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Use of Technology in Warehouse Operations

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ABSTRACT

The primary aim of this research is to examine how information technology impacts the efficiency of warehouse operations at a pharmaceutical supply agency. The study used a descriptive method and a cross-sectional study design. The participants were all professional staff members working in the stock and distribution directorate, and all of them were included in the study. The information technology tool employed in the study was found to enhance the performance of various warehouse operations, including inventory accuracy, picking accuracy, put-away accuracy, receiving time, order processing time, and warehouse space utilization. However, the study also revealed that the information technology implementation did not prevent theft and product leakage. Several challenges were identified, including frequent electric power interruptions, slow or unreliable internet connectivity, insufficient training and support for staff, and a lack of confidence among employees in using the information technology for effective warehouse operations management.

Keywords: *Inventory management, Supply chain management, Logistics, Information technology*

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1. Introduction

In this chapter, the history and profile of the organization are introduced, with a focus on the study that aimed to assess the utilization of information technology (IT) in improving warehouse operations. The organization in question is a governmental entity responsible for forecasting, procuring, warehousing, and distributing health commodities throughout the supply chain. The problem statement, research questions, study objectives, importance of the research, scope, and limitations of the study are all clearly presented. Traditionally, when people think of warehousing services, they often envision large old warehouses managed using manual systems for processes and inventory control. However, Rashid et al. (2023) point out that technological advancements have significantly improved warehouse management processes, making warehousing and logistics much more cost-effective for businesses while also increasing visibility and accountability in the industry.

One of the prominent implementations of technology in modern warehouses is for inventory management, providing real-time tracking of inventory levels for both staff and customers. This enables running live websites with up-to-date inventory information and facilitates inventory replenishment planning. The use of modern inventory management systems reduces reliance on traditional communication methods, like phone and email, as customers can monitor their inventory instantly and make faster decisions.

Motion reports are another crucial aspect of technology implementation in warehouses, serving as valuable tools for tracking sales and analyzing data in relation to seasonal trends or sales events, aiding in better planning. Warehouse One also employs technology in logistics processes, offering live tracking, job allocation systems, and integrated truck cameras to clients. The availability of information technology enables more efficient communication and management, essential in the competitive world of logistics. The strategic use of Management Information System (MIS) is highlighted as the world becomes more connected and globalized, emphasizing the need for organizations to use MIS as a strategic weapon. The implementation of Warehouse Management System (WMS) is designed to enhance efficiency in every aspect of warehouse operations, providing a well-organized approach to management. Bar code data collection solutions for warehouse management systems further improve administration processes.

1.1 Background of The Study

Warehouses face various challenges in today's dynamic business environment, including the integration of supply chains, globalization of operations, just-in-time trends, demanding customers, and rapid technological changes (Ramaa et al., 2012). These factors require warehouses to handle more and smaller transactions, store a wider variety of items, offer customized products and services, provide value-added services, process more returns, and handle a higher volume of global orders. Despite these increasing demands, warehouses have less time, less room for errors, a shortage of skilled staff, and limited Warehouse Management System (WMS) functionality. To cope with these challenges and enhance efficiency and customer satisfaction, logistics-related data utilization becomes crucial (More et al., 2016). Pharmaceutical warehousing involves managing the physical movement of inventory within and out of a warehouse. Common warehouse activities include receiving, inspection, put away, storage, inventory control, replenishment, order-picking, packing, cross-docking, staging, and shipping (Barthoidi & Hachman, 2017). Warehouses encounter issues that originate at higher levels of the supply chain, such as inaccurate quantification leading to the procurement of wrong inventory. Additionally, warehouses in low-income countries face challenges related to insufficient human resources, poor physical infrastructure and layout, and a lack of effective systems to track goods efficiently. These limitations result in stock-outs, overstocking, and wastage of healthcare resources.

The use of information technology tools like barcoding or radio frequency identification (RFID)

can improve product traceability, inventory visibility, leakage prevention, and security throughout the supply chain. Barcoding has proven successful in enhancing healthcare commodities warehouse operations in various developing countries, such as Pakistan and Tanzania. Before the introduction of barcoding in Pakistan, the warehouse used a time-consuming paper-based system, leading to distribution delays, numerous errors, and expired inventory. However, after implementing barcoding, the new system facilitated better shipment management, faster distribution to sub-national levels, easier tracking of dispatches, and improved control against leaks and theft. This resulted in reduced workload for personnel, faster report generation, and significantly fewer reporting errors.

Many central medical stores in sub-Saharan Africa have adopted Warehouse Management Systems (WMS) to automate system management and inventory control. WMS aids in tasks such as ordering, receiving, put-away, replenishment, picking/packing, shipping, cycle counting, and inventory control, aiming to reduce lead times, increase storage capacity, and improve labor productivity at central medical stores (Dickens, 2011). Inventory management is a critical aspect of logistics management, as it aims to maintain inventories at the lowest possible cost while ensuring uninterrupted supplies for ongoing operations. Neglecting healthy inventory management can lead to wasteful practices, financial resource waste, stock shortages, overstocking leading to expiration, and a decline in patient care quality. Studies show a strong positive correlation between inventory management practices, including the use of information technology, and a company's financial performance (Lwiki et al., 2013). Investing in modern technology and implementing Electronic Data Interchange (EDI) can help companies reduce inventory costs and improve returns. Common information technology tools used for warehouse and inventory operations management include Warehouse Management System (WMS), Electronic Data Interchange System (EDI), Enterprise Resource Planning (ERP), Barcoding and Barcode Scanners, Radio-frequency Identification (RFID), among others.

1.2 Problem Statement

According to Systems for Improved Access to Pharmaceuticals and Services, warehousing plays a crucial role in pharmaceutical supply chain management. Efficient warehouse management ensures the six rights of logistics: delivering the right products, of the right quality, in the right quantity, to the right place, at the right time, and at the right cost, throughout the supply chain system. The researcher conducted a small-scale evaluation by asking ten colleagues a simple question: "Are PFSA's warehouses significantly contributing to ensuring the six rights of logistics?" Based on the responses, the researcher identified gaps in fully realizing the six rights of logistics within PFSA's warehouses. Pharmaceutical Fund and Supply Agency (PFSA) are committed to providing uninterrupted access to affordable health commodities to the public. Since its establishment in 2007, the types and quantities of health commodities managed by its warehouses have been increasing. However, warehouse operations such as receiving, storage, and dispatch need improvement. There are also challenges with warehouse security and safety. PFSA, as a key player in the Ethiopian public health commodities supply chain, is responsible for quantification, procurement, warehouse management, stock control, and distribution of pharmaceuticals. One of the major challenges in the Ethiopian healthcare commodities supply chain is a high and frequent stock-out rate, leading to shortages of essential health commodities and potentially risking treatment discontinuation, increased mortality, drug resistance, particularly in cases of tuberculosis, and inadequate healthcare services. On the other hand, overstocking some commodities results in the wastage of scarce resources due to expiry. Moreover, there is a poor commodity tracking system throughout the supply chain.

