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Research Title

**ASSESSING THE IMPACT OF STRUCTURED EMPLOYEE
TRAINING PROGRAMS ON RISK MITIGATION EFFICACY IN
SAUDI ARABIA'S PHARMACEUTICAL SUPPLY CHAIN**

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Abstract:

Purpose: The pharmaceutical supply chain in the KSA is exposed to several substantial challenges, including reliance on imports and regulatory difficulties. Risk control through employee training is commonly regarded as a viable option; however, evidence that supports this assumption is lacking. The intent of this research was to use empirical methods to assess whether or not structured employee training processes and programs generated effectiveness in risk mitigation efforts in their significant sector.

Methodology: A quantitative, cross sectional survey design was used. A comprehensive, multi-section questionnaire was sent out to 241 respondents in various roles/functions of the KSA pharmaceutical supply chain. The statistical analyses done were primarily based on Pearson correlation and multiple linear regression analysis. The relationships between training quality, a learning culture in a company, and components of a training strategy were examined relative to risk mitigation results.

Findings: Unexpectedly, the three main hypotheses were shown to be inconsistent with the findings overall. None of the hypothesis tests were statistically significant. The multiple linear regression, when comparing risk mitigation to employee training quality ($p=0.231$) and the existence of a continuous learning culture ($p=0.258$) results were also statistically insignificant. Even through the construction of a multiple regression model any design components of a training strategy (i.e. design; supervisor support; opportunity to use) were not significant predictors of risk mitigation in the pharmaceutical supply chain ($F = 0.643$, $p=0.695$).

Conclusion: The evidence in this paper implies that employee training as an isolated intervention could be insufficient to deal with the complex underlying systemic, structural, and policy issues of the Saudi pharmaceutical supply chain, which raises questions about the universal application of the Resource-Based View. Effective risk management may necessitate a more holistic approach involving employee training but will also require systemic organizational change, as well as improvement of processes, and development of supportive policy frameworks.

Chapter 1

Introduction

1. Introduction

Risks in the supply chain may be experienced during production, transportation, procurement, and distribution processes. In the modern business environment where supply chains are global, companies are experiencing issues related to uncertainty and unexpected disruptions. The disruptions are further increased by political instability, economic fluctuations, changes in consumer behavior, outsourcing, and rapid changes experienced in product development (Ngii, 2017). In recent times, the supply chain disruptions have increased in the pharmaceutical industry. The vulnerabilities in the pharmaceutical supply chains were exposed by the emergence of Covid-19 (Alrajhi, 2024). The disruptions have adverse effects on various aspects of the organization. According to Shashi (2022) disruptions in the supply chain destroyed the reputation of 27% of businesses, 54% of them experienced reduced profitability, and 38% had reduced revenue. The challenges experienced by pharmaceutical companies include strict regulations, third party logistics, counterfeit products, stakeholder misalignment, demand sensing, and regulated prices (Shashi, 2022). The high profits earned in the industry allow companies to increase supply chain cost and reduce their focus on improving the efficiency of the supply chain. In this case, only a third of the revenue may be spent on supply chain management due to issues related to stakeholders' misalignment and ineffective transportation infrastructure. Other challenges tend to be overlooked hence reducing supply chain reliability and agility, which promote the success of an organization in this competitive business environment.

Saudi Arabia is considered to have the largest pharmaceutical market among the gulf cooperation council (GCC) countries (Alrajhi, 2024; Tawfik et al., 2022). The pharmaceutical industry of Saudi Arabia experiences issues like strict regulations, inventory management and demand forecasting issues, medicine shortage, and reduced profits (Tobiloba, Stephen, and Owen, 2023). The industry also highly relies on other countries like China, Europe, US, and India to get pharmaceutical products (Alrajhi, 2024; Tawfik et al., 2022). The problem of relying on other countries for supplies was seen after the emergence of Covid-19. During the period, countries closed their borders to contain the infection. This means that there was no movement of people or

products in and out of the countries. Saudi Arabia was forced to effectively manage its supplies, which negatively affected the delivery of services in the healthcare industry (Tobiloba, Stephen, and Owen, 2023).

The pharmaceutical industry of Saudi Arabia is regulated by the Saudi Food and Drugs Authority (SFDA) and the Ministry of Health (MoH) (Alhomaidan et al., 2023; Junnaidi and Bhalla, 2024; Tawfik et al., 2022). The SFDA is responsible for inspecting producers of pharmaceutical goods, pricing the products, providing licenses, sales, and registration (Junnaidi and Bhalla, 2024; Tawfik et al., 2022). Regulatory changes, the introduction and development of modern technologies, mergers and acquisitions have increased drug approvals and registration of pharmaceuticals from 5,498 in 2011 to 10,424 in 2020 (Alhomaidan et al., 2023). However, Saudi Arabia has maintained the traditional approach when it comes to procuring pharmaceutical products. This is a problem for public health institutions because the supply chain of essential medicine is disrupted. The disruption has been worse for the past five to ten years after it was mandated that public health institutions must use one procurement body that is managed by various oversight bodies to request for medical supplies and drugs (Junnaidi and Bhalla, 2024). The oversight bodies sometimes have conflicting objectives, which may affect efficiency in the procurement process.

Therefore, Saudi Arabia needs a resilient supply chain to address issues experienced in the pharmaceutical industry (Tobiloba, Stephen, and Owen, 2023). Resilience can be achieved through employee training, which will allow Saudi Arabia to manufacture pharmaceutical devices and drugs locally (Tawfik et al., 2022). This will reduce the high reliance on other countries to get the products, hence reducing the supply chain disruptions. Employee training will also promote research and development and innovation in the industry, leading to discovery of drugs, efficiency and effectiveness in services delivery, and reduced costs (Tawfik et al., 2022). This paper examines the role of employee training in risk control in Saudi pharmaceutical supply chains.

2. Problem Statement

The pharmaceutical industry of Saudi Arabia experiences various problems. First, the country experiences drug shortage due to limited research and development in the country and high spending on outpatient drugs (Tobiloba, Stephen, and Owen, 2023). Another issue is overdependence on importing pharmaceutical products and not manufacturing them locally.

According to Tawfik et al. (2022) Saudi Arabia only manufactures 30% drugs available in its market. The remaining 70% is acquired from India, US, Europe, and China (Alrajhi, 2024; Tawfik et al., 2022). This is a problem in the industry because it increases supply chain issues, increases costs and prevents the continuous provision of quality services, especially during unpredictable events like Covid-19 (Alrajhi, 2024; Tobiloba, Stephen, and Owen, 2023). Tawfik et al. (2022) went further by highlighting that drug shortage in Saudi Arabia is attributed to ineffective supply chain management, reduced profits on essential drugs, overreliance on drug importation, ineffective laws that may highly penalize licensed drug distributors and importers and pharmaceutical companies for law violations, lack of government policies that monitor changes in the industry, and lack of regulations that promote early notification in relation to drug shortages.

Additionally, the increasing population and chronic diseases in Saudi Arabia increases demand for pharmaceutical products. Over the years, Saudi Arabia has improved or increased research and development in the industry. Despite this, the introduction of new drugs in the market is a problem. This is attributed to the lengthy and costly approval of new drugs (Junnaidi and Bhalla, 2024). Also, limited research and development prevents local manufacturing. Poor results of research and development are due to inadequate infrastructure, limited skilled personnel, strict regulations, limited knowledge, and inefficient and expired drug patents (Tawfik et al., 2022). These issues have resulted in overreliance on importation of pharmaceutical products. The pharma companies, research institutes, and academic researchers are not coming together to promote the local manufacturing of products in Saudi Arabia.

Furthermore, the delay expenditure by the Saudi authorities, inexperience and lack of knowledge in development and discovery of new drugs, and extended procurement and registration processes cause supply chain issues in the pharmaceutical industry (Tawfik et al., 2022). Additionally, limited research exists on the role of employee training in risk control in Saudi pharma supply chains. Therefore, this research seeks to fill the gap by conducting a quantitative study.

3. The study objectives

Main Objective

- To examine the role of employee training in risk control in Saudi pharma supply chains

Secondary Objectives

- To identify the supply chain issues experienced in the pharmaceutical industry in Saudi Arabia
- To analyze how employee training can help address issues experienced in Saudi pharma supply chains
- To recommend training strategies that will help improve risk control in Saudi pharma supply chains

4. The Importance of Study

This study aims at examining the role of employee training in risk control in Saudi pharma supply chains. This study has both theoretical and applied importance. When it comes to theoretical importance, the study will contribute to literature related to supply chain management. In this case, the study will provide valuable insight on how employee training can help mitigate risks in the pharmaceutical industry in Saudi Arabia. Additionally, the study will fill the existing gap. As stated earlier, limited research exists on the role of employee training in risk control in Saudi pharma supply chains. Most studies have focused on how policies and regulations, and technology may be applied to reduce or mitigate supply chain issues in the Saudi pharmaceutical industry. This helps guide future studies and researcher by providing valuable information to them. Moreover, the study will further advance human capital and organizational learning theories. The human capital theory promotes employee training for efficiency and effectiveness in operation and improved performance and productivity. This theory goes hand-in-hand with the organizational learning theory encourages continuous training and development that would enable organization to address the risk management issues in the supply chain. The study will also provide information on risk management through supply chain resilience regulation. Finally, the study will help professionals in the industry to plan for unproductive events like covid-19, thus improving service delivery in the industry.

When it comes to applied importance, the study will help in addressing supply chain issues experience in the Saudi pharmaceutical industry. In this case, the study will recommend training of employees on supply chain issues, regulations, and detection of counterfeit products (Tawfik et al., 2022). This information will enable workers to understand issues experience in the

pharmaceutical industry and come up with appropriate solutions to the problems. The ability to address the issues will result in efficient delivery of healthcare services in the healthcare industry in Saudi Arabia. Additionally, providing solutions to the issues experienced in the pharmaceutical industry will reduce costs and increase profits. The increased profits earned will promote the collaboration of pharmaceutical companies, academic researcher, and research institutions. The collaboration will improve research and development in the country and promote the local manufacturing of pharmaceutical products. This will reduce the supply chain issues experienced, especially during unpredictable events like Covid-19.

The study will also allow the pharmaceutical industry in Saudi Arabia to prepare for unpredictable events like covid-19. The supply chain of Saudi pharmaceutical was greatly affected during the pandemic because of overreliance on importation. Increasing local manufacturing by 40% as stipulated in vision 2030 strategies will increase local manufacturing and enable the country to prepare for unpredictable events (Tawfik et al., 2022; Junnaini and Bhalla, 2024). Employee training on crisis management will also help in preparedness for emergencies and reducing and mitigating issues in future. Employee training will help reduce financial losses since they will adhere to the set regulation and chances of violating them and being penalized will be minimal. This will further increase profits for the companies.

5. Research Questions

Main Question

- What is the role of employee training in risk control in Saudi pharma supply chains?

Secondary Questions

- What supply chain issues are experienced in the pharmaceutical industry in Saudi Arabia?
- How does employee training address issues experienced in Saudi pharma supply chains?
- What training strategies will help improve risk control in Saudi pharma supply chains?

6. The Hypotheses

H1: Employee training reduces issues experienced in pharmaceutical industry supply chains

H2: The training strategy determines the effectiveness of risk control in pharmaceutical industry supply chains

H3: Continuous employee training reduces supply chain issues in the pharmaceutical industry

7. Theories explaining the study

This study can be explained through various theories. The first theory that may explain the study is the resource based theory. According to Senna et al. (2024), the resource based theory (RBT) suggests that companies have distinct capabilities when it comes to processing of resources. The resources are applied in the creation of a competitive advantage. In this case, the organization should be flexible in responding and adjusting to different situations. This theory is applied in employee training. In this case, employee training will equip them with appropriate knowledge and skills required to address supply chain issues. Additionally, training will enable them understand the challenges being experienced. The identification of challenges will promote formulation of appropriate strategies to resolve the issues. In other words, training equips employees with capabilities to handle and address supply chain issues in the pharmaceutical industry of Saudi Arabia.

Senna et al. (2024) and Shashi (2022) suggested that the study can also be explained through the contingency theory. The theory highlights that there is no perfect leadership style of decision making process because of the different business environments. In this study, contingency theory explains that there is no single training approach or strategy that is effective. This means that the companies in the pharmaceutical industry in Saudi Arabia must adopt various training strategies to effectively and efficiently address supply chain issues.

Another theory that explains this study is the human capital theory. According to Wuttaphan (2017), human capital theory highlights that employees must be trained and educated for improved performance and productivity. In this case, employee training will enable workers to effectively and efficiently manage and address issues experienced in the supply chain of the pharmaceutical industry in Saudi Arabia. This will promote efficiency in operation, thus improving performance.

Finally, organizational learning theory explains that people tend to learn from their mistakes. In this case, when a solution is implemented and the expected result is not achieved,

research will be conducted to identify and address the inconsistency. It involves consulting or gathering information from others, thus learning in the process. In this study, a quantitative study will be conducted to understand how employee training will help address supply chain issues in the pharmaceutical industry in Saudi Arabia.

Chapter 2:

Literature review

1. Introduction

1.1. The Critical Role of Pharmaceutical Supply Chains in Global Healthcare

The pharmaceutical industry occupies a foundational position in the architecture of modern society, serving as a critical engine for both financial development and social welfare (Singh et al., 2016). Its primary function revolves around the complex processes of inventing, developing, and producing medicines and therapeutic remedies, which are indispensable for public health (Shah, 2004). The ultimate objective of any healthcare system is to deliver appropriate care and effective treatment to patients, a goal that is fundamentally dependent on the performance of the Pharmaceutical Supply Chain (PSC). The PSC functions as a distinct intricate system that guarantees medicine delivery to patients with proper conditions at their required treatment time (Mehralian et al., 2015).

A properly functioning PSC holds critical importance because pharmaceutical industry progress together with dependable supply networks allows people to obtain necessary medications with minimal problems (Yu et al., 2010). Pharmaceutical products serve as essential components that directly affect both the operation and effectiveness of the entire healthcare sector (Mokrini et al., 2015). The proper management of medicine depends on product availability and integrity because it determines a nation's ability to handle public health issues effectively (Uthayakumar & Priyan, 2013).

Pharmaceutical inventory within this ecosystem refers to the stock of medical products which healthcare institutions use as their fundamental asset to address future requirements (Santhi & Karthikeyan, 2016). Pharmaceutical products differ from other perishable goods because they are more costly, and their management directly affects human health outcomes thus requiring public safety considerations (Santhi & Karthikeyan, 2016). Patient requirements and successful health results depend heavily on proper inventory management (Denton, 2013). When pharmaceutical stock is improperly managed it produces devastating effects that include both extreme patient health risks from medication shortages and major financial losses for healthcare

facilities (Romero, 2013). The high-risk environment requires decision-makers to provide special attention and plan ahead to achieve successful and dependable PSC operation (Uthayakumar & Priyan, 2013). The healthcare system depends entirely on its supply chain components thus its performance directly affects national health protection and population wellness improvement capacity.

1.2. Inherent Risks and Vulnerabilities in Modern Supply Chains

Modern supply chains exist as elaborate worldwide networks that connect numerous organizations across international borders in today's interconnected global economy (Khawka et al., 2024; Zara et al., 2024). The expansion toward higher productivity along with cost reduction and emerging market demand fulfillment has generated multiple new risks and vulnerabilities (Musa, 2012). Supply chains with increasing complexity create barriers to visibility which weakens an organization's ability to control its internal processes (Musa, 2012). Modern supply chains possess a complex and extended structure that creates an inherent fragility which makes them vulnerable to numerous types of disruptions (Musa, 2012).

