the literature (Aldrighetti et al., 2021). Distribution is crucial to a company's success as it immediately affects supply chain costs and customer satisfaction (Chopra, 2020). Long-term strategic decisions, such as the placement and capacity of any supply chain network, should be able to withstand an uncertain situation (Fattahi et al., 2017). Supply chain goals such as low cost to high responsiveness can be achieved with the proper distribution supply chain network (Ivanov & Dolgui, 2021). Participants further reported that often out-of-stocks were experienced due to delays associated with the fact that raw materials were mainly sourced from overseas. Similar sentiments were expressed and are accordingly discussed in more detail under the *local production* theme.

The primary data show that COVID-19 pandemic disrupted the distribution networks and global supply networks which resulted in changes in lead times, delays and variations in the availability of medicine in the pharmaceutical industry. Many pharmacies suffered longer lead times due to reduced inter-country movement of goods and services and limited in-country capability and technological capacity. Thus, it is

crucial to build resilience in the design of PSCs. As part of building resilience, conducting due diligence and prequalifying suppliers for disruptions, readiness may result in reduced lead times when major disruptions strike.

Theme 2: Demand planning and management – Key lessons

Demand planning and management emerged as a second theme which participants felt could have been better managed during COVID-19 disruptions. To that end, participants reflected as follows:

‘The implications, like I said, there’s a shortage of supply and then they lead to high demand and supply. So, you know, for them, it’s the basic economics. A pandemic will cause a negative shift in the supply and when demand is not checked. It leads to a high price, low supply price.’ (P07)

‘Yeah, I think it’s going to really boil down to supply and demand where the demand comes from and who can meet the supply. I think that the demand planning is critical now and the time spent in understanding statistics, understanding what is happening around the world, maybe looking at other trends. So, I think that there’s a fair amount of demand planning that we can do.’ (P01)

‘When we went out of stock, you can increase your forecast, so you don’t run out of stock. I think, like I say, you can increase your forecast in your supply chain to help, but as I say, you know what? Companies are wary to increase that drastically because you don’t know if you’re going to sit with that stock. And it’s actually money that’s sitting there and raw materials. And if it doesn’t get used or it expires before time, then again, its money lost.’ (P02)

‘Contributing to this was the unusual demand for specific products -such as multivitamins, mucolytics, some antibiotics – also put a direct strain on the supply chain. Challenges related to forecasting and acquiring raw material during COVID-19 were unprecedented.’ (P21)

‘You need to have proper forecasting models. And this means hiring people who have got expert in modelling a demand and then the request for raw material.’ (P07)

Participants indicated that the COVID-19 pandemic disruption disrupted the pharmaceutical industry’s demand forecasting. Accurate demand forecasting has always been a primary concern for the pharmaceutical industry planning owing to the number of downstream supply chain activities dependent on the demand for final product. Yet, Kamar et al. (2021) observed that forecasting the spread of COVID-19 has been vital in educating healthcare practitioners and governments on managing overcrowded healthcare systems. Findings from this study are consistent with those of Merkuruyeva et al. (2019) who found that demand forecasting can incorporate both statistical data and the knowledge and intuition of PSC network professionals at various stages in the process and is adaptable to the availability of sufficient demand information at any given time. Moreover, for pharmaceutical product demand forecasting, it appears that these attributes are insufficient in their own right. These findings demonstrate that despite improvements in data gathering, downstream data have

not been exploited for supply chain demand forecasting and planning (Badakhshan & Ball, 2023).

Panic buying also made demand planning very unpredictable. Another participant indicated that as the pandemic progressed, they noticed that they became overstocked and that as a result a large number of pharmacies started to cherry-pick the vitamins they wished to keep in stores, especially cheaper products. This resulted in pharmaceutical companies holding surplus of vitamins in warehouses, some of which had to be pulled out of the shelves. Verstlogistic (2018) asserts that there exists a significant imperative for organisations to enhance their demand management capabilities, because demand volatility stands out as one of the foremost challenges encountered by supply chains in the present era. Furthermore, Verstlogistic (2018) suggests that it is imperative for organisations to establish a holistic strategy for managing demand, which should include elements such as demand forecasting, sensing and shaping. The study revealed the need for more effective demand planning and management models and techniques as well as the lack of skills in this area. A comprehensive demand management strategy will go a long way in enabling pharmaceutical companies to adopt technologies that will improve demand visibility and responsiveness.

