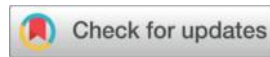


A Systematic Review of Adverse Influencing Factors in the Pharmaceutical Logistics Process



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Abstract

Introduction: Pharmaceutical logistics is a complicated process that includes the storage, distribution, and transportation of pharmaceutical items, such as prescription medications, vaccinations, and medical equipment. Medicine is vital to society's health. It is an essential component of the global healthcare sector since it guarantees that patients will get medical supplies and life-saving medications in a timely and safe manner.

Objective: The purpose of this research is to give a complete overview of the factors influencing the pharmaceutical logistics process.

Method: Following PRISMA principles, this review examines pharmaceutical supply chain management. This research is conducted in several databases from 2018 to 2022, including Web of Science, PubMed, Springer, Elsevier, and Scopus. This search was conducted using pharmaceutical logistics-related keywords.

Result: The results indicate the affecting factors identified into various categories such as observation and management, storage and warehousing, distribution, physical and financial resources, human resources, and risk management.

Conclusion: It concludes with suggestion for improving pharmaceutical logistics through increased risk management techniques, technology integration, and procedures, with the ultimate goal of guaranteeing the dependability and security of pharmaceutical supply chains.

Keywords: *Pharmaceutical, Logistics Process, Affecting Factors, Supply Chain, Systematic Review, PRISMA.*

1. Introduction

Timely and safe delivery of medicines from manufacturers to patients and health care providers is ensured through pharmacy management, a key link in health care

Comprehensive analysis of adverse reactions affecting medicines management requires identifying, analyzing and integrating key information deCampos et al. [1]. These barriers include factors such as shipping, storage, regulatory compliance, and logistics for design problems Franco [2]. Because pharmaceutical products are highly sensitive to environmental factors such as moisture, heat and light, proper handling, storage and transportation are essential to ensure that pharmaceuticals will apply and any safeguards deviated from approved guidelines may affect drug quality and may harm patients in addition to future economic losses Suhandi and Chen[3]. In the pharmaceutical industry, it is important to meet several national and international requirements on, which is also heavily regulated. Compliance with these standards can result in recalls, delays, and financial penalties, affecting the entire supply chain Hansen et al. [4]. An important part of pharmaceutical manufacturing is a complex global supply chain, which often crosses multiple international borders in purchasing initial supply chains, pharmaceutical ingredients (APIs), and finished products Silva and Fegadolli[5]. Pharmaceutical management must manage suppliers and customers to maintain quality and ensure supply, storage and warehousing, and other packaging safely for the sustainability of safe travel Although regulatory compliance is critical to maintaining global standards, proper distribution is essential to meet the demand. Returns and returns are handled through reverse logistics, and risk management is necessary to minimize disruption. Excellent customer service and support ensure stakeholder satisfaction, while technology integration improves follow-up and efficiency. Figure 1 illustrates the adapting to a rapidly changing environment requires stakeholders to collaborate and embrace challenges and new ideas.