All supply chains encounter disruptions and risks which make them unreliable during important moments according to Liu and Kivelö (2021). The various sources of risks emerge from both inside and outside environments. The internal risks consist of operational interruptions which include equipment breakdowns and production delays together with workforce conflicts and financial issues and compliance breaches. External risks present a diverse range of challenges that organizations cannot easily control since they include market dynamics and price instability together with natural disasters and climate change effects and geopolitical conflicts and supplier breakdowns (Zara et al., 2024). The implementation of lean and agile management principles for efficiency purposes has created new vulnerabilities in supply chain operations. The lean supply chain approach to inventory reduction makes every supplier or transit disruption capable of stopping production which creates widespread network consequences (Peck, 2005; Rani et al., 2024).

Numerous historical incidents have shown the fundamental weaknesses of supply chains. A fire broke out at the Philips microchip plant in 2000 which caused Nokia minimal problems but resulted in a USD 400 million loss for Ericsson which had only one supplier. The example shows how a supply chain risk event at one point can produce devastating effects on other members when

proper management does not occur (Musa, 2012). Recent global supply chain vulnerabilities have become evident through the COVID-19 pandemic which caused extensive product shortages and logistical bottlenecks and economic instability (Dandebo & Kivelö, 2021; Kumar et al., 2022). Supply chain disruptions have transitioned from being occasional incidents to the "new norm" because of their increasing frequency in current supply chain operations (Musa, 2012).

Specialized sectors such as pharmaceutical manufacturing face additional complexity in their operations. The PSC operates under strict regulations while requiring special product handling methods such as biologic cold chain management and essential patient safety and product integrity (Mehralian et al., 2015). The natural complexity of raw material movement combined with production stages and delivery pathways makes the system more susceptible to failure (Ghadge et al., 2013). The PSC faces risks through supply interruptions triggered by inadequate infrastructure and technical breakdowns and by extended delivery times and quality control failures and security threats and unanticipated expenses from tariff and duty variations (Fitzgerald, 2005). The complete system becomes vulnerable when any part of the supply chain fails because manufacturers depend on suppliers and distributors for essential medicines to reach patients (Micheli et al., 2008).

1.3. An Overview of Supply Chain Risk Management (SCRM) as a Strategic Imperative

Risk management in supply chains has evolved into a strategic essential because of natural vulnerabilities and high-risk conditions especially within pharmaceutical businesses (Zara et al., 2024). Supply Chain Risk Management (SCRM) refers to the established procedure that organizations use to detect and assess risks which affect supply chain operations and profitability (Waters, 2011). The main objective of Supply Chain Risk Management involves partners working together to control risks through joint actions which maintain profitable operations and supply chain stability (Tang, 2006). Organizations use this method to foresee potential dangers before they occur while building comprehensive plans to tackle them as opposed to dealing with disruptions after they happen (Kırılmaz & Erol, 2016).

The SCRM process is widely accepted as a systematic, cyclical framework. Although terminology may vary slightly, it consists of four key stages:

1. **Risk Identification:** The first essential stage requires structured supply chain evaluation to detect potential risk locations together with their emergence methods (Singhal et al., 2011); (Ritchie and Zsidisin, 2008). The process demands complete knowledge of supply chain structure and operational methods and environmental conditions to find possible failure points (Rani et al., 2024).
2. **Risk Assessment and Analysis:** The evaluation of identified risks requires understanding both their potential effects and their likelihood of happening (Christopher, 2011). The evaluation phase uses qualitative scenario analysis and quantitative Monte Carlo simulations to measure and rank threats (Zara et al., 2024). Organizations need to prioritize their threats based on importance because this approach enables them to allocate their restricted resources toward their top risks (Zara et al., 2024).
3. **Risk Mitigation and Control:** The stage requires organizations to create and execute plans for handling their selected risks. Organizations implement their risk responses through prevention techniques and impact reduction methods as well as risk transfer strategies such as insurance coverage and contingency planning for accepted risks (Christopher, 2011; Aqlan et al., 2015).
4. **Risk Monitoring and Review:** The implementation of SCRM requires continuous attention as it functions beyond a single project (Zara et al., 2024). Organizations need to track both risk elements and their risk reduction plans while altering their approaches according to changing circumstances (Zara et al., 2024). The iterative process of SCRM resembles the Plan-Do-Check-Act (PDCA) cycle which maintains supply chain resilience and adaptability over time (Tummala and Schoenherr, 2011).

The benefits of a well-designed SCRM framework become apparent through improved organizational outcomes. Organizations that handle their supply chain risks well achieve better competitiveness in their markets (Ferreira de Araújo Lima et al., 2020). A well-implemented SCRM approach produces better reliability along with better responsiveness and efficiency which drives supply chain profitability (Hendricks & Singhal, 2005). Organizations that actively handle risks gain protection against financial losses and operational disruptions and reputational damage which enables them to maintain their competitive advantage and sustainability in present-day global market volatility (Zara et al., 2024).

1.4. The Pharmaceutical Supply Chain in Saudi Arabia: Context, Growth, and Challenges

The Kingdom of Saudi Arabia through Vision 2030 has initiated a deep economic and social change which positions healthcare as a fundamental development element (Rahman & Al-Borie, 2021). The Vision 2030 framework targets the establishment of a thriving sustainable economy through diversification while prioritizing service improvement in healthcare and other public domains (AlGosaibi et al., 2020). The transformation process requires the application of modern technologies including Artificial Intelligence to strengthen diagnostic processes and patient care as well as hospital management systems (Kumar et al., 2025). The national strategic direction establishes the framework for the rapid development of pharmaceutical supply chains within the Kingdom.

The Saudi Arabian public healthcare system (PHS) functions through an intricate network which connects local raw material suppliers with primary and secondary pharmaceutical manufacturers and logistics providers and distributors and numerous public health service providers who operate under SFDA and Ministry of Health (MoH) regulatory oversight (Almutairi et al., 2020). The government has stimulated pharmaceutical sector growth through supportive regulations which resulted in substantial investment expansion (George & Elrashid, 2020). Expansion creates particular obstacles which hinder the PSC's operational effectiveness and dependability.

The Saudi health sector faces a significant challenge when it comes to maintaining steady PSC operations that fulfill patient requirements and resolve pharmaceutical shortages (George & Elrashid, 2020). Hospital pharmacies face two main problems related to medicine expiration and stock-outs because they struggle to maintain efficient supply chain management practices (Haszlinna Mustaffa & Potter, 2009). The sources of essential medicine shortages at the local level include multiple complicated factors which relate to supplier performance and logistical challenges and internal procurement operations (AlRuthia et al., 2023).

The successful implementation of new technologies under Vision 2030 faces multiple obstacles. AI and digital system adoption faces substantial obstacles because of limited AI-trained staff and healthcare staff resistance to change, and ethical and privacy issues related to AI implementation. The Kingdom's healthcare facilities continue to operate on older systems which

create integration challenges for new technologies thus producing data fragmentation that reduces AI-driven supply chain solution efficiency (Kumar et al., 2025).

The distinctive combination of geography and population characteristics in Saudi Arabia creates additional difficulties. Meeting the timely supply needs of distant locations represents a major logistical obstacle. The need to maintain the integrity of pharmaceuticals, particularly those requiring a stable cold chain, across vast distances and in a challenging climate requires a highly resilient and technologically advanced logistics network. While strategic initiatives like the National Strategy for Data & AI (NSDAI) and the Health Information Exchange (HIE) system aim to address these issues by centralizing data and fostering a digital-first environment, the path to a fully optimized and risk-resilient PSC in Saudi Arabia requires overcoming these substantial organizational, technological, and environmental challenges (Kumar et al., 2025).

1.5. The Human Element in Risk Management: The Need for Skilled Personnel

While technology, processes, and infrastructure are critical components of a resilient supply chain, the human element the skills, knowledge, and dedication of the workforce is arguably the most crucial and often overlooked factor in effective risk management. A resource-based view of an organization posits that human capital, when valuable, rare, and difficult to imitate, can be a primary source of sustainable competitive advantage. In the context of SCRM, this means that having a well-trained and risk-aware workforce is essential for navigating the complexities and uncertainties of modern supply chains (Liu and Liu, 2022).

Effective risk management is not an automated process; it relies on the cognitive and analytical abilities of individuals at every level of the organization. Skilled personnel are needed to identify subtle signs of potential disruptions, accurately assess the probability and impact of risks, and make sound decisions under pressure. The effective use of risk assessment tools such as FMEA and FTA require users to have sufficient experience and knowledge when evaluating risk parameters. The tools will generate false assurance if users lack adequate knowledge about methodologies and their operational contexts (Dandebo & Kivelö, 2021).

The growing use of AI and big data analytics in supply chains requires organizations to develop a highly skilled workforce. These technologies provide robust predictive forecasting and process optimization capabilities, yet their successful implementation relies on employees who

understand "AI literacy". To maximize the benefits of AI models professionals, need to comprehend their operational mechanisms and output interpretation as well as their utilization for inventory management and demand forecasting tasks. Healthcare professionals in Saudi Arabia lack the necessary skills which creates a major obstacle for AI adoption in healthcare supply chains (Kumar et al., 2025).

The establishment of risk awareness culture throughout a company represents essentially human responsibility. Leaders who successfully transmit risk management value need employees who want to engage in risk management processes (Liu & Liu, 2022). An organization that establishes a core team to spread risk awareness among all departments will break down barriers and enhance its ability to react to risk events (Handfield & McCormack, 2008). A complete SCRM strategy needs both technical expertise and strong interpersonal and communication skills to build interdisciplinary teamwork (Kumar et al., 2025). Supply chains that endure global market uncertainties become more resilient when organizations dedicate resources to employee development of skills and knowledge (Liu & Liu, 2022).

1.6. Research Gap: The Under-explored Impact of Employee Training on Risk Mitigation

Research regarding Supply Chain Risk Management (SCRM) extends over several decades and has produced an extensive understanding of risk identification and mitigation methods. Multiple investigations have studied the establishment of strong risk management strategies through supplier diversification combined with modern inventory control systems and technology implementation. The research consists of two main approaches: qualitative studies develop conceptual frameworks and exploratory reviews and quantitative studies produce analytical and simulation models for particular risk situations (Musa, 2012). Research in pharmaceutical supply chain challenges such as regulatory compliance and product integrity has attracted significant academic interest (George & Elrashid, 2023).

The human aspects of organizational performance and employee loyalty receive recognition through the influence of leadership styles and organizational culture and employee motivation according to Liu and Liu (2022). Research indicates that healthcare organizations need skilled personnel yet face knowledge barriers which prevent them from adopting AI technologies according to Kumar et al. (2025).

However, despite this broad landscape of research, a significant and specific gap persists. There is a notable lack of empirical studies that directly and systematically assess the causal impact of structured employee training programs on the efficacy of risk mitigation within the supply chain. While many studies implicitly suggest that a skilled workforce is beneficial, few have moved beyond this general assertion to provide concrete evidence of how formal training translates into improved risk management outcomes. Much of the focus has been on high-level strategies or technological solutions, with the foundational role of employee competency often assumed rather than proven.

The Saudi Arabian pharmaceutical supply chain demonstrates an exceptionally large gap between current conditions and desired outcomes. Some research exists about AI adoption problems and Saudi healthcare sector AI literacy requirements (Kumar et al., 2025) and others study drug shortage causes (AlRuthia et al., 2023) but no research connects these challenges to targeted employee training as a solution. Research lacks sufficient examination of structured training for risk identification and procedural compliance and crisis response which could directly enhance PSC resilience and performance in this rapidly transforming environment.

Therefore, this research exists to address the essential gap in current literature. This study advances past general human factors understanding by conducting empirical research to measure the direct impact of structured employee training programs on risk mitigation efficacy. The research targets Saudi Arabian pharmaceutical supply chains to generate specific evidence about human capital development for building resilient healthcare supply chains.

2. Dependent Variable: Risk Control and Mitigation Efficacy

A Supply Chain Risk Management program establishes its ultimate success through effective control of risks to maintain operational continuity while protecting financial performance and stakeholder interests (Zara et al., 2024). Efficacy stands as more than process implementation because it represents actual measurable results from those processes. A company demonstrates strength by identifying and handling economic social and environmental supply chain risks through effective contingency planning and building adaptable and resilient operations (Carter & Rogers, 2008). The following analysis breaks down risk control and mitigation efficacy by analyzing SCRM foundations along with its basic processes and risk types and assessment methods and mitigation strategies with pharmaceutical supply chain requirements in mind.

2.1. Defining Supply Chain Risk Management (SCRM)

There is no single, universally accepted definition of Supply Chain Risk Management, as its scope and focus can vary depending on the industry and the specific perspective of the researcher or practitioner (Sodhi et al., 2012). However, a consensus emerges around a core set of principles. Fundamentally, SCRM is the structured process of systematically identifying, analyzing, and responding to risks that threaten supply chain operations (Waters, 2011). It extends beyond simply managing known variabilities, such as demand fluctuations, to encompass the management of unknown, low-probability, high-impact disruptions and disasters (Sodhi et al., 2012).

A widely cited definition frames SCRM as "the management of supply chain risk through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity" (Tang, 2006a). This highlights a critical aspect of modern SCRM: it is not an isolated activity performed by a single firm but a collaborative effort that must extend across the entire network of suppliers, manufacturers, distributors, and customers. The goal is to create a resilient supply chain, which is defined as the ability of a system not only "to react to an unexpected disruption and maintain operations after the event" but also "to return to its original state or move to a new, more desirable state after being disturbed" (Rice and Caniato, 2003; Christopher and Peck, 2004). This requires a proactive stance, where potential risks are identified and mitigation plans are developed before a crisis occurs, rather than a purely reactive approach that attempts to manage damage after the fact (Kırılmaz & Erol, 2016).

2.2. The Core Process of SCRM

Effective SCRM is built upon a systematic and iterative process that allows organizations to continuously adapt to a changing risk landscape. This process can be visualized as a cyclical framework, ensuring that risk management is an ongoing strategic function rather than a one-time project (Tummala and Schoenherr, 2011). Leading companies like Ericsson, following major disruptions, have formally adopted such cyclical feedback-loop models to guide their risk management efforts (Norrman and Jansson, 2004). The process is generally broken down into four distinct but interconnected stages, as illustrated in the "Supply chain risk management" figure (Garver, 2008).

Figure 1: Supply chain risk management



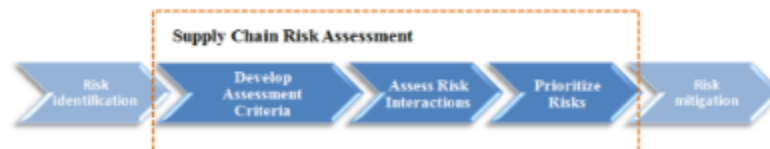
2.2.1. Risk Identification This is the foundational stage of the entire SCRM process, involving the comprehensive discovery and documentation of potential risks that could affect the supply chain (Ritchie and Zsidisin, 2008). The objective is to proactively highlight unfavorable factors that could impede an enterprise's ability to achieve its performance goals (Garver, 2008). This is a complex undertaking that requires gathering data from diverse sources, including internal reports, financial statements, and operational records, as well as external sources like market analyses and supplier performance reports (Zara et al., 2024).

The process of effective recognition depends on multiple methods. Risk workshops which involve different teams for brainstorming together with supplier interviews and logistic partner interviews and analytical tools including SWOT analysis and cause-and-effect diagrams and event tree analysis represent effective identification techniques according to Zara et al. (2024) and Brindley (2004). All risks that remain unidentified in the identification process will not appear in later stages of analysis or mitigation planning.

2.2.2. Risk Assessment and Evaluation The identification of potential risks leads to the subsequent stage where their importance needs evaluation. The analysis of risks requires organizations to determine both the chances of occurrence and the possible effects on operational and financial aspects and organizational reputation (Christopher, 2011). The assessment phase enables managers to direct their attention toward essential threats by quantifying and ranking risks (Zara et al., 2024).