The private sector has recognized the importance of warehousing in reducing costs, improving customer satisfaction, and enhancing business performance, leading to a professional and systematic approach to warehousing. Similarly, organizations in the developing world involved in public health have started focusing on commodity warehousing, recognizing its vital role in improving public health. Challenges like the increasing number of products and demand for reduced processing time can be addressed by improving inventory and warehouse management through the use of technologies. Warehouse and inventory management are crucial elements of pharmaceutical supply systems. Good inventory management enhances the performance of the pharmaceutical supply chain, while poor

management leads to financial resource waste, shortages of essential medicines, and expiration of others due to overstocking. Utilizing information technology tools in inventory and warehouse operations enhances overall performance. Data science plays a paramount role in firms' performance, providing data flow that makes the supply chain more robust and resilient without compromising efficiency.

The World Health Organization emphasizes the importance of access to medication for citizens, and a well-functioning medicine supply chain is essential to ensure this access. Medication expenditure in developed and transitioning economies ranges from 7% to 30% of total healthcare expenditure, while in developing countries, it can be as high as 25% to 65% of total health expenditures. Supply chain costs constitute about 25% of pharmaceutical costs, making investments in efficiency and effectiveness crucial. Therefore, information technology tools are vital for reducing healthcare commodity supply chain costs and improving efficiency, especially in warehouse operations. Warehouse operations management is a key aspect of supply chain management, and any inefficiency in warehouse administration can significantly impact the entire supply chain's performance and, consequently, the quality of healthcare services. To enhance healthcare service quality, an excellent and efficient healthcare commodity supply chain management system must be in place. The adoption and utilization of ICT tools can help optimize and improve warehouse operations' performance.

1.3 Research questions

The simple research questions of this find out about are;

- What is the degree of information technology utilization for warehouse operations management at Pharmacy supply agency from employees' perspective?
- What are the position of records technology on the overall performance of warehouse operations at prescription drugs fund and furnish employer from employees' perspective?
- What is the perceived overall performance of warehouse operations at pharmaceutical fund and furnish enterprise from employees' perspective?
- What are the challenges related with the use of statistics science in warehouse operations management at prescribed drugs fund and grant organization from employees' perspective?

1.4 Purpose of the study

The scope This study investigated the role of information technology (ICT) on the performance of pharmaceuticals warehouse operations. The study also assessed the level, perceived warehouse operation performance and challenges of ICT utilization.

1.5 Significance of the study

The Pharmaceutical Fund and Supply Agency (PFSA) holds the responsibility of selecting, forecasting, procuring, storing, and distributing essential healthcare commodities for public health facilities. To fulfill its mission effectively, a robust and efficient healthcare commodity supply chain, supported by information technology, is essential. Warehouse management plays a crucial role in the healthcare commodity supply chain, ensuring timely and efficient delivery. Poor warehouse management can lead to stockouts of essential medicines, expiration of products due to overstocking, financial losses, reduced product visibility, and high operational costs in the warehouse. Such inefficiencies significantly impact the overall performance of the supply chain and may result in a loss of trust in the system. Proper warehouse management can prevent these issues. On the other hand, the utilization of information technology can enhance warehouse operations' performance and the entire healthcare commodity supply chain (Ramma et al., 2012) (Barros et al., 2015). This study aims to investigate the role of information technology in warehouse operations at the Pharmaceutical Fund and Supply Agency. It also seeks to identify the extent and challenges of ICT utilization within the organization. Identifying challenges in ICT usage may help the agency develop mechanisms to address

these issues. Furthermore, the findings from this study can inform decision-making and future improvement plans. Additionally, this research can contribute to the existing body of knowledge and serve as a reference for future studies in the same field.

2. Literature Review

2.1 Overview of Warehouse Management

The warehouse plays a crucial role in the healthcare commodities supply chain. In lengthy procurement cycles, delays in initiating procurement can create uncertainty and lead to system-wide stock-outs (Yadav, 2015). Properly stored pharmaceutical products in the warehouse act as buffers against uncertainties and disruptions in the supply chain. On the other hand, poor warehousing and distribution practices result in shortages, stock-outs, and significant financial losses due to expired products in the warehouse. Stock-outs of critical pharmaceuticals cannot be tolerated as they would disrupt healthcare services. Maintaining an appropriate inventory level in the warehouse can help reduce the frequency of stock-outs. Improving the storage and distribution of pharmaceuticals can lead to waste reduction, increased availability, and cost savings. Warehouses can be classified into different types, such as manufacturing warehouses and distribution centers (Ghiani et al., 2004). Based on their roles in the supply chain, they can be categorized as raw materials warehouses, work-in-process warehouses, finished goods warehouses, distribution warehouses, fulfillment warehouses, local warehouses for direct customer demand, and value-added service warehouses.

Raw material warehouses hold raw materials near the point of induction into the manufacturing process. Work-in-process warehouses store partially completed assemblies and products at various points along an assembly or production line. Finished goods warehouses hold inventory used to balance and buffer variations between production schedules and demands. These warehouses are usually located near the point of manufacture, and the movement of goods is typically in bulk or full pallets, with replenishment needs ranging from monthly to quarterly. Distribution warehouses and distribution centers collect and consolidate products from various points of manufacture within a single company or from multiple companies for combined shipment to customers. These warehouses may be centrally located near the production area or customer base. The flow of products is characterized by full pallets or cases in and full or broken cases out. These facilities typically respond to daily, weekly, or monthly orders.

Fulfillment warehouses handle small orders for individual customers, receiving, picking, and shipping them. Local warehouses are strategically distributed in the field to shorten transportation distances and enable rapid responses to customer demands. They often pick single items and ship the same items to customers daily. Value-added service warehouses perform key product customization activities, such as packaging, labeling, marking, pricing, and returns processing. These facilities add value to the products before they reach the end customers.