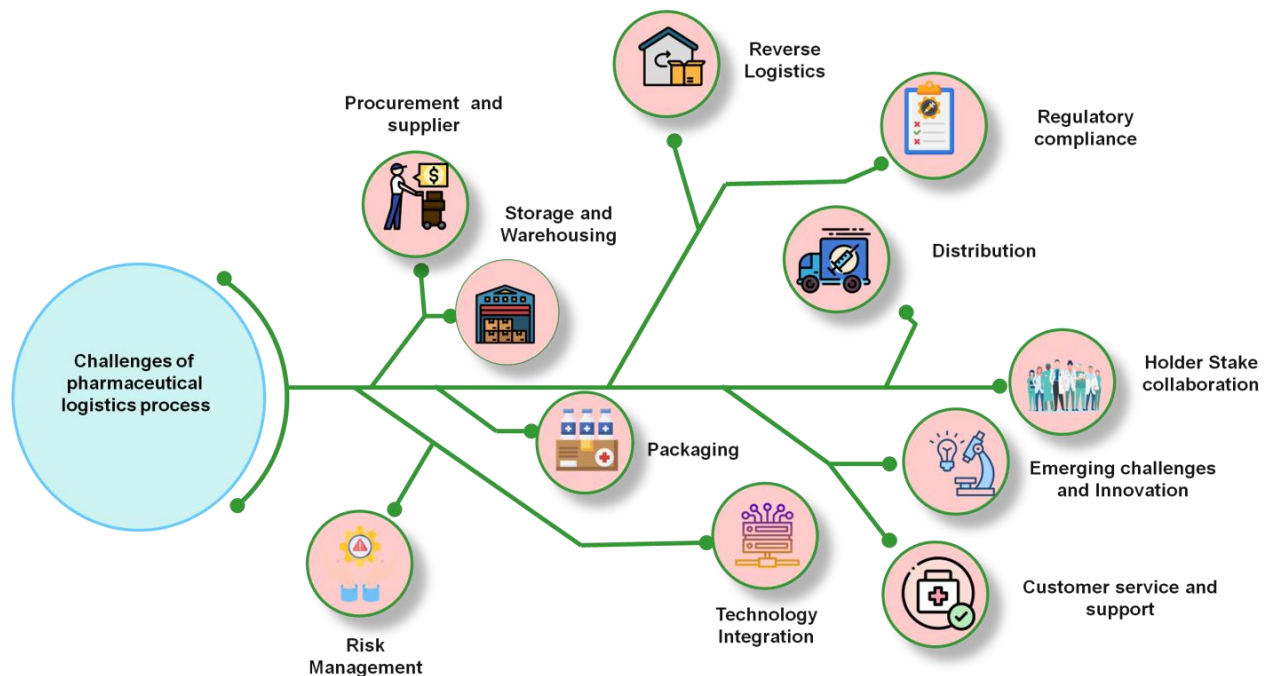


Figure 1: Challenges of pharmaceutical logistics process

This challenge can lead to delays, theft, counterfeiting, and contamination, all of which can compromise patient safety. Logistics companies also face challenges related to insufficient resources in some industries, especially in developing countries, where inadequate roads, lack of cooling, and reliable vehicles are prohibited can interfere with timely and safe delivery of medicines Lee and Lee[6]. Furthermore, the growing demand for biopharmaceuticals and customized pharmaceuticals requiring special handling and shipping poses new challenges for shippers. Such pharmaceuticals this often requires harsh conditions and short delivery times, making conventional shipping methods inappropriate Goodarzian et al. [7]. The emergence of technology advances included blockchain, the Internet of Things (IoT), and artificial intelligence (AI) offers prospects into improve traceability, transparency, with efficiency throughout the pharmaceutical supply chain. However, adoption of that equipment suffers from problems such as expensive installation costs, data security concerns and the need for industry-wide standards Sazvar et al. [8]. Ultimately, a systematic review of the negative effects of drug trafficking aims to inform stakeholders—manufacturers, shipping companies, law

enforcement, and medical professionals – get a better understanding of the key barriers to effective and safe drug delivery Seale et al. [9]. Companies can identify and address these problems and work to develop reliable, efficient, patient-centered logistics systems, ensuring that medicines reach individuals in good condition regardless of operational or geographic barriers. To address the difficulties confronting the pharmaceutical industry, the study also highlights every importance about stakeholder engagement and continued investment in infrastructure, technology and regulation will be in the works Palit and Bhogal [10]. This study aims to investigate in detail the major factors influencing pharmaceutical logistics procedures. It looks for areas where it may be improved to guarantee the efficient, safe, and reliable distribution of pharmaceutical products.

System in Overview

The remaining part of this paper as divided as 4 sections such as the PRISMA is explained in Section 2. In section 3 discussed the result, and finally conclusion is covered by section 4.

2. Methodology

The research model utilized the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) method to locate with choose significant information in a practical and transparent manner. Regarding searching multiple databases using well-defined criteria, including specific inclusion and exclusion criteria, to identify studies relevant to the objectives of the study, this approach is enabled choosing the learning objectives properly is effective.

