# Knowledge management for supply chain resilience in pharmaceutical industry: evidence from the Middle East region

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## Abstract

**Purpose** – This study investigates the role of supply chain knowledge management in enhancing pharmaceutical supply chain resilience.
**Design/methodology/approach** – This study focusses on the Middle East region, where semi-structured online interviews were conducted with 38 professionals from the pharmaceutical supply chain to collect empirical data.
**Findings** – The study reveals that supply chain knowledge management is a crucial value-adding practice that improves pharmaceutical supply chain resilience. Effective supply chain knowledge management enables organisations to develop agility, change, adaptability, problem-solving, response and innovation capabilities that support supply chain resilience. However, challenges related to supply chain management practices, people, processes and technology hinder the effective promotion of supply chain knowledge.
**Practical implications** – This study reminds managers that knowledge management is critical for building resilience in supply chains.
**Social implications** – The study highlights the importance of a resilient pharmaceutical supply chain for organisations and society. The study advocates that effective supply chain knowledge management can help ensure a sustained supply of high-quality pharmaceutical products and services during crises.
**Originality/value** – The study offers novel insights by examining pharmaceutical supply chain resilience from a knowledge management perspective and highlighting the potential of knowledge capabilities to enable supply chains to recover from crises and adapt to the new normal. This study also highlights the key strategic considerations for managing knowledge effectively throughout the supply chain.

**Keywords** Pharmaceutical supply chain, Supply chain resilience, Knowledge management, Visibility, Traceability
**Paper type** Research paper

## Introduction

The length and complexity of pharmaceutical supply chains have increased in recent years, rendering them vulnerable to disruptions caused by inadequate visibility and traceability (Roy, 2021). The coronavirus disease 2019 (COVID-19) pandemic has further exacerbated these vulnerabilities, resulting in unprecedented disruptions to global supply chains. This crisis has underscored supply chains' fragilities in facing major shocks and emphasising building resilience (Yaroson *et al.*, 2021). Consequently, supply chain leaders are rethinking their resilience strategies (Ivanov, 2021).

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The term "resilience" refers to the capacity of a system to recover rapidly and effectively from disruptions (Zighan *et al.*, 2022). Theoretical and practical insights into resilience have been developed in various disciplines, including ecology, engineering and technology and urban planning. These disciplines offer a unique and valuable opportunity to advance our understanding of supply chain resilience (Dwaikat *et al.*, 2022). However, despite these advances, practical and conceptual gaps remain in how knowledge management contributes to supply chain resilience (Umar *et al.*, 2021). Therefore, this research explores supply chain resilience from a Knowledge Management perspective and focusses explicitly on the pharmaceutical supply chain in the Middle East context.

This study addresses two main questions: (Q1) How can supply chain knowledge be effectively managed to enhance pharmaceutical supply chain resilience? and (Q2) What are the factors hindering knowledge management in the pharmaceutical supply chain and deterring the building of supply chain resilience? Thus, the research contributes to the conceptual gaps in understanding supply chain resilience in the pharmaceutical industry, emphasising the Middle Eastern context, which has not received sufficient attention in the literature.

The next section presents the literature review, which introduces the Middle Eastern pharmaceutical industry and the concepts of supply chain, resilience and knowledge management. This is followed by presenting the research methodology and the study findings. Finally, the paper concludes with theoretical, practical and social implications, limitations and directions for future research.

## Supply chain knowledge management

The role of knowledge in supply chain management is highly increased (Sartori *et al.*, 2022). Supply chain management includes a process of transforming useable information data to provide a knowledge base relevant and accessible to all supply chain members aiming to take advantage of this intangible capital of knowledge to share information and know-how, capitalise on experiences, promote access to knowledge and improve internal and external communication (Sangari *et al.*, 2015). This section will delve further into the various components and models of knowledge management, including the distinction between tacit and explicit knowledge, the socialisation, externalisation, combination and internalisation (SECI) model of knowledge conversion and development and the different components of a knowledge management system.

### *Tacit and explicit knowledge*

According to Nonaka and Takeuchi (1995), tacit knowledge is divided into cognitive and technical knowledge. Technical knowledge refers to the know-how, technical skills and capabilities a person gains through experiences. Cognitive knowledge comprises common mental patterns, thoughts, experiences, beliefs and perceptions that we take for granted, whereas technical knowledge involves individual skills or abilities acquired from working experiences. Whilst tacit knowledge is often difficult to put into words or communicate, explicit knowledge is formal and systematic that can be shared and transferred through communication systems, training and learning, documents, statements, specifications, scientific expressions and operations manuals (Abualqumboz *et al.*, 2021). Explicit knowledge has a straightforward format that can be encoded, transferred, reused and formalised in texts, graphics, tables, figures, drawings, pictures and diagrams organised in databases. Additionally, this knowledge can be reproduced or passed on amongst people. However, tacit and explicit knowledge complement each other (Mc Evoy *et al.*, 2019).

*SECI model of knowledge*

Organisational knowledge is created through the interaction between tacit and explicit knowledge. Scholars have proposed the SECI model (Socialisation, Externalisation, Combination and Internalisation) for knowledge converting and development. According to Lopez-Saez *et al.* (2010), the SECI model was created to formalise the various processes of creation, conversion and transmission of knowledge in organisations based on four distinct successive and deeply linked stages, as shown in Figure 1 below.

(1) *Socialisation* is the process of sharing experiences, so the creation of tacit knowledge is based on other tacit knowledge.

(2) *Externalisation* is transferring tacit knowledge into explicit knowledge through dialogue or collective reflection.

(3) *The combination* is the process of composing explicit knowledge into a knowledge system.

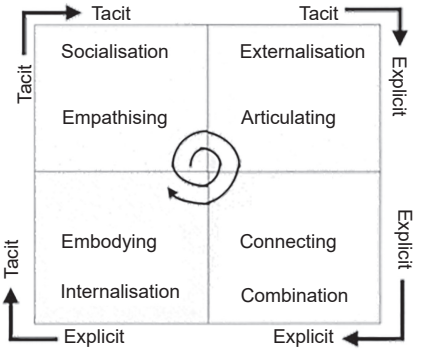
(4) *Internalisation* is defusing explicit knowledge amongst people to create new tacit knowledge.

The SECI model is a spiral working on an endless cycle and continually updating.

*Knowledge management components*

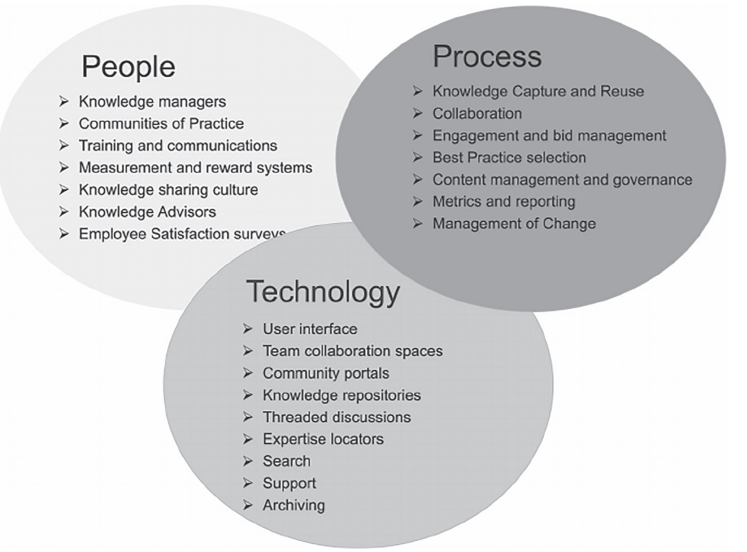
The SECI knowledge creation and transformation model focusses on transferring tacit knowledge to generate explicit knowledge and transmit it to others (Lopez-Saez *et al.*, 2010). However, Buenechea-Elberdin *et al.* (2018) argue that knowledge management must be understood as the instance of governance through which various essential resources are obtained, deployed, or used to support knowledge development. Mc Evoy *et al.* (2019) emphasise the importance of establishing a dominant culture around sharing knowledge, allowing members to add value to their expertise and generate new knowledge for the entire organisation. Therefore, the knowledge management system relies on people, processes and technology (Intezari *et al.*, 2017). People are the producers and consumers of knowledge, the process guides knowledge management and technology facilitates the gathering, storing and access to knowledge, as in Figure 2 below.

