

**The Impact of Digital Transformation and Predictive Supply Chain
Analytics on Operational Excellence and Sustainable Healthcare: An Applied
Study on Community Pharmacies in the Kingdom of Saudi Arabia**

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Abstract

This paper examines how digital transformation and predictive analytics in the supply chain affect community pharmacy operations in the Kingdom of Saudi Arabia in terms of operational excellence and sustainability. The first goal is to investigate the role of digital preparedness, perception of usefulness and ease of use of digital systems, and predictive analytics in the results of operational performance, inventory precision, and zero-waste in terms of operational performance. The descriptive-analytical research design was chosen, and a deductive line of reasoning was taken, based on the Technology Acceptance Model (TAM) and the Digital Supply Chain Maturity Model (DSCMM). Such an approach allows examining the connections between the adoption of digital and operational and sustainability metrics in the real-life pharmacy environment. Structured surveys were used as the primary data source in the study and the sample size was 315 participants (which included: staff pharmacists, pharmacy managers, supply chain managers and healthcare administrators) that were identified by purposive sampling. Constructs included in the survey were digital readiness, perceived usefulness and ease of use, accuracy of inventory and predictive capability, operational performance, and sustainability and zero-waste impact on a Likert scale. The analysis of data was done with descriptive statistics, correlation and ANOVA to test the main and sub-hypotheses. The results established that increased digital readiness contributes extensively to the operational performance, such as procurement effectiveness, supply chain responsiveness, and decision-making accuracy. Attributed usefulness and user-friendliness of digital systems positively affect accuracy of inventory and predictivity, resulting in a reduced number of stock-outs and efficient medication allocation. Moreover, the implementation of digital solutions and predictive analytics is of significant importance towards sustainability and zero-waste initiatives, lowering the number of expired medications, decreasing the number of unnecessary inventory, and facilitating greener pharmacy work. As per these results, the study suggests strategic investment in digital infrastructure, more staff training and digital literacy initiatives, the

culture of digital adoption, integration of sustainability objectives into operations planning, the regularity of evaluation and benchmarking, and supportive policies of healthcare authorities to facilitate national digital transformation.

keywords :Digital Transformation, Predictive Supply Chain Analytics, Operational Excellence, Sustainability, Zero-Waste, Community Pharmacies, Saudi Arabia, Technology Acceptance Model, Digital Readiness.

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Chapter one: Introduction

Introduction

Supply chains are one of the enablers of organizational effectiveness in any of the service and production industries. They are the combined set of activities, processes, information and flows of resources that guarantee the timely and cost-efficient flow of goods in the hands of the end users through suppliers. The supply chains in healthcare sector have even a bigger weight as they are directly associated with patient safety, continuity of treatment and the overall outcome of health to the population. The community pharmacies are the last and most essential connection in this system as a primary contact between the healthcare system and patients. Thus, the performance and the reactivity of drug supply chains are critical factors in uninterrupted availability of drugs and the prevention of elevated patient satisfaction rates.

Supply chain management is closely related to its operational performance. It includes the pointers like the accuracy of inventories, the speed with which orders are fulfilled, quality of the service, cost-efficiency, and waste minimization. The performance of the operations is enhanced when supply chains are effectively integrated, data-driven and demand responsive. Nonetheless, most community pharmacies in Saudi Arabia are still practicing conventional and reactive supply chain strategies. The decisions to be made about inventory are usually made based on the historical sales, a manual count of stock, or sometimes intuition instead of predictive analytics. Such a reactive approach results in either surplus stock, which capitalizes on the change and exposes the business to the risk of losing its stock or in stockouts which interfere with treatment regimens and are detrimental to patients, especially chronic ones.

Sustainable healthcare is not about a single event of offering quality services today, it is also about making healthcare systems economically sustainable, environmentally sustainable, and social equity in the long run. Healthcare sustainability demands effective use of resources, minimization of pharmaceutical waste, better use of

cost and better delivery of services. These objectives are directly related to supply chain optimization. Precise demand prediction and enhanced inventory management leads to reduction of expired drugs and trash in the landfill, reduction of operational expenses and enhancement of medication access in the market, which enhances the environmental, economic, and social aspects of sustainability at the same time.