2.2 Warehouse Design or Layout

Ensuring optimal operational efficiency requires careful conceptual planning and facility layout design (Gu et al., 2007). Warehouse layout planning involves assessing the space requirements of a warehouse and determining how that space should be organized to facilitate various warehouse activities. The primary objectives of layout planning are to use space efficiently, enable efficient handling of commodities, provide cost-effective storage, and offer flexibility to adapt to changing warehousing needs. In a typical warehouse or storage facility, two main activities, namely receiving/shipping and storing/retrieval, require careful consideration in space or layout planning.

The World Health Organization (WHO) recommends two main warehouse layout options for the storage of pharmaceutical products: the 'U' flow and the 'Through' flow. In the 'U' flow arrangement, goods receipt and dispatch areas are located on the same side of the building. This setup can lead to congestion if there is heavy incoming and outgoing traffic at the same time. However, the 'U' flow arrangement offers advantages such as proper utilization of dock resources, enabling cross-docking,

efficient use of lift trucks, and providing excellent safety measures. On the other hand, in the 'Through' flow arrangement, goods receipt and dispatch areas are situated on opposite sides of the building. The advantage of this layout is that there is little risk of congestion at the loading docks. However, security becomes a heightened concern due to the two-sided arrangement.

2.3 Types of things to do in the Warehouse/ Warehouse Operations

The most common and fundamental warehouse activities include receiving/unloading, inspection, put-away, storage, stock control, replenishment, order-picking, checking, packing, staging, labeling, kitting, cross-docking, and shipping/loading. Each of these tasks may involve multiple challenges (Barthoidi & Hachman, 2017). Among these activities, order-picking is the most labor-intensive process in most warehouses. Careful put-away can reduce travel time during order-picking (Barthoidi & Hachman, 2017). Let's delve into each of these warehouse activities:

Receiving: This involves unloading materials from supplier vehicles and moving them to the inspection area. Proper preparation and advance notification of incoming goods allow the warehouse to efficiently schedule and coordinate receipt and unloading with other activities (Barthoidi & Hachman, 2017). Receiving includes physically unloading incoming shipments, checking deliveries against purchase orders, and recording the details. Depending on the agreement between parties, quality control checks may also be performed. Rejected items may be sent back to the supplier based on their agreements. Inspection: This process involves drawing samples from the shipment and inspecting them to ensure compliance with purchase order specifications (Rashid & Mohd, 2020). Inventory Control: This is the process of operating a manual or automated inventory control system, or both, to provide instructions for moving materials to/from storage and to give management information on receipts, issues, and inventory balances. During physical inventory, coordination and reconciliation of inventories with bin-cards and automated records are done (Rashid et al., 2019). Put-away: It refers to the process of placing products into the appropriate storage locations after they have been delivered to the warehouse (Rashid & Amirah, 2017). Storage: This activity involves moving incoming components to the storage area. Proper storage conditions are crucial for pharmaceutical products and materials to maintain their quality, including environmental control such as temperature, light, humidity, sanitation, ventilation, and segregation (Baloch & Rashid, 2022). Replenishment: This is the process of transferring products from the storage area to specific picking areas to facilitate picking. Picking and Packing: Picking and packing entail gathering the products listed in a customer order and packaging them for shipment (Hashmi, 2022). Shipping: This is the process of loading packages onto transportation for distribution to customers (Hashmi et al., 2023).

Efficient and effective management and optimization of all warehouse activities are essential to meet or exceed customer expectations and reduce costs. Warehouse management systems and other information technology tools play a significant role in achieving these objectives (Kiril & Vera, 2013). Warehousing is a crucial part of the logistics system and an integral aspect of the healthcare commodities supply chain. Proper management and implementation of warehouse activities are vital to ensure customer satisfaction and cost-effectiveness. To achieve these goals, warehouse management systems and information technology tools are of paramount importance (Kiril & Vera, 2013).

2.4 Overview of Inventory Management

Effective inventory management is a crucial element of logistics management and serves as the heart of the pharmaceutical supply chain. Without a robust inventory management system, the entire pharmaceutical supply chain will suffer, leading to inefficiencies and wastage. Poor inventory management results in the wastage of financial resources, shortages or stock-outs of essential medicines, overstocking of other products leading to expiration, and a decline in the quality of patient care.

2.5 The Goal of Conserving an Inventory

In inventory management, there is always a balance to strike between the cost of holding stock

and the value of purchasing and scarcity. The primary reasons for maintaining inventory in the warehouse include ensuring availability, instilling confidence in the systems, reducing the unit cost of medicines, avoiding scarcity costs, minimizing ordering cost, and adapting to fluctuations in demands. In the pharmaceutical system, it is challenging to accurately forecast demand or be certain about supplier performance. Therefore, maintaining a realistic quantity of inventory in the warehouse is crucial to ensure availability and maintain confidence in the healthcare system. Ordering medicines in bulk allows for volume discounts and reduces shipping and port-clearance costs, enabling the provision of affordable products to the public. Changes in demand for specific medications are often unpredictable, and holding an adequate stock in a warehouse allows the system to cope with demand fluctuations.

While the pharmaceutical supply system needs to maintain a reasonable level of stock in the warehouse, holding excessive inventory also has drawbacks. Firstly, a significant amount of capital may be tied up in stock, limiting its availability for other purposes. Additionally, the costs for personnel, utilities, storage facilities, and other inventory holding expenses increase. Moreover, high inventory levels raise the likelihood of losses caused by expiry, spoilage, obsolescence, and theft (Hashmi et al., 2021a).

2.6 Warehouse operations Performance

Evaluating the performance of warehouse operations based solely on daily observations can be challenging (Barthoidi & Hachman, 2017). However, warehouse performance is commonly measured using indicators, which are present in the majority of research works (Staudt et al., 2014). Through a review of literature (Staudt et al., 2014), various authors' indicators used to measure warehouse performance were identified and categorized based on four dimensions: time, quality, cost, and productivity. The researcher defines these four performance indicator dimensions as follows:

I. Quality indicators are often the simplest to implement and measure. They typically assess how well specific tasks are performed. Common logistics indicators in this category include accuracy measurements such as order accuracy, inventory accuracy, and picking accuracy.

II. Time indicators focus on the duration required to complete specific activities. They reveal areas where time-saving measures can enhance overall warehouse operations performance. Indicators under the time dimension may include order processing time, customs clearance cycle time, and put-away time.

III. Financial indicators help managers identify supply chain cost drivers and aid in achieving a more efficiently managed warehouse operation. Indicators under the cost dimension may encompass total warehousing costs and the cost of goods damaged in the warehouse.