Knowledge is used by people and fed by them. The key to knowledge creation lies in how technology mobilises and converts knowledge. This requires a new way of managing




**Source(s):** Adapted from (Nonaka and Takeuchi, 1995)

**Figure 1.**
The SECI model




**Source(s):** Adopted from (Pemberton *et al.*, 2007)

**Figure 2.**
Knowledge management components Adopted from (Pemberton *et al.*, 2007)

relationships and communication with people. It also requires considering knowledge management not as a technique but as a process involving people (Buenechea-Elberdin *et al.*, 2018).

Moreover, Cook and Brown (1999) argue that people's "Knowledge" and "Knowing" should not be perceived as competition but as complementary. "Knowledge" constitutes a "useful" tool for actions in and through our concrete interactions with the world. In return, the "knowing" that develops in and from the actions can enrich the knowledge used in the practices. Consequently, studying the dynamics of knowledge in the organisation supposes an interest in the knowledge possessed (what they possess?) and the practices that mobilise it (what they do?).

## Knowledge management and supply chain resilience

Tukamuhabwa *et al.* (2015) defined supply chain resilience as "The adaptive capability of a supply chain to prepare for and/or respond to disruptions, to make a timely and cost-effective recovery and therefore progress to a post-disruption state of operations – ideally, a better state than prior to the disruption." (p. 5599). This definition implies that supply chain resilience involves complementary components of resistance and recovery. It also implies that an organisation must look into the whole supply chain's capabilities to adapt, grow and survive when faced with risks (Scholten and Schilder, 2015). According to Lusiantoro and Pradiptyo (2022), knowledge sharing is essential for supply chain resilience and its communicative nature can enhance supply chain collaboration. In the context of unprecedented disruptions, they posit that learning and knowledge sharing can facilitate open collaboration amongst supply chain actors, leading to improved responses and achieving supply chain resilience.

Furthermore, Lusiantoro and Pradiptyo (2022) emphasise the significance of "boundary objects" as a learning mechanism in crises, enabling effective mapping and sharing of knowledge. Ahmed *et al.* (2022) highlight the importance of a knowledge-sharing perspective for supply chain actors, arguing that socialisation between actors can increase knowledge-sharing

effectiveness and contribute to supply chain resilience. Likewise, Umar *et al.* (2021) found that knowledge sharing and collaboration amongst supply chain members can improve supply chain resilience facilitated by information technology (IT) advancements.

In the pharmaceutical supply chain, Roy (2021) stresses the role of knowledge in driving traceability and visibility as critical components of supply chain resilience. Supply chain traceability refers to the ability to trace the flow of materials and information back to its origins (Razak *et al.*, 2021). Visibility refers to knowing the entire supply chain at each tier of operations and understanding all the touchpoints that make up the supply chain (Somapa *et al.*, 2018). It works when suppliers, partners and customers operate as a hub in the movement of goods and the flow of information (Somapa *et al.*, 2018). Pettit *et al.* (2019) argue that synchronising all supply chain components and emphasising greater visibility and traceability help companies better anticipate issues, limit the impact of supply chain disruptions and improve overall operations. According to Roy (2021), whilst visibility and traceability are the prerequisites of resilience, superior supply chain knowledge management is the prerequisite for outstanding visibility and traceability. By leveraging the capabilities of visibility and traceability, companies can collect and analyse large amounts of data, which enhances the ability of the supply chain to identify patterns, market trends and opportunities for improvement, especially during severe crises (Razak *et al.*, 2021). These capabilities also enable companies to track and monitor product flows, facilitating greater transparency and accountability within the supply chain. Ultimately, integrating visibility and traceability capabilities into knowledge management processes can lead to more informed decision-making, better risk management and greater supply chain resilience (Roy, 2021).

Extending the knowledge-based view into supply chains maintains that an organisation can benefit from the diverse knowledge of supply chain members to address the challenges related to competition and innovation (Jermsittiparsert and Srisawat, 2019). Managing knowledge at the supply chain level can be a leverage mechanism to reduce supply chain variability and disruption and increase supply chain integration and collaboration efforts. This requires an extended-knowledge management system that comprises internal and external supply chain mechanisms. The internal mechanisms refer to the knowledge management activities within an organisation, such as knowledge sharing, knowledge acquisition and knowledge retention, which Umar *et al.* (2021) suggest that it supports the supply chain's adaptation to post-disaster operations. On the other hand, external mechanisms refer to the knowledge management activities between supply chain partners to ensure smooth knowledge flow, such as supplier development initiatives and joint product development (Lopez-Saez *et al.*, 2010).

Going further, Razak *et al.* (2021) assert that effective supply chain knowledge management is the leading enabler of supply chain visibility and traceability, allowing a timely response to the business environment's dynamic change and supporting organisation development. Papert *et al.* (2016) found that high visibility is essential to control the complexity of deliveries, assign responsibilities and deal with possible unforeseen events. Hastig and Sodhi (2020) argue that monitoring the status of products throughout the supply chain is critical for traceability and to prevent damage or improper handling of the product.

## Pharmaceutical supply chain

The pharmaceutical supply chain is a complex network of organisations comprising various actors working together to meet customer demands efficiently and timely (Yaroson *et al.*, 2021). The typical pharmaceutical supply chains include raw materials manufacturing, pharmaceutical production, distribution centres, hospitals, pharmacies, physicians and patients. Pharmaceutical supply chain management aims to coordinate this vast network of actors to ensure the smooth flow of products from upstream to service delivery points whilst

maintaining quality, safety, affordability and efficiency standards (Papalexi *et al.*, 2020). Every node in the network must contribute value and perform its functions optimally, collaborating to ensure reliability and efficiency in the supply chain (Meehan *et al.*, 2017).

Knowledge-sharing is imperative in the pharmaceutical industry, which is intensive in generating information and requires a massive capacity to analyse and transform data into information (Alkalha *et al.*, 2019). Nevertheless, knowledge-sharing is a challenging process in this supply chain due to the lack of a trust culture and absorptive capacity (Haque and Islam, 2018) highlighted the paradox of knowledge-sharing, arguing that pharmaceutical companies continually require innovation, research and development, which requires effective knowledge-sharing and collaboration. Yet, this sharing may expose companies to imitation and threats to their privacy. Therefore, the complexity of the knowledge in the pharmaceutical industry stems from the fact that the knowledge and the industry's technology are dynamic and transferring the knowledge consumes more time compared with other industries (Bhatti *et al., 2*020). This makes pharmaceutical supply chains highly dependent on knowledge sharing as companies strive to be more resilient, agile and responsive to external threats. Companies, accordingly, must balance the benefits of knowledge sharing with the risks of knowledge leakage, copying, or sharing with those who can potentially harm their intellectual property (Bogers, 2011). This requires companies to develop strategies to protect their knowledge, such as adopting appropriate legal, contractual and technological mechanisms. At the same time, they need to establish trust, build relationships and create a culture of collaboration and knowledge sharing amongst their supply chain partners (Huo *et al.*, 2021). In this context, Alkalha *et al.* (2019) emphasised the role of data protection capacity in safeguarding data and privacy. Likewise, Chowdhury *et al.* (2019) emphasised the role of intellectual capital management as a critical success asset in the pharmaceutical industry to enjoy protection for their new products and greater investment in R&D.

Knowledge-sharing in the pharmaceutical industry supply chains also varies considerably in terms of the role of government in regulating and overseeing the pharmaceutical industry, the higher-education sector and incentives for R&D. For example, in addition to the traditional relationships -suppliers, manufacturers, third-party logistics, wholesalers and retailers-the companies exchange the required knowledge to select the suppliers with the regulatory bodies. Also, the regulatory bodies control the medicines' prices in some countries (Alkalha *et al.*, 2019).