2.1 PRISMA diagram

The PRISMA is a guideline used to enhance transparency and reporting quality in systematic reviews. In this study, it ensures a structured approach by clearly defining the search strategy, selection criteria, and data extraction process from databases like web of science, PubMed, and others. It helps identify and assess key factors affecting

pharmaceutical logistics, ensuring comprehensive and unbiased analysis. Figure 2 shows the processing of prisma.

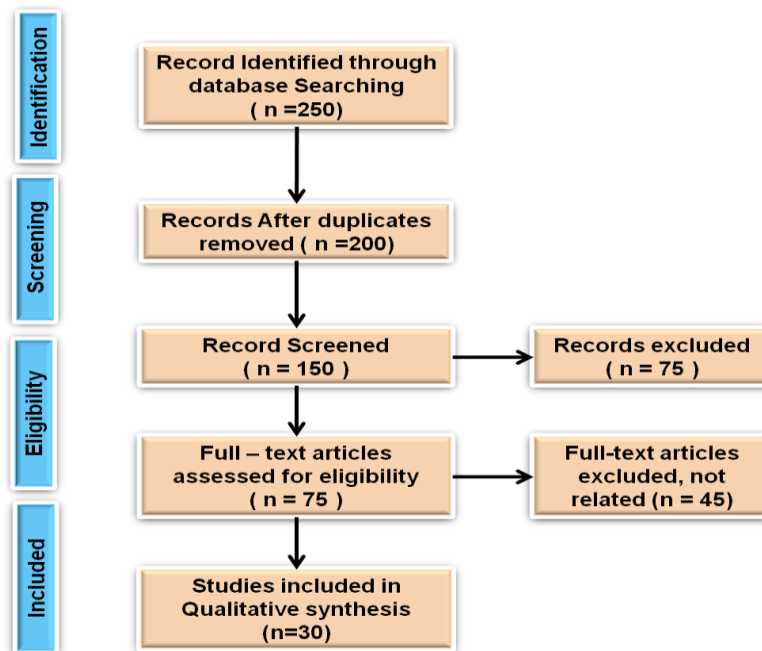


Figure 2: PRISMA Flow diagram

- ★ **Databases:** The study synthesizes findings from recent research (2018-2022) across databases like web of science, PubMed, Springer, Elsevier, and Scopus to offer comprehensive analysis. This approach ensures a comprehensive analysis of current knowledge, trends, and challenges in the field offering a well-rounded understanding of the factors influencing pharmaceutical supply chains.
- ★ **Searching criteria:** The keywords relevant to the topic, such as Pharmaceutical logistics, and supply chain management. Drug distribution, Logistics challenges, cold chain management, pharmaceutical supply chain, drug storage, Transportation logistics, risk management pharma, healthcare supply chain, logistics disruptions. These keywords help in finding relevant research articles and literature that address the various aspects of pharmaceutical logistics and associated challenges.

★ Study Inclusion and Exclusion criteria

- ♣ **Inclusion criteria:** To provide the requirements for selecting papers related to the research topic. In this section, after screening 200 documents, 150 were identified as potentially relevant for additional investigation. This step often entails selecting studies that meet certain criteria, such as publication date, relevance to the research issue, study type, and population demographics. Additionally, the content must be relevant to the subject of the research, such as addressing significant topics. The studies may also need to incorporate a specific set of treatments or results that are directly related to the investigation's direction. For instance, research findings that examine psychological over a specific period could be chosen. From the 150 records checked, 100 full-text publications were evaluated for qualification, assuring that merely the studies most closely associated with the investigation's objective advanced to the subsequent synthesis stage.
- ♣ **Exclusion criteria:** Exclusion criteria are used for removing research that does not fulfill the essential standards for inclusion. In this instance, 75 records were removed after the initial screening, with 45 full-text articles irrelevant to the topic at a subsequent stage. Exclusion criteria is include studies with inadequate data, publications released in languages that those conducting the studies are unable to comprehend, or papers that are outside the area of the research, such as those focus on different statistics, activities, or results. Furthermore, studies with significant systematic shortcomings or bias are excluded, and articles that did not directly address the research question or lacked sufficient data to contribute to the final synthesizing. This process ensured that only 30 studies were included in the final synthesis, representing the most relevant and robust evidence for the research.

