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Analysis of the supply chain risk management in pharmaceutical industry

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ABSTRACT

This study investigates the escalating complexity and risk in global supply chains, with a particular focus on the pharmaceutical industry. As trade chains become longer and more intricate, the likelihood of disruptions increases, affecting the efficiency and reliability of supply chains. Despite its significance, research on risk management practices specific to the pharmaceutical industry remains limited. This study addresses this gap by evaluating how pharmaceutical companies in Pakistan assess and manage risks. Data were collected through a structured questionnaire distributed to pharmaceutical companies and other industries and analyzed using SPSS. The study, which used a five-point Likert scale and non-probability convenience sampling of 150 to 165 respondents, highlights the impact of supply-related, production-related, and demand-related risks on supply chain operational performance. Findings indicate that addressing these risks through targeted strategies can significantly enhance supply chain management and operational efficiency. The study emphasizes the importance of comprehensive risk assessment and mitigation strategies to improve resilience and performance in the pharmaceutical industry. Limitations include a restricted timeframe and sample size, suggesting the need for further research in different industries and regions to validate and expand on these findings.

Keywords: *Pharmaceutical, Supply chain, Supply chain uncertainty, Supply chain risk management, Supply chain resilience*

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1. Introduction

1.1 Background

The world is witnessing a period of universal competition that is intensifying the offer, eventually increasing the length and complexity of the trade chains (Baloch & Rashid, 2022). This incline in complexity causes a greater possibility of the occurrence of failures along the supply chain and, consequently, that they do not have the efficiency that would be expected or desired (O'Connor et al., 2016). The notion that disruptions are inevitable and that all supply chains are, in this way, subject to risk is an issue that is increasingly relevant in the literature (Craighead et al., 2007; Marley et al., 2014). Global adverse events, such as natural disasters, trade wars, or terrorist attacks, generate uncertainty and vulnerability in the management of supply chains. Supply, which makes it essential that companies plan this type of risk and develop mitigation and contingency plans adapted to their reality, thus becoming more resilient.

Resilient supply chains are a relatively recent issue that has gained emphasis in recent decades due to the various threats and disasters in the world. The Ericsson Crisis in 2000 and the Japan tsunami that affected Toyota in 2011 are some of the well-recognized incidences of disasters (Ho et al., 2015; Jüttner, 2005; Zhao et al., 2013). Therefore, the companies must anticipate disruptions and develop plans that minimize impacts on their supply chains. Businesses must be familiar with the supply chain's links and interdependencies to identify potential risks, their probability, consequences, and severity. The pharmaceutical supply chain risk not only may waste assets but may also intimidate patients' lives. Health systems must evaluate and execute strategies to address the pharmaceutical industry's supply chain risks. Besides, the performance of pharmaceutical companies as key performers in the supply chain substantially affects supply chain efficacy and competence. Management of risks within the pharmaceutical supply chain, apart from resulting in process upgrading, efficiency upsurge, and diminishing business risk, may also help health systems achieve supply chain management (SCM) goals regarding availability, excellence, and affordability. At the same time, supply chain risk management is strictly under research, as the central topical readings were limited to manufacturing sectors. Uncertainty within the supply chain may escalate hazards and ineffectiveness. Supply chain improbability or uncertainty is often used to enhance the term; supply chain chance and dangers are associated with uncertainty (Rashid et al., 2024a; Rashid et al., 2024b).

1.2 Problem Statement

A risk management action plan can be designed to best prevent, or at least mitigate, reduce, and control the identified risks (Narasimhan & Talluri, 2009). However, there is controversy over how to evaluate risk and uncertainty in the supply chain. The proposal related to the practical application of risk valuation and control in the supply strategy is small (Christopher et al., 2011). An assessment related to the literature specifies that few studies assess the challenges associated with risk management strategies for companies, especially those used in the pharmaceutical industry. So many writers have highlighted the Importance of research on supply chain risk management, so this research is said to be vital as it helps to understand how pharmaceutical companies assess these issues (Juttner, 2005; Rashid et al., 2024c). In addition, the choice of sector for analysis is extremely important, as the supply chain is complex and extremely sensitive. Customer service levels below 100% are unacceptable, as they directly impact public health and safety (Mehralian et al., 2012).

1.3 Research Questions

The present work seeks to understand, in a real-world context, the strategies of mitigation and contingency of risks used by pharmaceutical companies to be more resilient, pursuing to respond to the following research questions:

Q1: How is risk assessed and managed in the supply chain by pharmaceutical companies?

Q2: What risks, according to the perception of managers, are identified as the most relevant?

Q3: What can be fundamental supply chain risks in the PSC context?

1.4 Purpose of the Study

The main purpose of this study is to analyze supply chain risk management in the pharmaceutical industry. The purpose is also to study the analysis, impacts, and strictness (severity) of SC risk practiced by corporations; furthermore, the usefulness of mitigation methods and strategies to mitigate the risk has also been discussed in the study. The main purpose of the study or research is to analyze the' concept of resilience in supply chains' and the strategies that exist to identify and manage their risk.

1.5 Significance of the Study

The research reading has significantly highlighted the main risk factors as well as issues caused by risks involved from different perspectives in the pharmaceutical supply chain. The study is particularly significant for pharmaceutical companies' supply chain and risk management. These companies are working to mitigate, minimize, and transfer risks to enhance their resilience in the industry.

1.6 Outline of the Study (Dissertation Structures)

In general, this study has been divided into the following parts (chapters). Chapter 1: Introduction, where contextualization of the problem and the objectives of the dissertation. Chapter 2: The main concepts to be studied in the current study define the supply chain and supply chain management concepts and the associated risk and uncertainty. Subsequently, the conception related to supply chain resilience and its description. Chapter 3: Applied methodology: We used a methodological approach and discussed data collection tools, sampling techniques, data processing techniques, etc. Chapter 4: In this chapter, some cases of chains were identified. The supply chain of Pakistani pharmaceutical companies. A comparison was made between the literature and the actual practices of these companies in managing risk. Questionnaire responses were analyzed using SPSS software to identify the reality and similarities of the variables. Chapter 5: The main conclusions and the limitations and contributions provided by this work.

1.7 Definitions

1.7.1 Risk

Risk can be a consequence of likelihood; therefore, it's somewhat anticipated. If the likelihood of an event is high, the result of any occurrence may have an extremely unfavourable influence on the availability chains; the occurrences of that event characterize substantial risks or dangers for the chains. Risk is a function or purpose of the level of uncertainty as well as the impact of an event (Raj Sinha et al., 2004).

1.7.2 Supply chain risk

The probability of an occurrence which is associated with or related to inbound supply from single supplier's failures or source marketplace events, within which its outcomes close in the lack of the acquiring firms to fulfill the customer's demands or causes threats for the customer's life, health, and safety (Zsidisin 2003). Any risk-related knowledge, materials, and product's movements from inventive suppliers' to the delivery of the ultimate invention for the ending user (Jüttner, 2005).

1.7.3 Supply chain, risk, and management

The controlling of supply chain risks through coordination or collaboration among the provision chain partners is ensured for effectiveness and continuousness (Tang, 2006). The identification and controlling of risks enclosed by the availability networks and externally via the synchronized method amongst supply chain members to diminish supply chain vulnerability altogether (Jüttner, 2005).

1.7.4 Uncertainty

Uncertainty arises when decision-makers cannot evaluate the end result of the event or the likelihood of its occurrence (Rashid et al., 2024c).

2 Literature Reviews

2.1 Introductions

This chapter summarises the literature and focuses on one of the four main topics, namely, the conception of supply chain management. Delivery and logistics, discussion in writing on uncertainty and risk, the concept of supply chain flexibility, and finally, a concise overview of the writing on supply chain management in the pharmaceutical industry, its specifics, and links to the above concepts.

2.2 Underpinning Theories and Models

2.2.1 Supply chain

Internal and external factors constantly influence companies, which can affect not only their position in the global market but also their competitiveness (Marley et al., 2014). The survival of companies in the current context of hyper-competition requires adopting strategies that ensure a sustainable advantage over their competitors (Albhirat et al., 2024; Marley et al., 2014). According to Monczka and Morgan (2000), market trends incentivise companies to implement more flexible strategies to better respond to customer needs, and the supply of goods must be given greater relevance.

It was in the early 1980s that the concept of a supply chain emerged. The term chain of supply refers to a new management research area. Emerged and intended to respond to changes in the market (Lewis & Talalayevsky, 2004). Although, with globalization, companies have started to increase their supply chains, with new links in their chains, new types of disruptions emerged, such as disasters, natural disasters, terrorism, and industrial disputes that affected the economy. For this reason, the concept of the supply chain came to be considered by industries and other areas, such as politics (O'Connor et al., 2016). Consequently, according to Monczka and Morgan (2000), it led to the redefinition and connection of business activities, namely "logistics" (integrated transport, storage, and distribution) and operations management based on production.