The risk assessment process follows the "Supply Chain Risk Assessment Process" diagram (Cooper et al., 2005) through multiple steps. The first step involves creating assessment criteria which often employs a matrix that maps probability against impact (Eccles and Obe, 2010). The evaluation of risk interactions reveals that multiple minor risks can combine to create a significant major event (Kuang and Cho, 2016). Risks receive priority levels that include 'critical', 'difficult', 'routine' and 'low importance' for developing the mitigation strategy (Eccles and Obe, 2010).

Figure 2: Supply chain risk assessment



2.2.3. Risk Mitigation and Control This is the action-oriented phase where strategies are developed and implemented to manage the prioritized risks. The goal is not always to eliminate risk entirely, but to control it to an acceptable level. There are several primary mitigation strategies, as detailed in the table "Supply chain risks mitigation" (Aqlan et al., 2015; Zara et al., 2024):

- **Risk Avoidance:** Eradicating the risk completely by eliminating its cause, such as by ceasing a high-risk operation. This is most appropriate for risks with both high probability and high impact.
- **Risk Reduction:** Reducing the probability or impact of a risk through actions like quality assurance tests, redundancy checks, or better tools and operator training.
- **Risk Transfer:** Shifting the financial burden of a risk to a third party, typically through insurance or contractual agreements. This is suitable for low-probability, high-impact events like natural disasters.
- **Risk Acceptance:** For risks with low probability and impact, an organization may choose to accept the risk and deal with the consequences if it occurs, often with a contingency plan in place.

The selection of a strategy depends on a cost-benefit analysis of the risk versus the cost of mitigation.

Figure 3: response strategy for risk

Response Strategy	Risk Description
Risk Avoidance	●Avoiding the risk completely by eradicating its causes. The residual risk in this case is zero ●This strategy is more appropriate in the case when there are risks with high probability as well as high impact ●Appropriate when the risks involve changing the operations, planning or re-engineering the whole supply chain
Risk Reduction	●In this strategy , risk is reduced rather than eliminating it ●Appropriate when risk has low or medium probability and high impact ●This strategy is suitable in managing the operational risks occurring on daily basis e.g., Examples of this strategy are redundancy checks, quality assurance tests, using better tools, operators training, etc.
Risk Transfer	●In this strategy, risk is transferred to another party (residual risk may exist) ●This strategy is most appropriate when risk has low probability but high impact ●Suitable to be used in unexpected risks such as natural disasters and terrorist attacks ●Examples of such strategies are buying insurance and third party contracts
Risk Acceptance	●The strategy is applied when the risk is acceptable enough, the residual risk remains the same ●This strategy is adopted when the risks involved have low or medium probability and low impact ●This strategy is most appropriate when the cost incurred by other strategies is much higher than their impact ●This strategy is adopted when the risks can be controlled by contingency plans
Ignoring Risk	●In this strategy the risk is completely ignored. ●This strategy is applied with the risks having minor impact on the operations and low chances of occurring ●This strategy is similar with risk acceptance but this strategy identify and analyze the risk and at the end ignore it, however, analyze that the magnitude of the risk does not rise up i.e., have a watch over the risks.
Risk Exploit	●This strategy is applied when the impact of the risk is positive, i.e., in favor of the firm. ●This types of positive risks are assumed as opportunities ●The risk exploit strategies include enhancing the risk, realizing the risk, accepting the risk and sharing the risk.

2.2.4. Risk Monitoring and Review SCRM is a dynamic process because the risk landscape is constantly changing (Zara et al., 2024). Therefore, the final stage involves the continuous monitoring of identified risks and the regular review of the effectiveness of mitigation plans (Musa, 2012). This can be achieved by using Key Performance Indicators (KPIs) like lead time accuracy and supplier performance to provide real-time insights into emerging threats. Regular audits and assessments are necessary to identify new risks and re-evaluate existing ones. Establishing feedback loops with stakeholders, including suppliers and customers, is also crucial to ensure that risk management strategies remain relevant and effective, allowing for the continuous improvement of the entire process (Zara et al., 2024).

2.3. Taxonomy of Supply Chain Risks

To effectively manage risks, it is essential to first understand their nature and origin. Risks can be categorized in various ways to provide a structured framework for analysis. A common

approach is to classify them based on their source (internal or external) or by the specific supply chain flow they disrupt (material, information, or financial) (Zara et al., 2024; Musa, 2012).

2.3.1. Internal Risks (Operational, Financial, Compliance) Internal risks are those that originate from within the organization or its immediate supply chain network and are generally considered more controllable (Waters, 2011). These can be broadly grouped as follows:

- **Operational Risks:** These pertain to disruptions in the day-to-day processes of the company. Key operational risks include equipment failures, which can cause significant production delays; labor disputes or shortages; and production bottlenecks (Zara et al., 2024). They also include process variability, capacity inflexibility, and under-productivity (Wu et al., 2006; Sheffi & Rice, 2005). Within the pharmaceutical industry, specific manufacturing risks like poor production planning, lack of requisite skills, and quality control failures are major concerns (He et al., 2017).
- **Financial Risks:** These risks stem from the financial management and stability of the organization and its partners. They include budget overruns, cash flow problems, exchange rate volatility, and risks associated with the financial strength of suppliers or customers, such as the possibility of bankruptcy (Zara et al., 2024; Musa, 2012). The failure of a single key partner, as seen in the Enron scandal, can send financial shocks throughout the entire supply chain (LaLonde, 2002).
- **Compliance Risks:** These risks arise from the failure to adhere to laws, regulations, and industry standards. In the pharmaceutical sector, this is a particularly acute risk area, given the stringent regulations governing drug manufacturing, storage, and distribution (Kumar et al., 2025). Non-compliance can result in severe financial penalties, legal action, and reputational damage (Zara et al., 2024).

2.3.2. External Risks (Environmental, Geopolitical, Market, Supplier) External risks originate from outside the organization's direct control, making them harder to predict and prevent, thus necessitating a focus on mitigation and resilience (Waters, 2011). Key external risks include:

- **Environmental Risks:** These are risks posed by natural disasters such as earthquakes, floods, and hurricanes, as well as the broader impacts of climate change like water scarcity (Zara et al., 2024; Musa, 2012). Catastrophic events like the 2006 Taiwan earthquake,

which severed undersea cables and disrupted seaport operations, highlight the vulnerability of global supply chains to natural forces (Musa, 2012).

- **Geopolitical Risks:** These include risks from political instability, wars, terrorism, and changes in trade policies or restrictions (Zara et al., 2024; Musa, 2012). The security of trade lanes and the political stability of sourcing countries are major considerations in global supply chain design (Blanchard, 2009).
- **Market Risks:** These are associated with the volatility of the market, including unpredictable shifts in customer demand, price fluctuations of raw materials and energy, and the actions of competitors (Zara et al., 2024; Musa, 2012). For example, a sudden spike in fuel prices can dramatically increase transportation costs and erode profit margins (Crone, 2006).
- **Supplier Risks:** These are risks associated with the upstream supply base. They include the potential for supplier bankruptcy, delivery delays, quality failures, and unethical practices such as the use of child labor (Zara et al., 2024; Musa, 2012). Over-reliance on a single supplier (single sourcing) is a well-documented and significant risk, as any disruption at that supplier can bring the entire downstream chain to a halt (Musa, 2012).

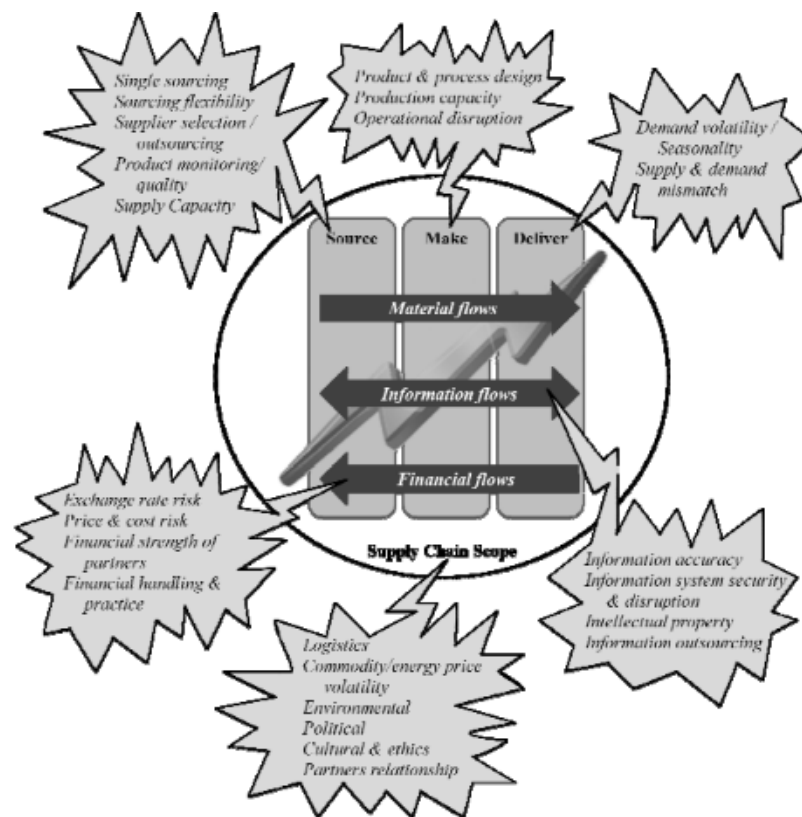
2.3.3. Flow-based Risks (Material, Information, and Financial) Another useful taxonomy, proposed by Musa (2012), is to view risk based on its impact on the three primary flows that connect supply chain partners. This framework, illustrated in "Figure: Risk issues in supply chain" (Musa, 2012), helps in understanding the cascading effects of disruptions.

- **Material Flow Risk:** This involves the physical movement of products, from raw materials to finished goods. Risks here include transportation disruptions, port congestion, customs delays, inventory loss or damage, and production stoppages. A failure in the material flow directly impacts the ability to meet customer demand.
- **Information Flow Risk:** Information is the bonding agent of the supply chain, triggering material and financial flows. Risks in this domain include data inaccuracy (e.g., from the bullwhip effect), information system failures or security breaches (e.g., hacking, viruses), loss of intellectual property, and disruptions from outsourcing IT services. Poor

information sharing can lead to incorrect forecasts, mismatched supply and demand, and inefficient coordination (Guo et al., 2006).

- **Financial Flow Risk:** Also known as cash flow, this represents the movement of money between supply chain partners. Risks include exchange rate fluctuations, price and cost volatility, customer or supplier bankruptcy, and delays in payment. A disruption in the financial flow can quickly lead to liquidity problems and threaten the viability of firms across the network.

Figure 4: supply chain scope



2.4. Methodologies for Risk Assessment and Prioritization

Organizations need to implement structured procedures for risk assessment and prioritization after identifying their potential threats. This process enables organizations to dedicate their restricted resources towards controlling the most critical risks that endanger their

operations. Organizations analyze risks by using two main evaluation methods which include both qualitative and quantitative frameworks (Zara et al., 2024; Musa, 2012).

2.4.1. Qualitative vs. Quantitative Approaches The two primary approaches to risk assessment offer different levels of depth and analytical rigor.

- **Qualitative Analysis:** This approach relies on descriptive scales and expert judgment to evaluate risks. Organizations evaluate risks through the use of expert judgment and descriptive scales which include "low," "medium," and "high" according to Aqlan and Lam (2015). The method of qualitative assessment works best for early risk evaluations and when numerical information is unavailable or difficult to collect. Expert interviews along with scenario analysis and risk matrix development represent this category of risk assessment techniques. Through risk matrices organizations can visually display identified risks so managers recognize which high-probability high-impact threats need immediate action (Zara et al., 2024).
- **Quantitative Analysis:** Mathematical models together with statistical methods assess risk probabilities alongside their impacts by assigning numerical values. Such analysis provides an unbiased detailed evaluation of risks. The analysis methods combine probability assessment with sensitivity testing and Monte Carlo simulations that generate thousands of financial or operational risk predictions (Zara et al., 2024). The resource-intensive nature of quantitative analysis produces strong foundations for critical decision-making about safety stock optimization and financial risk mitigation evaluation.

The analysis of SCRM literature indicates that qualitative methods dominate the research field but quantitative modeling shows increasing popularity although it represents a smaller portion of the studies (Musa, 2012).

2.4.2. Common Frameworks: FMEA, FTA, House of Risk (HoR), and SCOR Model Several established frameworks are widely used to structure the risk assessment process:

- **Failure Mode and Effects Analysis (FMEA):** FMEA represents one of the most common tools used to identify and analyze risks according to Dandebo and Kivelö (2021). This method uses a well-structured approach which begins at the lowest level to find potential

failure modes within processes and products. The analysis assesses each potential failure by considering its Severity (S) together with its Occurrence probability (O) and Detection probability (D) before it results in harm according to Bergman and Klefsjö (2012). The three assessment factors multiply together to produce a Risk Priority Number (RPN) which determines the order of risk mitigation priorities according to Zara et al. (2024). Dandebo and Kivelö (2021) present an example of an FMEA spreadsheet in their publication. The standalone capability of FMEA makes it an effective tool for supply chain risk analysis according to Musa (2012).

- **Fault Tree Analysis (FTA):** The analytical approach of FTA operates as a top-down deductive method which differs from FMEA. The analysis begins with one major undesirable event (such as "supply chain shutdown") which it analyzes by tracing every equipment failure and human error that might cause it (Tummala & Schoenherr, 2011). FTA proves to be an effective tool for detecting critical failure sources while showing how different failure occurrences connect (Dandebo & Kivelö, 2021). This method serves as a complementary tool with other approaches to create a more detailed assessment of risks (Musa, 2012).
- **House of Risk (HoR):** The HoR methodology represents a new model which unites principles from FMEA and House of Quality (HoQ) to manage supply chain risks effectively. The model consists of two distinct phases. HoR Phase 1 starts by identifying risk events together with their risk agents and computing Aggregate Risk Potential (ARP) values through occurrence and severity analysis and event correlation. The ARP value serves as a basis for determining which risk agents need immediate attention. HoR Phase 2 develops and ranks prevention strategies according to their capabilities to solve the main risk agents and their implementation complexity.
- **Supply Chain Operations Reference (SCOR) Model:** Supply Chain Operations Reference (SCOR) Model: The SCOR framework functions as an essential diagnostic system to evaluate supply chain operations although it does not serve as a risk assessment tool. The SCOR model creates five standardized supply chain process categories which include Plan, Source, Make, Deliver, and Return. Organizations should initially use the SCOR model to identify every supply chain activity before applying FMEA or HoR risk

assessment methods to each process for a complete supply chain evaluation (Rani et al., 2024).

2.5. Key Strategies for Risk Mitigation

After the assessment and prioritization of risks organizations must implement strategies to minimize their supply chain's potential disruption. Organizations need to implement multiple strategies which should be customized according to their unique risk profile and operational environment (Chopra and Sodhi, 2004). The most effective approaches often involve building redundancy and flexibility into the supply chain.

2.5.1. Supplier Diversification and Dual Sourcing Dependence on one supplier presents a major weakness to organizations according to Musa (2012). The main protective approach involves diversification which means obtaining supplies from numerous vendors along with entering new territorial markets according to Zara et al. (2024).

- **Dual Sourcing or Multi-Sourcing** means working with at least two suppliers for your materials or components. The organization establishes backup suppliers to maintain continuous material delivery when one supplier faces disruptions such as factory fires or labor strikes (Dandebö & Kivelö, 2021). Suppliers compete with each other to provide better pricing and quality when organizations use this approach which also improves supply reliability (Musa, 2012). The complexity of administration grows when using this method, but the resilience benefits exceed the drawbacks especially for essential components according to Thun et al. (2011).