3. Results and discussion

In this part, we thoroughly detailed observations and management, storage and warehousing, distribution, physical and financial resources, human resources, and risk management.

3.1 Observation and management

Patel et al. [11] looked at the care, prospective observational research was carried out in India, observation, and epidemiology of mucormycosis patients. Analyses of the 465 patients' microbiology, predisposing variables, treatment, and 90-day mortality were conducted. According to the findings, diabetes was the primary risk factor for all kinds of mucormycosis. In 62.2% of cases, participants underwent surgery, and in 81.9% of cases, amphotericin B was the main medication. A higher rate of survival was linked to the combination of medicinal and surgical therapy. The study found significant gaps in the therapy of mucormycosis, and additional investigation is necessary into the rarer Mucorales. The findings underscored the desire for more research to effectively manage the condition. Figure 3 shows the observation and management.

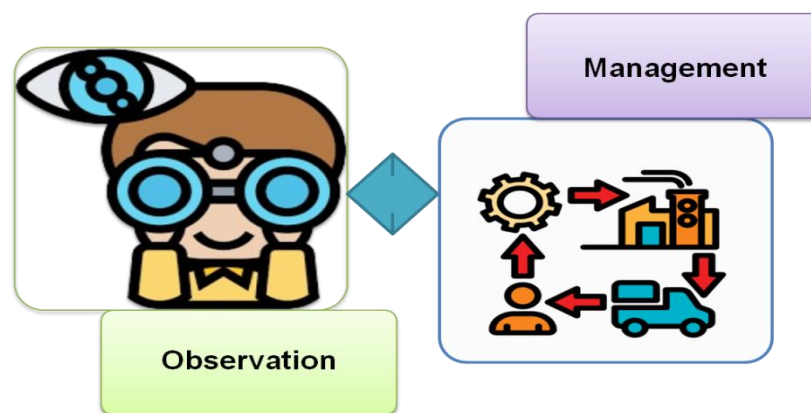


Figure 3: Framework of observation and management

COVID-19, and SARS-CoV-2 infection caused a global public health disaster that caused severe lung damage and cardiovascular disease Wu et al. [12]. Patients with already-

presented cardiovascular illnesses were more likely to experience increased morbidity and mortality. Antiviral drugs activate angiotensin converting enzyme 2 (ACE2) in the nasopharynx, causing cytokine storm, hypoxia, stress, and cardiotoxicity were among the mechanisms that contribute to COVID-19-associated cardiovascular injury, observation, and management. COVID-19 patients receiving COVID-19 therapy and those with coexisting cardiovascular diseases, deserve particular attention. Specialized cardiovascular care was required for the prevention and management of this pandemic.

Kefale and Shebo[13] analyzed the availability of vital medications (EMs) at health centers in Adam the city. A cross-sectional survey of six Haryana civil services(HCs) was done using self-administered surveys and observing checklists. The study assessed the availability of eleven tracer medicines both throughout the previous year and at the time of the evaluation. The Inventory Management Assessment Tool (IMAT) indicators and SPSS version 21 were used to analyze the statistics. The results showed that purchase decisions in five HCs were made following a necessary medicine list. The Ethiopian Pharmacological Fund and Supply Agency (PFSA) and private sources were the sources of personnel for four HCs, as shown in Table 1.

Table 1: Observation and management

Author	Observation and management	Description
Patel et al. [11]	Mucormycosis in India	Prospective observational study analyzing 465 mucormycosis patients' microbiology, predisposing variables, treatment, and 90 day mortality.
Wu et al. [12]	COVID-19 cardiovascular impact	Analysis of the cardiovascular effects of COVID-19, noting increased morbidity and mortality in patients with preexisting cardiovascular conditions.