IV. Productivity indicators assess how efficiently resources are utilized, including material handling equipment, labor, vehicles, and warehouse space. Storage space utilization is one of the indicators under the productivity dimension.

2.7 Commonly Used ICT Tools in Warehouse Operations Management

Commonly employed information technology (IT) tools that facilitate effective and efficient management of warehouse operations, as well as the entire supply chain in general, include Warehouse Management System (WMS), Electronic Data Interchange System (EDI), Enterprise Resource Planning (ERP), Barcode and Barcode Scanner, Radio-frequency Identification (RFID), and other similar technologies.

2.8 Warehouse Management System (WMS)

As stated by Awuah-Gyawu et al. (2015), warehouse management system refers to advanced technologies and operational methods that optimize all aspects of warehousing functions, encompassing

inventory movements and information flows within these functions. The primary objective of the warehouse management system is to control the movement and storage of materials within a warehouse and process related transactions, including shipping, receiving, put-away, and picking (Ramaa et al., 2012).

2.9 Radio-Frequency Identification (RFID)

Radio frequency identification (RFID) is an emerging technology that is revolutionizing warehouse operations. RFID utilizes radio signals to exchange information between handheld devices and RFID tags, enabling smooth and efficient warehouse management. This technology is believed to enhance security, productivity, inventory control, and traceability within the warehouse setting. RFID can also monitor the temperature of various products, such as perishable food, vaccines, and pharmaceuticals that require a cold chain, ensuring their proper handling and storage.

2.10 Electronic Data Interchange System (EDI)

According to Walton & Marucheck (1997), EDI is characterized as the electronic exchange of standardized business transactions between computers. It represents a move towards paperless record transfer or transactions. By adopting EDI, logistics operating costs are reduced due to decreased labor and material expenses associated with printing, mailing, and handling paper-based transactions, as well as lower clerical costs. EDI also aids in reducing order cycle time and inventory, thereby enhancing competitiveness and minimizing expenses.

2.11 Barcode and Barcode Scanner

As stated by Bhandari (2015), barcoding refers to the application of computer-readable codes on various items, cartons, containers, pallets, and even rail cars. These codes are made up of parallel lines of varying thickness with spaces in between, which can be scanned by a barcode scanner. The information contained in the barcode includes the country code, manufacturer name, product details, date of manufacture, expiry date, batch number, and more. These details are essential for inventory management at the customer's end. Barcoding offers the advantage of easy identification of inventory items during storage, retrieval, pickup, inspection, and dispatch. It also reduces paperwork and processing time, leading to minimized human errors and increased productivity in the logistics system through enhanced speed, accuracy, and reliability. During order processing, barcodes assist in maintaining the identification of products based on their entry date in the warehouse or their expiry date. This facilitates material storage, replenishment, and dispatch using FIFO (first in first out) or FEFO (first expired first out) inventory management systems. In a warehouse setting, barcoding enables real-time updates of inventory records.

2.12 Enterprise Resource Planning (ERP)

Enterprise Resource Planning (ERP) Systems are comprehensive information systems used to automate all activities and functions within a business. These systems are transaction-based and integrated across the entire enterprise. Essentially, they enable the capture of data for the entire business into a single computer package, providing a centralized source for all key business information, including inventory, customer orders, and financials (Jadha, 2015). Implementing an ERP system requires a significant investment but offers numerous functionalities, such as financial applications, service applications, human resource applications, and reporting applications. Within the ERP system, there are specific modules dedicated to supply chain functions, including inventory and supply applications, manufacturing applications, and sales and shipping applications. These modules support supply chain activities such as raw materials acquisition, production processes, and customer order fulfillment, encompassing the transactions and processes that drive the entire range of supply chain activities.

2.13 Empirical Literature Review

Numerous studies have been conducted globally by various scholars to investigate the impact of data science on supply chain management. For instance, a study in the Vietnam textile industry using cause and effect analysis found a strong positive relationship between data science usage and high organizational performance, including marketing performance, financial performance, and customer satisfaction (Tseng et al., 2011). In recent years, companies have been increasingly investing in supply chain data science, indicating a growing recognition of the role of information and communication technology (ICT) in the supply chain. In the competitive landscape, the competition is not just between individual companies but between entire supply chains, making data science-enabled supply chains a source of competitive advantage for firms. Research in Turkey on a company in the fast-moving consumer goods sector revealed that restructuring the supply chain with the use of data technologies had positive effects on performance criteria such as supply, production, and distribution (Rasheed & Rashid, 2023). Similarly, studies conducted in various African countries have demonstrated the positive impact of data science on warehouse operations and supply chain management. For instance, a study in Nairobi, Kenya, showed a positive relationship between data science utilization and logistics performance of companies in the county (Rashid et al., 2022a, b). Another study in western Kenya investigated the impact of inventory management automation on supermarket performance and found a strong positive linear relationship between automation and supermarket performance, with organizational factors like size, culture, and management structure moderating this relationship (Hashmi et al., 2021a, b).

Further research in Ghana and Kenya also highlighted the importance of data science tools in enhancing warehouse performance (Gyaw et al., 2015; Karimi & Namusonge, 2014). In the context of sugar manufacturing companies in Kenya, it was found that inventory management practices, including data technology, lean inventory systems, and strategic supplier partnerships, had a strong positive correlation with the company's financial performance (Lwiki et al., 2013). Barcoding has been successfully used to improve warehouse operations in developing countries like Pakistan and Tanzania, leading to reduced errors, faster distribution, and increased control of leaks and theft (Hashmi et al., 2020a, b). An analysis of scientific articles published between 2009 and 2014 highlighted that data science contributes significantly to supply chain management by improving data quality, operational efficiency, integration, and collaboration (Rashid et al., 2020a). Bhandari (2015) concluded in their investigation that technology enhances supply chain competitiveness and performance by improving overall logistics effectiveness and efficiency.

While there is a lack of specific research on the impact of data science on pharmaceutical warehouse operations, insights from other supply chain studies can be applied to pharmaceutical warehouse management. The systematic approach used by the private sector can be directly relevant to the challenges faced by public health warehousing worldwide (Rashid & Rasheed, 2022). Therefore, this research aims to fill the existing gaps and explore the role of data science in the performance of pharmaceutical warehouse operations at pharmaceutical fund and supply agencies.