2.5.2. Inventory Management and Safety Stock Policies Inventory functions as an important safety net which protects organizations from uncertain situations and interruptions. The lean philosophy supports low stockpiles, but a robust SCRM approach understands the value of strategic inventory levels to maintain operational continuity (Peck, 2005).

Safety Stock: Organizations should keep elevated safety stock quantities of essential parts to withstand supply interruptions which stem from supplier delays or unexpected demand increases (Dandebö & Kivelö, 2021; Zara et al., 2024). Simulation research demonstrates that proper safety stock quantities can lower supplier delay effects by 30% (Zara et al., 2024).

Vendor-Managed Inventory (VMI): The supplier controls inventory level tracking and automatic replenishment within a VMI framework. The system decreases stockout probabilities and inventory expenses through better coordination together with clearer visibility (He et al., 2017). The shared supply chain management system works to reduce the bullwhip effect which makes supply chain demand fluctuations grow larger (Disney & Towill, 2003).

2.5.3. Enhanced Collaboration and Information Sharing Low-capital mitigation strategies involving improved communication among supply chain partners and enhanced relationships serve as effective approaches.

- **Collaboration:** The development of trust-based connections between suppliers and customers creates better understanding which results in improved joint risk management practices. Joint risk assessments together with common contingency plan development represent collaborative risk management processes between supply chain partners according to Zara et al. (2024).
- **Information Sharing and Visibility:** Timely accurate information sharing of demand forecasts together with inventory levels and production schedules is essential for minimizing uncertainty. Open communication channels combined with transparent information systems enable both earlier problem detection and faster solution development which boosts supply chain flexibility and reliability according to Dandebö & Kivelo (2021) and Chang et al. (2014).

2.5.4. Integration of Technology (AI, Blockchain, IoT) SCRM experiences a transformation through advanced technologies that deliver enhanced capabilities for visibility and analytical and automated processes.

Artificial Intelligence (AI) and Machine Learning (ML): The application of AI enables businesses to achieve advanced demand forecast capabilities and prediction of supply chain interruptions and better optimization of their inventories and logistics operations according to Kumar et al. (2025). AI-powered systems analyze extensive datasets to detect patterns and risks which human analysts cannot detect according to Richey et al. (2023).

Internet of Things (IoT): The implementation of IoT sensors enables live tracking of transit goods which monitors their present location as well as temperature and other relevant environmental

parameters. The pharmaceutical cold chain requires this system as its most vital component because temperature control is essential (Lawal, 2025).

Blockchain: The implementation of blockchain technology improves supply chain tracking and transparency through unalterable transaction logs. Blockchain serves as an effective solution to fight counterfeit pharmaceutical products while tracking product origins (Kumar et al., 2025).

2.6. Specifics of Risk Mitigation in the Pharmaceutical Supply Chain

Specialized strategies must be developed for pharmaceutical supply chain operations because their performance determines human health outcomes (Santhi & Karthikeyan, 2016). The general principles of SCRM require sector-specific adaptations for addressing PSC risks.

2.6.1. Ensuring Product Quality and Integrity Pharmaceutical products must maintain their quality and efficacy as an absolute requirement. Patient safety faces major risks from product quality deterioration.

- **Supplier Quality Control:** The main risk in PSC involves obtaining products from suppliers who maintain variable quality standards. Organizations need to establish strict supplier evaluation methods that include on-site inspections as well as ongoing performance tracking. Companies need to set up defined quality agreements and procedures to handle defective products that stop them from being processed for patient delivery (He et al., 2017).
- **Cold Chain Management:** Modern medicines including biologics and vaccines need continuous cold chain maintenance because they are temperature-sensitive products. The failure of cold chain management renders products both ineffective and potentially dangerous. Organizations should use IoT sensors for temperature monitoring and implement validated packaging solutions together with comprehensive temperature-controlled shipment tracking protocols (Kumar et al., 2025).

2.6.2. Adherence to Regulatory and Compliance Standards The pharmaceutical sector operates under strict regulatory frameworks throughout the world. Product recalls and fines and legal actions occur when companies fail to meet the regulations established by the Saudi Food and Drug Authority (SFDA) (Kumar et al., 2025).

Regulatory Knowledge and Training: Organizations need to establish training programs that teach employees at every level about current Good Manufacturing Practices (GMP) together with Good Distribution Practices (GDP) and all applicable national and international regulations (Verheijen, 2018).

Traceability and Documentation: Organizations need to establish detailed documentation systems that enable proof of regulatory compliance. Blockchain technology stands as a potential solution for creating secure transparent records that track drugs from manufacturing to distribution thereby helping audits and recalls (Kumar et al., 2025).

2.6.3. Preventing Drug Shortages and Managing Demand Volatility Drug shortages are a critical public health issue that can disrupt patient care and lead to negative health outcomes. They are a significant challenge in many countries, including Saudi Arabia (AlRuthia et al., 2023).

- **Demand Forecasting:** While forecasting pharmaceutical demand is notoriously difficult due to factors like physician preferences, disease outbreaks, and regulatory changes, it is a critical mitigation tool (Haszlinna Mustaffa & Potter, 2009). Hospitals and pharmacies must utilize the best available statistical methods and collaborate with public health bodies to create more accurate forecasts (George and Elrashid, 2023).
- **Strategic Inventory and Production Flexibility:** To buffer against unexpected demand surges or supply disruptions, holding strategic stock of essential medicines is a key strategy (Denton, 2013). Furthermore, building flexibility into production and sourcing allows manufacturers to respond more quickly to shortages. This includes having contingency plans with alternate suppliers and maintaining some level of reserve production capacity (He et al., 2017).

3. Independent Variable: Structured Employee Training

The efficacy of any risk management system, regardless of its technological sophistication or procedural rigor, is ultimately determined by the people responsible for its implementation. Processes and strategies are inert without a workforce equipped with the requisite knowledge, skills, and motivation to execute them effectively. Structured employee training is the primary organizational mechanism for cultivating this human capability. It serves as the bridge between

having a risk management plan and having a risk-aware culture capable of dynamic response. This section explores the role of structured employee training as the critical independent variable influencing risk mitigation efficacy. It examines how training enhances organizational performance, builds essential human capital, serves as a cornerstone for specific risk management activities, and addresses the models and challenges associated with its implementation in complex supply chains.

3.1. The Role of Employee Training in Enhancing Organizational Performance

At a fundamental level, employee training is a strategic investment in an organization's most valuable asset: its people. The direct link between training, employee motivation, and organizational performance has been extensively explored in management literature. Organizations recognize that to achieve their goals, they must motivate their employees, and training is a powerful tool for doing so. When organizations provide developmental opportunities, it signals to employees that their growth is valued, which in turn fosters motivation, satisfaction, and loyalty. This motivated and satisfied workforce is more likely to exhibit higher levels of job performance (Liu and Liu, 2022).

The benefits of training are multifaceted and manifest across individual, team, and organizational levels (Aguinis and Kraiger, 2009). For the individual, training enhances skills and knowledge, leading to improved proficiency and career advancement opportunities. For the organization, a better-trained workforce translates directly into improved productivity, higher quality output, and a greater capacity for innovation (Prasad et al., 2019). In the context of the supply chain, training in areas such as quality management, logistics coordination, and process efficiency leads to tangible improvements in operational metrics. Research has shown that differentiation among competing firms is often based on the skills, knowledge, and motivation of their staff (Aguinis and Kraiger, 2009). Therefore, by investing in training, organizations are not merely conducting a perfunctory HR function; they are actively sharpening their competitive edge and building a foundation for sustained performance.

3.2. Linking Training to Human Capital Development and Competitive Advantage

The strategic importance of employee training is best understood through the lens of the Resource-Based View (RBV) of the firm. This theory posits that a firm's sustainable competitive

advantage is derived from its unique, valuable, and hard-to-imitate resources. While physical assets and technology can often be replicated by competitors, a highly skilled, knowledgeable, and cohesive workforce its human capital is a resource that is exceptionally difficult to duplicate (Liu and Liu, 2022). Structured employee training is the most direct and effective means of cultivating this inimitable human capital.

By systematically developing the capabilities of their employees, organizations create a workforce that can innovate, solve complex problems, and adapt to changing market conditions more effectively than their rivals. This is particularly relevant in high-stakes environments like the pharmaceutical supply chain, where the ability to manage complex logistics, ensure regulatory compliance, and respond to crises is paramount. Financial management practices, for example, are significantly more effective when mediated by strong human capital, demonstrating that even financial performance is deeply intertwined with employee competence (Birhane et al., 2023).

Therefore, training should not be viewed as a cost center but as a strategic investment in building the organization's core competencies. It transforms employees from interchangeable units of labor into a source of strategic value. This perspective aligns with the modern understanding of supply chain management, where success depends not just on optimizing processes but on the intelligence, creativity, and problem-solving abilities of the people who manage those processes (Isfahani et al., 2013).

3.3. Employee Training as a Cornerstone for Risk Management

While the general link between training and performance is well-established, its specific role as a cornerstone of effective SCRM is even more critical. A comprehensive risk management framework is only as strong as the people who operate within it. Training transforms abstract risk policies into concrete actions and embeds risk-aware thinking into the daily operations of the supply chain.

3.3.1. Building a Culture of Risk Awareness A proactive risk management culture begins with awareness. Employees at all levels must be trained to recognize potential risks in their specific areas of work and understand how their actions can impact the broader supply chain. This requires a concerted effort to move beyond a "check-the-box" compliance mentality to one where risk awareness is an integral part of every decision. One effective approach is to establish a core team

responsible for raising risk awareness throughout the entire enterprise, helping to overcome organizational silos and improve overall responsiveness (Handfield & McCormack, 2008). Training programs function as the primary method to spread awareness among supply chain members so they understand their responsibilities for defending against disruptions. Organizations must grasp complete details about technological innovation risks to establish effective prevention measures especially during skill risk management (He et al., 2017).

3.3.2. Developing Competencies for Risk Identification and Analysis Effective SCRM requires specific, technical competencies. Employees need to be trained on the methodologies and tools used for risk identification and analysis, such as FMEA, FTA, and HoR. The accuracy and utility of these tools are directly dependent on the user's experience and knowledge. Without proper training, assessments can be subjective and may lead to a false sense of security, where critical risks are overlooked or mis-prioritized (Dandebo & Kivelö, 2021). For example, in the context of the Saudi healthcare system's push toward AI, training must bridge the significant knowledge gaps among professionals who often lack the necessary skills to leverage these advanced tools for tasks like inventory management and demand forecasting (Kumar et al., 2025). Structured training ensures that risk analysis is conducted with rigor and consistency across the organization.

3.3.3. Training for Crisis Management and Business Continuity Planning When a disruption does occur, the response must be swift, coordinated, and effective. This capability is not innate; it must be built through training and practice. Developing comprehensive Business Continuity Plans (BCP) and Disaster Recovery Plans (DRP) is a critical first step, but these plans are useless if they sit on a shelf. Organizations must form dedicated crisis management teams and train them to execute response plans during emergencies. Team training utilizes simulated scenarios along with practical exercises to develop their capability of handling unexpected interruptions so they can reduce downtime and maintain vital operations throughout and following emergencies (Zara et al., 2024).

3.4. Models and Approaches for Effective Training Programs Organizations need training programs which deliver targeted solutions for their workforce and business requirements. Organizations rarely achieve success through standard training methods. The most successful training programs combine multiple educational models to create extensive competency development systems.

3.4.1. Technical Skills and Procedural Training This training level represents the base stage which teaches employees to execute their tasks both accurately and without danger.

- **Technical Skills:** Manufacturing organizations must train employees about proper equipment operations and maintenance methods to lower equipment failure rates and enhance production output (He et al., 2017). Modern digitization requires additional training for employees to handle new software platforms alongside data analytics tools and AI-driven systems (Kumar et al., 2025).
- **Procedural Training:** Employees receive instruction about which employees should follow Standard Operating Procedures (SOPs) and regulatory standards as well as safety practices. A research study found that "Workers not following SOP" serves as a major risk factor which demonstrates the necessity of this training type (Rani et al., 2024). All pharmaceutical companies must provide essential training about GMP and GDP standards because they ensure regulatory compliance (Verheijen, 2018).

3.4.2. Collaborative and Interdisciplinary Training Supply chains function as complex networks which need risk management strategies that eliminate departmental barriers. The training programs need to establish systems that connect departmental procurement, logistics, finance and supplier relationships (Zara et al., 2024). The National Center for Artificial Intelligence (NCAI) in Saudi Arabia promotes medical and technological collaboration between healthcare institutions and technology companies because innovation emerges from the intersection of these fields (Kumar et al., 2025). Stakeholders who receive cross-functional training will develop comprehensive understanding of supply chain risks which enables them to create integrated solutions collaboratively.

3.4.3. The Use of Simulation and Scenario-Based Training This approach is particularly effective for developing risk response and crisis management skills.

- **Scenario Analysis:** This method involves creating hypothetical but plausible disruptive scenarios (e.g., a key supplier bankruptcy, a natural disaster, a sudden port closure) and having teams work through how they would respond (Singhal et al., 2011). This type of

planning helps prepare employees mentally and procedurally for a wide array of potential problems (Waters, 2011).

- **Simulations:** Using computer-based simulation models, organizations can test the resilience of their supply chain and the effectiveness of different mitigation strategies under various conditions (Musa, 2012). Through this method, organizations can study system dynamics while detecting system bottlenecks without risking any operational damage. Decision-makers gain essential training from these simulations which demonstrate how their crisis decisions produce complex effects beyond initial outcomes.

3.5. Challenges to Implementing Effective Training in Supply Chains

Although training delivers obvious advantages implementation faces numerous difficulties especially for small and medium-sized enterprises and dynamic healthcare organizations in Saudi Arabia.

3.5.1. Cost, Resource Allocation, and Measuring ROI Organizations spend substantial funds on training programs which include advanced technology and extensive simulations (Kumar et al., 2025). Small and medium-sized enterprises face difficulties when trying to convince their management about the high costs of these training programs (Ferreira de Araújo Lima et al., 2020). Organizations find it challenging to evaluate the financial benefits of risk management training since its main advantage involves preventing future losses which cannot easily be measured. Organizations face a significant challenge when trying to obtain funding because of this issue (Kumar et al., 2025).

3.5.2. Overcoming Cultural Resistance and Change Management New processes and technologies introduced through risk management initiatives often face employee resistance. In the Saudi healthcare sector, resistance to AI adoption has been noted, stemming from concerns over job displacement and a general mistrust in algorithms. Effective training programs must be paired with a robust change management strategy that communicates the benefits of the new approach, addresses employee concerns, and emphasizes how new tools and skills will augment, rather than replace, human expertise (Kumar et al., 2025). Without buy-in from the workforce, even the best-designed training program is likely to fail.

3.5.3. Addressing Workforce Knowledge and Skill Gaps A primary reason for training is to close existing skill gaps, but the scale of these gaps can itself be a challenge. In many organizations, there is a fundamental lack of the necessary skills to effectively implement and manage modern SCRM systems (Kumar et al., 2025). In developing countries or rapidly modernizing sectors, the baseline of digital and analytical literacy may be low, requiring more foundational and extensive training programs (He et al., 2017). Designing and scaling training to meet the diverse needs of a large workforce, from frontline operators to senior managers, is a significant logistical and pedagogical challenge that requires careful planning and sustained commitment from leadership.

4. Summary of Past Studies and the Research Gap

The field of Supply Chain Risk Management (SCRM) has garnered significant academic and practical attention over the last two decades, particularly in the wake of major global disruptions that have exposed the vulnerabilities of interconnected networks (Musa, 2012). Research has evolved from foundational conceptual work to more nuanced empirical studies and quantitative models (Musa, 2012). However, despite this progress, specific gaps remain, particularly concerning the quantifiable impact of human capital development on risk mitigation (Musa, 2012). This section summarizes the findings from previous literature about pharmaceutical sector SCRM while reviewing human factor research and methodological approaches and clearly identifies the research gap for this study.