Kefale and Shebo [13]	Medication availability in health centers	Cross-sectional survey evaluating the availability of eleven essential medications in health centers. The study that purchase decisions were based on a necessary medicine list and identifying sources of medication.
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3.2 Storage and warehousing

Erdoganand Ayyildiz [14] suggested pharmaceutical warehouses were critical for delivering medicines, particularly during a pandemic. Choosing the optimum site for a pharmaceutical warehouse requires careful consideration. The study aimed to determine the ideal site for a crucial medication distribution city in Turkey. In a spherical fuzzy environment, two powerful multi-criteria decision-making (MCDM) techniques were combined, the Evaluation Based on distance from average solution (EDAS) and analytic hierarchy process (AHP). For first time, every fuzzy integrated methodology was used to the challenge of selecting a location for pharmaceutical warehouses. The findings were discussed using predetermined criteria, and a robustness study was performed to assess the validity, sensitivity, and efficacy of the suggested methodology.

Qashlim and Basri [15] concentrated on administering the pharmaceutical warehouse in Mamasa Regency, particularly every transfer about medications to clinics. A Supply Chain Management (SCM) system was created utilizing Hypertext preprocessor (PHP) programming and a MySQL database, with a waterfall development process. The technology enables doctors to submit prescription requests more quickly and report real-time drug usage. It was useful as drug availability, management, and response information, assisting the health department in its duty as a supervisor or governing body. The study makes recommendations for pharmaceutical warehouse management

that will benefit the institutions and corporations involved, highlighting the role of information technology in supporting daily operations, as shown in Figure 4.

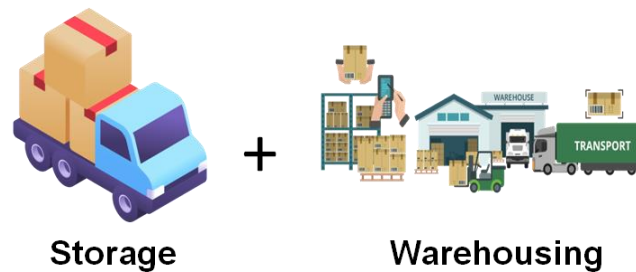


Figure 4: Flow of storage and warehousing

Köse et al. [16] discussed an pharmaceutical warehouses serve an important role in the pharmaceutical supply chain, ensuring that pharmacies have enough inventory for high-demand goods while also completing orders for low-demand ones. The project solves a real-world drug distribution problem in a pharmacy warehouse, fulfilling the needs of 186 pharmacies throughout nine regions. A two-stage optimization approach was utilized to identify ideal distribution routes that reduce transportation time and costs while preserving the company's infrastructure. The multiple-traveling salesman approach was utilized to find optimal routes, and the system was simulated to find the best trip frequencies and vehicle utilization savings. The findings reveal that using the created approach can save 52% in vehicle usage and 46% in daily distance travel.

The article's growing importance of the atmosphere in the supply chain for every feature and protection of unpreserved yield necessitates tracking of temperature during warehouse storage Baruffaldi et al. [17]. It was accomplished by geographic mapping operations. However, there was a scarcity of approaches and tools to help executives navigate temperature warehouse mapping. A method for calculating and displaying temperature profiles for every storage site during a certain period was presented in the study. Two outside logistics organizations give a variety of case studies that are used to validate the system. An expiring product warehouse's storage assignment problem was

given a support-decision model, it was utilized into manage prepared decisions and the put-away procedure when things were subjected to heat stresses.

Ahmadi et al.[18] examined the use of intelligent inventory management (IIM) techniques to the management of perishable pharmaceuticals in a central warehouse and several regional hospitals as part of a healthcare supply chain. The product's age distribution was believed to be generation-dependent, with every agent in the chain obtaining fresh supply from its agent upstream. Methods of reinforcement learning, such as Deep Q-network and Q-learning, are utilized by IIM methodologies to establish inventory policies. For the items they buy, these guidelines provide hospitals with almost ideal order volumes and distributions of remaining life. Using a genetic algorithm (GA) and a randomized mixed integer modeling model, the effectiveness of IIM policies was compared to periodic policies.