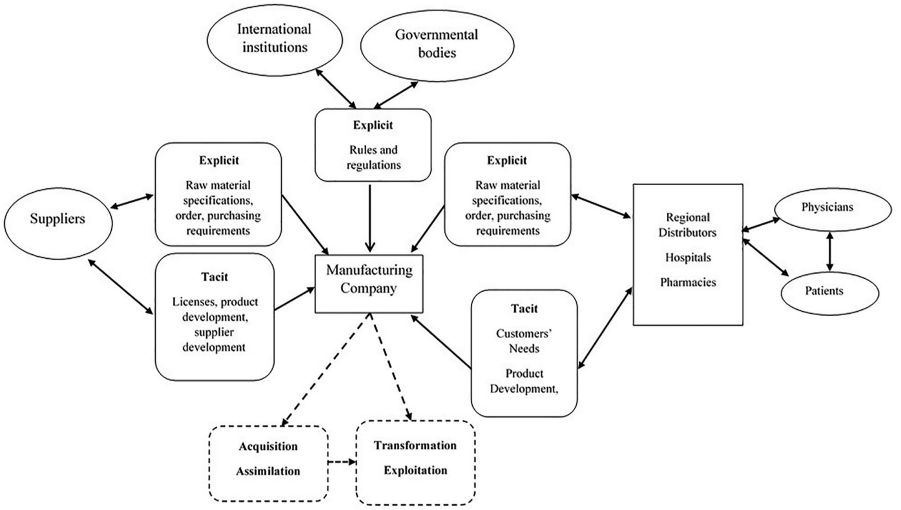
Furthermore, pharmaceutical companies interact with governments and international institutions to exchange routine information and directly sell medicines to governmental hospitals (Asamoah *et al.*, 2011). However, the pharmaceutical industry's relationship between the suppliers, the manufacturers' companies and the customers (wholesalers, logistics, retailers and doctors) is highly integrated. For instance, companies expand their quality implementation across their supply chain (Alkalha *et al.,* 2019). In this case, the manufacturers involve the key suppliers and customers in new product development and develop the performance of the suppliers, the wholesales and the retailers to maintain the quality and achieve supply chain quality integration (Friedli *et al.,* 2010). Also, the suppliers might act as the company's partners in case the suppliers are involved in the product development or if a supplier provides the manufacturing licence for a company (Alkalha *et al.,* 2019).

Therefore, several entities formulated the pharmaceutical supply chain and played critical roles in knowledge dissemination across the supply chain. As a result, manufacturing companies, as a focal point, need to improve their absorptive capacity to exploit tacit knowledge (Alkalha *et al.*, 2019). To do so, the companies benefited from their explicit Knowledge to acquire and assimilate the external knowledge using the company routine, facilitating knowledge transformation and exploitation (Lichtenthaler, 2016). The supply

chain's knowledge flows, whether tacit or explicit, are bidirectional. Figure 3 summarises how the supply chain in the pharmaceutical industry is designed and how tacit knowledge can be transformed into explicit.

Figure 3 above highlights the transformative nature of the knowledge absorption process, in which companies can convert tacit knowledge into explicit forms. This process is facilitated by exchanging explicit knowledge with stakeholders, including international institutions and governments, external partners such as suppliers and customers and other critical actors in the supply chain, such as hospitals, distributors, pharmacies, physicians and patients. The explicit knowledge shared with customers tends to focus on their needs and requirements, serving as a basis for product development. In contrast, the knowledge exchanged with suppliers is geared towards enhancing product development and supplier performance.

Moreover, knowledge transfer, particularly in the form of licences, is critical in knowledge absorption. Licences, as legal documents, represent explicit knowledge. They codify the terms and conditions of the granted permissions, which can be documented, transmitted, or stored (Nonaka and Takeuchi, 1995). However, obtaining and leveraging licences for business purposes involves tacit knowledge (Lowe, 2006). This tacit knowledge often stems from the experience, expertise and personal skills required to navigate regulatory systems or understand the strategic implications of licences (Eklund and Kapoor, 2022). Suppliers typically provide training and support to manufacturers' employees to facilitate the transfer of this tacit knowledge (Alkalha *et al.*, 2019). Acquiring a licence within the pharmaceutical industry frequently demands extensive experience and a thorough comprehension of the intricate regulatory and compliance requirements, making it challenging to replicate. Consequently, acquiring and utilising licences can involve explicit knowledge (the licence itself) and tacit knowledge (the skills and experience required to obtain and leverage the licence).




**Source(s):** Created by the Research Team

**Figure 3.**
The process of knowledge sharing in pharmaceutical supply chain

Supply chain knowledge goes through two distinct stages: potential and realised. In the potential stage, companies acquire supply chain knowledge, which is then assimilated through the company's routines and processes. In the realised stage, the newly acquired knowledge is transformed by combining it with existing knowledge and the old knowledge is either adjusted or deleted. Finally, the companies exploit the knowledge by utilising it in products, processes and services.

## The pharmaceutical industry in the Middle East

The Middle East region has a growing pharmaceutical industry. Nevertheless, the industry faces unique challenges and opportunities, including a complex regulatory environment, local production, access to medicines and supply chain resilience (Haloub *et al.*, 2022). There are several differences in the perspectives on supply chain management between Western and Middle Eastern countries. According to Jamali *et al.* (2020), these differences may be attributed to variations in business culture, regulatory environments, infrastructure and technology adoption. Notably, whilst these factors may be less emphasised in the Middle East, the relatively familial business culture (Metcalfe, 2006) emphasises social relationships and collaboration more.

The regulatory environment in Middle Eastern countries may be less developed and standardised (Jamali *et al.*, 2020). Furthermore, Western countries may be earlier adopters of new technologies, whilst Middle Eastern countries may be slower to adopt due to factors such as the lack of infrastructure (Raudeliuniene *et al.*, 2021). Besides, population and gross domestic product (GDP) per capita are growing at a higher rate in the Middle Eastern than in Western countries, resulting in Middle Eastern countries becoming significant economies and competitive players in the international markets (Kalliny and Benmamoun, 2014).

Moreover, the supply chain of the Western pharmaceutical industry is research-intensive, digital-oriented, fully-integrated and incorporates up-to-date transparency best practices, resulting in greater efficiency throughout the entire supply chain. The interactions of the supply chain members intervene in the discovery, development, manufacturing, marketing and sale of drugs worldwide. Innovative companies protect their developments through a solid protection system and intellectual property rights (Dierks *et al.*, 2013; Robaczewska *et al.*, 2019). However, in the Middle East, there are cases in which this legal protection is limited or does not exist. Therefore, only a little information is exchanged, such as demand forecasting, stock level, production plans, maximum/minimum inventory level, reorder point and order amount, which are the primary information provided and utilised as a decision support tool between the supply chain members (see Chowdhury *et al.*, 2019; Alkalha *et al.*, 2019).

Whilst the role of knowledge management in building supply chain resilience is vital for pharmaceutical companies in both the Middle East and the West, cultural, regulatory and market factors may influence the strategies and approaches companies use in each region (Narayana *et al.*, 2012). Pharmaceutical companies in the Middle East may need to comply with different regulatory requirements compared to Western companies and knowledge management strategies may need to be tailored to meet these requirements (Alzoubi *et al.*, 2020). Moreover, the Middle East market may be less developed or less mature than Western markets, which may influence the availability of resources and the level of competition (Holtorf *et al.*, 2019).

Therefore, studying the role of knowledge management for supply chain resilience in the pharmaceutical industry in the Middle East region can provide insights into the unique challenges and opportunities in this region, which may differ from those in Western countries, as highlighted by Jamali *et al.* (2020). Understanding these differences can help develop targeted strategies to enhance supply chain resilience and improve the availability of medicines for patients in the Middle East region.

## Research methodology

### *Research design*

This inductive study is of exploratory nature, investigating how supply chain knowledge could be effectively managed to enhance pharmaceutical supply chain resilience. The inductive method is a relatively flexible scientific method to explore or formulate theories (Williams and Moser, 2019). Also, this study focussed on constructing knowledge; hence a social constructivism research paradigm was adopted, assuming that knowledge is a mental construction through people's cognition (Easterby-Smith *et al.*, 2021).