2.14 Conceptual Framework of the Study

A conceptual framework is a compilation of relevant literature that aims to provide a logical explanation for a particular phenomenon. It clarifies the essential components to be investigated, including key factors, concepts, variables, and their presumed relationships, presented both graphically and in written form. Variables are concepts that can be measured and take on different quantitative values. The dependent variable is influenced by or is the outcome of the independent variable. In this research, the independent variable is data science (ICT), while the dependent variable is the performance of warehouse operations.

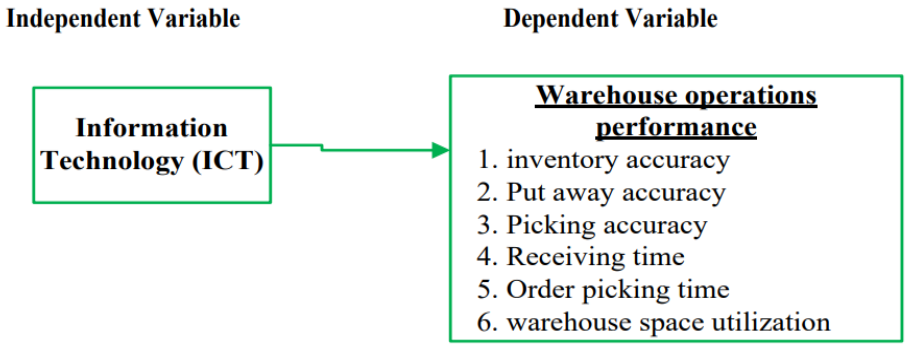

Figure 1: Research model

Source: Literature

2.14.1 Hypothesis

H1: Information technology positively associated with Inventory accuracy.

H2: Information technology positively associated with Put away accuracy.

H3: Information technology positively associated with Picking accuracy.

H4: Information technology positively associated with receiving time.

H5: Information technology positively associated with order picking time.

H6: Information technology positively associated with warehouse space utilization.

2.15 Identified Literature Gap

The researcher conducted a thorough review of various scholarly articles in the fields of supply chain management, warehouse operations, and information technology. These studies aimed to explore the role of ICT in supply chains and its impact on overall performance. Additionally, the researcher examined research conducted in developing countries, some of which focused on warehouse and information technology issues.

However, it is noteworthy that the majority of the reviewed literature pertained to business sectors and did not specifically address issues within the health commodities supply chain. Notably, no research was found that specifically investigated the pharmaceutical fund and supply agency (PFSA) to examine the impact of data technology on warehouse operations performance. As a result, this research project aims to bridge that gap and serve as a valuable reference for future studies in this area.

3. Methodology

This section discusses the lookup design, pattern and sampling method, data source and information collection instruments, statistics series manner and techniques of analysis.

3.1 Description of The Study Area

A study was conducted at the central pharmaceutical supply agency situated in Addis Ababa. This organization is a legal entity established under the regulations of the Federal Democratic Republic of Ethiopia Government to ensure the continuous supply of health commodities to the public at affordable prices. Currently, the agency operates nineteen branches, with only two of them located in Addis Ababa, while the rest are situated outside the city. The distribution of services by these branches

is based on geographical demarcation.

3.2 Research Design

A conceptual framework is a researcher's blueprint that outlines how a study will be conducted, including key factors, concepts, variables, and their presumed relationships. The two main research approaches are quantitative and qualitative methods, but a mixed approach, combining both qualitative and quantitative designs, was adopted for this study. The aim is to investigate the role of information technology (IT) in the performance of warehouse operations at the central pharmaceutical supply agency. The study assessed the level of IT utilization and perceived performance of warehouse operations management while identifying some challenges related to IT usage. The Stock and Distribution Directorate is responsible for warehouse operations management at the central pharmaceutical supply agency. It is headed by the director, and there are two teams, the revolving drug fund (RDF) team and the health program team, with various positions such as coordinators, officers, managers, supervisors, and clerks.

The target population for this study was all professionals working under the Stock and Distribution Directorate, totaling 53 staff members. A census approach was used to include all individuals from the target population, resulting in a sample size of 50. Both primary and secondary sources of data were utilized in this study. The primary data collection instrument was a structured questionnaire, which was designed to address the research questions. Interviews were also conducted with key personnel, including the director and team coordinators. Secondary data were gathered from published journals, books, and the internet.

Ethical considerations were addressed by obtaining verbal consent from respondents, ensuring anonymity in questionnaire responses, and assuring confidentiality. To ensure validity, a pilot study was conducted, and adjustments were made based on feedback. The reliability of the data collection instrument was tested using Cronbach's Alpha. Data analysis involved using Statistical Package for Social Sciences (SPSS) to compute descriptive statistics for the quantitative data, while qualitative data were presented narratively. Both sets of data were triangulated to strengthen the study's findings and provide a comprehensive understanding of the topic.

4. Data Analysis and Findings

4.1 Introduction

This section is based on the analysis of data and also discuss the calculated values. It begins with the general description of data (i.e. demographics) followed by the descriptive statistics, reliability analysis, correlation analysis and hypothesis testing through regression analysis.

4.2 Response Rate

The Developed questionnaire was distributed in the target population and the total 252 responses was collected.

4.3 Demographic Profile of Participant

The demographics profile of the respondents is shown in given below table 1

Table 1: Demographic profile of participant

Demographic variable	Category	Frequency	Percentage
Gender	Male	229	90.9
	Female	23	9.1
Age	Less than 25 years	70	27.8
	25- 30 years	153	60.7
	36-40 years	20	7.9
	Above 40 years	9	3.6

Experience	less than 3 years	144	57.1
	3 to 6 years	71	28.2
	7 to 10 years	27	10.7
	above 10 years	0	0
Designation	Executive	119	47.2
	Assistant Manager	88	34.9
	Manager	32	12.7
	Senior Manager	4	1.6
	Director	9	3.6
Income	25,000- 40,000	84	33.3
	41,000- 70,000	111	44.0
	71,000- 100,000	38	15.1
	Above 100,000	19	7.5
Education	Diploma	12	4.8
	Intermediate or less	59	23.4
	Graduation	102	40.5
	Masters	74	29.4
	M Phil/PhD	5	2.0

Source: Literature

4.4 Descriptive Statistics

The skewness and kurtosis values are calculated to examine the univariate normality. According to Hair et al. (2018), the acceptable values of skewness and kurtosis for the establishment of univariate normality is +2.5 to -2.5. The given below table 2 illustrate the descriptive statistics:

Table 2: Descriptive Statistics

Construct	Mean	Std. Dev.	Skewness	Kurtosis
Information Technology	3.25	0.58	.025	-.318
Inventory accuracy	3.37	0.77	-.432	-.339
Put away accuracy	3.56	0.62	-.378	-.114
Picking accuracy	3.49	0.57	-.230	.083
Receiving time	3.69	0.58	-.171	.337
Order picking time	3.91	0.65	-.560	.743
Warehouse space utilization	3.76	0.67	-.581	.737

Source: Literature

The presented above table 2 illustrate that the construct warehouse space utilization (WSU) (Mean=3.76, s.d = 0.67) has the maximum skewness (sk=0.581) while the construct information technology (ICT) (mean=3.25, s.d=0.58) has the lowest skewness (sk=0.025). On the other hand, the construct order picking time (OPT) (Mean=3.91, s.d. =0.65) has the highest value of kurtosis (k=0.743), whereas, the construct picking accuracy (PA) (Mean=3.49, s.d.=0.57) has the lowest kurtosis (k=0.083). These outcomes indicate that all skewness and kurtosis values are not less or greater than the acceptable range (i.e. $\pm$2.5) so that the univariate normality was establish.