3.3 Distributions

Sylim et al. [19] issue of drug counterfeiting puts the general public and customers in danger. Poor, phony, incorrectly labeled, or counterfeit drugs were found in 30% of pharmacy outlets investigated in the Philippines in 2003. The Philippine Food and Drug Administration (FDA) suggested the public to check product registration certificates and report any cases of imitation. Blockchain technology, which resembles a digital ledger, was currently being developed to facilitate information exchange within the official medication distribution network. The project's purpose was to develop and test a blockchain-based pharmaceutical surveillance system that enables information sharing across the official drug delivery network. The system would run on a smart contract, where the Swarm Distributed File System (DFS) would run. The system will use the heritage standard and comply with data standardization criteria.

Xie et al. [20] examined the distribution and occurrence of 34 personal care and pharmaceutical products (PPCPs) within sediments, aquatic species, fish diets, and environment about pearl river delta (PRD). The strength concerns connected to these

chemicals were evaluated in connection to their ingestion in seafood. The most common PPCPs found included were antibiotic, norfloxacin, ofloxacin, and spectinomycin. PPCP levels in sediment and water samples were rather modest, with spectinomycin, medication, a medication called the antibacterial agent, and ibuprofen being the most commonly discovered in feeds. The painkiller and medication were commonly found in aquatic species. The study concluded that medicated diets were a possible source of PPCPs in PRD mariculture zones, but other human-caused causes should not be overlooked.

Lake et al. [21] looked at data from 2011 to 2014 on healthcare-associated infections (HAIs) in pediatric settings. More than 60% of HAIs were found to be caused by *Staphylococcus aureus*, *enterococcus facials*, *Klebsiella pneumoniae* and/or *oxymora*, *Escherichia coli*, and coagulate-negative staphylococci. Compared to PICUs, pediatric wards have higher resistance, but it was lower overall in NICUs. Although the percentage of carbapenem-resistant organisms was low, *Pseudomonas aeruginosa* from CAUTIs and CLABSIs surpassed 20% in a few locations. The paper is the first assessment of antibiotic resistance data especially suited to pediatric settings that are given to the national healthcare safety network (NHSN), identify prioritized objectives for antimicrobial stewardship efforts in pediatric hospitals, as shown in Table 2.

Table 2: Customer distribution

Author	Distribution	Description
Sylim et al. [19]	Drug counterfeiting	The FDA suggested verifying product registration and reporting imitations. A blockchain-based pharmaceutical surveillance system was developed for secure information sharing across the official drug distribution network.
Xie et al. [20]	Personal care & pharmaceuticals (PPCPs)	PPCPs were studied in sediments, aquatic species, and environments around the pearl river delta. PPCPs were found in aquatic species and feeds, suggesting medicated diets are a potential source in mariculture zones.

Lake et al. [21]	Healthcare associated infections (HAIs)	Resistance was higher in pediatric wards compared to NICUs, with pseudomonas aeruginosa being significant in certain infections.
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3.4 physical and financial resources

Malik and Kanwal [22] looked at how social obligation information affects financial performance in publicly traded drug companies. Data from 2005 to 2014 were examined using qualitative analysis of annual reports. Quantitative approaches were employed to assess factors and create an index. A connection between corporate sustainability reporting directive (CSRD) and financial success was suggested using brand equity. The results showed that laboratories disclosed more than other firms, with the average rate of disclosure increasing annually. Pharmaceutical companies mostly share information about community involvement. The association between financial success and the CSRD declaration is demonstrated by the significant regression findings about brand recognition. Figure 5 shows the physical and financial resources.