4.1. Synthesis of Existing Literature on SCRM in the Pharmaceutical Sector

Research devoted to Pharmaceutical Supply Chain (PSC) demonstrates its distinctive operational challenges together with the essential need for proper risk management (George & Elrashid, 2023; He et al., 2017). Research in this field primarily investigates operational factors together with logistical elements and technological solutions to protect product availability and integrity (George & Elrashid, 2023). The management of pharmaceutical inventory stands as a fundamental theme throughout this research. Research studies in Bahraini private hospital pharmacies revealed that both inventory level control and demand forecasting showed positive effects on the overall performance of the Pharmaceutical Supply Chain (George & Elrashid, 2023). The industry emphasizes operational methods including stock evaluations and lead duration

control and statistical prediction methods to minimize stock depletion costs and manage expiration risks (George & Elrashid, 2023).

The identification and classification of risks stands as a major research topic in supply chain management. Supply chain risks consist of incidents which disrupt inbound supply operations that make it impossible for firms to satisfy customer demand or endanger customer safety (Zsidisin, 2003, as referenced in Ellis et al., 2009). Risks exist in multiple categories that include environmental risks and organizational risks and supply chain-specific risks but understanding them requires identification of risk sources and drivers together with their consequences and mitigation approaches (Li & Barnes, 2008). The method of risk classification adapts to different organizational contexts so practitioners can develop customized response plans (Misita et al., 2016). Risk sources exist in various forms because they include both specific physical dangers like rockfalls and wide-ranging threats like terrorism which demand a multidimensional comprehension (Scavia et al., 2020; Aven & Guikema, 2015).

The analysis of HUAWEI's supply side revealed four essential risk categories that apply to complex industries: manufacturing risk which includes production and quality risks and skill risks and logistics risk which includes transportation and inbound delivery risks and lead time and information risk and inventory risk (He et al., 2017). The study identified that skill and production risks represented the primary dangers which required risk mitigation through staff training and feasibility studies and enhanced risk awareness (He et al., 2017).

More recent studies have begun to explore these challenges within the specific context of Saudi Arabia. The Saudi pharmaceutical industry experiences significant drug shortages, a problem attributed largely to an overreliance on importation from countries like the US, China, India, and Europe, with only 30% of pharmaceuticals being locally manufactured (Tawfik et al., 2022). This dependence was starkly exposed during the COVID-19 pandemic when border closures and protectionist measures by exporting nations created severe vulnerabilities in the Kingdom's healthcare supply chain, hindering the provision of quality care (Alrajhi, 2024; Tobiloba et al., 2023). These shortages are further exacerbated by ineffective supply chain management, low-profit margins on essential drugs, lengthy and costly procurement processes, and a lack of government policies that promote early notification of potential shortages (Tawfik et al., 2022; Junnaidi & Bhalla, 2024).

4.2. Review of Studies on Human Factors, Leadership, and Employee Roles in SCRM

Parallel to the process- and technology-focused research, another stream of literature has examined the "human side" of supply chain management, investigating factors like leadership, motivation, and collaboration. This research acknowledges that supply chains are managed by people, and their behaviors, decisions, and skills are critical determinants of performance.

Research performed in hospital organizations of Eastern China demonstrated that transformational leadership functions as a strong positive factor which enhances employee job performance outcomes (Liu & Liu, 2022). The findings revealed that monetary incentives together with employee loyalty directly enhanced performance outcomes thus demonstrating the operational value of motivated and committed staff (Liu & Liu, 2022). The research demonstrates that organizational achievements depend heavily on how companies handle their workforce through leadership and motivation practices.

Human-centric activities place high value on collaboration and communication as their fundamental components. Research on Small and Medium-sized Enterprises (SMEs) revealed that structured communication between critical suppliers serves as an essential success element in SCRM (Dandebo & Kivelö, 2021). The research shows that employees need to establish trustworthy relationships with their external partners to effectively manage risks. The broader SCRM literature supports this approach by recommending joint risk assessments and shared contingency plans between suppliers to enhance supply chain resilience (Zara et al., 2024). The ways supervisors and safety managers communicate play a vital role in determining occupational risks according to Burns and Conchie (2013).

Research conducted in Saudi healthcare organizations demonstrates how essential human elements are to healthcare operations. The main obstacles to progress consist of inadequate skilled workers along with insufficient knowledge base regarding essential areas such as drug development and discovery (Junnaidi & Bhalla, 2024; Tawfik et al., 2022). The obstacles toward AI adoption in healthcare extend beyond technical issues because human elements play a significant role in these challenges. Professionals resist adopting AI systems because they lack trust in algorithmic processes and organizations face a fundamental skills shortage within their workforce and require technical experts to work alongside medical practitioners (Kumar et al., 2025). Research shows that ongoing employee training generates necessary knowledge and skills

which develops R&D potential while also fixing supply chain problems (Bilal et al., 2024). The implementation of training programs focused on machine learning and AI-driven predictive analytics serves to deliver real-time supply chain data while building resilience and enhancing demand forecasts which leads to cost reductions and waste minimization (Aljohani, 2023; Tobiloba et al., 2023; Junnaidi & Bhalla, 2024).

Previous research demonstrates leadership along with motivation and teamwork as essential components yet fails to provide precise training assessments. Current research fails to establish concrete evidence of the benefits gained through formal training programs which specifically target risk management capabilities.

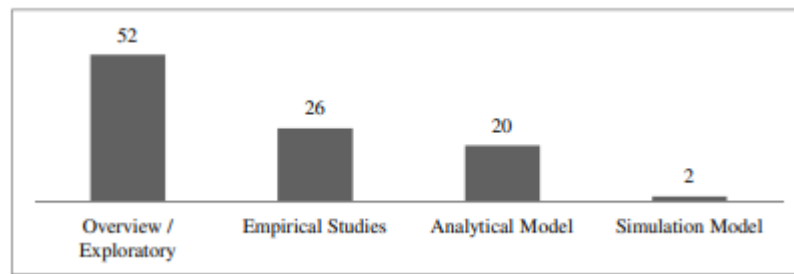
4.3. Discussion of Methodological Approaches in Previous SCRM Research

The current research gap becomes clearer when analyzing the methodological framework used in SCRM studies. According to Musa (2012) the field of research shows a clear preference for both qualitative and conceptual research methods based on his bibliometric analysis of 138 articles published from 1995 to 2009. The research categorized 138 articles from 1995 to 2009 and identified specific methodological patterns in the studies (Musa 2012).

This pattern is visually represented in the chart titled "Percentage of publication by types of research method" from the study by Musa (2012), which shows the following distribution:

- **Overview / Exploratory Studies:** This category, which includes conceptual models and literature reviews, constituted the vast majority, accounting for 52% of the research (Musa, 2012).
- **Empirical Studies:** This group, comprising case studies, interviews, and surveys, made up 26% of the articles reviewed (Musa, 2012).
- **Analytical Models:** Quantitative studies using optimization, decision-tree, or other mathematical models represented 20% of the literature (Musa, 2012).
- **Simulation Models:** This was the least common approach, accounting for only 2% of the studies (Musa, 2012).
-

Figure 5: Methodological Approaches in Previous SCRM Research



This distribution demonstrates that while awareness of SCRM has grown, and practitioners have increasingly been the subject of empirical case studies, there remains a "clear deficiency of empirical studies" and an "obvious lack of quantitative approaches" designed to test specific hypotheses and model complex risk interactions (Sodhi et al., 2012; Musa, 2012). Although the number of quantitative studies has increased over time, a large portion of this work tends to focus on a specific, narrow area (e.g., optimizing an inventory policy) and often ignores the need to handle the supply chain as a complex, integrated system (Musa, 2012). This methodological tendency has left a gap for more holistic, empirical research that tests the effectiveness of specific organizational interventions, such as training, on overall system performance.

4.4. Identifying the Research Gap: A Lack of Empirical Evidence on the Direct Causal Link Between Structured Training Programs and Risk Mitigation Efficacy in the Saudi Pharmaceutical Context

Synthesizing the findings from the preceding sections reveals a clear and compelling research gap. The existing body of knowledge has established several key points: (1) The pharmaceutical supply chain is a complex, high-stakes environment fraught with significant risks (George & Elrashid, 2023); (2) The Saudi Arabian PSC, in particular, faces a unique set of challenges related to logistics, drug shortages, and the difficult process of digital transformation under Vision 2030 (Tawfik et al., 2022; AlRuthia et al., 2023; Kumar et al., 2025); (3) Human factors such as leadership, motivation, and the need for skilled personnel are acknowledged as being important for supply chain performance (Liu & Liu, 2022; Junnaidi & Bhalla, 2024); and (4) The field of SCRM has been dominated by conceptual and qualitative studies, with a need for more empirical research that tests specific, causal relationships (Musa, 2012).

The confluence of these points illuminates the gap: there is a lack of specific, empirical evidence that establishes a direct causal link between the implementation of structured employee training programs and the resulting efficacy of risk mitigation within the pharmaceutical supply chain. This gap is especially acute and relevant within the Saudi Arabian context. While studies have identified a "workforce training and knowledge gap" and "limited skilled personnel" as barriers to progress in Saudi healthcare, this has often been presented as a general challenge rather than being framed as a testable hypothesis (Kumar et al., 2025; Tawfik et al., 2022). Although some authors mention that limited knowledge and skills hinder local manufacturing, and conclude that training would address this, these connections are not explored in depth or tested empirically (Tawfik et al., 2022). Past studies provide valuable insight but have focused more on digital technology and regulatory frameworks rather than on how employee training can directly address supply chain issues.

4.5. Contribution of the Current Study: Bridging the Gap by Providing an Empirical Assessment

This research is designed specifically to address the identified gap in the literature. Its primary contribution will be to move beyond the broad acknowledgment of human factors and provide a focused, empirical assessment of the role of a specific intervention structured employee training on a crucial organizational outcome risk mitigation efficacy. By doing so, this study will make several important contributions.

First, it will provide concrete evidence to either support or challenge the widely held assumption that training directly improves risk management capabilities. This moves the discussion from a conceptual argument to an evidence-based one. Second, by grounding the research in the Saudi Arabian pharmaceutical supply chain, it will generate highly relevant, context-specific insights. These findings will be of immense practical value to hospital administrators, pharmaceutical executives, and policymakers within the Kingdom who are tasked with strengthening the healthcare system in line with Vision 2030. It will help them make more informed decisions about investing in human capital development as a strategic tool for building resilience. Finally, this study will connect the concepts of regulatory frameworks and digital technologies to training, providing valuable insights for strengthening the Saudi pharma supply chains. From a methodological standpoint, this study will add to the limited but growing body of

quantitative, hypothesis-driven research in the SCRM field, offering a model for how the impact of specific organizational initiatives can be empirically measured.

5. Theoretical Framework of the Study

To provide a robust analytical foundation for assessing the impact of structured employee training on risk mitigation efficacy, this study is underpinned by a combination of established management and behavioral theories. No single theory can fully capture the complex interplay of human capital, organizational processes, and contextual factors involved in supply chain risk management. Therefore, a multi-theory framework is employed to explain *why* and *how* training is expected to influence risk mitigation outcomes. This framework integrates the Resource-Based View (RBV), Contingency Theory, the Technology-Organization-Environment (T-O-E) framework, Stakeholder Theory, and principles from learning theories to create a holistic model for analysis.

5.1. Resource-Based View (RBV): Viewing Trained Employees as a Source of Sustainable Competitive Advantage

The Resource-Based View (RBV) of the firm posits that an organization's ability to achieve and sustain a competitive advantage lies not in its market position, but in its unique internal resources and capabilities. For a resource to be a source of sustainable competitive advantage, it must be valuable, rare, inimitable (difficult to imitate), and non-substitutable. While tangible resources like technology and capital are often acquirable by competitors, intangible resources like knowledge, culture, and employee skills are much more difficult to replicate (Liu and Liu, 2022).

This study applies the RBV by conceptualizing a highly trained workforce as a critical, strategic asset.

- **Valuable:** A well-trained workforce is immensely valuable because it directly enhances the efficacy of risk mitigation. Trained employees are better equipped to identify potential failure modes, conduct accurate risk assessments, and execute complex contingency plans, thereby reducing the financial and operational impact of disruptions and ensuring business continuity (He et al., 2017; Zara et al., 2024). This capability directly contributes to the firm's bottom line and operational stability.

- **Rare:** While many organizations conduct some form of training, the development of a deeply embedded, risk-aware culture through comprehensive, structured, and continuous training programs is rare. Many firms, especially SMEs, lack the resources or strategic foresight for such an investment, making a highly competent workforce in SCRM a scarce resource (Ferreira de Araújo Lima et al., 2020).
- **Inimitable:** This is the most critical characteristic. A competitor can purchase the same risk management software or copy a procedural manual, but they cannot easily replicate the collective knowledge, problem-solving skills, and cohesive culture of a competitor's well-trained workforce. This "human capital" is built over time through shared experiences, continuous learning, and organizational investment, making it path-dependent and socially complex and thus, very difficult to imitate (Liu and Liu, 2022).

Therefore, the RBV provides the core theoretical argument for this study: structured employee training is the mechanism through which an organization develops a valuable, rare, and inimitable human capital resource that, in turn, drives superior risk mitigation efficacy and creates a sustainable competitive advantage based on resilience.

5.2. Contingency Theory: The Effectiveness of Training is Contingent on the Type of Risk and Organizational Context

Contingency Theory is based on the premise that there is no single "one best way" to organize or manage. Instead, the optimal course of action is contingent upon the specific internal and external factors of the situation (Musa, 2012). The effectiveness of a particular management practice depends on how well it fits with the context in which it is applied. This perspective is crucial for understanding the relationship between training and risk mitigation.

The application of Contingency Theory in this study suggests that the impact of employee training on risk mitigation efficacy is not uniform; rather, it depends on several contextual variables:

- **The Nature of the Risk:** Different types of risks require different competencies and, therefore, different types of training. For example, training on FMEA and statistical process control may be highly effective for mitigating internal operational risks (e.g., manufacturing quality failures). However, for managing external, low-probability, high-

impact risks like geopolitical instability or pandemics, training in scenario planning, crisis communication, and agile response would be more appropriate (Aqlan et al., 2015). The "fit" between the training content and the organization's specific risk profile is critical.

- **Organizational Factors:** The effectiveness of training is contingent upon the internal environment of the organization. For example, a training program is more likely to succeed in an organization with a supportive leadership style, a culture that values learning, and sufficient resources allocated to the initiative (Liu and Liu, 2022). In a culture of resistance, the same training program might fail entirely (Kumar et al., 2025).
- **Environmental Factors:** The external environment also shapes the effectiveness of training. In the highly regulated Saudi pharmaceutical market, training on regulatory compliance is not just beneficial but essential for survival (Kumar et al., 2025). In a highly volatile market, training focused on agility and responsiveness will yield greater benefits.

Contingency Theory thus provides a framework for analyzing *when* and *why* specific training programs are effective. It posits that the greatest risk mitigation efficacy will be achieved when training programs are carefully designed to be contingent upon the specific risk landscape, organizational culture, and external environment of the Saudi pharmaceutical supply chain.

5.3. Technology-Organization-Environment (T-O-E) Framework: Analyzing the Interplay of Factors Influencing the Adoption of Risk Mitigation Practices

The Technology-Organization-Environment (T-O-E) framework provides a holistic, multi-level perspective for studying the adoption and implementation of new technologies and processes within an organization (Kumar et al., 2025). It is particularly well-suited for this study because it moves beyond individual-centric models (like the Technology Acceptance Model) to capture the broader institutional and contextual determinants that shape organizational change, making it ideal for analyzing the adoption of risk management practices at an institutional level (Drazin, 1990, cited in Kumar et al., 2025).