Theme 3: Supply chain coordination – Key lessons

Participants echoed the sentiment that when the supply chain system is vulnerable to disruption, coordination becomes even more necessary when it comes to multiple tasks such as stock management, logistical support and various layers such as suppliers-manufacturers and manufacturers-retailers. In this regard, participants stated:

‘I think that the risk for us all is the relationship with our clients. So all the pharmacies are my clients, your customers, your client. We have to begin our process with our clients in demand. And we have to make sure that we are able to service them so that they can service the end-user, because end-user are the consumer at the end of the day.’ (P01)

‘I think for us on our side, we work from home. So we still keep the communication lines open between us and customers in terms of like pharmacies, hospitals, doctors. And it did work because, you know, if patients needed something and the customer needed something, it was still that supply chain.’ (P02)

‘We try to develop relationships with the suppliers so they would let us know in stock. Well, it’s difficult because the same way as, you know, I don’t want to share my stuff with someone else and that, you know, but if they had to work together with all the manufacturers.’ (P06)

Participants cited supply chain coordination issues as a significant cause for concern. They also reported that a lack of coordination happens when various phases of the supply chain have goals that conflict with one another or when information moves between stages slowly and gets distorted. The literature shows that inadequate coordination can significantly affect accurate product demand forecasts, the ability to plan and schedule properly and supplier

relationship (Sabouhi et al., 2018). Superior supply chain design and execution involving short production lead times and fast delivery will give rise to competitive advantage.

Streamlined distribution channels allow producers to rapidly have the latest products on sale in stores worldwide to take immediate advantage of fast-changing demand (Uddin, 2020). Closely related to demand forecasting and planning is the need to improve supply chain coordination between the multiple tasks such as stock management, logistical support and the various supply chain players such as suppliers, manufacturers, warehouses, distributors and retailers. Investment in technologies which enhance coordination is likely to improve supply chain resilience in times of major disruptions.

Theme 4: Inventory management – Key lessons

Inventory management emerged as another theme from the primary data. This is how the theme emerged following the responses from the participants:

‘Being unable to get drugs from overseas as quickly as we used to do that’s the main thing. The stock’s going into much longer due to lack of inventory. Lockdown caused significant problems.’ (P04)

‘Whether it’s finished goods or raw materials for your product, getting the actual supply was the biggest problem.’ (P22)

‘Therefore this resulted in out of stocks for end users and overstock at the factories as production continued, but dispatch and shipping was halted.’ (P24)

‘Stock-outs could not service clients due to Loss of product shelf life, and products could not move off the shelf due to the movement restrictions.’ (P25)

‘It created the shortages, and there were panics, you know, from the consumer out there, and they supply them short dated, you know, short, dated stock and stock the old inventory they sold last year. Because they’re unable to provide stock, there would be no shortages, and the stock would not be short-dated.’ (P06)

Theme 4 reveals the way in which the COVID-19 pandemic has disrupted inventory management and how safety inventory can help a supply chain improve product availability or medicine availability in the face of the volatility of supply and demand unpredictability. It has been noted that inventory management in a supply chain may be attributed to losses owing to short-dated stock. Despite this, inventory management in most practical situations is hindered by different storage and replenishment limits (Li et al., 2021). In their study investigating major supply chains following the COVID-19 pandemic, McKinsey and Company (2022) report that majority of companies were planning significant changes to their inventory management strategies. Increasing the quantity of safety inventory improves product availability and enhances the profit a retailer may earn from sales such that this will increase the degree of safety inventory raises inventory storage costs (Afzali et al., 2019). This is especially important in businesses with short product lifespans and variable demand like some medicines have.

Stocking up on surplus inventory might assist in mitigating demand volatility but can be disastrous if new items hit the market and demand for those already on hand dries up. In this case, the stock on hand is of no use. Furthermore, employing data analytics to optimise inventory will enable the company to develop the ability to see constraints in real time, thus allowing the company to evaluate safety inventory and put in place develop contingency plans (Phocas, 2023). The study shows how increasing the quantity of safety inventory may reduce supply and demand volatility, thus improving product availability and inventory management as a whole. The use of data analytics will improve supply chain visibility in that companies will be able to notice constraints real time and will also enable companies optimise their safety inventory.