4.5 Reliability Analysis

The internal consistency of data and error related to data collection was examine by applying reliability analysis (Hair et al., 2018). The value of reliability should at least 0.70 or greater. . The given below Table 3 illustrate the reliability analysis:

Table 3 Reliability Analysis

Construct	Standardized Cronbach's Alpha s	Mean	Standard Deviation
Information Technology	.795	3.25	0.58
Inventory accuracy	.807	3.37	0.77
Put away accuracy	.801	3.56	0.62
Picking accuracy	.812	3.49	0.57

Receiving time	.787	3.69	0.58
Order picking time	.805	3.91	0.65
Warehouse space utilization	.780	3.76	0.67

Source: Literature

The presented above table 3 indicating that the construct picking accuracy (PA) (Mean=3.49, s.d.=0.57) has the highest reliability (α=0.812) while the construct warehouse space utilization (WSU) (Mean=3.76, s.d = 0.67) has the minimum reliability (α=0.780). However, these results illustrating that all adapted constructs has at least 0.70 reliability so that all constructs used for this study are reliable for this research.

4.6 Correlation Analysis

Correlation analysis calculated the strength of association among each pair of constructs that emphasize the uniqueness of constructs/variable. The acceptable value of correlation should be in the range of ±0.30 to ±0.90 (Rashid, 2016). The given below table: 4 illustrates the correlation analysis:

Table 4: Bivariate Correlation

Construct	T_ICT	T_IA	T_PAA	T_PA	T_RT	T_OPT	T_WSU
Information Technology	1						
Inventory accuracy	.552**	1					
Put away accuracy	.430**	.425**	1				
Picking accuracy	.341**	.308**	.331**	1	.		
Receiving time	.430**	.435**	.355**	.363**	1		
Order picking time	.265**	.235**	.360**	.333**	.472**	1	
Warehouse space utilization	.426**	.354**	.424**	.382**	.600**	.605**	1

** Correlation is significant at the 0.01 level (2-tailed).

Source: Literature

According to calculated outcomes presented in given above Table (ref. table:4) shows that the strongest relationship (r=0.605) is among warehouse space utilization (WSU) (Mean=3.76, s.d = 0.67) and order picking time (OPT) (Mean=3.91, s.d. =0.65), while the weakest association (r=0.235) is among order picking time (OPT) (Mean=3.91, s.d. =0.65) and inventory accuracy (IA) (Mean=3.37, s.d. =0.77). Since these values illustrate that the association among each pair of constructs is not less than +0.20 and also not greater than +0.90 so that all adapted constructs measure dissimilar concept and no issue with multicollinearity (Hashmi et al., 2021a).

4.7 Hypothesis Testing

All proposed hypothesis was tested by the regression analysis. Results along with interpretation are discuss in given below sections:

4.7.1 Hypothesis 1

The hypothesis one proposed that "Information technology positively associated with Inventory accuracy". Simple regression was applied to test this hypothesis and the consolidated results are presented in given below tables:5.

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.552a	.305	.302	.64099

a. Predictors: (Constant), Information Technology

b. Dependent Variable: Inventory accuracy

Source: Literature

The given above model summary tables 5 illustrate that the value of adjusted R-square is 0.302 which emphasize that the predictor Information Technology can predicts 30.2% variance in inventory accuracy. The possibility of error in this calculated model is 0.64099.

Table 6: ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	44.972	1	44.972	109.457	.000b
	Residual	102.716	250	.411		
	Total	147.687	251			

a. Dependent Variable: Inventory accuracy

b. Predictors: (Constant), Information Technology

Source: Literature

The presented above ANOVA table 6 highlights the significant level of association among independent and dependent variables. As the sig-value is (0.00) which is less than 0.05 so that information technology has the statistically significant association with inventory accuracy.

Table 7: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	Std. Error	Beta		
1	Inventory accuracy	1.007	.230		4.382	.000
	Information Technology	.727	.070	.552	10.462	.000

a. Dependent Variable: Inventory accuracy

Source: Literature

The calculated outcomes presented in given above coefficient table 7 illustrate that; Information technology has the significant influence on inventory accuracy (i.e. sig value is less than 0.05). Moreover, the value of beta (0.552) shows that if information technology increases by single unit then inventory accuracy will be positively changed by (0.552) unit. Thus the hypothesis one was retained.

4.7.2 Hypothesis 2

The hypothesis two proposed that "Information technology positively associated with Put away accuracy". Simple regression was applied to test this hypothesis and the consolidated results are presented in given below tables 8.

Table 8: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.430a	.185	.182	.56310

a. Predictors: (Constant), Information Technology

b. Dependent Variable: Put away accuracy

Source: Literature

The given above model summary tables 8 illustrate that the value of adjusted R-square is 0.182 which emphasize that the predictor Information Technology can predicts 18.2% variance in Put away accuracy. The possibility of error in this calculated model is 0.56310.

Table 9 ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	18.025	1	18.025	56.845	.000b
	Residual	79.271	250	.317		
	Total	97.296	251			

a. Dependent Variable: Put away accuracy

b. Predictors: (Constant), Information Technology

Source: Literature

The presented above ANOVA table 9 highlights the significant level of association among independent and dependent variables. As the sig-value is (0.00) which is less than 0.05 so that information technology has the statistically significant association with Put away accuracy.