This concept received more attention in the 1990s as companies started to bet on more horizontal management (Christopher & Towill, 2001). In this form of management, all the parts inherent to the organization have improved, not only their information flow throughout the hierarchy as well as partnerships with suppliers, in the sense of obtaining raw materials at the most competitive prices and with the best possible quality, and with other partner companies (Moktadir et al., 2018; Rashid et al., 2024d). According to the same authors, if the performance of everyone involved had a high degree of efficiency, this would have positive consequences at the global level. Another reason why the supply chain was seen with renewed interest was due to the fact that consumer habits are constantly changing (Gonzalez et al., 2008; Rashid et al., 2024e). These authors also refer to the fact that globalization and the consequent increase in competition brought a new vision to both companies and consumers, in that they started to have more options. This has led companies, so that they can react to the needs of their market, to begin to change their way of production and the logistics at the stock level (Rashid et al., 2024f). This allowed the products to reach customers more quickly, making possible better coordination

among several parts or proportions of the supply chain and also an improvement in communication between the various partners, among other aspects (Narasimhan & Talluri, 2009).

From the most basic essential raw materials to the final consumer, all activities involved, and which are directly linked to the movement of products through the previous chain, are considered by Monczka and Morgan (2000) as a supply chain part (Kern et al., 2012). This includes the acquisition and demand of raw materials, inventory management, order processing, the time itself of production, transport, storage of products, and the service provided upon delivery to the final customer in the supply chain. All the technology that is needed is also included throughout this chain. to carry out all these activities. The Council of Supply Chain Management Professionals *(*CSCMP, 2017), referred to in Lambert (2008), similarly to the aforementioned author, also considered that the supply chain encompasses all processes that are linked to the production and delivery of the product. In brief, the transfer of goods from the supplier's to the final consumer's is included in the supply chain.

However, it only takes into account four processes, namely planning and the source of materials, raw materials, the production itself, and the delivery, and it is in these that it includes all the other factors, such as the acquisition and search for these raw materials or the management of the inventory. According to Gonzalez et al. (2008), the definition of the supply chain is a set of three or more entities (individual organizations) directly involved in the upstream and downstream flow of the products, services, finances, and/or source information for the customer. The same authors consider that due to its complexity, the supply chain can have three levels: direct supply chains, extended supply chains, and the final supply chain. For Lewis and Talalayevsky (2004), the supply chain is, in a way, a link between companies, and it is a procedure that begins with the raw materials and ends with the customer, who will be the final consumer of the product. It also includes sharing information and materials for a product and/or service. More recently, Christopher and Towill (2001) also defined the supply chain as "a set of links or network that associates internal and external suppliers with internal and external customers".

The Council of Supply Chain Management Professionals (CSCMP, 2017) had already proposed a definition in 1997. Currently, Vitasek, from Supply Chain Leaders (CSCMP, 2017:186), elaborates on the chain of supply as follows: "1) starts with the unprocessed raw material, which ends without the end consumer using the unfinished products; the supply chain unites so many firms. 2) Material and information exchanges change in the very logistical process, extending from the procurement of raw materials to the distribution of the final products to the end user. Vendors, service providers, and customer management systems are connected to supply chains. This meaning is very similar to the previous one; however, it no longer considers only four processes but starts to consider all activities in the chain in a global way.

2.2.2 Supply chain management

In the 1960s, logistics had mainly an operational aspect; that is, it was seen as a system of integrated activities. In the 1970s, it became characterized by having a functional and strategic area (Kern et al., 2012). In this decade and through the development of information technologies and the improvement of transport networks, which now have a greater connection between the company's stakeholders and their areas of activity, logistics management has given rise. The transition to the 1980s stems from globalization, and we are witnessing exponential growth in the offer of transport services, generating flexibility, an incline in the level of service, and a decline in costs (Gonzalez et al., 2008).

Feisel et al. (2015) broaden their scope of supply chain management. Supply in addition to logistics, concluding that their requirements must be at a certain level of coordination of business processes and logistical activities not only within the company but also with other organizations in the supply chain. The supply chain concept arises in this way with the objective of supporting the logistical activities, namely purchasing, manufacturing, distribution, and sales. The integration of these activities allows each player in the supply chain to generate, process, and receive different types of information, improving their financial performance (Lewis & Talalayevsky, 2004).

According to Melnyk et al. (2014), the 1990s were characterized by the quest for efficiency and reorganization of business processes, the integration of logistics, operations management, and marketing with inter-organizational processes in the supply chain to simplify the flow of services and goods. The fundamental objective of such integration is to improve the efficiency of the flow of products from the manufacturing of raw materials to the final customers by allocating resources and opportunities among companies (Christopher & Towill, 2001). Rapid advances in technology and information systems have facilitated this integration, paving the way for further productivity gains and a better understanding of market changes and customer needs. Van der Vorst and Bulens (2002) defined supply chain management as planning, coordinating, and controlling all business processes and activities so that we can provide customers with value-added products at the lowest cost while meeting the demands of other interested parties.

As accordance with the Experts' Committee on Supply Chain Management, management of supply chains covers the forecasting techniques of all related events, including procurement, adaptation, and all activities related to logistics management. This likewise incorporates coordination as well as joint efforts with other network associates. Suppliers can be contractors, brokers, service providers, third parties, or consumers. Supply chain management essentially combines internal supply and demand management's with corporate governance with globalization, global purchasing, and other factors that expand and complicate supply chains, it is essential to effectively coordinate the flow of materials inside and outside the organization so that the products and services are available as soon as possible, which makes this concept so important as much as possible. Monczka and Morgan (2000) argue that cost is the main reason for the transition to global resources.

Carter et al. (2015) define supply chains as an upward and downward network of end-user organizations that integrate several methods as well as events that can create value in the shape of products and services. According to Carter et al. (2015), the new supply chain concept defines the supply chain as a network of companies linked to processing and recycling partners. The organization that creates the knobs of the system may be thought of as a pliant agent that's affects others and the entire system.

In short, supply chain management seeks to reduce costs, increase satisfaction, and create value for customers in order to increase a competitive advantage (Carter et al., 2015). For this reason, supply chain managers try to simplify and optimize the supply chain through its end-to-end integration, on the one hand, by balancing performance needs and cost reduction; on the other hand, by balancing customer expectations and requirements, such as risk related to the supply chain (Chandra & Kumar, 2000).

2.2.3 Uncertainty and risk

Garattini et al. (2008) define supply chain risks as ash and occurrences that negatively impact supply chain processes and thus negatively impact expected outcomes such as service levels and costs. According to Matook et al. (2009), although risk has always existed and influenced the supply-demand balance, several factors have emerged recently. Increased risks, such as focused efficiency instead of efficiency, globalization of the supply chain, specialized factories, and decentralized distribution, lead to outsourcing and reduction (concentration) of suppliers. Market complexity and uncertainty require more flexibility in organizing and managing relationships with other supply chain partners (Mentzer et al., 2001).

Rosenhead et al. (1972) first categorized decisions into three different categories based on available information: reliability, risk, and uncertainty. When making decisions based on trust, all variables are known and trustworthy, as is the relationship between information (input) and decision (output). Risk decision-making is based on probabilistic models that are based on predictable conditions and try to control the ratio. If the information is incomplete or insufficient, that is, when unforeseen events are eliminated, the decision is made under uncertain conditions.

According to Van der Vorst and Buhlen (2002), uncertainty is associated with supply chain

conditions. In this case, the decision-makers are not sure which solution does not have a clear vision of the goal. Your lack information or knowledge about the supply chain and the environment; you cannot process this information and effectively predict the consequences of its actions; and you cannot act in destructive situations. Underestimating uncertainty can influence strategic decisions, leading to ignorance of actions that can protect society from threats and harm or gain a competitive advantage in the face of uncertainty (Gupta & Maranas, 2003). According to Heckmann et al. (2015), most authors define risk management and supply chain decisions as uncertainty. These studies will take risks into account and make decisions when dealing with risks (such as uncertainty).

According to Kern et al. (2012), the term "risk" now covers any risk associated with the information's flow, materials, or products from the first manufacturer in their supply chain to their final consumer. These threats can come from environmental, organizational, or supply chain factors and are unable to accurately forecast or accurately predict their impact on various outcomes and variables (such as cost and quality) in the supply chain. Threats to the environment are caused by accidents such as fires, socio-political problems (environmental protests or terrorist attacks), or natural disasters. Organizational risk corresponds to the risk arising from the company's activities, and individual members of the organization and its scope may include resource risks (strikes), IT system failures, or equipment failures.