The framework analyzes adoption through three interacting contexts:

- **Technological Context:** This refers to the characteristics of the technologies being used for risk management. It includes the availability, complexity, and compatibility of tools

such as risk assessment software, AI-driven forecasting systems, and real-time monitoring platforms. The success of employee training is directly related to this context; employees must be trained on the specific technologies the organization uses, and the usability of those technologies will impact the training's effectiveness.

- **Organizational Context:** This is the dimension where structured employee training resides. It encompasses the characteristics of the organization, including its size, culture, leadership support, communication structures, and, most importantly, the skills and knowledge of its workforce. The T-O-E framework allows this study to position employee training not as an isolated event, but as a key organizational resource that interacts with technological and environmental factors.
- **Environmental Context:** This dimension includes the external arena in which the organization operates. For the Saudi pharmaceutical supply chain, this includes the regulatory pressures from the SFDA and MoH, the level of competition, and the demands of external stakeholders like suppliers and patients.

The T-O-E framework allows this study to model the complex relationship where effective training (an Organizational factor) enhances an employee's ability to use risk management systems (a Technological factor) to navigate and control threats originating from the external landscape (the Environmental factor).

5.4. Stakeholder Theory: Understanding the Role of Training in Aligning the Interests of Various Supply Chain Stakeholders

Stakeholder Theory asserts that an organization's success depends on its ability to manage its relationships with a wide array of stakeholders any group or individual who can affect or is affected by the achievement of the organization's objectives. In the context of the public healthcare supply chain, these stakeholders include not only internal employees and managers but also external groups such as patients, suppliers, government regulators (e.g., SFDA, MoH), and logistics providers (Kumar et al., 2025).

This theory is critical to the study because it frames risk mitigation not as a purely internal, profit-driven activity, but as a responsibility with multi-faceted consequences. A failure in the

supply chain such as a drug shortage or a quality control lapse has a direct and negative impact on multiple stakeholders.

- **Patients** are harmed through lack of access to essential medicines.
- **Suppliers** are harmed by production halts and damaged relationships.
- **Regulators** are concerned with public safety and compliance failures.
- **Employees** are affected by the stress and operational chaos of managing a crisis.

Therefore, effective employee training must be designed from a stakeholder-oriented perspective. It should equip employees with the skills needed to manage these complex relationships to mitigate risks collaboratively. This includes training in:

- **Supplier Relationship Management:** Developing skills for clear communication and joint risk assessments with suppliers (Dandebo & Kivelö, 2021).
- **Regulatory Compliance:** Ensuring a deep understanding of the requirements of bodies like the SFDA to protect both the public and the organization (Kumar et al., 2025).
- **Patient-Centric Operations:** Fostering an understanding that the ultimate goal of the supply chain is patient safety and well-being, which helps to prioritize actions during a disruption (Kumar et al., 2025).

Stakeholder Theory provides the ethical and operational justification for why training must be broad and collaborative, moving beyond internal procedures to encompass the competencies required to align the interests and actions of all parties toward the shared goal of a resilient and reliable pharmaceutical supply chain.

5.5. Adult Learning and Social Cognitive Theories: How Training Influences Employee Behavior, Self-Efficacy, and Capability in Risk Management

While the preceding theories explain why training is strategically important at the organizational level, learning theories explain the mechanism through which training actually works at the individual level. Adult Learning Theory (Andragogy) suggests that adult learners are most motivated when learning is problem-centered, relevant to their work, and allows them to draw upon their own experiences. Social Cognitive Theory, developed by Albert Bandura,

emphasizes that learning occurs in a social context and is driven by the dynamic interaction of personal factors, environmental influences, and behavior. A key concept from this theory is **self-efficacy**, which is an individual's belief in their own capacity to execute behaviors necessary to produce specific performance attainments.

These theories are directly applicable to training for risk mitigation:

- **Behavioral Change:** Effective training for SCRM must go beyond simple knowledge transfer; it must be designed to change behavior. Employees must not only *know* the risk procedures but must be able to *execute* them effectively under pressure.
- **Building Self-Efficacy:** Training, particularly through hands-on methods like simulations and scenario-based exercises, builds employees' confidence in their ability to handle risk events (Dandebo & Kivelö, 2021). An employee with high self-efficacy is more likely to take proactive steps to identify a risk or to act decisively during a crisis, rather than freezing or waiting for directions.
- **Problem-Centered Learning:** Training is most effective when it is framed around solving real-world supply chain problems. By using case studies of past disruptions (e.g., the Ericsson fire) or potential future scenarios relevant to the Saudi context, trainers can make the content immediately applicable and engaging for employees (Musa, 2012).

These learning theories provide the final piece of the theoretical framework, explaining the micro-level process through which a "structured employee training program" develops the individual competence and confidence (self-efficacy) that, when aggregated across the workforce, produces superior organizational "risk mitigation efficacy."

Chapter 3

Research Methodology

1. Introduction

It describes the methodological structure adopted for exploring the research problem and testing the hypotheses set in Chapter 1. The overarching objective is to provide an empirical study on the impact of employee education on enhancing the effectiveness in mitigating risk in the complex setting of the Saudi pharmaceutical supply chain. The chapter presents a succinct summary of the research design, identifying the population and sample that were chosen for the present study, the instruments used for data collection, the shortcomings encountered in the study, and the statistical methods adopted for data analysis. Every step was carefully chosen in order to ensure a systematic, valid, and reliable way of answering the research questions.

2. Research Design

A cross-sectional study design based on survey research methods was used, where data were collected from a representative population sample at a single point in time. The methodology is useful for obtaining information regarding the current status of training practice and knowledge of risk management in the industry and allowing for in-depth analysis of relationships between different variables.

The present study is consistent with a positive paradigm, assuming that social phenomena can be objectively examined through the use of measurable and observable data. As such, a quantitative research approach was adopted to enable the gathering of quantitative data and statistical analysis of priori hypotheses. This method is most suitable for defining and explaining the relationship between the independent variable (employee training/teaching practices) and dependent variable (the effectiveness of risk mitigation).

3. Population of the study

The study analyzes a broad demographic overview of those who are involved in the pharmaceutical supply chain industry in the Kingdom of Saudi Arabia, including employees, volunteers, and

administrators. The study includes professionals who hold vital positions in procurement, production, quality control and assurance, logistics and distribution, and regulatory affairs in pharmaceutical production sites, distribution companies, and third-party logistics companies.

4. Sample Characteristics

The study in question adopted a non-probabilistic sampling method of participant recruitment. Specifically, convenience sampling and snowball sampling methods were applied. The study began with the identification of a starting pool of available professionals across applicable trade sectors; subsequently, participants were invited to pass on information regarding the study, as well as the survey link, to their qualified peers within their professional networks. Such a research design selection was seen as the most effective and practical way of identifying a highly specialized and geographically diverse population for which there is no systematic and readily accessible sample frame.

5. Sample Size Determination

The sample utilized in this research comprises $N = 241$ valid and complete surveys. This sample is considered appropriate and sufficient for the planned statistical analyses. As indicated by a highly accepted rule of thumb for multiple regression analyses, at least 10 to 15 participants are required for every predictor variable to attain an acceptable level of statistical power. Since the initial regression model used in the present research involves four predictor variables, our sample of 241 far exceeds this requirement, thus minimizing the risk of Type II errors and establishing the reliability of the findings.

6. Data Collection Procedures

Data collection was completed using a rigorous and developed self-administered questionnaire. The following section will describe the development and instrumentation of such a tool.

6.1. The Research Instrument

The development of the questionnaire was guided through an extensive review of relevant literature, and a proposed theoretical orientation. Specifically, the questionnaire comprised seven sections (A-G) with substantive items to be rated using a 5-point Likert scaling of 1 = Strongly

Disagree to 5 = Strongly Agree. When constructing the questionnaire features of the questionnaire afforded strong validity for:

- Content Validity: this was achieved in part, to the extent to which items were framed from a strong theoretical base and adapted scales that had prior validation, e.g., LTSI and LCQ.
- Face Validity: this was achieved specifically through sound question construction, to capture what is relevant to the practitioners' experience in the Saudi pharmaceutical supply chain.

6.2. Data Collection Protocol

The questionnaire was developed and programmed into an online survey application which aided in distribution and ease of responding. A URL link to the survey was shared electronically via professional networking sites (e.g., LinkedIn) and also through emailing various professional contacts within the Saudi pharmaceutical sector, both were contacted electronically. Data collection lasted for six weeks in 2025. The survey included introductory statements indicating the purpose of the research, provided assurance of confidentiality and anonymity of all responses, and stated the participation was voluntary.

7. Study Determinants

The research parameters includes the following delimiters:

- Time delimiter: Data collected within a defined time period in the year 2025. Therefore, the findings are indicative of the industry during that time frame.
- Geographical delimiter: This study is geographically limited to Registered Pharmacist(s) practicing in the Kingdom of Saudi Arabia. The findings describe the context of the distinctive regulatory, cultural, and operational environment of its pharmaceutical supply chain and cannot be assumed to be directly generalized to other countries.
- Thematic delimiter: The research focuses specifically on the relationship between employee training programs and risk mitigation efficacy. While other factors influence risk management (e.g., technology, capital investment), they are outside the thematic scope of this investigation. The study is also limited to the pharmaceutical industry and does not extend to other sectors.

8. Method of Analysis

All quantitative data collected from the 241 questionnaires were coded, entered, and analyzed using the IBM Statistical Package for the Social Sciences (SPSS), Version 29.0.2.0.

Chapter 4

Practical Study

1. Data Analysis

The data analysis followed a structured, multi-stage process designed to address the research objectives and hypotheses.

1.1. Data Preparation and Reliability Analysis

First, the raw data was cleaned and screened for errors. Composite variables were then computed for each of the multi-item constructs by calculating the mean score of the corresponding items (e.g., Total_Risk_Score, Risk_Mitigation_Efficacy, overall_Training_Quality).

1.2. Descriptive Statistics

We calculated descriptive statistics to describe the sample and summarize the main variables. We used Frequencies and percentages to describe the demographic characteristics of the respondents and Means and standard deviations were calculated for all key composite variables to understand their central tendency and dispersion.

1.3. Inferential Statistics (Hypothesis Testing)

To test the research hypotheses, the following inferential statistical tests were performed:

- **Pearson Correlation (r):** This test was used to examine the strength and direction of the linear relationship between two continuous variables. It was employed to test H1 (the relationship between Overall_Training_Quality and Total_Risk_Score) and H3 (the relationship between Continuous_Learning_Culture and Total_Risk_Score).
- **Multiple Linear Regression:** This analysis was used to test H2 by assessing the ability of a set of predictor variables to explain the variance in an outcome variable. The model used Risk_Mitigation_Efficacy as the dependent variable, and six key qualities of the training strategy

(Training_Design, Supervisor_Support, Learning_Climate, Motivation_To_Transfer, Opportunity_to_Use, Learner_Readiness) as the independent (predictors) variables.

This is for the identification of the most significant determinants of risk control effectiveness.

The statistical significance of all tests was determined using a p-value threshold of $p < 0.05$.

2. Results

2.1. Introduction

This chapter provides the results from the statistical analysis of data obtained from 241 individuals working in the pharmaceutical supply chain in Saudi Arabia. The chapter begins with the demographic characteristics of respondents, detailed descriptive statistics for the variables of interest and culminates with the results from the inferential statistical tests used to evaluate the three hypotheses. All analyses were completed using IBM SPSS Statistics.

2.2. Demographic Profile of the Sample

The characteristics of the 241 participants were analyzed using frequency distributions. The demographic profile of the sample is detailed in Table 1.

Table 1: Demographic Profile of Respondents (N=241)

Characteristics of studied participants		No.	%
Age group	18-25 years	31	12.90%
	26-35 years	52	21.60%
	36-45 years	53	22.00%
	46-55 years	50	20.70%
	56 years and above	55	22.80%
gender	Female	117	48.50%
	Male	124	51.50%
Current position	Entry-level	132	54.80%
	Specialist/Technician	4	1.70%
	Supervisor/Team leader	4	1.70%

highest level of education	Manager	75	31.10%
	Director or above	26	10.80%
	High school or below	35	14.50%
	Diploma/Technical certificate	3	1.20%
	Bachelor's degree	109	45.20%
	Master's degree	71	29.50%
	Doctorate (Ph.D., MD, etc.)	23	9.50%
Total years of experience in pharmaceuticals industry	Less than 1 year	14	5.80%
	1–3 years	50	20.70%
	4–6 years	73	30.30%
	7–10 years	52	21.60%
	More than 10 years	52	21.60%
Department/functional area	Procurement	97	40.20%
	Production/Manufacturing	7	2.90%
	Quality Assurance/Control	9	3.70%
	Logistics/Distribution	10	4.10%
	Regulatory Affairs	74	30.70%
Company size	Fewer than 10	10	4.10%
	10-49	27	11.20%
	50-99	41	17.00%
	100-499	70	29.00%
	500 or more	93	38.60%

The sample is from a wide variety of industry. The age distribution is fairly even across all groups from 26 years and above. In terms of gender, the sample is roughly equal, with 51.5% the respondents identifying as male and 48.5% identifying as female respondents. The educational level of the sample was good with almost half (45.2%) holding a bachelor's degree and almost one-third (29.5%) holding a Master degree. One of the more notable characteristics was that more than half (54.8%) of the respondents identified as being in an entry-level position whereas the remaining 31.1% were at the Manager level. Other positions included senior buyer (12.2%) and director (1.2%). The most well-represented departments were Procurement (40.2%) and Regulatory Affairs (30.7%). The majority of participants were from medium-to-large companies.

2.3. Descriptive Statistics of Study Variables

Descriptive statistics, including means and standard deviation, were calculated for the main composite variables used in the hypothesis testing. These variables were derived by calculating the mean of all items from the respective sections of the questionnaire, as discussed in the methodology. Findings regarding the descriptive statistics can be viewed in Table 2.

Table 2: Descriptive Statistics of Composite Study Variables

	Mean	Std. Deviation
Total Risk Score	3.27	0.30
Risk Mitigation Efficacy	3.24	0.31
Overall Training Quality	3.24	0.22
Continuous Learning Culture	3.25	0.51

The mean scores for the four key constructs all cluster closely to the mid-point (3.24-3.27) of the 5-point Likert scale. This shows that the respondents had a generally neutral or moderately agreeable level of agreement for all of the overall major areas of the study. As reflected in the aggregate data analysis, there are no strong positive or negative trends of agreement in the data, and the deviation statistics show low variability, indicating a moderate level of consensus across the participants.

2.4. Hypothesis Testing

Inferential statistics were used to test the three research hypotheses. The significance level (alpha) for all tests was set at 0.05.

Hypothesis 1: Employee training reduces issues experienced in pharmaceutical industry supply chains.

This hypothesis predicted a negative correlation between the quality of training and the level of supply chain issues. A Pearson correlation analysis was conducted between Overall Training Quality and Total Risk Score.

Figure 6: Correlation between Training Quality and Risk Score



industry supply chains.

To test which aspects of a training strategy, predict risk control effectiveness, a multiple linear regression was performed. The analysis aimed to predict Risk Mitigation Efficacy from six aspects of training (Learner Readiness, Motivation to Transfer, Training Design, Supervisor Support, Opportunity to Use, and Learning Climate).

The overall model summary showed that the set of training variables was not a good predictor of risk mitigation efficacy. The model explained only 1.6% of the variance in the outcome ($R^2 = 0.016$), and the overall regression model was not statistically significant, $F(6, 234) = 0.643$, $p = 0.695$).

The contributions of the individual predictors are detailed in Table 3.