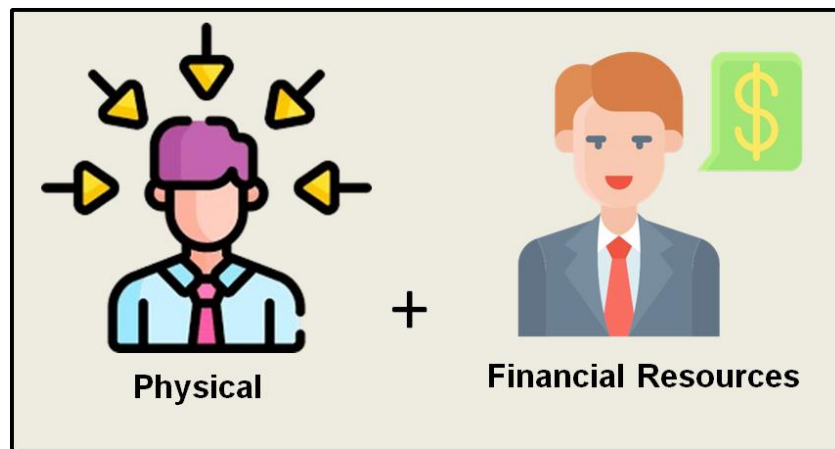


Figure 5: Physical and financial resources

Ghazal et al. [23] used currently to remove pharmaceuticals from liquid effluents from a variety of sources, such as hospital discharge and municipal trash, were reviewed in the article. Persistent organic molecules, known as pharmaceutical contaminants, were

challenging for traditional wastewater treatment methods to eliminate. Advanced oxidation processes could degrade these pollutants, but they may introduce toxic intermediates if not monitored. Though they were phase-changing technologies that transfer pollutants, physical methods such as membrane filtration and carbon adsorption can provide a barrier. For preserving and breaking down both parent and transformation molecules, a variety of procedures working together can be perfect. The benefits of both approaches were combined in hybrid technology, which removed the most pollutants. To minimize pharmaceutical residues before they enter the environment, the review highlighted the need to use integrated wastewater treatment techniques. It was suggested that advanced oxidation methods be used in conjunction with filtration, adsorption, or biological processes as a potential solution. The most effective treatment techniques for wastewater-containing medicines depend on the wastewater's amount and quality and the dangerous effects and residues of the pharmaceutical chemicals.

Nandy and Nandy [24] investigated the evolution of research and development (R&D) operations in Indian pharmaceutical corporations over the last 30 years. It highlighted how India has developed into the pharmacy of the world and how the business strategies of these organizations align with the notion of developing in India and benefit the global community. The book also highlights how these corporations use modern marketing methods to sell breakthrough pharmaceuticals worldwide, create a continuous supply chain, and gain worldwide competitiveness by exporting. It also investigates the relationship that financial success through panel data analysis (PDA), an econometric technique.

3.5 Human Resources

Health businesses were increasingly experiencing staff shortages, pushing the use of Human Resource Information Systems (HRIS) as a possible solution. HRIS can gather, store, and report workforce data, giving insight into someone's career path. However, few studies have examined healthcare organizations and their impact on HR leadership.

Tursunbayeva [25] suggested an frequently prioritize particular tech types or automation effects, ignoring the broad variety of possible uses for these technologies. The research seeks to close this gap by categorizing human resources (HR) technological disruptions. Health businesses and HR professionals must use HR information system (HRIS) carefully, balancing innovation, effectiveness, productivity, constitutional, moral, and compliance challenges, and HRH well-being and contentment.

Meskó et al. [26] provided an AI could alleviate the shortage of healthcare workers by enhancing big data analytics, administration, diagnosis, and decision-making. However, it must handle technological, ethical, and legal issues. The expanding human resource crisis requires a workforce, and innovative technology in healthcare can assist tackle a variety of issues. The medical curriculum, including post-graduate education, must equip practitioners for the practical application of technology. In addition to posing ethical questions, the authors claim that AI can address the scarcity of human resources. While AI was not intended to replace caretakers, those who utilize it were more likely to replace those who do not, and this should be planned.