The last type of risk, supply chain risk, is caused by interactions between different organizations within a given supply chain. Any inefficiency caused by this relationship carries such risks. Thus, various environmental and organizational risks and uncertainties are the source of other organizations in the supply chain (Das & Teng, 1998).Firms should use supply chain risk management techniques to minimize or at least mitigate these effects (Tang & Tomlin, 2008; Manuj & Mentzer, 2008). Their goal of supply chain risk management is to define methods for identifying, assessing, mitigating, and monitoring risk factors in the supply chain (Chandra & Kumar, 2000). Their purpose in risk identification is to identify all important threats (Kern et al., 2012), distinguish between different types of risks, and understand the causes and conditions that lead to them (Narasimhan & Talluri, 2009).

Carter et al. (2015) gave the following classifications according to width and degree of impact: There are four types of micro threats: search risk, logistic risk, supply risk, and sand infrastructure risk. Macro-risks are associated with environmental threats as they contain natural disasters and man-made disasters such as earthquakes, wars, and economic disasters. Melnyk et al. (2014) and Glickman and White (2006) categorized supply chain risk into five categories: process risk, control risk, demand risk, risk lists, and environmental risk factors to consider.

The first two types of risk are associated with in-house organizational variables; the third and fourth are elements of the internal supply chain outside the organization; and the fifth are factors in the external supply chain. The process Risk is associated without disruption of the sequence of actions associated with the creation of goodwill. Control the risks that arise from the failure of a company's application, such as purchasing policies, inventories, etc. Demand risk is associated with uncertainty and interruptions in the provision of products or information from the network or their market. Supply risk is similar to demand risk, but only from suppliers. Finally, the last risk comes from outages outside the company and the supply chain. Deliver goods where ever they work, such as in the event of natural disasters (Bronzo et al., 2013). Marley et al. (2014) proposed eight categories: supply risk, operational risk, demand risk, security issue, macro-I risk, political risk, resource risk, and competitiveness.

Supply risk is defined as the possibility that the purchasing organization will fail to meet the needs of its customers or threaten their lives and customers' safety due to the failure of individual suppliers or their supply to the market (Carter et al., 2015). Another study divided supply chain risk into downstream and downstream processes. External threats and risks associated with the entire supply chain exist throughout their supply chain. They emphasize that supplier dependence or over-reliance on supply sources is what they see as the main obstacle to a sustainable supply chain (Carter et al., 2015). Opportunistic behavior and insufficient supplier response to changes in demand, technological developments, and new regulations can negatively impact performance (Hallikas & Lintukangas, 2016;

Peck, 2005; Garattini et al., 2008). Risk, supplier quality inefficiencies (Matook et al., 2009; Thun & Hoenig, 2011), logistics process inefficiencies (Ghadge et al., 2012), and supplier rotation funding (Gu et al., 2017) are another source of fluctuations in consumer demand and a major source of collateral damage (Rashid et al., 2024g). More agents in the supply chain distribute agent risks throughout the supply chain, leading to cyber threats (Ghadge et al., 2012). Mistrust and/or low transparency between members of the supply chain are the main causes of these errors (Ghadge et al., 2012; Rashid et al., 2023). Finally, external threats come from factors outside the supply chain. Recommendations such as terrorist attacks, regulatory changes, and natural disasters can seriously disrupt operations (Ghadge et al., 2012; Jüttner, 2005). To address the above risks, managers must make decisions and implement appropriate measures that require risk analysis, risk identification, control, and mitigation to reduce supply chain vulnerabilities (Glickman & White, 2006). However, from a business perspective, it is difficult to justify investing in mitigation measures that are clearly not related to financial returns (Rajagopal et al., 2017). To debunk the myth that "no person is appreciated for resolving problems or issues that never occurred and to promote best practices for supply chain risk management and risk mitigation, measures must be tested and their impact on business results must be verified (Jüttner, 2005). Managers should try to assess risk by assessing the likelihood of the risk occurring and its consequences (Heckmann et al., 2015). However, it is extremely problematic for companies to recognize the main sources of risk exposure, which complicates the process of identifying risks.

2.2.4 Supply chain resilience

The supply chain faces various challenges and difficulties, such as fluctuating demand and rising consumer demand, as mentioned, as the supply chain becomes more complex and fragile. Since all sources of risk cannot be prevented (Stone et al., 1997) and statistics on the frequency and likelihood of exposure to risk are often lacking, traditional supply chain risk management practices emphasize the importance of risk management and risk mitigation as a way to proactively and effectively manage and mitigate predictable downtime (Feisel et al., 2015). Glickman and White (2006) pointed out that management should place emphasis on developing a supply chain that can respond effectively to shocks.

A key aspect of supply chain resilience and process continuity is the ability to classify major sources of risk and implement monitoring capabilities to adequately reduce risk exposure (Pettit et al., 2013). In this way, companies can avoid disruptions or accelerate recovery from disruptions by improving resilience (Melnyk et al., 2014). While there is no single definition of supply chain resilience, some studies define it as the capacity of the supply chain to anticipate internal and external shocks, respond quickly to disrupting occurrences, and sustain the endurance of core business processes in the face of emergencies, the uncertainty of the operating environment (Feisel et al., 2015).

According to McGuire (2002), supply chain flexibility is the key to the existence and profitability of the supply chain. The supply chain continues to suffer significant damage at the international and national levels. Knowing where to invest in chain flexibility can help them adapt faster and recover faster (Alrazehi et al., 2021). Therefore, more and more studies emphasize the need to regularly monitor the flexibility of supply chain risk management to maintain the continuity of key operations (Ambulkar et al., 2015). Ambulkar et al. (2015) distinguish between flexibility and sand flexibility. The author believes that "reliability" is the capability of a network to handle errors during operation. A strong supply chain is desirable, but that does not mean that it will be sustainable. After a break, the author uses the term "flexibility" to denote the skill of a network to return to its original form or exchange it for a new, more ideal form. Since the expected conditions may differ from the baseline, the definition implies flexibility and adaptability.

Supply chain resilience is described as the ability to respond and acclimatize to unusual events and threats that can disrupt critical supply chain operations (Heckmann et al., 2015). Melnyk et al. (2014) take a comparable view of supply chain resilience and define it as "the ability of the supply chain to prepare for unanticipated events, respond to interruptions, and improve from interruptions through continuousness. In connection with the structure of management and activities. Melnyk et al. (2014) stated the ability of a company to step up from supply chain disruptions is defined as "the ability to

withstand disturbances and recover from disruptions." Resistance includes the active resistance of the element, that is, the ability to avoid interruptions, and the ability to passively regenerate the element and continue to operate after an interruption. Marley et al. (2014) apply the concept of supply chain flexibility, based on their work on Ponomarov and Holcombo (2009), which is defined as the ability to adapt to supply chain preparation sand or handle disruptions in order to restore profitability by interrupting order fulfillment.

There is no agreement in the supply chain management literature on how to analyze and define flexibility, and there is no consensus on how to define flexibility. Several authors, such as Feisel et al. (2015), have provided their own definitions or frameworks as the basis for systematic reviews and quantitative studies in the literature. Preparation, response, and recovery are considered properties that increase the flexibility of the supply chain (Khan & Burnes, 2007). Feisel et al. (2015) and Gu et al. (2017) added flexibility, speed, transparency, and collaboration to quality lists representing specific supply chain capabilities to meet the required level in the face of potentially disruptive events.

Flexibility is understood as the capacity to adapt to unforeseen variations (McGuire, 2002) Flexibility is the design and planning of a system with built-in functionality that can be used not only during breaks but also during day-to-day operations (Melnyk et al., 2014) and has many facets: supply flexibility (multiple approvals) of suppliers; manufacturing flexibility (maintaining standard processes in factories, integrating interoperability in more factories, or integrating more functions in each factory); transport flexibility (different carriers or routes); distribution flexibility (delayed) (Shin & Park, 2021).

Working with partners in the supply chain is another flexibility trait (Wieland & Wallenburg, 2013), which involves working with partners through collaborative planning and communication to figure out and reduce chain risks (Fan & Stevenson, 2018). Stock collaboration helps increase the transparency and speed of the entire supply chain (Fan & Stevenson, 2018; Scholten et al., 2014; Scholten & Schilder, 2015), enabling companies to respond quickly to fluctuations in supply and demand (Bronzo et al., 2013).