Table 3: Multiple Regression Analysis Predicting Risk Mitigation Efficacy

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.127	0.016	-0.009	0.31154

ANOVA (p-value) = 0.669

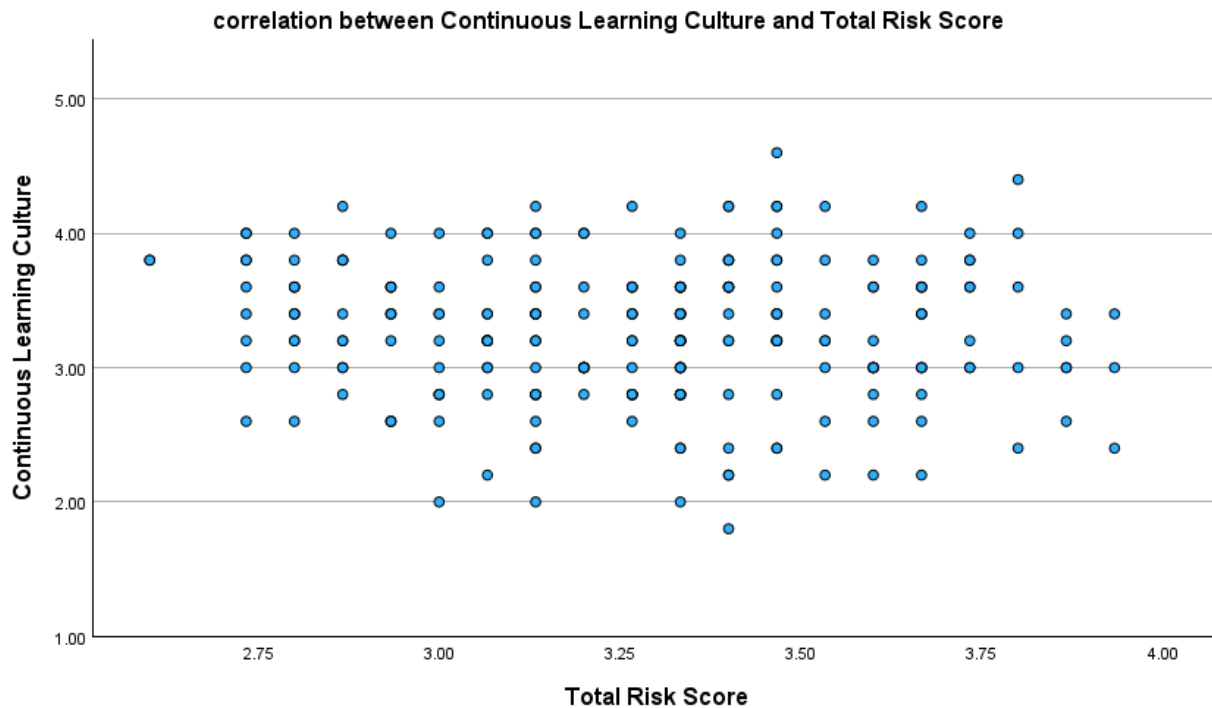
Dependent Variable = Risk Mitigation Efficacy	B	Beta	t-value	Sig. (Coefficient)
Learner Readiness	0.035	0.066	0.999	0.319
Motivation to Transfer	0.026	0.048	0.728	0.467
Training Design	0.046	0.087	1.341	0.181
Supervisor Support	0.021	0.039	0.589	0.556
Opportunity to Use	-0.017	-0.035	-0.530	0.597
Learning Climate	0.007	0.009	0.135	0.893
Constant	2.865		9.641	<0.001

As shown in Table 3, none of the individual predictor variables had a statistically significant effect on Risk Mitigation Efficacy (all p-values are far greater than 0.05). Given that neither the overall model nor any individual training dimension was a significant predictor, therefore we failed to reject null hypothesis 2.

Hypothesis 3: Continuous employee training reduces supply chain issues in the pharmaceutical industry.

This hypothesis predicted a negative correlation between an organization's learning culture and supply chain issues. A Pearson correlation analysis was conducted between Continuous Learning Culture and Total Risk Score.

Figure 7: Correlation between Learning Culture and Risk Score



The analysis showed a very weak negative correlation, r (coefficient) = -0.073, p = 0.258. Although the direction was hypothesized, the relationship is not statistically significant as the p -value (0.258) is well above the 0.05 threshold. Therefore, we failed to reject null hypothesis 3.

2.5. Results Summary

This chapter presented the results of the statistical analysis. The demographic data revealed a diverse and experienced sample, heavily represented by entry-level staff and those in procurement and regulatory affairs. The descriptive statistics showed a general neutrality in responses across all key variables. Crucially, the inferential analyses failed to provide statistical support for any of the three research hypotheses. No significant relationships were found between employee training (either its quality or its continuity) and the reduction of supply chain issues. Furthermore, no specific aspect of the training strategy was found to be a significant determinant of risk mitigation efficacy.

3. Discussion

3.1. Introduction

The principal aim of this study was to investigate and determine the extent to which structured employee training programs would improve risk mitigation processes in the Saudi Arabian pharmaceutical supply chain in an empirical research process. The study was grounded in a strong theoretical base, which consisted of Resource-Based View (RBV) contingent theory, and principles and characteristics associated with adult learning theory; all indicated that employee training should be deployed as a strategic asset in organizational risk management capabilities. In the end, the analyses returned unexpected results which contradicted theory and the original hypothesis. This chapter draws on previous chapters to provide meaning and integrates potential reasons to account for the unexpected results and outlines the implications for theory, practice, and future research.

3.2. Interpretation of the Unexpected Findings

The results of this study present a clear contradiction to assumptions that structured employee training programs directly enhance risk mitigation efficacy in supply chain operations. All three hypotheses were not supported by the empirical evidence, revealing a complex reality that challenges conventional wisdom about the relationship between training and risk management.

Hypothesis 1: The Absence of a Negative Relationship Between Training Quality and Risk Levels

The first hypothesis proposed a negative relationship between the overall quality of training and the amount of supply chain risks faced by pharmaceutical organizations. The results of the analysis indicate a very weak positive correlation ($r = 0.077$, $p = 0.231$) which not only did not achieve statistical significance but was also in the opposite direction of the theoretical prediction. This indicates that, contrary to what was theorized, higher quality training programs do not necessarily lead to less risk in the Saudi pharmaceutical supply chain context.

This finding disputes the basic tenets of the Resource-Based View, which states that developing human capital, through training, creates valuable, rare, and inimitable resources that will drive competitive advantage (Liu and Liu, 2022). The lack of this relationship could indicate that the

systemic challenges of the pharmaceutical supply chain in Saudi Arabia are not something that can be addressed, or mitigated, through quality training interventions alone. Recent global perspectives showing systemic challenges within the Saudi pharmaceutical industry, such as excessive reliance on imports (22.55% of medications are made locally), regulatory difficulties, and supply chain interruptions during the coronavirus pandemic (Alshehri et al., 2023) cannot be ignored by an individual training program, leading to a context whereby employees can be more competent but the overall supply chain risk in the Saudi pharmaceutical industry remains unchanged.

Hypothesis 2: The Ineffectiveness of Training Strategy Components

The second hypothesis addressed whether factors, unique aspects, of training strategy determine risk control effectiveness. Results from the multiple regression analysis found no significant predictors ($p < 0.05$) in the six training components (Training Design, Support from Supervisors, Learning Climate, Motivation to Transfer, Opportunity to Use, and Learner Readiness), for predicting risk mitigation efficacy. The overall regression model explained 1.6% of the variance in risk mitigation efficacy ($R^2 = 0.016$) and was non-significant ($F(6, 234) = 0.643, p = 0.695$).

The finding was particularly out of the blue, as there is good evidence in the literature supporting the value placed on these components of training, and previous researchers have suggested that supervisor support and learning climate are key determinants of training effectiveness (Prasad et al., 2019). The failure of these components to have anything to do with risk mitigation efficacy may indicate a more profound complexity in the paths from training to risk management behaviour than previously conceived, particularly in the Saudi context.

Furthermore, the lack of any significance, even relatively low significance, across training components may highlight the broader complexity of implementation as barriers specific to the Saudi pharmaceutical industry. Several barriers to successful training implementation in Saudi Arabia have been identified in the literature, including cultural resistance to change, access to resources, and the constantly evolving regulatory landscape requiring constant formation of their own knowledge (Kumar et al., 2025). Further, the pharmaceutical industry in Saudi Arabia is subject to important contextual factors related to regulatory compliance and complicated approval processes with multiple oversight from the Saudi Food and Drug Authority (SFDA) and the Ministry of Health (MoH) (Abozaid et al., 2025). These contextual factors may create conditions

in which risk management training programs are intricately designed but produce no improvement in risk management.

Hypothesis 3: The Absence of Relationship Between Continuous Learning Culture and Risk Reduction

The third hypothesis stated that organizations with a stronger culture of continuous learning would have fewer supply chain issues. Although the correlation was in the expected negative direction ($r = -0.073$), it was very weak and not statistically significant ($p = 0.258$), which would suggest that an organization having a learning-oriented organization culture does not necessarily lead to reduced supply chain risk in a Saudi Arabian pharmaceutical context.

This finding is interesting because an organization learning theory in learning discourse suggests that environments of continuous learning should lead to a greater ability for an organization to adapt to a changing environment and reduce risk (Wuttaphan, 2017). The finding could possibly mean that the challenges with the pharmaceutical supply chain in Saudi Arabia are more than an organization's learning capabilities can handle. This may include external factors relating to political or commodity related issues of disruption that are not wholly effective based on the individual control of organizations (Díaz-Curbelo et al., 2019).

3.3. Possible Explanations for the Unexpected Results

Contextual Factors Specific to the Saudi Pharmaceutical Industry

The surprising results could be explained by some situational elements that are specific to the Saudi Arabian pharmaceutical supply chain. The market has an unusual high level of complexity for prescription medicine, with many governing bodies and strict regulatory standards that may pose more difficult challenges than those addressed by typical instructional frameworks (Kumar et al., 2025). There is also a great reliance on imported products in the Saudi pharmaceutical market, with considerable exposure to external supply chain interruptions which cannot be alleviated solely through workforce training. (Tawfik et al., 2022).

Effective implementation of risk management practices has been directly associated with specific barriers in the Saudi Arabian pharmaceutical sector. These barriers include a lack of infrastructure capable of supporting new concepts and practices, problems sourcing data to back up the decision-

making processes, and an inadequate supply of personnel to educate decision makers (Hamad et al., 2023). These structural barriers may lead to a gap between the quality of training employees receive and the ability to practically apply risk mitigation strategies.

Measurement and Methodological Considerations

The unanticipated findings could result from problems in measurement together with methodological difficulties. The research utilized self-report instruments to assess both training quality and risk mitigation efficacy which possibly created response bias or social desirability bias. Because the pharmaceutical industry operates under strict regulations respondents might have provided answers which they thought would be socially desirable instead of truthfully describing their real circumstances.

The single time point survey approach of the study possibly restricted the researchers from observing how training effectiveness evolved over time. The effects of training tend to appear during extended timeframes which cannot be observed during a single survey period. Research conducted in different environments demonstrates that organizational outcomes from training require several months to years before their complete effects become evident (Aguinis and Kraiger, 2009).

The Complexity of Risk Management in Pharmaceutical Supply Chains

The pharmaceutical supply chain contains distinct complexities which create particular problems for training programs to prove measurable results. The pharmaceutical supply chain operates under rigorous regulatory standards while requiring advanced technical expertise to ensure product quality and patient safety (Mehralian et al., 2015). Traditional training methods fail to adequately address the complex pharmaceutical supply chain risks because of their complicated requirements.

The current research demonstrates supply chain risk management needs both individual competencies and systemic modifications that involve supplier diversification along with technological integration and improved collaboration mechanisms (Díaz-Curbelo et al., 2019). The lack of systemic changes may be the reason why individual training programs do not succeed in producing measurable risk reduction.

Cultural and Organizational Barriers

The business environment in Saudi Arabia contains cultural and organizational factors that could reduce the effectiveness of training programs. Studies show that cultural opposition to change serves as a major obstacle for new practice implementation in Saudi businesses (Kumar et al., 2025). The pharmaceutical industry demonstrates a higher level of resistance to change because its established operational procedures and regulatory standards push organizations to maintain their current practices.

The hierarchical structure of many Saudi organizations blocks the adoption of risk management practices that depend on cross-functional collaboration and front-line employee empowerment. Research demonstrates that risk management success depends on open communication networks and joint responsibility-sharing practices which prove difficult to establish in organizations with strict hierarchical structures (Handfield & McCormack, 2008).

3.4. Implications for Theory

Challenges to the Resource-Based View

The results of this research present a significant challenge to the Resource-Based View (RBV) of the firm that suggest human capital development, realized through training, will create sustainable competitive advantages. The absence of a relationship between training quality and risk mitigation effectiveness indicates that the RBV may not be able to fully account for the nuances involved in risk management in a highly regulated industry, such as pharmaceuticals. This challenge to RBV aligns with the recent research that suggests the RBV is not uniformly applicable across different organizational contexts and practices (Senna et al., 2024). From the findings, it can be suggested that human capital as a strategic resource may only have value in terms of training and the employee's competency, when the necessary supporting organizational/ environmental factors are concurrently available for the employee to leverage their skills and capabilities.

The Need for Contextualized Training Theory

The unexpected results point to the necessity of more contextualized theories of training effectiveness which account for industry and contextual factors. The inability of traditional training models to predict risk management outcomes in the Saudi pharmaceutical context suggests that training theory must be contextualized due to the unique characteristics of industries and contexts of done. Such a finding is aligned with Contingency Theory, whereby the effectiveness of

management practice is determined by the fit between the practice and contextual organization (Musa, 2012). With the results of this study suggesting that training programs may need to be designed specifically for the challenges of the Saudi pharmaceutical industry, rather than generic training approaches.

Implications for Adult Learning Theory

Research findings demonstrate that adult learning theory recommends training to focus on problems which relate to learners' workplace experiences. The lack of correlation between training quality and risk outcomes demonstrates that conventional adult learning approaches might not adequately address the complex systemic problems encountered by the Saudi pharmaceutical industry. The findings call for advanced learning methods which integrate the organizational environment and broader learning context. Learning approaches which integrate systems thinking along with cross-organizational collaboration and organizational change management should be considered for implementation.

3.5. Implications for Practice

Rethinking Training Investment Strategies

Research shows that pharmaceutical organizations in Saudi Arabia need to reevaluate their training investment strategy. Organizations should move past individual employee training programs because they require comprehensive strategies to eliminate barriers preventing effective risk management implementation.

Effective risk management requires organizations to invest in organizational restructuring alongside process improvement and technological integration because these elements establish the necessary conditions for success. Studies reveal that training effectiveness achieves significant improvement through proper organizational structures and processes as demonstrated by Kumar et al. (2025) .

The Need for Systemic Interventions

Again, the surprising results suggest that effective risk management in the Saudi pharmaceutical supply chain may need systemic interventions that go beyond individual training programs such as regulatory reform, or industry collaborative initiatives, or provision for investments in supply

chain infrastructure that reduce the root causes of risk. These systemic types of action are congruent with emerging research into supply chain resilience has also called for collaborative risk management approaches amongst multiple stakeholders throughout supply chain networks (Díaz-Curbelo et al., 2019). The findings from this study suggest that organizations can only do so much to improve risk management through internal training programs.

Implications for Human Resource Management

It has also contributed to human resource management practice in Saudi pharmaceutical organizations. The results indicate no relationship between training quality and the risk outcomes, and this suggests traditional human resource development approaches may not be effective to tackle the broader more complex issues associated with the industry.

This means it is necessary to consider a more holistic approach to human resource management that aligns any training program with overall organizational development. This could encompass employee career development that builds long-lasting capabilities, specific performance management systems (PMS) that reward risk management behaviors and organizational culture change initiatives aimed at socializing collaborative risk management approaches.