Table 10: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Put away accuracy	2.058	.202		10.194	.000
	Information Technology	.461	.061	.430	7.540	.000

a. Dependent Variable: Put away accuracy

Source: Literature

The calculated outcomes presented in given above coefficient table 10 illustrate that; Information technology has the significant influence on Put away accuracy (i.e. sig value is less than 0.05). Moreover, the value of beta (0.430) shows that if information technology increases by single unit then put away accuracy will be positively changed by (0.430) unit. Thus the hypothesis two was retained.

4.7.3 Hypothesis 3

The hypothesis three proposed that "Information technology positively associated with picking accuracy". Simple regression was applied to test this hypothesis and the consolidated results are presented in given below tables 11.

Table 11: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.341a	.116	.113	.54067

a. Predictors: (Constant), Information Technology

b. Dependent Variable: Picking accuracy

Source: Literature

The given above model summary tables 11 illustrate that the value of adjusted R-square is 0.113 which emphasize that the predictor Information Technology can predicts 11.3% variance in picking accuracy. The possibility of error in this calculated model is 0.56310.

Table 12: ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	9.543	1	9.543	32.647	.000b
	Residual	72.496	248	.292		
	Total	82.040	249			

a. Dependent Variable: Picking accuracy

b. Predictors: (Constant), Information Technology

Source: Literature

The presented above ANOVA table 12 highlights the significant level of association among independent and dependent variables. As the sig-value is (0.00) which is less than 0.05 so that information technology has the statistically significant association with picking accuracy.

Table 13: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		

1	Picking accuracy	2.400	.194		12.364	.000
	Information Technology	.335	.059	.341	5.714	.000

a. Dependent Variable: Picking accuracy

Source: Literature

The calculated outcomes presented in given above coefficient table 13 illustrate that; Information technology has the significant influence on Picking accuracy (i.e. sig value is less than 0.05). Moreover, the value of beta (0.341) shows that if information technology increases by single unit then picking accuracy will be positively changed by (0.341) unit. Thus the hypothesis three was retained.

4.7.4 Hypothesis 4

The hypothesis four proposed that "Information technology positively associated with receiving time". Simple regression was applied to test this hypothesis and the consolidated results are presented in given below tables 14.

Table 14: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.430a	.185	.182	.52044

a. Predictors: (Constant), Information Technology

b. Dependent Variable: Receiving time

Source: Literature

The given above model summary tables 14 illustrate that the value of adjusted R-square is 0.182 which emphasize that the predictor Information Technology can predicts 18.2% variance in receiving time. The possibility of error in this calculated model is 0.52044.

Table 15: ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	15.381	1	15.381	56.786	.000b
	Residual	67.714	250	.271		
	Total	83.095	251			

a. Dependent Variable: Receiving time

b. Predictors: (Constant), Information Technology

Source: Literature

The presented above ANOVA table 15 highlights the significant level of association among independent and dependent variables. As the sig-value is (0.00) which is less than 0.05 so that information technology has the statistically significant association with receiving time.

Table 16: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Receiving time	2.305	.187		12.351	.000
	Information Technology	.425	.056	.430	7.536	.000

a. Dependent Variable: Receiving time

Source: Literature

The calculated outcomes presented in given above coefficient table 16 illustrate that; Information technology has the significant influence on receiving time (i.e. sig value is less than 0.05). Moreover, the value of beta (0.430) shows that if information technology increases by single unit then receiving time will be positively changed by (0.430) unit. Thus the hypothesis four was retained.

4.7.5 Hypothesis 5

The hypothesis five proposed that "Information technology positively associated with Order picking time". Simple regression was applied to test this hypothesis and the consolidated results are presented in given below tables 17.

Table 17: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.265a	.070	.066	.62536

a. Predictors: (Constant), Information Technology

b. Dependent Variable: Order picking time

Source: Literature

The given above model summary tables 17 illustrate that the value of adjusted R-square is 0.066 which emphasize that the predictor Information Technology can predicts 6.66% variance in Order picking time. The possibility of error in this calculated model is 0.62536.

Table 18: ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	7.367	1	7.367	18.838	.000b
	Residual	97.770	250	.391		
	Total	105.137	251			

a. Dependent Variable: Order picking time

b. Predictors: (Constant), Information Technology

Source: Literature

The presented above ANOVA table 18 highlights the significant level of association among independent and dependent variables. As the sig-value is (0.00) which is less than 0.05 so that information technology has the statistically significant association with Order picking time.

Table 19: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Order picking time	2.956	.224		13.183	.000
	Information Technology	.294	.068	.265	4.340	.000

a. Dependent Variable: Order picking time

Source: Literature

The calculated outcomes presented in given above coefficient table 19 illustrate that; Information technology has the significant influence on Order picking time (i.e. sig value is less than 0.05). Moreover, the value of beta (0.265) shows that if information technology increases by single unit then Order picking time will be positively changed by (0.265) unit. Thus the hypothesis five was retained.

4.7.6 Hypothesis 6

The hypothesis six proposed that "Information technology positively associated with Order picking time". Simple regression was applied to test this hypothesis and the consolidated results are presented in given below tables 20.

Table 20: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate

1	.426a	.181	.178	.60823

a. Predictors: (Constant), Information Technology
b. Dependent Variable: Warehouse space utilization

Source: Literature

The given above model summary tables 20 illustrate that the value of adjusted R-square is 0.178 which emphasize that the predictor Information Technology can predicts 17.8% variance in Warehouse space utilization. The possibility of error in this calculated model is 0.60823.

Table 21 ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	20.466	1	20.466	55.322	.000b
	Residual	92.485	250	.370		
	Total	112.951	251			

a. Dependent Variable: Warehouse space utilization
b. Predictors: (Constant), Information Technology

Source: Literature

The presented above ANOVA table 21 highlights the significant level of association among independent and dependent variables. As the sig-value is (0.00) which is less than 0.05 so that information technology has the statistically significant association with Warehouse space utilization.

Table 22 Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Warehouse space utilization	2.162	.218		9.915	.000
	Information Technology	.491	.066	.426	7.438	.000

a. Dependent Variable: Warehouse space utilization

Source: Literature

The calculated outcomes presented in given above coefficient table 22 illustrate that; Information technology has the significant influence on Warehouse space utilization (i.e. sig value is less than 0.05). Moreover, the value of beta (0.426) shows that if information technology increases by single unit then Warehouse space utilization time will be positively changed by (0.426) unit. Thus the hypothesis six was retained

5. Summary and Conclusion

5.1 Conclusion

The main objective of the research was to examine the influence of Information and Communication Technology (ICT) on the performance of pharmaceutical warehouse operations. Additionally, the study aimed to assess the level of ICT usage, perceived warehouse operation performance, and the challenges related to its implementation. The research was specifically conducted on pharmaceutical companies in Karachi, Pakistan, and it was based on the existing warehouse management theory. The target population for this study comprised all professional staff responsible for managing warehouse operations in pharmaceutical firms in Karachi. Due to the difficulty of gathering data from every individual in the population, a sample size of fifty (50) employees was determined using the Census approach. To collect data from the respondents, a structured questionnaire was designed and distributed among the targeted population. After obtaining the data, its validity was analyzed to ensure the reliability of the results. The research hypothesis was tested through regression analysis, which confirmed that all proposed hypotheses were supported, indicating a positive impact of information technology on warehouse operations performance. Interestingly, it was observed that information technology had a greater effect on inventory accuracy, with the highest beta value of 0.552.