Consistent with Kern et al. (2012), vendor risk-taking may be categorized into process improvement and backup strategies. Process improvement strategies aim to reduce the likelihood of identified hazards. Alliance building (Fan & Stevenson, 2018) and supplier development (Manuj & Mentzer, 2008) are examples of process improvement strategies that can increase the levels of interaction between a purchasing organization and its contractors. Most organizations use buffering strategies to hedge risks, such as increasing inventory and managing alternative sources of supply.

Melnyk et al. (2014) also believe that buffering strategies are an excellent way to increase resilience through redundancy. Maintaining surplus resources, such as safety stocks or low capacity utilization, helps to minimize the impact of downtime (Gu et al., 2017). Redundancy helps companies buy time during power outages but costs companies dearly (Shin & Park, 2021). Another aspect is the development of a risk-oriented culture. Building resilience is very important. This culture can be developed by integrating risk factors and management practices with decision-making. Make decisions (Breen, 2008) and create a business continuity plan (Marley et al., 2014). Melnyk et al. (2014) also recommend that companies develop a management orientation. Break: General awareness of the importance of learning opportunities caused by supply chain disruptions.

Supplier recommendations also apply to developing supplier relationships, including integrating information and logistics into the supply chain, forecasting with suppliers, and collaborating to improve processes (Bronzo et al., 2013; Rashid & Rasheed, 2023). Supplier relationships can result in varying levels of dependency for a company. Some companies may emphasize reliance on a single supplier, while others may choose to work with multiple suppliers. Stronger relationships can be built with exclusive suppliers because the company relies on them. Go deeper and provide greater integration for effective supply chain risk management (Fan & Stevenson, 2018). On the other hand, when it comes to resource mobilization, society is at greater risk. In addition, reliance on exclusive suppliers can lead to higher transaction costs, which will lead to higher raw material prices, jeopardize price

competitiveness, and affect customer satisfaction and the bottom line. Company advantage market competitiveness (Hallikas & Lintukangas, 2016).

2.2.5 Supply chain management in the pharmaceutical sectors

The pharmaceutical industry is described as the collection of methods, activities, and organizations that research, develop, and manufacture drugs. Over-the-counter medicines include branded, generic, and even over-the-counter medicines (McGuire, 2002). The pharmaceutical industry is very imperative to their population and is one of the driving forces behind life extension, increased performance, and improved quality of life (Lichtenberg et al., 2015). Because of their impact on the health and well-being of certain population groups, societies in this sector are subject to different laws and regulations (Garattini et al., 2008; Mehralian et al., 2012; Yu et al., 2010). According to the characteristics of market competition, the government should try to balance the clinical and economic benefits of the sector (Mehralian et al., 2012).

Marketing teams, R&D efficiency, a shortened drug lifecycle, government regulation, reduced patents, manufacturing flexibility, and increased costs are the main challenges facing the pharmaceutical industry today (Mehralian et al., 2012). According to Mehralian et al. (2012), the pharmaceutical supply chain is the pathway from a drug's origin to distribution to the final consumer. It is qualitative and perfectly positioned with flawless timing. Customer service levels below 100% are undesirable because they directly impact public health and safety, and the supply chain is complex and very sensitive. The promotion of large stocks is a technique many pharmaceutical companies use to provide high-quality services (Mehralian et al., 2012). However, unless supply chain cooperation is simplified and managed to meet customer needs, it will be difficult to guarantee 100% availability of available products (Chandra & Kumar, 2000).

Thus, the main goal of the drug supply chain is to ensure a consistent progression of medications to patients with minimal delay at optimum prices, low stock-outs, and no errors. In the pharmaceutical industry, the supply chain typically consists of the following components: start-up manufacturers, aftermarket manufacturers, warehouses and distribution centres, wholesalers, healthcare professionals, and pharmacies, with the patient being the endpoint. Moktadir et al. (2018) highlighted the benefits of pharmaceutical industry initiatives in managing the distribution process through more sophisticated communication methods and reducing defects and errors in the packaging process. Ultimately, the labelling process can save lives. Privett and Gonsalvez (2014) discussed several problems related to the pharmaceutical supply chain, namely efficient inventory management, lack of transparency in demand and dependence on professional human resources, and difficulties compounded by the complexity of the supply chain process, product, and market intermediaries in many systems (Matook et al., 2009).

The complex and dynamic network structure of the pharmaceutical supply chain makes risk management is difficult (Ahmad et al., 2009). In addition, the supply chain is responsible for ensuring the continuity of drug supply to customers (Manuj & Mentzer, 2008), and any risk that affects this could be at risk. (Hung et al., 2005) To correct these deficiencies, it is important to assess current risks and take action to address them to ensure drug quality and business agility (Moktadir et al., 2018). Pharmaceutical companies can reduce the cost and frequency of business interruptions by correctly identifying and analyzing risks, eliminating waste, and improving supply chain efficiency (Rogachev, 2008). Thus, effective risk analysis helps design mitigation measures for the supply chain (Chandra & Kumar, 2000). As the drugs are highly regulated by regulatory agencies, more attention is paid to risk management in the pharmaceutical industry (Craighead et al., 2007; O'Connor et al., 2016).

Furthermore, because of economic, social, and political unrest in less developed states, the supply of drugs poses a greater risk (Melnyk et al., 2014). By developing appropriate plans and strategies, supply chain risk management can lead to high productivity (Breen, 2008; Mangla et al., 2015). Based on your findings, companies should adopt a formal framework that will help them identify, quantify, and mitigate supply chain risks (Khan & Burnes, 2007; Mangla et al., 2016). Pharmaceutical industry managers must develop resilience to improve supply chain productivity and efficiency. Quality

must be a significant aspect of supply chain management because drug quality is very important to human health, and its damage can cause significant damage to reputation and financial losses for society. Overall, a pharmaceutical company's supply chain is a source of competitive advantage and must be strong to be effective (Ahmad et al., 2009).

2.3 Independent Variables Affect Dependent Variables

Several risks affect supply chain performance in the pharmaceutical industry, both internally and externally.

2.3.1 Supply related risks

The organizations are presented with several risks associated with the rising tide of their supply chains. Supply risks are associated with suppliers, relationships, purchasing, and supply networks. The reason for supply or supplier risk may differ greatly in developing countries than in developed and advanced countries. These may include supply business risk, changes in innovation or technology, product design and portfolio, quality problems, production capacity, and production constraints on the supply market (Zsidisin et al., 2000). Supplier risks are related to events that affect the supplier's continuity and lead to disruption or termination of the customer-supplier relationship. This particularly affects the effects of provider overpayment, the threat of financial instability, and the lack of funding (Wagner et al., 2014). The other type of disruption occurs when direct rivals of a customer firm cause the dissolution of a connection or relationship. Organizational lock-in poses a significant risk when the purchasing team relies on a supplier over which it has limited control. Unresolved issues in supplier manufacturing can expose limitations and weaknesses, such as deficiencies and fragile functions like delivery reliability (Park et al., 2013; Srinivasan et al., 2011). In addition, low-quality raw materials, products, or services purchased pose a higher risk and may have a significant impact on the end-to-end consumer supply chain (Zsidisin et al., 2000). Finally, the product design may have detrimental effects on customer costs and competition in the event that suppliers fail to adapt to technological changes (Zsidisin, 2003).

2.3.2 Production-related risks

Production or operation risks interpret the position within the firms that consequences the capabilities to make goods and services (Wu et al., 2006). It may include socio-technical hazards such as machine breakdown or failure, IT failure and breakdowns, the malfunctioning of the equipment, disruptions in the supply of electricity or water, in addition to human-centered issues like sabotage, vandalism, industrial accidents, labor strikes, etc (Chiu & Choi, 2016). Production risk is the likelihood of an occurrence related to their central firm that might distress the firm’s inside capability to produce goods and services, the excellence and suitability of production, and/or the productivity of the company. Sources of operational or production risk reside within the firm and can result from a failure in core operations, inadequate manufacturing, or processing capability (Rashid et al., 2022a).

There is a prevalent prospective for failure inside the organization, similarly as with customers (demand risk) and suppliers (supply risk). Again, these risks affect both the capability to produce sand and satisfy customer demand. Since most of the procedures are distinct, optimal performance of the equipment is vital. Any malfunction of the equipment can lead to interruptions in the manufacturing procedures, mainly caused by insignificance on the employee’s part. Though mostly procedures are mechanized, steps are available that can lead to disorders and complaints due to the human risk. These risks can be prevented by providing proper training to the employees.

As pharmaceutical products directly affect the customer's health, it is important to produce high-quality products. This can be achieved by following strict guidelines at all supply chain stages. Proper testing should be done. All suppliers should use storage space to store material, and they may not have the same level of pest control procedures as their customers. Goods that do not store raw or used items may become contaminated. Apart from product value, a responsible organization must still

consider its risks within the supply chain and use risk management. In brief, the researchers decided to consider these risks in this study.