### *Data collection*

This study focusses on the Middle East Region. The empirical data were collected based on a semi-structured interview. The interview grid comprises two main themes: the role of knowledge in building supply chain resilience; and the challenges and enablers of supply chain knowledge management. The interviews were conducted between May and November 2020. Due to the lockdown during the data collection, all interviews were conducted online using Zoom or Teams. Social Media platforms (mainly LinkedIn) were used to approach the study participants. However, initially, we relied on our professional and personal networks to reach the participants. During the interviews, the participants were asked to name other people with knowledge of the research topic. In total, 38 people working in 12 different pharmaceutical companies in the Middle East were interviewed. Whilst some companies operate through vertical integration with a narrow vertical structure, others outsource some of their operations. The table below shows the characteristics of these companies representing different pharmaceutical companies (Mainline, R&D and Generic), as shown in Table 1 below. The three typologies of pharmaceutical companies derive from the US Bureau of Labour Statistics.

The study participants were managers and senior supply chain professionals from several points of the pharmaceutical supply chain. The participants were CEOs, General Managers, Supply Chain Managers, Operations and Production Managers, Procurement Managers, Logistic Managers, Warehouse Managers and Pharmacists. Table 2 below shows the key characteristics of the study participants.

Whilst conducting interviews, we adhered to ethical conduct, including upholding informed consent, withdrawing possibility, privacy and confidentiality and practising integrity and honesty.

### *Data analysis*

The data analysis was focussed on knowledge management relationships between different actors in a pharmaceutical supply chain in the Middle East region. Thus, the unit of analysis was the supplier-buyer relationship exploring the knowledge-sharing process amongst the supply chain members. The data analysis was two-fold. First, to answer the first research question, the thematic analysis approach was used (Braun and Clarke, 2006). The data analysis started by finding the initial codes from the data. This open coding technique allowed for the creation of first-rate provisional categories. In the second stage, we used axial coding to weave linkages between and amongst the previously defined groups. This method allowed for the creation of higher-order consolidated categories. Finally, the second-order theoretical categories were aggregated and linked to form theoretical aggregates.

The fishbone model was used to answer the second research question. Fishbone is an effective tool for studying processes and situations and identifying the possible causes of a specific problem. Besides, we weighted the different dimensions of challenges facing supply chain management against each other, where the probability of identifying the leading causes increases. The Pareto chart, also called the 80–20% curve, was used to do so. It allows

| Company | Location | Company size | Company type | No of participants | Note |
|---|---|---|---|---|---|
| A | Saudi Arabia | More than 500 employees | Mainline | 5 | The company provides a large number of approved drugs on the market. It has internationally acclaimed research and development laboratories and a large manufacturing plant |
| B | United Arab Emirates | More than 500 employees | Mainline | 4 | |
| C | Jordan | More than 500 employees | Mainline | 4 | |
| D | Egypt | More than 500 employees | Mainline | 4 | |
| E | Qatar | More than 500 employees | R&D | 4 | The company focusses on research to develop new products |
| F | Saudi Arabia | Less than 500 employees | R&D | 3 | |
| G | United Arab Emirates | Less than 500 employees | Generic | 3 | The company is a mass-producer of expired drug patents |
| H | Saudi Arabia | More than 500 employees | Generic | 3 | |
| I | Jordan | More than 500 employees | Generic | 3 | |
| J | Jordan | Less than 500 employees | Generic | 3 | |
| K | Egypt | Less than 500 employees | Generic | 3 | |
| L | Qatar | Less than 500 employees | Generic | 2 | |

**Source(s):** Created by the Research Team

**Table 1.** Summary of participating companies

assigning an order of priorities, stating that a few are responsible for most of that effect in any group of elements or factors contributing to the same effect. It facilitates the comparison of numerous dimensions of a problem, considering that the distribution of the effects and their possible causes are not linear but that 20% of the total causes cause 80% of the effects to be originated.

## The study findings

### *The flow of knowledge in the pharmaceutical supply chain*

The results show that various dynamic, scientific, social and economic factors shape the pharmaceutical industry's supply chain in the Middle East. In addition, some pharmaceutical companies work in both domestic and foreign markets. Consequently, their processes must comply with various regulations and policies, which apply to drug development and approval, manufacturing and quality control, marketing and sales. Likewise, agents such as researchers from public institutions and the private sector, educational institutions, doctors and pharmacists and public opinion are also influential in knowledge sharing in the pharmaceutical industry.

| Job roles of interviewees | No. of interviews | Experience | | Company size | | Company type | | |
|---|---|---|---|---|---|---|---|---|
| | | Less than 5 years | More than 5 years | Less than 500 employees | More than 500 employees | Mainline | R&D | Generic |
| CEO | 2 | | 2 | 1 | 1 | x | | x |
| General Manager | 4 | | 4 | 1 | 3 | x | x | x |
| Supply Chain Managers | 8 | 3 | 5 | 3 | 5 | x | x | x |
| Operations Manager | 7 | 3 | 4 | 4 | 3 | x | x | x |
| Procurement Manager | 6 | 3 | 3 | 3 | 3 | x | x | x |
| Logistic Manager | 5 | 3 | 2 | 2 | 3 | x | x | x |
| Warehouse Manager | 3 | 2 | 1 | 2 | 1 | x | x | x |
| Store Manager | 3 | 2 | 1 | 2 | 1 | x | x | x |
| Total interviews | 38 | | | | | | | |

**Source(s):** Created by the Research Team

**Table 2.**
Details of interviewees

First, the conversion of explicit knowledge to tacit knowledge occurred through socialisation. Given that the pharmaceutical supply chain is often long and complex, requiring the expertise of multiple disciplines with different levels of expertise, it is unsurprising that different types of knowledge could be generated to support partnerships. According to a Supply Chain Manager, "*Explicit information is easy to exchange between supply chain members through demand management, inventory management, purchasing management, specifications, packaging, quality standards, loading and storage conditions and control management. But tacit information is difficult to exchange because it involves intellectual and practical skills. Despite this, some explicit information for supply chain members constitutes tacit information for other teams, which can be used to develop new explicit knowledge.*"

The results indicated that the companies get tacit knowledge through "learning", interacting and incorporating new ways of acting and work practices for team members. For instance, the Operations Manager mentioned, "*Tacit knowledge is acquired from observation, imitation, practices, negotiations, feedback and the causes of change in specifications and new requirements. This begins with creating an interactive working environment [the interviewee referring to "NetSuite" ERP system] that allows team members [i.e. supply chain partners] to share their experiences and mental models, thus transferring tacit knowledge from one team member to another*".

Then this knowledge is externalised and combined into the system using an organisational knowledge system. According to the IT manager, *"knowledge created by each person becomes organisational knowledge; most of this knowledge is stored in the system and organisation's database so that each [supply chain partner] could benefit from it"*. Moreover, the Production Manager added, *"The company keeps new knowledge related to the new formula in a special system for this purpose"*. The Supply Chain Manager added, *"We keep records for any new knowledge related to suppliers' evaluation or quality specification, and we share it with other departments"*. After the knowledge is converted to explicit, the companies share it across functions, which is shared across supply chain partners through the ERP system. The Logistics Manager explained, *"We have our internal system that facilitates sharing the knowledge as everything is stored in the system, and we can easily retrieve*

*and search"*. The Logistics Manager also highlighted that the company's ability to share knowledge with their supply chain partners helped to build trust and collaboration within the supply chain due to the improved decision-making process and accessibility to information regarding suppliers when Covid disruptions stormed the supply chain.

The new explicit knowledge generated by the company routinely enriches the internal knowledge, which helps create and exploit knowledge through internalisation. For example, the Purchasing Manager said, *"The standard operating procedures are a must, but in some cases, we learn new skills by doing the job, and then we might adjust the standard operations procedures"*. A Production Manager explained: "*At the onset of the COVID-19 pandemic, our company faced significant supply chain disruptions due to sudden changes in demand patterns and disruptions in transportation and logistics. However, our open channel communication with our suppliers helped us remain resilient. In some severe cases, we had to identify alternative suppliers and transportation routes quickly, but this came following a discussion with our current suppliers. Hence, we were able to pivot quickly and effectively in response to our large customers' demand"*. This emphasises the value of leveraging knowledge across the supply chain to quickly respond to changing environment. This new "know-how" is articulated and conveyed throughout the internalisation process through continual interactions with supply chain members in which teams pool their information and study it from many viewpoints, thereby combining their distinct individual perspectives into a new collective perspective.