3.6. Implications for Policy

The Need for Regulatory Support

The unexpected results indicate that optimal risk management in the Saudi pharmaceutical supply chain may require the implementation of regulatory frameworks that enable organizations to employ optimal risk management practices. In the current regulatory environment, marked by complex approval processes and oversight from a diversity of bodies, effective risk management may be challenged by regulatory processes that cannot be overcome through training initiatives alone.

Regulatory reform needs to become more straightforward by reducing bureaucratic complexity while providing organizations with motivation to implement risk management strategies. The implementation of simplified approval systems together with unified regulatory requirements along with performance-based regulatory incentives would drive organizations to manage risks effectively.

Investment in Industry Infrastructure

Research indicates government funding of pharmaceutical industry infrastructure must take place to build supportive environments for risk management operations. The implementation of supply chain infrastructure alongside research and development capabilities and technology platforms will create improved risk monitoring and management systems. These investments match Saudi Arabian Vision 2030 targets which focus on creating a diversified economic structure that remains resilient. The research indicates that multiple investments need to be coordinated between human development programs and infrastructure support systems to achieve these objectives.

The Role of Professional Development

The unexpected results highlight the potential need for more systematic approaches to professional development in the Saudi pharmaceutical industry. A systematic approach to professional development is required for the Saudi pharmaceutical industry beyond current organizational training practices. The pharmaceutical industry requires professional development programs which tackle shared obstacles and develop common competencies that extend beyond individual organizational training programs.

The proposed initiatives should implement professional certification programs together with industry-wide training standards and collaborative learning networks to support knowledge exchange between organizations. Research demonstrates that collaborative approaches prove especially effective when organizations need to tackle complex systemic challenges which individual organizations cannot solve on their own (Dandabo & Kivelö, 2021).

3.7. Limitations and Future Research Directions

Study Limitations

There are a number of limitations that should be acknowledged in the interpretation of the results of this study. First, the design used was cross-sectional and therefore cannot assume causality with regard to the relationship between training and risk management. Moving forward, it would be ideal to use longitudinal designs to track the timeline of training and provide for a more clearer isolated assessment of the overall effect that employee training had on the minimization of risk and context raid.

Second, the results of this study were based on self-report measures of training quality and effectiveness of risk management, which could limit the influence these findings might have because of potential response biases. Future research might include some objective measure of the effectiveness of training and risk management functionality that could substantiate the findings of this study.

Third, we focused on the Saudi pharmaceutical industry, which limits the external validity of the findings to other industries or even other geographic contexts. Future research might examine the training and risk management relationship in other industries and cultural contexts to determine the boundary conditions of this relationship.

Future Research Directions

The unanticipated findings from this study point to numerous critical research directions for the future. The Saudi pharmacy setting requires additional qualitative research to study the processes which determine whether training affects risk management results. The study could apply case study or ethnographic methods to understand barriers and facilitators that enable successful risk management.

Future research should create a systematic intervention which links training with other organizational interventions. The research approach should combine multiple studies that bring together training with process improvement alongside technology implementation and organizational change.

Future research should evaluate the performance of different training methods across various industries as well as cultural settings. Such research would reveal the circumstances where training proves beneficial for enhancing risk management results.

Future research should track the effects of training on risk management performance during extended periods. Longitudinal studies should track risk management capabilities across time while investigating factors that either strengthen or diminish training effectiveness

.4. Conclusion

The aim of this study was to provide an empirical assessment of the impact of formal employee training programs on risk management effectiveness in the Saudi Arabian pharmaceutical supply

chain. The results provide a substantial challenge to existing primarily theoretical expectations of the relationship between training and risk management, given that not a single hypothesis was statistically supported. These unexpected results indicate that the relationship between training and risk management may be even more complicated than previously theorized, when applied to the Saudi pharmaceutical context.

The findings made have substantial implications for theory, practice, and policy. In terms of theory, the framework of Resource-Based View widely presumed to be universally applicable, must be approached with increased contextualization. Accordingly, from a practical perspective, organizations will need to pursue a more holistic approach to risk management to overcome systemic barriers rather than viewing the employee training program as a single component. In terms of policy, the results support the establishment of a regulatory context and investment in infrastructure to allow conditions conducive to risk management effectiveness.

Although the outcome of this inquiry is unexpected, it offers meaningful vantage points on the complexities of achieving effective risk management in complicated and regulated fields. Perhaps the outcome reveals a notion that effective risk management in the Saudi pharmaceutical supply chain will require concerted effort on multiple levels: individual training programs, organizational development action, collaboration across the industry, and supportive regulatory structures.

As part of a growing body of literature related to supply chain risk management, this study offers empirical evidence of this construct, in a different but equally important context. The outcome of this study causes researchers and practitioners to consider the processes by which training programs may have a realized impact on risk management outcomes and to think about ways to engage more effective and sophisticated responses to the multifaceted challenges associated with modern supply chains.

Future studies should continue exploring these connections through similarly descriptive qualitative studies, longitudinal designs, and comparative approaches across various industries and settings. Only through a sustained inquiry into these questions will we be able to do more than continue to scratch the surface of a significant body of knowledge regarding conditions which contribute to effective risk management across complex organizational landscapes.

These findings, though unexpected, should not be considered a negative of the research but rather a contribution to scholarly knowledge about the complex relationships between organizational performance and human capital development. Science is developed through an accumulation of evidence, which includes finding results that do not support previous assumptions and theories. The findings of this current study provide a sound basis for future research and practice in the significant area of supply chain risk management.

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Appendixes:

1. Questionnaire of the study

Section A: Demographics (8 items)

Please answer the following questions by selecting or filling in the most appropriate response.

1. Age:

- ☐ 18-25 years
- ☐ 26-35 years
- ☐ 36-45 years
- ☐ 46-55 years
- ☐ 56 years and above

2. Gender:

- ☐ a. Male
- ☐ b. Female

3. Highest level of education completed:

- ☐ a. High school or below
- ☐ b. Diploma/Technical certificate
- ☐ c. Bachelor's degree
- ☐ d. Master's degree
- ☐ e. Doctorate (Ph.D., MD, etc.)

4. Total years of professional experience in the pharmaceutical industry:

- ☐ a. Less than 1 year
- ☐ b. 1–3 years
- ☐ c. 4–6 years

- ☐ d. 7–10 years
- ☐ e. More than 10 years

5. Current position level:

- ☐ a. Entry-level
- ☐ b. Specialist/Technician
- ☐ c. Supervisor/Team leader
- ☐ d. Manager
- ☐ e. Director or above

6. Department/functional area (select one):

- ☐ a. Procurement
- ☐ b. Production/Manufacturing
- ☐ c. Quality Assurance/Control
- ☐ d. Logistics/Distribution
- ☐ e. Regulatory Affairs
- ☐ f. Other: _____

7. Company size (number of employees):

- ☐ a. Fewer than 10
- ☐ b. 10–49
- ☐ c. 50–99
- ☐ d. 100–499
- ☐ e. 500 or more

Section B: Supply Chain Risk Assessment (15 items)

Adapted from Punniyamoorthy et al. (2013) Supply Chain Risk Scale

Instructions: For each statement below, please indicate your level of agreement regarding supply chain risks in your organization using the 5-point scale.

Supplier Side Risks (5 items)

1. Our suppliers frequently experience quality problems with their products
2. We face unexpected defaults from our key suppliers
3. Our company is overly dependent on single suppliers for critical materials
4. Suppliers often deliver materials late, causing disruptions
5. Our suppliers sometimes fail to meet regulatory compliance requirements

Manufacturing/Process Side Risks (5 items)

6. Our production processes experience frequent disruptions
7. We face significant variation in our manufacturing processes
8. Our production capacity is often insufficient to meet demand
9. Equipment breakdowns frequently affect our operations
10. Maintaining Good Manufacturing Practice (GMP) compliance is challenging

Logistics and Distribution Risks (5 items)

11. Cold chain integrity is difficult to maintain throughout distribution
12. Transportation issues frequently affect our product delivery
13. Our warehouse capacity is often insufficient for storage needs
14. Inventory management problems lead to stockouts or overstocking
15. Product traceability throughout the supply chain is challenging

Section C: Training Transfer Assessment (20 items)

Adapted from Learning Transfer System Inventory (LTSI)

Instructions: The following statements relate to your most recent training experience and your workplace. Please indicate your level of agreement with each statement.

Learner Readiness (4 items)

- 16. Before training, I had a good understanding of how it would fit my job-related development
- 17. I was prepared to learn from the training program
- 18. I understood the objectives of the training before attending
- 19. I felt ready to participate actively in the training

Motivation to Transfer (4 items)

- 20. I get excited when I think about trying to use my new learning on my job
- 21. I am motivated to use the skills I learned in training
- 22. I believe the training will help me do my job better
- 23. I am committed to applying what I learned in training

Training Design and Content (4 items)

- 24. The activities and exercises helped me know how to apply my learning on the job
- 25. What was taught in training closely matches my job requirements
- 26. The training content was relevant to my work situation
- 27. The training provided practical examples I can use at work

Supervisor Support (4 items)

- 28. My supervisor supports my use of skills learned in training
- 29. My supervisor sets goals that encourage me to apply my training
- 30. My supervisor provides feedback when I use new skills
- 31. My supervisor helps me overcome obstacles to using new skills

Opportunity to Use Training (4 items)

- 32. I have opportunities to use the skills I learned in training
- 33. The resources I need to use what I learned are available to me

- 34. My workload allows me time to try new things I learned
- 35. I can practice the skills I learned without negative consequences

Section D: Learning Climate (10 items)

Adapted from Learning Climate Questionnaire (LCQ)

Instructions: The following statements relate to your experience with training instructors/facilitators. Please indicate your level of agreement.

- 36. I feel that my instructor provides me choices and options
- 37. I feel understood by my instructor
- 38. My instructor conveyed confidence in my ability to do well
- 39. My instructor encouraged me to ask questions
- 40. I feel a lot of trust in my instructor
- 41. My instructor listens to how I would like to do things
- 42. I feel that my instructor cares about me as a person
- 43. My instructor tries to understand how I see things before suggesting new approaches
- 44. The instructor made sure I understood the goals and what I needed to do
- 45. I feel able to share my concerns with my instructor

Section E: Risk Mitigation Efficacy (15 items)

New items measuring the dependent variable

Instructions: Please indicate your level of agreement with the following statements about your ability to manage supply chain risks.

Risk Identification Capability (3 items)

- 46. I can quickly identify potential supply chain risks in my work area
- 47. I am skilled at recognizing early warning signs of supply chain problems
- 48. I can distinguish between different types of supply chain risks

Risk Assessment and Analysis (3 items)

- 49. I can accurately assess the likelihood of supply chain risks occurring
- 50. I am capable of evaluating the potential impact of supply chain risks
- 51. I can prioritize risks based on their severity and probability

Risk Response and Mitigation (3 items)

- 52. I know how to develop effective responses to supply chain risks
- 53. I can implement appropriate risk mitigation strategies
- 54. I am skilled at selecting the best risk management approach for different situations

Crisis Management and Recovery (3 items)

- 55. I can effectively manage supply chain crises when they occur
- 56. I know how to coordinate recovery efforts after a supply chain disruption
- 57. I can make quick decisions during supply chain emergencies

Communication and Collaboration (3 items)

- 58. I can effectively communicate risk information to colleagues and management
- 59. I collaborate well with others to address supply chain risks
- 60. I can coordinate with external partners to manage supply chain risks

Section F: Saudi Context Factors (10 items)**Adapted from Saudi Green HRM studies and Vision 2030 objectives**

Instructions: Please indicate your level of agreement with the following statements about your organization's context.

Organizational Support for Training (5 items)

- 61. My organization aligns training programs with Saudi Vision 2030 objectives
- 62. Adequate resources are allocated for employee training and development

- 63. Training programs comply with SFDA (Saudi Food and Drug Authority) requirements
- 64. Management actively supports continuous learning and development
- 65. Training is considered essential for career advancement in my organization

Cultural and Environmental Factors (5 items)

- 66. Training programs are adapted to fit Saudi cultural values and practices
- 67. My organization addresses Saudi-specific pharmaceutical supply chain challenges
- 68. Training considers the unique regulatory environment in Saudi Arabia
- 69. Local market conditions are incorporated into training content
- 70. Training programs respect Islamic principles and Saudi work culture

Section G: Training Outcomes and Performance (8 items)

Measuring actual training transfer and performance improvement

Instructions: Please indicate your level of agreement regarding the outcomes of your training experience.

Individual Performance (4 items)

- 71. My job performance has improved since attending training
- 72. I am more efficient in my work since completing training
- 73. Training has enhanced my problem-solving abilities
- 74. I make fewer errors in my work since attending training

Organizational Performance (4 items)

- 75. Training has contributed to better supply chain performance in my organization
- 76. Our team's effectiveness has improved through training
- 77. Training has helped reduce supply chain disruptions in my department
- 78. Overall organizational performance has benefited from employee training programs

2. Arabic Abstract:

المخلص

الهدف: تواجه سلسلة الإمداد الصيدلانية في المملكة العربية السعودية العديد من التحديات الجوهرية، بما في ذلك الاعتماد على الاستيراد والصعوبات التنظيمية. ورغم أن التحكم في المخاطر من خلال تدريب الموظفين يُعتبر خياراً شائعاً ومجدياً، إلا أن الأدلة التي تدعم هذا الافتراض محدودة. هدفت هذه الدراسة إلى استخدام أساليب تجريبية لتقييم مدى فعالية برامج وعمليات تدريب الموظفين المنظمة في تعزيز جهود تخفيف المخاطر في هذا القطاع الحيوي.

المنهجية: تم استخدام تصميم دراسة مسحية كمية ومقطعية. وُزِع استبيان شامل متعدد الأقسام على 241 مشاركاً يشغلون أدواراً ووظائف متنوعة في سلسلة الإمداد الصيدلانية بالمملكة. اعتمدت التحليلات الإحصائية بشكل أساسي على تحليل ارتباط بيرسون وتحليل الانحدار الخطي المتعدد، حيث تم فحص العلاقات بين جودة التدريب، وثقافة التعلم، ومكونات استراتيجية التدريب، وارتباطها بنتائج تخفيف المخاطر.

النتائج: بشكل غير متوقع، أظهرت النتائج عدم توافقها مع الفرضيات الرئيسية الثلاث، حيث لم يكن أي من اختبارات الفرضيات ذا دلالة إحصائية. كانت نتائج تحليل الانحدار الخطي المتعدد غير دالة إحصائياً أيضاً عند مقارنة تخفيف المخاطر بجودة تدريب الموظفين ($p=0.231$) ووجود ثقافة التعلم المستمر ($p=0.258$) علاوة على ذلك، لم تكن أي من مكونات استراتيجية التدريب (مثل التصميم، ودعم المشرف، وفرصة التطبيق) منبئات ذات دلالة إحصائية لفعالية تخفيف المخاطر في سلسلة الإمداد الصيدلانية. ($F = 0.643, p=0.695$)

الخلاصة: تشير الأدلة في هذه الدراسة إلى أن تدريب الموظفين، كتدخل منعزل، قد يكون غير كافٍ للتعامل مع القضايا النظامية والهيكلية والسياساتية المعقدة والمتجذرة في سلسلة الإمداد الصيدلانية السعودية، مما يؤثر تساؤلات حول التطبيق الشامل لنظرية "المنظور القائم على الموارد (Resource-Based View)". قد تتطلب الإدارة الفعالة للمخاطر نهجاً أكثر شمولية يشمل تدريب الموظفين، ولكنه يتطلب أيضاً تغييراً تنظيمياً نظامياً، وتحسين العمليات، وتطوير أطر سياسات داعمة.