2.3.3 Demand related risks

Demand risks result from the dilemmas emerging from downstream supply chain procedures and implications (Jüttner, 2005). Their demand risks can arise from the ambiguity triggered by their customer's unanticipated demands. Regarding demand risk, an inaccurate demand forecast can be calculated and evaluated (Tummala & Schoenherr, 2011). Bullwhip, effects, or distortion effects can also be highly risky factors to demand risks. Distractions happen due to an incompatibility between the firm's forecasts and fixed demand and the consequent control of the supply chain. The concerns of such breaks are the obsolescence of the product, unproductive capacity utilization, and costly deficiencies. A prime issue in this situation, affecting forecast quality and hence demand side disruptions and interruptions, is the bullwhip effect, described by an escalation of demand uncertainty upstream of the supply chain. Lewis and Slack (2003) identified that batching, distorted information, price fluctuations, sales promotions, and shortages of gaming are the leading causes of the bullwhip effect. Over-reactions, second-guessing, redundant interventions, and distrust increase the bullwhip effect (Christopher et al., 2011). Though demand risk in some respects the 'bread and butter' of the supply chain, these issues still exist as a noteworthy risk for many firms and companies.

2.3.4 Supply chain operational performance

Pahl and Voß (2014) clarify that work performance refers to measurable organizational characteristics. These include production rates, reliability, defect rates, cycle time, delivery time, quality costs, waste disposal, and asset management. Srinivasan et al. (2011) define the conception of supply chain function as the level of performance of processes embedded within the supply chain of a factory. Some of the measures used specifically to determine the performance of a company's supply chain include supplier performance, customer satisfaction, cost of the stocks, delivery time, product availability, performance and lead time. Performance measurement is demarcated as r the method of measuring the efficiency and effectiveness of a given procedure core purpose (Gunasekaran & Kobu, 2007). Effectiveness is the level that consumer's requests spare encountered and efficiency monitors practice of a firm's possessions when providing a pre-specified level of consumer gratification (Rashid et al., 2022b). It is the responsibility of the decision makers to develop metrics for evaluating performance.

Prevailing theoretic readings propose performance benefits for firms executing SCRM by avoiding interruptions and depressing manufacturing accidents (Manuj et al., 2014; Thun & Hoenig, 2011). SCRM permits responding to the exterior situation and improves operational performance. The increasing complexity of supply chains and the undefined environment make organizations vulnerable to risks and disturbances (Bode & Wagner, 2015). The existing works identify the influence of SCRM on a firm's enactment, over-depressing operational loss, fast reaction, and anticipation of interruptions in supply chains (Manuj & Mentzer, 2008; Ritchie & Brindley, 2007; Thun & Hoenig, 2011). Consequently, the organization's requirement is to collect information about processes concerning indecision in the environment as well as achieve superior performance. In the context of SC, information is related to logistics, inventory, quantity, quality, market, technology, and policies, to name a few (Fan et al., 2017). The information concerning manufacturing, supply, and demand is highly indeterminate, complex, and ambiguous. In this reading, we contend that SCRM, including risk detection, prevention, response, and recovery, acts as firms' capabilities for gathering and processing supply chain information. Therefore, as an information processing system, the SCRM helps to mitigate uncertainty (Fan et al., 2017) and is helpful for improving operational performance (Fan et al., 2017; Kauppi et al., 2016). In the recent past, supply chain disruptions have obstructed the performance of companies. In particular, supply chain risk assessment activities are only acceptable if supply chain risks inhibit supply chain operational performance. (Wagner, 2008; Gligor et al., 2015; Chiu & Choi, 2016; Priya & Vivek, 2016). From the above discussion, the proposed model permits us to perceive whether supply, production, demand, and SCOP can be the basis for SCRA. Similarly, this f model will permit us to

distinguish how g SCOP is influenced by other hypotheses.

2.4 Strategies to Mitigate Risks

As mentioned above, GRCA, when properly implemented, has a role relevant in minimizing the occurrence of undesirable risks whose consequences may be at the source of disruptions in the supply chain, whether internal' or external to the corporation (Marley et al., 2014). An accurate comprehension of the diversity and interdependence of risks in a supply chain is essential for managers to be able to plan an adequate strategy to mitigate risks (Moktadir et al., 2018). However, according to Melnyk et al. (2014), three gaps were detected in GRCA, namely: the absence of an adequate definition for the dimensions of risk, how it is managed in the global supply chain, and a lack of research on regulators in processes involving risk management (Kern et al., 2012). For Feisel et al. (2015), it is necessary to focus more research on strategies aimed at the risks themselves.

Appropriate strategies are needed to mitigate risks resulting from specific situations, which mean a precise identification of the factors that are at the origin of those risks (Melnyk et al., 2014). Time-order strategies imply less significant investments, but they have the objective of obtaining quick results (Marley et al., 2014). According to research by Carter et al. (2015), short-term strategies do not mean that there is an absence of risk management; on the contrary, they are given less importance. According to Feisel et al. (2015), as "the skill of modification or reacting with a little loss in time, effort, charges, or performance," this strategy can be a fundamental weapon to win an advantage in the competitive global market. Flexibility is important because it allows for greater efficiency in the coordination of several processes in the supply chain and helps companies deal with market fluctuations and/or unexpected situations that may arise (Moktadir et al., 2018).

Finally, concerning the environment in which the supply chain is inserted, this is relevant because it will be decisive in choosing the strategy to adopt with regard to the management of risks (Moktadir et al., 2018). Managers must have a rigorous sense of a chain of supply and always consider its degree of complexity before planning any strategy proper. In this way, the probability of mitigating risks will be greater (Feisel et al., 2015). For Carter et al. (2015), risk management strategies may be grouped into seven categories: avoidance, postponement, speculation, evasion, controlling, transfer/sharing, and security. These strategies' can be interlinked. The risk avoidance strategy is useful when the company detects a product that will not be profitable or an inappropriate market for your product, for example.

This implies that the company has carried out exhaustive research on the situation. way to avoid risks to its supply chain (Moktadir et al., 2018), the strategy that involves deferment may be suitable for companies dealing with customized production or with products whose life cycle is relevant, for example speculation is a strategy in which manager's plan in advance with a view to taking into account the demand of customers. This strategy is dependent on the environment in which the firm runs, inserts, and their respective market segments (Marley et al., 2014). Evasion allows companies, in cases of risk, not to be affected so intensely since this strategy foresees that companies have their own network of partners, namely customers, suppliers, and production sites, spread across multiple locations (Moktadir et al., 2018).

As for control, the adoption of vertical integration within the company can lead to a decrease in supply risks and serious communication failures that can affect the supply chain (Kern et al., 2012). The strategy involving transfer and sharing allows companies, through outsourcing, for example, to minimize the probability of risks to their supply chain (Marley et al., 2014). Finally, security is important because it can detect risks that could harm any of the links in the chain of supply. Timely identification of potential external factors in the supply chain, such as chemical materials, is crucial to avoiding more serious problems in the supply chain (Kern et al., 2012). Feisel et al. (2015) suggest the following strategies for mitigating logistical risks and supply, indicated in table 1.

Table 1: Strategies for Mitigating Logistical and Supply Risks

Anticipate the price fluctuation of the supplies	• to anticipate and cater for the price fluctuation of the supplies in the current market of the SC.
Be aware of supplier's risk	• Favor a particular type of supplier for a high volume of products and others for low volume • Centralize redundancy for low-volume products in a few flexible suppliers.
Increase in alternative source of the supplier	• Diversify your supplier network so that you aren't reliant on a single supplier.
Increase of Inventory	• Decentralize inventory of low-value (predictable) products, • Centralize inventory for high-value (unpredictable) products.
Increase of Flexibility in demand risk	• Map out your supply chain to get a clear comprehension of which things are generally vulnerable to risk. • Centralize flexibility in a few places in case of high cost. • Stay up to date on current occurrence and familiarize with your contingency plan likewise.
Increase of capacity	• Favor capacity over cost for high value products • Favor cost over capacity for low-value products • Centralize high capacity on flexible sources (if possible) • Build a centralized capacity for unpredictable demand.

Source: Literature

Many more ways to asses/identify, mitigate the risk. Some firms use FMEA model of risk managements, some uses Fish bone method and some uses 5 Whys method to identify, access and then mitigate/minimize the risk accordingly.