*The role of knowledge in building supply chain resilience*

The study participants viewed supply chain knowledge as a critical enabler of organisational resilience. Knowledge at the supply chain level helps improve the quality and quantity of new knowledge. For instance, a Supply Chain Manager said, *"Knowledge exchange between companies helps us continuously improve our knowledge, enhancing our ability to face challenges in the business environment."* Likewise, a supply chain manager said, *"Knowledge exchange with other partners helps us continue learning and development."* The data analysis finds that knowledge management throughout the supply chain helps the organisations gradually develop resilience capability that helps them face challenges in the external environment and recover after a disturbance, as shown in Figure 4 below.

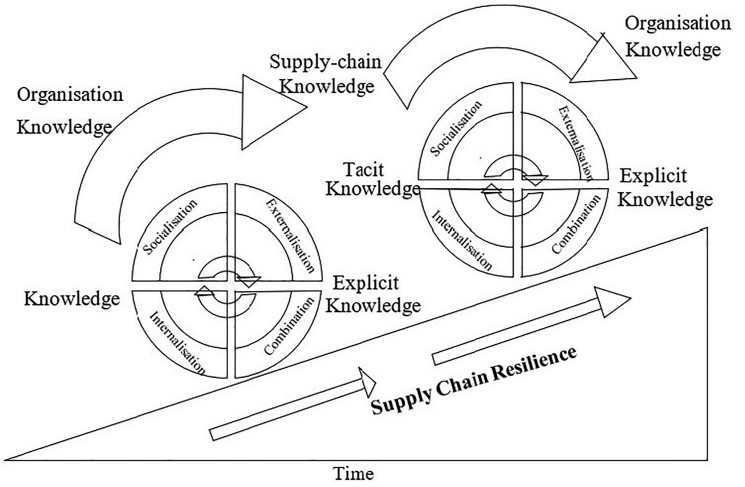



**Figure 4.**
The gradual process of developing resilience capability

**Source(s):** Created by the Research Team

The pharmaceutical supply chain has a considerable accumulation of tacit knowledge, skills and competencies; each supply chain member is a source of unique knowledge. In managing the supply chain knowledge, the organisation continuously acquires new knowledge through ongoing interactions with other points. It acquires tacit knowledge and converts it into explicit knowledge that will be redistributed to other members within the supply chain and new tacit knowledge will develop. An operations manager mentioned, *"If you want to have a stable operations system, you must consider the most important vital signs in logistics and track the product flow during all phases of the supply chain."* A Supply Chain Manager added, *"We need to keep everyone in the supply chain informed with inventory updates, preventing stockouts. The main driver is to control the risks that may affect its supply chain, which also allows problems to be detected before they occur"*.

Going further, a Supply Chain Manager asserted that "*we have to understand logistics as a strategic tool that helps us face not only adverse situations but also take advantage of them."* In this context, a Procurement Manager added, *"Successful execution depends on the accuracy and speed with information. This information is transmitted by direct communication, and we assimilate it into new knowledge"*. Finally, a Logistic Manager states, *"Supply chain data contain the crucial information needed to improve the supply chain performance. Therefore, it is not only necessary to think about implementing supply chain integration. It is also essential to track and maintain integration constants to ensure information is sent, received, interpreted and redistributed externally"*.

In the pharmaceutical industry, the problems, risks and challenges in the external work environment outweigh the capabilities of individual organisations. Therefore, organisations within the supply chain must work together to meet these challenges and cooperate in developing capabilities that support their resilience. According to the study participants, the role of supply chain knowledge in enhancing the organisation's resilience lies in developing several capabilities. For instance, the director of operations and production said, *"Knowledge and continuous learning is the basis of all organisational capabilities development and enhancing."* Furthermore, a Supply Chain Manager argued, *"Under current circumstances, we cannot rely on our knowledge only, but rather we must benefit from our partners to develop new capabilities supporting our resilience."*

The data analysis finds that building organisational resilience leads to supply chain resilience in two ways. First, having these resilience capabilities allow an organisation to have -and grant-greater control, improve the efficiency of their business, streamline processes, make deliveries on time and improve the level of service throughout the entire supply chain. In this sense, the beneficiaries will always be each member of the supply chain to adapt to adversity and find creative solutions to reverse it. Moreover, knowledge sharing supports organisational resilience by reducing uncertainty, increasing the supply chain visibility and traceability to make data-driven decisions using real-time data and improving agility in detecting and responding to disruptions.

The data analysis, conducted using NVivo 12, investigated the capabilities contributing to supply chain resilience and yielded 126 initial codes. These codes were subsequently analysed through cluster analysis in NVivo using coding similarity and categorised into five main capabilities, as shown in Figure 5 below. It is important to note that the frequency of a theme does not necessarily indicate its importance. However, this approach allows for a focussed consideration of the theme's informed implications (Goffin and Koners, 2011).

(1) *Agility Capability*

According to the study participants, exchanging knowledge at the supply chain level improves organisational agility. For instance, an Operation Manager said, *"Supply chain knowledge helped us develop our flexibility and the ability to detect and capture the outstanding*

*opportunities in the market."* Likewise, a Supply Chain Manager said, *"Sharing knowledge with our suppliers and distributors led our company to acquire the flexibility to grow and the ability to prevent negative events."* Likewise, a General Manager said, "*Sharing information in the supply chain helps us better understand the changing environment's characteristics. Therefore, it is indispensable to collaborate and develop the ability to cope with the environment and facilitate reactive and proactive responses to all these changes"*. The Logistic Manager added, *"Exchanging knowledge offers great supply chain visibility, which offers immediate information and channels it through pertinent notices to allow agile management, as a first step to achieving more resilient supply chains."*

(2) *Change Capability and Adaptability*

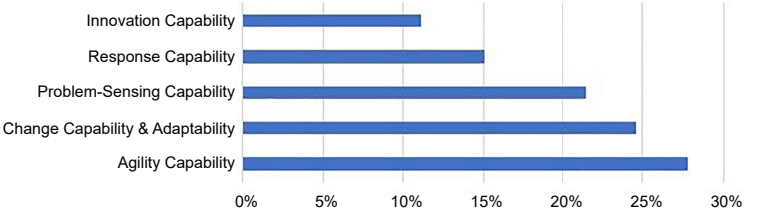
Sharing knowledge within the supply chain improves organisational adaptability and better coping with the dynamic business environment. Adaptability requires the construction of strategic flexibility facilitated by internal and external information. For example, a General Manager argues, *"The current business environment points to an era of far-reaching changes in business strategy, operations and technology. A new set of information must guide efforts to succeed in this era, and our global supply chain is a good source of this information"*. The supply chain knowledge becomes a strategic resource for better changing capability. For instance, a Supply Chain Manager said, *"Changes occurring globally are causing unpredictable situations. Faced with this reality, we need our partners' support to continuously gain new insights and knowledge and establish certain changes strategies"*.

(3) *Problem-Sensing Capability*

Managing Supply chain knowledge enhances the organisation's problem-sensing and responsiveness capability. It enhances the organisation's ability to identify the initial state of a situation, the final state to reach, the obstacles that prevent moving from the initial state to the final state and the procedures to overcome those obstacles. For instance, a Supply Chain Manager argues that *"supply chain knowledge provides the organisation with the capacity for quicker problem-solving and acting reactively, without wasting time, and finding the most appropriate solutions for each case."*

(4) *Response Capability*

Supply chain knowledge enhances the organisation's ability to evaluate, control and project the future. In addition, it supports organisational resilience through actions favouring the optimal maintenance of a business's operations. According to a chief execuitve officer (CEO), "*Companies need to access knowledge in the face of environmental threats and adversities that continuously arise. These challenges are beyond the company's knowledge and capabilities, and we have to exchange information with our partners in the supply chain effectively"*. A Supply Chain Manager argues that *"The knowledge within the supply chain provides the organisation*




**Source(s):** Created by the Research Team

**Figure 5.**
Capabilities for supply chain resilience

*the capacity to observe market dynamics, and unlock the ability for market analysis to develop effective operational actions towards potential threats."*

(5) *Innovation Capability*

The supply chain knowledge positively impacted innovation in the studied pharmaceutical companies. Knowledge creation and transfer within the supply chain are organisations' innovative vehicles. It is especially noticed in the studied organisations that exchanging internal knowledge with supply chain members helped develop innovative approaches to adapt to disruptive supply and demand patterns. According to an Operations Manager, "*In a dynamic business environment, organisations have better chances to survive if they have high-coordination to gain sufficient knowledge resources that improve operational routine and innovation ability."* A Procurement Manager argues that *"By sharing information in both directions – "downstream" and "upstream," the organisation will have the ability to improve products' time to the market, reduce cost and effectively plan for future needs."*

Based on the findings above, it is evident that the capabilities for supply chain resilience are integrated and interdependent. The capabilities identified include Agility Capability, Change Capability and Adaptability, Problem-Sensing Capability, Response Capability and Innovation Capability. These capabilities are not mutually exclusive but work together to create a more resilient supply chain. The integration of these capabilities relies on tacit and explicit knowledge sharing. For example, agility capability relies on exchanging knowledge at the supply chain level, improving organisational flexibility and detecting and capturing outstanding market opportunities. This knowledge exchange involves, for example, insider knowledge of supplier relationships that cannot be easily codified.