5.2 Discussion

The obtained results are consistent with previous research conducted in similar areas, and all proposed hypotheses were supported. The discussion of the hypothesis results is presented in the following sections:

Information and Communication Technology (ICT) tools commonly used to effectively manage warehouse operations and the entire supply chain system include Warehouse Management System (WMS), Electronic Data Interchange System (EDI), Enterprise Resource Planning (ERP), Barcode and Barcode Scanner, Radio-frequency Identification (RFID), and others. According to Awuah-Gyawu et al. (2015), WMS is described as a modern technology that enhances and improves the functional performance of warehouses by facilitating the movement of inventory and the flow of information between various functions. WMS primarily regulates the movement and storage of materials within the warehouse and handles related transactions such as shipping, receiving, put away, and picking. Radio Frequency Identification (RFID) is another advanced technology that significantly transforms warehouse operations. This technology enables smoother and more efficient warehouse processes. Previous studies suggest that RFID can enhance security, productivity, inventory control, and traceability. Enterprise Resource Planning (ERP) is another effective and widely used tool that primarily relates to the firm-level information system. It is used to streamline overall business activities and allows firms to capture information and data from the entire business into a single computer package. This provides a centralized source for all information-based functions of the business, including financials, inventory, and customer orders (Dhodi, 2018). Previous research studies and their findings demonstrate that ICT has a positive relationship with high firm performance in terms of financial and marketing performance, as well as customer satisfaction (Tseng et al., 2011).

5.3 Implications

This research study has offered valuable insights to practitioners based on the findings, and it provides implications for firms to enhance their performance. The study reveals that only a few pharmaceutical firms utilize Information & Communication Technology (ICT) for their inventory store or warehouse operations. The current level of technology adoption in warehouses is relatively low. To improve warehouse operational activities, it is crucial for firms to strengthen and optimize their ICT systems by adding valuable features and integrating it with other technologies. The study highlights the importance of firm management realizing the significance of ICT, as it can streamline tasks and lead to more efficient operations. However, it was also observed that the current usage of ICT does not entirely prevent product leakage and theft. To address this issue, proper implementation of ICT in the warehouse, such as installing CCTV cameras at various points, plays a significant role in enhancing security and detecting potential incidents. To further enhance the usage and adoption of ICT, it is suggested that pharmaceutical firms organize seminars and training sessions for their staff. These initiatives will improve the knowledge and skills of employees, ultimately leading to improved overall performance for both the employees and the firm.

5.4 Limitations & Recommendations

Similar to any other research study, this study has certain limitations and recommendations that can guide future researchers in bridging the gaps and advancing knowledge in this subject area. The limitations of this research are related to its focus on the pharmaceutical industry and the restriction of results to the industry level, without examining the scenario at the branch level. To enhance the generalizability of findings, future researchers are encouraged to investigate the role of Information & Communication Technology (ICT) on warehouse performance in other industries across Pakistan. Additionally, testing this research model in different geographical regions is recommended to gain a broader perspective and facilitate experience-sharing and benchmarking. Warehouse operation performance is not solely influenced by the implementation of ICT; other factors such as warehouse design, material handling, and availability can also play a significant role. To comprehensively understand the factors influencing warehouse operational activities, future research should explore these

additional elements. Specifically, examining how these factors impact pharmaceutical firms will contribute to improving the level of participation and effectiveness of warehouses in healthcare supply chains.

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Appendix: Questionnaire

S. No.	Items
ICT1	The agency is using information technology (IT) to manage the receiving activities of products into the warehouse.
ICT2	The agency is using information technology (IT) to manage the put-away (placing products into the right storage locations) activities of products into the warehouse.
ICT3	The agency is using information technology (IT) to manage the order picking activities of products within the warehouse
ICT4	The agency is using information technology (IT) to generate invoices for receipts and issued products from the warehouse
ICT5	The agency is using Information technology (IT) to track the batch, manufacturing and expiry date of the products within the warehouse
ICT6	The agency is using information technology (IT) to control and track overstocked, slow moving, under stocked, near expiry, and stock-out products within the warehouse.
ICT7	The agency is using information technology (IT) to generate useful report easily to support decision making(real time data availability)
ICT8	The level of information technology (IT) usage for warehouse operations is minimal
ICT9	The management recognize the importance of information technology(IT) for warehouse operations management
IA1	The warehouse inventory accuracy rate is good enough
IA2	The employed information technology (IT) tool helps to improve inventory accuracy.
IA3	The employed information technology (IT) tool helps to enhance stock visibility within the warehouse
PAA1	The warehouse picking accuracy is at good level
PAA2	The time elapsed/required to process an order is minimal(or within a reasonable time period
PAA3	The employed information technology (IT) tool helps to improve put-away accuracy
PA1	The employed information technology(IT) tool helps to improve order picking accuracy during customer order fulfillments
PA2	The employed information technology (IT) tool helps to reduce order processing time.
PA3	The employed information technology(IT) tool helps to enhance the visibility, quality, and accessibility of warehouse transaction data(provide real time data)
RT1	The time elapsed to receive the incoming commodities is minimal(within the standard time period)
RT2	The warehouse put-away accuracy is at good level
RT3	The employed information technology (IT) tool helps to reduce product receiving time.
OPT1	The employed information technology (IT) tool helps to reduce wastage due to expiry by commanding first expired first out (FEFO) principle
OPT2	The employed information technology (IT) tool helps to reduce the paper based works and human errors.
OPT3	The information technology (IT) tool helps to prevent theft and leakage of products.
WSU1	The warehouse space utilization is good
WSU2	The employed information technology (IT) tool helps to improve warehouse space utilization.
WSU3	Low level of staff confidence in the employed information technology (ICT) is one of the vii challenges for effective utilization

Source: Literature