2.5 Theoretical Model

It is essential that companies continue to search for new ways to deal with risk. By taken into account the global economic and supply chain context in which they control, firms must prepare for act whenever necessary and in such a way as not to be affected by complex risks that may emerge (Carter et al., 2015). Regarding logistical and supply risks, which will be the risks focused with the greatest depth in this thesis, there is still little research on its influence on the chain of supply. The various authors referred to in the subchapters referring to the risks mentioned researched its origin, however still a lack of information concerning its performance in the chain, which companies are most affected and if there are strategies that can be implemented to act on this specific type of risk. The theoretical model is depicted in figure 1.

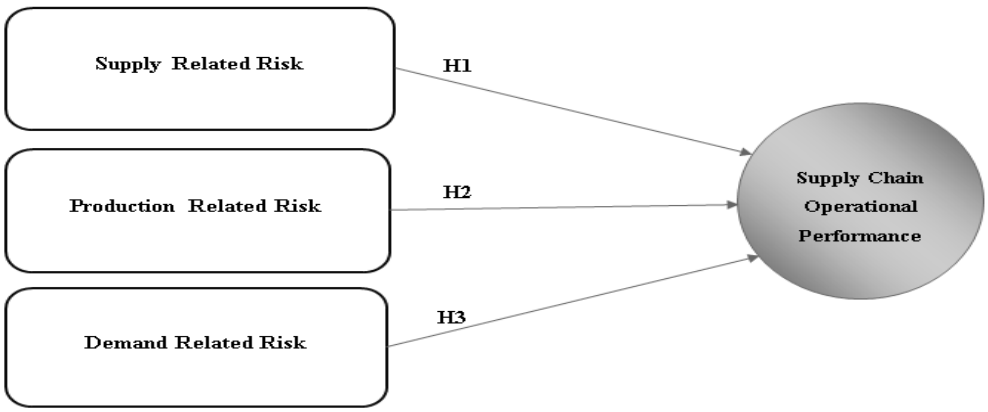

Figure 1: Theoretical model

Source: Authors' own creation

2.6 Hypotheses

In order to meet the objectives for this research and fill the aforementioned gaps in the literature, hypotheses were developed to be tested in this study. It is possible that a company that has supplies in its organization prepared to deal with risks will try to have a portfolio of reserve suppliers in order to guarantee the flow of the supply chain in the event of the occurrence of these risks since both situations demonstrate concern with risk management. Communication is an essential factor between companies and suppliers. It allows visibility in the supply chain, which allows for anticipating corrective actions, if necessary. In this sense, hypothesis 1 was elaborated.

H1: There f is a significant relation between k supply-related risk and supply and chain operation performance.

To deal with the risks related to operation (production) like failure of any machine or equipment or labor related issues which may cause the operation loss, we dealt this risk with f the performance of supply chain t operation.

H2: There is a significant relation between operations (production) related risk and supply chain operation performance.

One of the reasons that causes disturbance in the supply chains is their demand forecast that they are not in a position to be cater for. Such a situation can lead to the existence of urgent fulfillment. In order to find out if there really is a relationship between these two aspects, hypothesis 3 arises.

H3: There is a significant relation between demand related risk and supply chain operation performances.

The above model demonstrations the relation of the independent variables which show an impact one their Supply Chains Operational performance. Supply related risk, (SRR), production, related risks (ORR) and demand related risks (DRR) make an effect on the supply chain operational performance of the firm.

3. Research Methodology

3.1 Introduction

In this section, the methodology adopted for this work is presented. The formulated hypotheses and propositions were initially addressed to meet the outlined objectives. Following this, the methodology used to collect the data and the instrument used to analyze the data are described.

3.2 Research Approach

In this investigation, a questionnaire was used as the data collection tool to address the study's objectives. This questionnaire was directed to companies in the pharmaceutical sector in Pakistan and those in other industries. This questionnaire is concerned with the risk and delays in the supply chain (Hashmi et al., 2021a; 2021b; Rashid et al., 2024h). The data collected through their questionnaire has been processed and analyzed using SPSS application software from statistical product and service solutions. It is quantitative research. Quantitative research has the "purpose of expressing facts, information, data, and opinions in numerical measures" (Rashid et al., 2021; Rashid & Rasheed, 2022; Hashmi & Mohd, 2020). According to Haq et al. (2023), the quantitative method does not pose a trustworthiness issue like the qualitative method. According to Laureano et al. (2014), the quantitative approach uses cause-and-effect reasoning, variable reduction, and hypotheses to confirm, accept, or reject the proposed relationships. It is essential to keep in mind the aim and objectives of the study so that the data can be gathered accordingly. This study used conclusive research to discover the issues and challenges connected with supply chain risk management. An ample amount of research has been conducted in the selected field of research, which helped form the basis of the study. The conclusive

research has helped identify the different variables associated with the research topic. Below Figure 2 is an example of study flow.

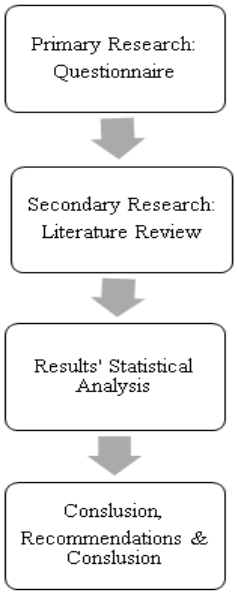

Figure 2: Example of a Study's Flow

Source: Literature

3.3 Data Collection Tools and Instruments

In the present investigation, the data collection tool is a questionnaire that was aimed at pharmaceutical companies in Pakistan. A questionnaire survey is intended to gather information. The surveys were adopted by past investigations with acceptable reliability (Cronbach's alpha) (Hashmi et al., 2020a; 2020b; Ngah et al., 2024a). The questionnaire has 2 sections: the first section has demographic questions (gender, job experiences, age, income, designation, and education), and the second section has 20 questions on independent variables (supply related risk, production related risk, and demand related risk) and dependent variables (supply chain operational performance) (Rashid et al., 2019; Rashid & Amirah, 2017). The third part concerns their factors of risk, and it is intended that the company assess the probability of the occurrence of various types of disruption that may affect supply chain operational performance (Rashid, 2016; Khan et al., 2021; 2022). Their items in the poll were estimated by a five-point Likert-type scale, and they were shipped off to their objective respondents through Google Forms, just as in printed copies to a portion of the respondents. The point is to plan a straightforward and simple questionnaire for the better comprehension of the respondent, so more exact and dependable information can be gathered. The scale points range from 1 (strongly disagree) to 5 (strongly agree) (Ngah et al., 2024b). The data collected through this questionnaire was processed and analyzed using the SPSS application software. Below table 2 highlight the source and measure of the study variable.

Table 2: Source and Measure of the Study Variable Description

Variable Type	Variable Name	References (Source Of Scale)
Dependent Variable	Supply Chain Operational Performance	Wagner et al. (2008), Gligor et al., (2015), Chiu d. and Choi (2016), Priya and Vivek (2016).
Independent Variable	Supply-related risk,	Wagner (2008)
Independent Variable	Production-related risk	Finch(2004)

Source: Literature

3.4 Sample

The data collected was the primary information, as we gathered it from the applicable representatives working in the supply chain offices or departments of a pharmaceutical industry in Pakistan. The sample size of the data gathered is multiple times larger than the number of questions accessible in the questionnaire. For sample size, we use non-probability convenience sampling (Agha et al., 2021). The sample size is between 150 and 165 respondents.

3.5 Data Collection

The link containing the questionnaire carried out in Google Forms, and the link shared by social media mediums like WhatsApp with the concerned persons having professional experience in supply chain pharmaceuticals to attain identification of the person responsible for their company (Rashid et al., 2020; Khan et al., 2023a). The collection of questionnaires was collected between October 2021, December of the same year, and January of the following year.

3.6 Ethical Consideration

The information and data gathered through the survey from the respondents were intended to be used for the purpose of examination at the given point. It is utilized uniquely to satisfy the research objective, and the individual data given by the respondents in the survey did not flow anywhere and remained profoundly secret. This paper was just utilized for academic purposes.

3.7 Data Processing Techniques

To determine the type of test to use to test hypotheses, parametric or non-parametric, it is necessary first to assess the assumptions for performing parametric tests, that is, about the normality of the independent variable and the homogeneity between the variances in the groups (Laureano et al., 2014; Khan et al., 2023b). Therefore, for each hypothesis, it is necessary to use Kolmogorov-Smirnov or Shapiro-Wilk to test that variable for normality and then that of Levene. In this case, normality exists. The Shapiro-Wilk test is suitable for small samples, namely less than 30 (Laureano et al., 2014). As for the Kolmogorov-Smirnov is used for samples more significant than 30 (Laureano et al., 2014). When it is intended to determine whether or not two populations show significant differences, the t-student test is used, a parametric test for dependent variables with a normal distribution (Haque et al., 2021; Das et al., 2021). To compare the means of two or more populations, if the variable under study is normal, an analysis of variance (ANOVA) should be used.