Theme 5: Logistics management – Key lessons

Logistics management emerged as another theme from the primary data as developed from the following sentiments from the participants.

‘So obviously, the number-one rule of logistics is efficiency. We also got reverse logistics, which has to be considered.’ (P01)

‘How do we then increase the lifespan of our products as a result of trying to accommodate the delays in logistics, transportation and supply chain issues?’ (P16)

‘Your logistics, you had to improve ... It also affected your service levels.’ (P18)

‘Delivery personnel had to wear PPE and have their vehicle sanitised. We had 100 vehicles in our fleet, but we don’t keep 110 drivers, and as soon as one gets infected, they shut down the whole wings of the facility and all fleets. These things were a tremendous logistical nightmare and came with a huge cost because they still paid employees who went on sick leave.’ (P25)

Participants noted the importance of efficient logistics as one of the key lessons they believe the industry has learned from the disruptions of supply chains. The participants emphasised the need of effective logistics in the management of supply chain interruptions, a significant insight derived from the industry’s encounter with the epidemic. The aforementioned interruptions have emphasised the interconnectedness present within the supply chain and have brought attention to the necessity of implementing comprehensive contingency plans. Fundamentally, these encounters emphasised the significance of perceiving logistics not merely as an independent operation, but rather as a strategic competency that is pivotal to the robustness of the supply chain.

The lessons acquired from this experience inside the sector can serve as a valuable resource for informing future policies aimed at strengthening resilience against potential shocks. Streamlined distribution channels allow producers to rapidly have the latest products on sale in stores worldwide to take immediate advantage of fast-changing demand (Uddin, 2020). Competitive advantage is gained through superior supply chain design and execution involving short production lead times and fast delivery. The COVID-19 pandemic brought additional pressure on supply chains because they now have more pressure to

develop and adapt to a context of economic constraint (Ferreira et al., 2021). The optimisation of logistics encompasses more than just expeditious conveyance; it also entails the capacity of the entire supply chain to promptly adjust to unforeseen circumstances, hence emphasising the need of agility and flexibility. The capacity to adapt swiftly, reorganise distribution channels, collaborate with alternative transportation suppliers and effectively engage with regulatory bodies emerged as crucial factors in maintaining uninterrupted supply.

Theme 6: Local production – Key lessons

Theme 6, titled ‘Local production – Key lessons’, encompasses valuable findings derived from the research, shedding light on the significance and consequences of domestic manufacturing within the realm of SCM. The aforementioned statement highlights the significance of local production in addressing supply chain interruptions, fostering community bonds, and impacting the overall velocity and effectiveness of the supply chain. The following quotations demonstrate local production as a theme.

‘We still kept production going. More local production is needed. I think if we have a lot more goods produced locally definitely, it will help, more local production.’ (P02)

Plants for production and research and development must be established in the area.

‘This is also not an option, since most of the businesses with whom we deal are global conglomerates, and many of the things we sell are sourced internationally. Because of this, we need to consider whether or not it makes sense to do R&D and manufacture goods here rather than sending them outside.’ (P09)

‘We still kept production going. More local production is needed. I think if we have a lot more goods produced locally definitely, it will help, more local production.’ (P02)

‘I think it’s complicated to say because, when it comes to production, they tend to plan, but you cannot plan for something like COVID because it’s difficult to predict the outcome. But if you look at things like your anticoagulants, the demand has skyrocketed, so it also means the production, but it’s a global issue.’ (P08)

Participants expressed a general view that the challenges of global sourcing and logistics have shown the urgent need for the local production of some of the raw materials. Good sources of supply and local production make it possible for the PSCs to be more responsive (Clapp & Moseley, 2020). On the one hand, the current local production policy ought to be reviewed to strike a balance between the anticipated demand and the output level of suppliers. As a result, a sizeable amount of emergency supplies is quite essential. In addition, it is of the utmost importance to ensure that none of the local production is located in high-risk zones or strategic bottlenecks. On the other side, it is also vital to identify local equivalents and to suggest and validate the APIs (Taqi et al., 2020).

Alternative materials provide businesses with more sourcing possibilities, and local providers may guarantee a high supply of raw materials. In the process of developing

TABLE 3: Key lessons and strategies for managing supply chain disruption for the pharmaceutical supply chains.