Similarly, Change Capability and Adaptability rely on constructing strategic flexibility facilitated by internal and external information, which relies on supply chain partners' tacit and explicit knowledge to identify and anticipate changes in the business environment. The tacit knowledge enables supply chain partners to develop effective strategies for change management and adapt to the dynamic business environment. Moreover, the Problem-Sensing Capability relies on managing supply chain knowledge to enhance the supply chain partners' problem-sensing and responsiveness capability. This also requires sharing tacit knowledge to identify the initial state of a situation, the final state to reach, the obstacles that prevent moving from the initial state to the final state and the procedures to overcome those obstacles.

The Response Capability also relies on supply chain knowledge to evaluate, control and project the future. The exchange of knowledge with supply chain partners enables the partners to observe market dynamics, unlock the ability for market analysis and develop practical operational actions towards potential threats such as Covid-19. Finally, Innovation Capability positively impacts innovation in the studied pharmaceutical companies. The exchange of knowledge with supply chain partners helps develop innovative approaches to adapt to disruptive supply and demand patterns. This knowledge exchange involves sharing tacit knowledge, such as intuitively understanding how to optimise certain logistics processes without or with partial availability of detailed data.

To summarise, the capabilities for supply chain resilience identified in our findings are integrated and interdependent, relying heavily on exchanging tacit and explicit knowledge between supply chain partners. The exchange of knowledge enables organisations to identify and anticipate changes, develop effective strategies for change management, enhance problem-sensing and responsiveness capability, evaluate, control and project the future and develop innovative approaches to adapt to disruptive supply and demand patterns.

*The challenges of knowledge management in supply chains*

The study participants argue that effective supply chain knowledge management allows for better information visibility across the supply chain. However, knowledge management in the supply chain suffers from the "Blind Men and an Elephant" syndrome. There are likely several distinct perspectives on supply chain knowledge management, which lead to different extrapolations. Some aspects of the supply chain knowledge are more visible (e.g. patents, intellectual property), but the majority consist of know-how, know-why, experience, expertise, opinions and stories that tend to be complex to be shared amongst the supply chain members. The data analysis identified several codes representing the challenges and difficulties in promoting supply chain knowledge. These codes were grouped into four leading causes, supply chain management, technology, process and people, as shown in Figure 6 below. The Fishbone diagram was used to identify the main challenges facing supply chain knowledge management and the possible causes of the problem.

(6) *Supply Chain Management*

A robust supply chain integration results in high-performance business processes. Supply chains are built on the strengths and weaknesses of each supply chain member. A CEO states, *"Supply chains are a complex network of companies connected. These companies operate within a work environment, industries, and different content. As a result, these companies produce different knowledge in line with the nature of their business. The differences between supply chain members pose a challenge to knowledge management*". According to the data analysis, organisational behavioural obstacle represents the main challenge facing supply chain knowledge management. For instance, a Procurement Manager said: "[Organisational] *Behavioural obstacles such as learning problems within organisations contribute to the distortion of information. These issues are often related to how the supply chain is structured and the node communication*". Summarising the obstacles that faced knowledge management in the supply chain (drawing on data from the companies interviewed) is as follows:

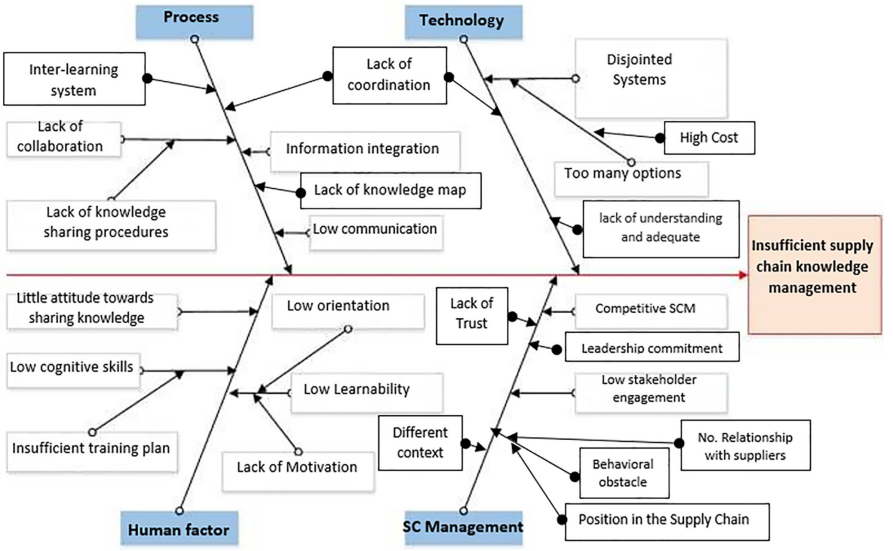



**Figure 6.**
The main challenges facing supply chain knowledge management

**Source(s):** Created by the Research Team

(1) Supply chains are usually designed to foster cooperation between partners. However, in competitive environments, knowledge sharing may be perceived as risky due to the potential knowledge attrition.

(2) The companies had distinct corporate cultures influencing their approaches to knowledge-sharing practices.

(3) Inward-looking companies tended to prioritise their knowledge management practices, which were incompatible with those of other companies.

(4) Nodes in the supply chain have shown reactive behaviour to local emergencies rather than proactively addressing root causes.

(5) A culture of blame is evident.

(6) A lack of trust between supply chain partners results in opportunistic behaviour that undermines overall performance.

(7) Insufficient leadership commitment hinders inter-organisational knowledge sharing.

(8) A lack of confidence leads to significant duplication of effort. Additionally, information available at different nodes is often not shared or ignored due to a lack of trust.

The study finds that supply chain knowledge management would likely be less effective without solid leadership commitment. A Supply Chain Manager said, "*An organisation may have the best knowledge management system, but it takes leadership to share knowledge to a level that will put the supply chain in the best possible position to be successful.*" Furthermore, efficient knowledge sharing in the supply chain requires a high level of visibility and coordination amongst the different participants—lack of trust and leadership commitment to knowledge management deter the development of an effective knowledge management system. According to an Operations Manager, "*If top management is not committed to knowledge management adoption in SC, it seems to have led to a common understanding concerning organisational vision, strategies, and supplier/customer relationship management was not present.*"

(1) *People*

People are the basis of knowledge and experiences within any organisation. The desire and ability of these people to share and exchange this knowledge amongst themselves is the basis for knowledge management's success, whether within the organisation or supply chains.