The Wilcoxon-Mann-Whiteney test is a non-parametric test for making comparisons between two independent samples that constitute small groups. The Kruskal-Wallis test aims to compare three or more groups of independent populations constituted by a nominal qualitative variable (Laureano et al., 2014). The objective is to determine whether there is equality between the means (Laureano et al., 2014). To verify the possible existence of correlations, the Pearson correlation can be used for normal distributions, while the Spearman correlation is suitable for distributions that do not meet normality (Laureano et al., 2014). The correlation coefficient, which can vary between -1 and 1, measures the intensity and direction of both parametric and non-parametric relationships between two variables. The closer the correlation coefficient is to the extremes of this range, the stronger the correlation between the variables.

4. Results and Findings

The current section represents the aftereffects of the survey performed with the use of SPSS.

4.1 Descriptive Profile of the Data

The research was carried out with the aim of studying the issues and challenges connected to supply chain risk management. For this, their primary data was gathered from questionnaires, which were specially designed according to the research objectives. Data was gathered from individuals with

experience in supply chain management's field. For this, questionnaires were sent to individuals from different departments and on different levels so that they could share their opinions and views by filling out the questionnaires. The respondents were selected based on their experience in the field of supply chain management. Their views and opinions were highly valued during the survey. Table 3 defines the profile of the participants. Most of the participants fell within the age range of 26–35 years (55.2%), about 23.3 percent fell within the age range of 18–25 years, about 19.0% fell within the age range of 36–45 years, and the remaining 2.5 percent were above 45 years old. Male participants dominated the response rate (66.3%) as compared to their (33.7%) female counterparts. More than 56.4% of participant's master's degree holders (25.2%) had a graduation's degree, 0.6% had a diploma or equivalent degree, 5.5% were intermediate, and 12.3% had an MPhil's degree. On-hand job experiences: (22.1%) respondents had work experience of less than 3 years; (41.1%) of the participants had 3 years to 6 years of work experience in the organization; (24.5%) had 7 years to 10 years' experience; and only (12.3%) respondents had above 10 years work experience. Majority off participant fell in f the designation of supervisors (25.8%), Assistant managers (23.3%), about (17.8%) were on the position of Managers, (8.6%) were Senior Managers, (2.5%) were Directors and (22.1%) were fell in others category.

Table 3: Demographics Profile of Participants

Demographic Variable	Category	Frequency	Percentages
Gender,	Male	108	66.3
	Female	55	33.7
Age Group	18 To 25 Years	38	23.3
	26 G To 35 G	90	55.2
	36 F To 45 G Years	31	19.0
	Above 45 Years	4	2.5
Job Experience	Less Than in 3 Years	36	22.1
	3 To 6 Years	67	41.1
	7 To 10 Years,	40	24.5
	Above 10 Years	20	12.3
Designation	Supervisor, Assistant	42	25.8
	Manager	38	23.3
	Manager	29	17.8
	Senior Manager	14	8.6
	Directors	4	2.5
	Others	36	22.1
Education	Diploma	1	0.6
	Intermediate	9	5.5
	Graduation	41	25.2
	Masters	92	56.4
	M.phil	20	12.3

Source: SPSS output

4.2 Validation of the Model

Inner consistency reliability is the degree to which all items on a specific subscale measure a similar idea (McCrae et al., 2011). The composite reliability of satisfactory values well-defined in the literature (Hair et al., 2011) would not be inferior to the threshold t value of 0.7 (Rasheed & Rashid, 2023). Their Cronbach's alpha (α) was likewise determined to approve the inner consistency of the constructs. As per the thumb rule presented by Amirah et al. (2024), values greater than 0.9, 0.8, and 0.7 were categorized as outstanding and satisfactory respectively. Tables 5 to 8 below represent the Cronbach's alpha and composite reliability marks of all variables. Reliability tests were performed for each variable to check the consistency of the model. According to Rashid and Rasheed (2024). Cronbach's alpha value should be greater than 0.7, demonstrating the model's reliability.

4.2.1 Validity and reliability test

Once the primary data was collected, it was inserted into SPSS to check its reliability and validity. SPSS provides a statistical reliability test, which helps determine whether the data is reliable enough to be tested for hypothesis acceptance. The results of reliability are included below:

Table 4: Case Processing Summary

		N	%
Cases,	Valid,	163	100.0,
	Excluded[a]	0	.0
	Total,	100	100.0,

A. Listwise deletion based on all variables in the procedure.

Source: SPSS output

The table 4 above shows the case processing summary, which indicates that 100 responses were taken from the use of questionnaires to gather the data in this research. No cases were excluded while analyzing the data.

Table 5: Reliability Statistics Of Supply-Related Risk

Cronbach's Alpha	Cronbach's Alpha Based On Standardized Items	N, Of Items
.726	.738	5

Source: SPSS output

Table 5 expresses the reliability statistics of supply-related risk. The data gathered from questionnaires was inserted into SPSS to test its reliability so that it could be used to test the hypotheses. The test results show that the Cronbach's Alpha value is 0.726, meaning the data is 72.6% reliable. In other words, all items of independent, variable, and supply-related risk are reliable for each item (Rasheed et al., 2023).

Table 6: Reliability Statistics of Production-Related Risks

Cronbach's, Alpha	Cronbach's, Alpha-Based, On Standardised Items	N, Of Items
.853	.854	5

Source: SPSS output

Table 6 determines the reliability statistics of production-related risks. The data gathered from questionnaires was inserted into SPSS to test its reliability so that it could be used to test the hypotheses. The test results show that the Cronbach's alpha value is 0.853, meaning the data is 85.3% reliable. In other words, all items of independent, variable, operation-related risk are reliable for each item.

Table 7: Reliability Statistics of Demand-Related Risk

Cronbach's, Alpha	Cronbach's, Alpha-Based, On standardized Items	N, Of Items,
.870	.872	5

Source: SPSS output

Table 7 demonstrates the reliability statistics of demand-related risk. The data gathered from questionnaires was inserted into SPSS to test its reliability so that it could be used to test the hypotheses. The test results show that the Cronbach's alpha value is 0.870, which means that the data is 87.0% reliable. In other words, all items of independent, variable, demand-related risk are reliable for each item.

Table 8 : Reliability Statistics of Supply Chain Operational Performance

Cronbach's, Alpha	Cronbach's, Alpha-Based, On Standardized Items	N, Of Items,
.776	.778	5

Source: SPSS output

Table 8 determines the reliability statistics of supply chain operational performance. The data

gathered from questionnaires was inserted into SPSS to test its reliability so that it could be used to test the hypotheses. The test results show that Cronbach's alpha value is 0.776, meaning the data is 77.6% reliable (Rasheed et al., 2024a). In other words, all items of dependent, variable, and supply chain operational performance are reliable for each item.

4.3 Hypotheses, Testing

Hypotheses were tested by applying linear and regression tests via SPSS software.

4.3.1 R, R-square, and adjusted R-square

We can see the strong strength relationship between dependent and independent variables as per the R-value, which is 0.741 in Table 9.

R-square determines the accuracy of variable regression. The value of the R-square shows that independent variables explain 54.9% of the dependent variable.

Moreover, the adjusted R square determines the unbiased accuracy of the regression. Here, we have 54.1% unbiased accuracy of regression.

Initially, the projecting power of the structural model was assessed by the coefficient of determination (R2 values) of the endogenous construct (Esposito et al., 2010; Henseler et al., 2009; Rasheed et al., 2024b), and the significance level of the path-v coefficients was elaborated (Henseler et al., 2015). The R2 value represents the proportionate variety that can be clarified to obey at least none of the indicator factors (Elliott & Woodward, 2007). Falk and Miller (1992), and Hair et al. (2012) endorsed a least acceptable threshold of an R2 value of v = 0.10. Esposito et al., (2010) suggested the R2 values assessment standard is 0.10 to 0.19 as weak, 0.2 to 0.33 as moderate, and above 0.67 as substantial, respectively. Table 9 shows the R2 was 0.549, which means it fell within the criteria of Esposito et al. (2010), which is moderate.