Key lesson	Strategies
Build resilience in the design of pharmaceutical supply chains	Conducting due diligence for the disruption readiness of suppliers
Maintaining uninterrupted supply	Reduce supply and demand volatility Increase the quantity of safety inventory Reorganise distribution channels, collaborate with alternative transportation suppliers Effectively engage with regulatory bodies
Improve supply chain visibility	Embrace the use of data analytics
Improve supply chain coordination	Focus on inventory management and logistical support for suppliers, manufacturers, warehouses, distributors and retailers Invest in technologies which enable coordination
Develop a comprehensive demand management strategy	Embrace the use of effective demand planning and management models and techniques Develop skills in the area of demand planning and management
Build a local network of suppliers	Develop an effective enterprise and supplier development strategy

APIs and establishing their inventory, upstream suppliers ought to be taken into consideration. In a major survey conducted among leading companies during the COVID-19 pandemic, McKinsey and Company (2022) found that almost 90% of respondents expected to pursue some form and degree of regionalisation or localisation in the short term. In line with other studies mentioned earlier, many companies seem to seriously favour localisation of production. Not only will this improve supply chain resilience, but also it will contribute to the skills and enterprise development locally. This study revealed a number of key lessons for the PSCs. These lessons are summarised in Table 3.

Conclusion

The aim of the study was to explore the key lessons learned by the pharmaceutical industry in South Africa from the COVID-19 pandemic supply chain disruptions. The study identified the following six themes: supply chain networks, demand planning and management, supply chain coordination, inventory management, logistics management and local production. The study’s findings presented earlier revealed the areas which the COVID-19 pandemic had impacted. This study makes a meaningful contribution to the body of knowledge on the supply chain disruptions, particularly in the pharmaceutical industry by building on the studies which were conducted during COVID-19, many of which were not based on empirical data. The study highlighted the five key areas which are critical for managing supply chains in times of major disruptions. Over and above making some contribution to the supply chain disruption research and discourse, the study has pointed supply chain professionals in a direction which will enable them to develop a disruption strategy during major disruptions. The study has also provided justification for policymakers in support investment in the development of the requisite skills for the pharmaceutical industry and the development of local

production facilities. Considering the size, strategic importance and complexity of the pharmaceutical industry, lessons from this study may well benefit many other industries of similar or lesser complexity.

Limitations and direction for future research

Despite the study's contribution to the body of knowledge on supply chain disruptions, it was not without limitations. While the study sought to elicit responses from participants with deep knowledge of the pharmaceutical industry, it did not consider the perspectives and insights of employees at junior levels who generally outstay senior members of management in companies. Thus future studies can also include perspectives from junior members of staff. Using the themes which emerged from this study, qualitative analysis using exploratory factor analysis could be used to determine factors which are crucial to manage major disruptions in the various industries. Another limitation that is acknowledged is that being qualitative in nature, the study only elicited views from a limited number of participants, albeit they possess the necessary expertise. For an industry of this size, future studies could consider a quantitative approach where the views of all supply chain practitioners are canvassed.

Drawing upon the findings of this investigation, further scholarly inquiries may further explore the formulation of tactics aimed at augmenting the robustness of PSCs, particularly in response to disruptions akin to the COVID-19 outbreak. This may encompass the examination of novel demand planning and management models, the exploration of technical breakthroughs that have the potential to enhance supply chain coordination, and the identification of optimal approaches to inventory management, with a specific focus on safety stock. Moreover, there is a need for a more comprehensive exploration of the potential of local manufacturing in strengthening supply chain resilience, with a particular focus on examining the socioeconomic effects associated with this transition. Furthermore, it is worth exploring the potential effects of proactive strategies, such as the prequalification of suppliers based on their preparedness for disruptions. This approach has the potential to result in decreased lead times during times of crisis.

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Competing interests

The authors have declared that no competing interest exists.

Authors' contributions

B.T. conceptualised the article, collected data and wrote the first draft. D.P. supervised the study, reviewed and edited the article.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of Johannesburg, Ethics Committee at the Department of Business Management (No. 21SOM10).

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Data availability

The data that support the findings of this study are available on request from the corresponding author, R.P.

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