Mousa and Othman [27] influenced of implementing green HRM practices on the long-term performance of healthcare companies is examined in this study. A combination of study designs was used, comprising 14 semi-structured interviews with HR managers, operational managers, and Chief executive officers (CEOs). A study was conducted to collect data from 69 respondents who implement green HRM practices at different tiers of management. Green HRM practices were found to be modestly implemented, with a mean score of 2.42 on a 5-point rating. The most significant approaches were green hiring and green training and participation, which resulted in excellent sustainability performance, as shown in Table 3.

Table 3: Overview of human resources

Author	Description
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Tursunbayeva [25]	Examines that HRIS can address staff shortages in healthcare by providing career path insights and addressing various HR challenges. Highlights the need for a balanced approach to technological innovation in HR leadership.
Mesko et al. [26]	Discusses how AI can help mitigate healthcare worker shortages through enhanced data analytics, and decision-making.
Mousa and Othman [27]	Examines how green HRM practices affect healthcare organizations' long-term success.

3.6 Risk Management

Zillien [28] proposed a modeling methodology for prioritizing medications according to the comparative risks every pose to aquatic life, using hospital purchasing and prescription information. A module for prioritizing risks and another for predicting emissions make up the design. 16 drugs were used to test the model at two university hospitals in the Netherlands. All of the predictions were within 10 times the measured values. The risk prioritization module assigns a ranking to each medication according to its assessed relative hazard to aquatic life, indicating that emission mitigation methods should primarily target antibiotics and NSAIDs.

Bolcato et al. [29] examined the function of medical-legal litigation in clinical risk management in the context of modern healthcare. An analysis of 206 medicolegal dispute resolution instances done in the past agreed toward a medical facility from the year 2014 to 2015 discovered that around twenty percent of circumstances classified as sentinel events weren't reported due to variables such as the case of a latency period and serious health damage appearance. Healthcare workers are also reluctant to report these events, which is a significant issue. The study suggested that evaluating medico-legal improved sentinel event reporting, and it proposed applying an organizational framework to provide a speedy mechanism for reporting sentinel occurrences during medico-legal case assessment.

Samartín et al. [30] looked at prioritizing training and improvement initiatives, hospital units were to be divided into three risk categories by the research. A multidisciplinary team was assembled, a bibliographic search was conducted, and drugs were identified to create a risk map. Location, staff turnover, frequency, and severity were among the requirements for the map. Each unit had its cumulative risk of severity determined, and a risk probability index was created. If the risk probability index of a unit was less than 1, it was classified as low risk, if it was between 1 and 2.9, it was classified as intermediate risk. Priorities and development procedures were traditional for every unit. There were 447 high-risk drugs found, with the highest risk being found in intensive care medicine, reanimation, and palliative care. The risk prospect index was used to determine and rank the improvement activities, as shown in Table 4.

Table 4: Risk management approach

Author	Risk management approach	Description
Zillien [28]	Prioritizing medications for aquatic life	For ranking medications based on their risk to aquatic life, using hospital purchasing predicted data.
Bolcato et al. [29]	Legal cases pertaining to medicine in clinical risk management	The study recommended improving sentinel event reporting and suggested an organizational framework for faster reporting during medico-legal assessments.
Samartin et al. [30]	Prioritizing training and improvement initiatives	A risk map by dividing hospital units into three risk categories based on location, staff turnover, frequency, and severity.

4. Conclusion

This systematic research analyzed the important aspects that influence pharmaceutical direction, such as management, storage, distribution, resource allocation, and risk

management. Resolving these concerns is essential to ensure that medicines are delivered efficiently and securely. To improve the export of medicines by improving risk management combined with technology and simplification of processes. By making the supply chain more dependable and safe, these steps should assure fast and safe delivery of supplies. The examination underlines the fundamental of combining advanced innovations such as digitization and blockchain with improved risk management strategies to growth supply chain resilience. Furthermore, enhanced operating procedures and employee training are critical for decreasing inefficiencies and waste. Overall, these improvements are critical for maintaining a responsible and efficient pharmaceutical supply chain that assures the timely and safe delivery of critical healthcare equipment.

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