The study found many barriers related to knowledge management in supply chains linked to people. According to an Operations Manager, "*Some employees tend to resist sharing their knowledge because of the notion that knowledge is property; ownership . . . Members who trust each other are willing to exchange knowledge and simultaneously want to embrace knowledge from other members.*"

Through the data analysis, the difference in the context between the companies that make up the supply chain constitutes one of the obstacles to sharing knowledge. This is two-fold: The first is the unwillingness of people working in an organisation to learn knowledge that may be viewed out of context or the content of their work. The second relates to the lack of willingness to exchange knowledge outside the organisation's framework and generate new knowledge. For example, a General Manager said, *"The behaviour of employees and their desire to learn is shallow outside the organisation's framework, as employees feel that this knowledge is unimportant and do not have the desire to learn it."* Likewise, a Warehouse Manager said, "*Knowledge includes people's intuitions, perspectives, beliefs, values, and experiences. Therefore, it is difficult to integrate people in various organisations within or in different countries to learn from each other.*"

The data analysis also finds that organisational culture is a practical knowledge transfer factor, and organisations must form a culture that supports knowledge sharing. According to a Supply Chain Manager, *"The success of knowledge sharing rests mainly on the investment of the individuals and their rational and emotional interest in participating in a collective process, a process that requires a relationship between individual representations and the common knowledge space."* Participants also mentioned a lack of training. For instance, a General Manager, "*Heavy reliance on technology by employees that are unrealistic, little or no training of employees on Information and communications technology systems and processes, reluctance by the same employees to use technology due to lack of familiarity, and maintenance of the said systems."*

It has been found that knowledge transfer is affected by individual and organisational behaviour and positively or negatively impacts its implementation. This is explained by individuals' interest and initiative to transfer knowledge reflected in the development and implementation of incentives, which can be monetarily aiming to successfully intervene in the possibility of knowledge transfer of people in an organisation. In this sense, replication activities in knowledge transfer allow company employees to work with their partners in the sending companies and understand the knowledge they acquire. Furthermore, companies can intensify their cooperative competition with partners through replication activities.

(2) *System*

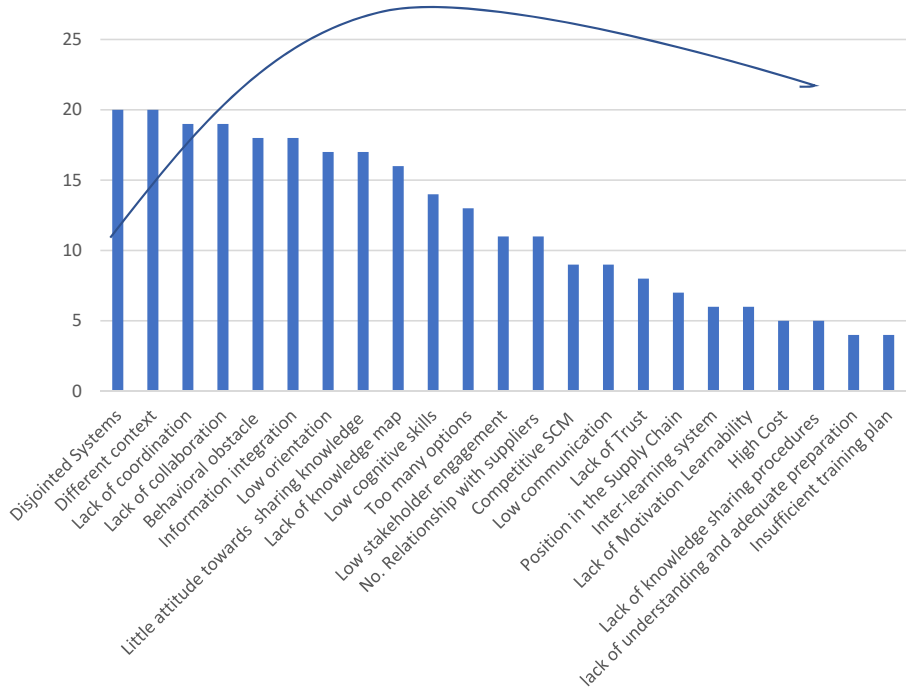
The supply chain involves intertwining specialised knowledge from several areas to solve complex problems and innovate or transform that knowledge into something greater. In knowledge sharing, replication activities strengthen companies, build trust in relationships with partners, increase communication in a shared language and symbols and establish. According to the data analysis, communication and coordination are the main critical elements in successful knowledge transfer, understood as the extent to which activities, people, routines and tasks work together to achieve objectives, generating more opportunities to share knowledge. For instance, an Operations Manager said, *"Knowledge is usually transferred through communicating or coordinating among employees and organisation. Hence, it is a complex process requiring robust communication and coordination systems among organisations to capture knowledge"*. A CEO argues, "*Often the coordination at a high level is complicated among the supply chain members due to the different natures of the organisations within the chain."* It has also been found that most knowledge is lost between members and tiers. Throughout the supply chain, the members' structure and integration vary with the passage from one phase to another. For instance, a Logistic Manager said, "*So we risk losing valuable knowledge in these composition changes or transmitting knowledge inappropriately within the supply chain phases, especially when moving to more than one level on the chain, such as suppliers of suppliers or customers' customers."* Besides, the study participant emphasised the role of interpretations, where each supply chain member gives to the documentation can be altered by the subjective criteria of its context, leading to errors or delays. According to the data analysis, the other challenges are insufficient knowledge exchange with processors, wrong procedures and an ineffective inter-learning system.

(3) *Technology*

Technology plays a significant role in knowledge management and sharing between organisations in supply chains. However, at the same time, it may be one of the most critical obstacles in exchanging knowledge, especially with the diversity of technology and the different systems that can be used, which leads to a disjointed and disconnected system. For instance, a General Manager said, *"Technology has changed how organisations operate, providing instant access to information and data over long distances. Nevertheless, technology*

*does not operate in a vacuum, and organisations today must adapt and use different solutions."* Likewise, a CEO said, *"Sometimes technology is a challenge that obstructs the application and management of knowledge. Organisations have invested in information and communications technology. However, most of these systems and processes mismatch with other supply chain members, particularly when you are a member of a complex supply chain"*. The study participants also mentioned creating knowledge repositories without considering the need to manage their content and failing to understand and relate knowledge management to the supply chain's function. Other obstacles to its successful development have also been identified, such as the lack of technological infrastructure, the difference in technological infrastructure between countries and the high cost of investing in information and communications technology systems. The Pareto chart below illustrates the main challenges facing knowledge management in the supply chain.

According to Figure 7 above, one of the essential difficulties supply chains face in developing and exchanging knowledge amongst the chain members is the difference in the context between the chain members. As each organisation's core business differs, the surrounding and internal work environments also differ. Therefore, each organisation is concerned with producing knowledge compatible with its environment and these organisations produce different knowledge that others within the chain may deem unimportant or unsuitable for the organisation's work. The difference in the context leads to a difference in administrative leadership, administrative practices, systems and procedures used, organisational culture, organisational structure and knowledge management procedures. This may constitute an obstacle to transferring and sharing knowledge amongst the chain members.




**Source(s):** Created by the Research Team

**Figure 7.**
The main challenges facing knowledge management in the supply chain

*Managing knowledge throughout the supply chain*

This study identified several critical factors for supply chain knowledge management to succeed, including solid business relationships, visionary leadership, a culture of knowledge creation and sharing, a commitment to lifelong learning, a solid foundation in the basics of knowledge and a robust framework for managing and storing information. Furthermore, the effectiveness of supply chain knowledge management is influenced by various factors. Seven crucial success indicators emerged from this study:

(1) Establishing a knowledge management system that aligns with corporate objectives and recognises how knowledge benefits supply chain participants is crucial. It should be accompanied by a reliable mechanism for monitoring both the success of the knowledge management program itself and the impact that knowledge management has on business outcomes.

(2) A clear vision and framework serve as the "hook," outlining the value of knowledge sharing and creating a common language to improve core knowledge within the supply chain. This would help ensure that all participants clearly understand the shared knowledge and how it can be applied to their specific roles and responsibilities.

(3) A culture empowering employees enables informal networking, fosters knowledge creation and encourages knowledge sharing across organisational and geographical borders. This finding is consistent with the argument of Memon *et al.* (2020).

(4) Continuous learning at all levels is essential. Individuals are encouraged to ask questions, challenge assumptions and learn. Teams learn from other organisations and share their learning. This finding is consistent with the argument of Bag *et al.* (2020).

(5) Knowledge sources must be transparently recognisable, accessible and shareable. This means that all supply chain partners should be aware of what knowledge exists, where it is stored (e.g. standardised modules on the ERP system) and who has access to it. This finding is consistent with Pettit *et al.*'s (2019) and Roy's (2021) arguments.