Table 9: Model, Summary[b]

Model,	R,	R Square,	Adjusted R Square,	Standard . Error Of V The Estimate V	Change Statistics, R Square Vs. Change	F V. Change	Df1,	Df2,	Sig. F, Change	Durbin-V Watson
1,	.741[a]	.549	.541	.44020	.549	64.555	3	159	.000	2.105

A. Predictors: Constant, Drr, Srr, Prr
B. Dependent Variable: Scop
Source: SPSS output

The sig value in table 10 shows that the independent variables are rare supply related to risk. Production related to risk, and demand, related to risk, are significant to the dependent variable, which is supply chain operational performance, because the sig value is 0.00 here, which is less than 0.05 (Kim, 2017).

A sig value of 0.00 or less than 0.05 is considered significant (Hair et al., 2011).

Table 10: ANOVA

Model,		Sum Of Squares,	Df,	Mean Square,	F,	Sig.
1	Regression	37.527	3	12.509	64.555	.000[b]
	Residual	30.810	159	.194		
	Total	68.337	162			

A. Dependent Variable: SCOP
B. Predictors: Constant, DRR, SRR, PRR
Source: SPSS output

From the sig values in Table 11 below, it can be inferred that all variables have a significant

impact. Likewise, all independent variables have an impact on the dependent variable. The sig values of all independent variables are less than 0.05. The primary objective of the reading under focus was to examine the direct relationships between the dependent variable (supply chain operational performance) and, secondly, to assess the hypothesized relationships among the constructs or hypotheses through a structural model. Three (03) direct relationships with supply chain operational performance (a dependent variable) were tested in this study. All three (03) of the total hypotheses were supported in this study. (See table 12)

Table 11: Coefficients

Model,	Unstandardized Vs. Coefficients		Standardized Vs. Coefficients	T	Sig.	95.0% V N Confidence Interval For B		Correlations,			Collinearity Vs. Statistics	
	B,	Std. I Error	Beta,			Lower, Bound	Upper, Bound	Zero-Orders	Partials	Parts	Tolerances	Vifs
1 (Constant)S	1.656	.173		9.586	.000	1.314	1.997					
SRR	.180	.067	.217	2.672	.008	.047	.313	.643	.207	.142	.429	2.332
PRR	.205	.065	.280	3.148	.002	.076	.333	.678	.242	.168	.358	2.791
DRR	.245	.069	.318	3.525	.001	.108	.382	.690	.269	.188	.348	2.876

A. Dependent Variable: SCOP

Source: SPSS output

4.3.2 Regression equation

To compare the results of the above tables, a regression equation has been designed, which is as below:

Supply Chain Operational Performance = 1.656 + 0.180 Supply vs. related vs. risk + 0.205 Production, related, risk + 0.245 Demand is related to risk.

Direct Relationship with Firm Performance

Hypothesis 1: Supply-related risk has a significant relationship with supply chain operational performances.

The result shows that the relationship between supply-related risks and supply chain operational performance has a significant relationship. Hence, H1 was accepted.

Hypothesis 2: Production-related risk has a significant relationship with supply chain, operational, and performance.

The result shows that the relationship between production-related risk and supply-chain operational performance has a significant relationship. Hence, H2 was accepted.

Hypothesis 3: Demand-related risk has a significant relationship with supply chain and operational performance.

The result shows that the relationship between demand-related risk and supply chain operational performance is an insignificant relationship. Hence, H3 was accepted.

4.4 Hypotheses Assessment Summary

Table 12 below presents a summary of the hypotheses based on the findings.

Table 12: Hypotheses Assessment Summary

Hypotheses	Result
H1: There is a significant relationship between supply-related risk and supply chain operation performance.	Accepted
H2: A significant relationship exists between production-related risk and supply chain	Accepted

operation performance.	
H3: There is a significant relationship between demand-related risk and supply chain operation performance.	Accepted

Source: Based on the SPSS results

5. Conclusion, Discussion, Implications, Limitations, and Recommendations

5.1 Conclusion

The research was based on examining the risk factors related to supply chain risk management in the pharmaceutical industry. It is known that this has been a significant concern for environmentalists, policymakers, and industries. The number of risks in Pakistan is increasing due to increasing supply chain disruptions. The rate of risk issues has also increased because of many factors. So, the study focused on finding out ways that we can help manage the supply chain risks in the pharmaceutical industry in a better manner so that the difficulties and challenges can be avoided. Supply-related, production and demand-related risks have been taken as independent variables for this. Alternatively, the operational performance of the supply chain was taken as the dependent variable. The result indicates that the effects of supply-related risk (SRR) on supply chain operational performance (SCOP) are significant and have the same impact as the variable of production-related risk (PRR) on supply chain operational performance (SCOP) and the same impact with the variable of demand-related risk (DRR) on supply chain operational performance (SCOP). So, it is concluded that if the companies operating in different industries in Pakistan use these strategies and methods, they can contribute to the effective management of supply chain risk, which may be better for the supply chain department and the organization.

5.2 Discussion

Certain risks are highly transferable, and if their mitigation and minimizing are not managed adequately, it results in affecting the health of people and the environment (Janno & Koppel, 2021). Assessment, identification, and mitigation or minimizations are considered to be very important parts of supply-chain resilience. With time, it has been seen that the industries have evolved, and the daily risk activities and processes have also evolved. Every day, it is known that all over the world, a variety of dangerous and highly risky items are transported from one place to another. The highly risky factors are differentiated based on their characteristics and nature, which helps in planning and managing supply chain risks effectively and efficiently. Effective supply-related, production-related, and demand-related risks could positively influence the operational performance of the supply chain in pharmaceutical companies. This study presents a valued understanding of prescribing information processing features of supply chain risk management. SCRM c is an information-concentrated procedure whose implementation is highly dependent on obtaining and appropriately exploiting pertinent material, evidence, and information, therefore requiring consideration of the information feature of managing risks (Fan et al., 2017). Risk assessment techniques are widely used by businesses to analyze and identify the risks so that the risk management strategies and approaches can be managed and implemented effectively. The study analyzed the supply chain operational performance in pharmaceutical industries by examining the supply chain risk described in the classes of literature. In the study, the researcher's findings found three main risk features that affect supply chain operations in their framework of pharmaceutical 'industries.

The main involvement of the research is as follows:

1 Understanding the impact of the supply chain on supply chain operations through the supply chain risk assessment model.

2: Testing the supply chain risk assessment models using risk mitigation strategies.

5.3 Implications

From the findings, it is proven that supply-related risks, production-related risks, and demand-related risks could positively help in overcoming the issues and challenges related to supply chain risk management, ultimately improving supply chain operational performance. Their research has implications on the basis of results that how a supply chain can increase its performance by supply-related risk, production-related risk, demand-related risk, and objectives of the business can be easily achieved because result shows and models also try to predict the significance of variable supply-related risk, production-related risk, and demand-related risk in supply chain operational performance if we choose the pharmaceutical industry. Therefore, it is suggested that the companies use these approaches and methods to manage their supply chain risk mitigation or minimizing approaches effectively and efficiently.

5.4 Limitations

Research faces different types of limitations, which restrict the findings and results. During this research, time was the biggest limitation, as it was carried out in a limited time frame. The study was part of academic research, which meant carrying it out within the given time frame. Other than this, a small sample size of 150 to 165 respondents was selected due to the limited time and convenience, which also influenced the overall findings and results. As other studies have some limitations, this study has some limitations as well. The first thing is that it has a time constraint, as this study explored in a short period of time. Moreover, the second thing is that this research also had a geographical limitation as it was conducted in only one city, which is Karachi, Pakistan.

5.5 Recommendations

The study aimed to examine and evaluate the issues and challenges associated with managing supply chain risk. The study proved that supply-related risks, production-related risks, and demand-related risks could positively help in overcoming the issues and challenges related to supply chain risk management. Therefore, it is recommended that the companies operating in Pakistan use the same strategies and methods to manage supply chain risk strategies effectively and efficiently. In the future, it can help companies manage supply chain risk in an effective way to avoid any mishaps or problems. Future research might be conducted to study the alternatives to these types of risk identification, assessments, and mitigation strategies. Future research may be conducted to study the alternatives that were studied in this study by changing the population. It can also be studied to evaluate the risk factors in the FMCG industry. Furthermore, it can also be performed in different regions of Pakistan as well as outside of the country. There is a significant relationship between operation-related risk and supply chain operation performance. One of the reasons that causes disturbance in the supply chains is their demand forecast, which they are not in a position to cater for. Such a situation can lead to urgent fulfilment. In order to find out if there is a relationship between these two aspects, hypothesis 3 arises. H3: There is a significant relationship between demand-related risk and supply chain operation performance. The above model demonstrates the relationship between the independent variables, which show an impact on their supply chain operational performance. Supply-related risks (SRR), production-related risks (ORR), and demand-related risks (DRR) have an effect on the supply chain operational performance of the firm.

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