(6) A well-developed information technology infrastructure and databases are necessary to support collaborative work and facilitate knowledge sharing.

Managing knowledge throughout the supply chain is a complex process that requires a multifaceted approach, including leadership, culture, technology and systems. This study offers valuable insights for organisations seeking to develop resilient pharmaceutical supply chains through effective knowledge management.

## Conclusion

Unlike developed countries, a significant feature of the pharmaceutical supply chain in emerging economies is that they are not involved in proper knowledge-sharing activities. This study explores the role of supply chain knowledge management in building pharmaceutical supply chain resilience. It contributes to supply chain management literature in two areas; managing supply chain knowledge for resilience and the difficulties facing the pharmaceutical supply chain in sharing knowledge within the Middle East context.

In this regard, enhancing knowledge-sharing activities becomes a cornerstone for the pharmaceutical supply chain, specifically the ones from developing countries. Knowledge sharing helps the pharmaceutical supply chain acquire, store, share and develop new knowledge. This supports their ability to be prepared, respond and recover from a disruption based on high visibility and traceability. Furthermore, supply chain knowledge helps

organisations gradually develop agility, change, adaptability, problem-solving, response and innovation capability, which support organisational resilience. This organisational resilience level leads to supply chain resilience in two ways. First, knowledge sharing ensures supply chain visibility and traceability to keep them up to date, giving them the best possible experience to avoid adverse situations. Also, sharing knowledge implies that supply chain organisations cooperate in developing capabilities that support their resilience and overcome external and internal difficulties. Thus, an organisation's resilience capabilities will support other supply chain members to adapt to adversity situations and find creative solutions to reverse them.

However, there are various problems in knowledge-sharing activities related to supply chain context, people, technology and processes that delay or do not allow the possibility of knowledge-sharing. In this context, visibility is necessary to drive supply chain resilience. Still, organisations must invest in technology and digital transformation to achieve complete supply chain visibility. Besides, a cohesive culture of knowledge sharing where supply chain members are closely knitted helps the knowledge flow, which improves resilience.

*Theoretical contribution*

The theoretical contribution of our research is significant in several ways. Firstly, whilst previous studies have examined the role of knowledge management practices in supply chain resilience, such as the role of knowledge management in creating a risk culture (Liu *et al.,* 2018), our study focusses specifically on the pharmaceutical industry, which is highly regulated and subject to unique challenges. As a result, our findings shed new light on how managing knowledge can build resilience in this particular industry, which can inform future research and practice.

Moreover, our study goes beyond examining the role of knowledge creation and sharing in building supply chain resilience, as some previous studies have done (cf. Scholten and Schilder, 2015; Colicchia *et al.,* 2018). Instead, we specifically investigate the role of knowledge management in building the required capabilities that facilitate supply chain resilience. Doing so provides a more comprehensive understanding of how knowledge management can support resilience-building efforts in the pharmaceutical supply chain. Additionally, our study is unique in that it was conducted in the Middle East region, which is an area that has received relatively little attention in the supply chain resilience literature. As such, our study contributes to filling a gap in the knowledge in this region and provides valuable insights that can be applied to other similar countries facing similar challenges.

Overall, our research makes a valuable academic contribution to the literature by enriching our understanding of the role of knowledge management in building resilience in the pharmaceutical supply chain, providing insights into the required capabilities for resilience and shedding light on the challenges associated with supply chain knowledge management in a highly regulated industry.

*Practical implications*

This study provides empirical evidence for decision-makers on building supply chain resilience through knowledge management. Also, the study demonstrated how managing knowledge builds the needed capabilities, improving the pharmaceutical industry's resilience. A resilient supply chain empowered by a robust knowledge-sharing environment (including people, systems and technology) can quickly mobilise resources to ramp up production to meet that demand if a sudden increase in demand for a particular product occurs. Furthermore, the process of actively fostering the flow of knowledge between supply chain partners can help supply chains become more resilient by improving the visibility of potential risks and opportunities throughout the chain. For example, managers

are advised that better access to the supply chain knowledge and information can be achieved by regularly updating their knowledge base in light of technology, systems and people to stay up-to-date with the latest developments in the industry, identify potential issues early on and take proactive measures to mitigate risks and improve their supply chain's overall resilience. Finally, our paper reveals new insights into the challenges facing knowledge management in the supply chain, such as the organisational behavioural challenges (e.g. learning problems within supply chain partners that contribute to the distortion of information across the whole supply chain). Therefore, managers need to foster a culture of knowledge-sharing within their organisations.

*Social implications*

Our research has several social implications that should be highlighted. Firstly, as the pharmaceutical industry is responsible for producing and delivering essential medicines, any disruption in the supply chain can have severe consequences for society. Therefore, our research highlights the need for pharmaceutical companies to invest in knowledge management practices that can help build a more resilient supply chain, which, in turn, can positively impact society. Additionally, our findings underscore the need for collaboration and trust amongst supply chain partners to ensure the smooth functioning of the supply chain. The lack of trust and collaboration can lead to opportunistic organisational behaviour, which ultimately undermines the overall supply chain performance and, consequently, the availability of essential medicines to the general public. Thus, our research provides insights that can guide policymakers and industry leaders in implementing policies and strategies that promote collaboration and trust amongst supply chain partners, which can have a positive impact on society by creating a level playing field but at the same time incentivising companies to invest in innovation, technology and knowledge management.

*Limitations and suggestions for future research*

Although this study provides important insights into the role of supply chain knowledge management in building pharmaceutical supply chain resilience, some limitations offer further research opportunities. Firstly, this study employed a qualitative methodology and therefore, further confirmatory research using a quantitative approach is needed to validate the results. Secondly, the study identified the main challenge hindering supply chain knowledge management, but future research could explore the challenges and enablers of supply chain knowledge management in more detail. Thirdly, the study focussed on companies operating in the Middle East region, and the generalisability of the findings to other regions may be limited. Therefore, future studies are recommended to collect data from other regions and compare the results with this study to gain a broader perspective. Fourthly, it is essential to note that the study only focussed on the perspective of the pharmaceutical manufacturing companies and did not consider the perspectives of other actors in the pharmaceutical supply chain, such as suppliers, distributors and customers. Future research could expand the scope to include these perspectives to gain a more holistic understanding of the role of supply chain knowledge management in building pharmaceutical supply chain resilience. Sixth, the study did not investigate the specific types of knowledge capabilities that are most important for building supply chain resilience in the pharmaceutical industry. Future research could delve deeper into this topic to identify the knowledge capabilities most critical for building resilience in the industry (e.g. multiple criteria decision-making might be helpful to differentiate their importance, ranking and feasibility). Lastly, the study did not explore the impact of external factors, such as political instability or natural disasters, on supply chain resilience in the pharmaceutical industry. Future research could investigate how these factors affect supply chain knowledge management and resilience.

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## Further reading

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## Appendix
## Interview protocol

(1) Can you describe your role and responsibilities within the pharmaceutical supply chain?

(2) In your opinion, how critical is knowledge management to ensure supply chain resilience in the pharmaceutical industry?

(3) Can you give an example of a situation where knowledge management was critical in maintaining supply chain resilience in your organisation? What lessons did you learn from this experience?

(4) How do you ensure that knowledge related to the pharmaceutical supply chain is effectively captured, stored, and shared across your organisation, particularly in the context of maintaining resilience?

(5) What are some of the biggest challenges you face when managing knowledge related to the pharmaceutical supply chain, and how do you overcome these challenges?

(6) How do you assess the effectiveness of your knowledge management practices in improving supply chain resilience, and what metrics or indicators do you use?

(7) How does your organisation ensure that knowledge management practices are integrated into broader supply chain management strategies, and what are some of the benefits of this integration?

(8) How do you see knowledge management evolving in the context of supply chain resilience in the pharmaceutical industry over the next few years, and what new challenges or opportunities do you anticipate?

(9) How does your organisation and supply chain address potential risks to areas such as intellectual property or data security when implementing knowledge management practices for supply chain resilience?

(10) What advice would you give to other organisations looking to improve their knowledge management practices to enhance supply chain resilience in the pharmaceutical industry? What are some best practices or lessons learnt that you can share?

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