The pharmacy industry in the world is rapidly changing due to digital technologies. Raised real-time data, predictive demand forecasting, and automatic replenishment processes are becoming possible with the help of artificial intelligence (AI), Internet of Things (IoT) technologies, and cloud-based management systems. The technologies enable pharmacy managers predict the patterns of demand, make a better coordination with suppliers, reduce wastes, and provide life-saving drugs when needed. The reactive-predictive supply chain model transformation increases operational excellence and better service delivery to patients.

This change in Saudi Arabia is in line with Saudi vision 2030 goals of modernization of the healthcare sector, digital transformation, and sustainability of the system. Nationally led programs like Wasfaty, Nafith, and Seha Virtual Hospital are the efforts of the Kingdom to create a more connected, efficient, and technology-focused healthcare system. Regardless of all these attempts, not all community pharmacies have actively implemented predictive supply chain analytics or other sophisticated digital solutions to streamline their operations.

The relevance of the topic is consequently scholarly and practical. Academically, it can be seen that research gap exists in terms of studying the combined effect of digital transformation and predictive supply chain analytics on operational excellence and sustainable healthcare in pharmacies of the Saudi community. Practically, a higher level of forecasting reliability, efficient inventory management, and minimization of pharmaceutical waste can greatly contribute to the quality of the services, saving money, and contributing to the long-term sustainability objectives.

To this end, exploring the interaction between digitalized supply chains, operational performance and sustainable healthcare is a decisive move in creating smarter, data-driven operations models to community pharmacies in Saudi Arabia- models that supersede the old responsive models of operation with predictive, efficient and patient-centred models.

Research Problem

Based on the discussions above, it is clear that the community pharmacies in Saudi Arabia are in the fragmented and mostly reactive supply chain environment. Although the Kingdom is undergoing a wider digital health transformation, the majority of pharmacies still use manual input of inventory and one-off point-of-sale systems and past sales records that cannot reflect the current consumption trends and changes in supply. It causes two continuing functional issues, stockouts that disrupt patient care and overstocking that causes wastage of medication, losses of finances, and environmental costs. Although predictive analytics, automation, and integrated digital platforms have been increasingly implemented in hospitals and larger distributors, the community pharmacies are on the edge of this technology ecosystem. The lack of a common national digital platform between the pharmacies and their suppliers, regulators, and central warehouses further enhances this gap in operations. Lacking real-time visibility, automated notifications, and a centralized medication tracking database, pharmacies find it difficult to make accurate demand forecasts, predict shortages, or take a more proactive approach to market disruptions such as it was evidently seen during the COVID-19 pandemic. Furthermore, the absence of uniform principles regarding the digital migration and the inadequacy of the workforce training in the modern supply chain systems makes the problem even worse. Numerous pharmacy employees do not have the digital skills necessary to use advanced inventory management tools, serving as another obstacle to change and a source of continuation of the old way of doing things. The major issue with that, correspondingly, is the low level of digital transformation and predictive supply chain analytics implementation among the pharmacies operating in the Saudi community,

and the consequential unfavorable consequences on the operational efficiency, availability of medications, waste minimization, and sustainability of healthcare in the long term. As such, the primary research question may be based on the following: How can digital transformation and predictive analytics of the supply chain change operational performance and sustainable healthcare in Saudi Arabian community pharmacies?

Research Objectives

Main Objective

- The primary aim of the research paper is to explore to what extent digital transformation and predictive supply chain analytics can be used to improve the work of a community pharmacy in Saudi Arabia in terms of operation performance and the promotion of sustainable healthcare through the use of the central research question related to the aspects of improving the accuracy of the forecasts, efficiency of the inventory, and minimization of waste.

Sub-Objectives

The study aims at realizing the following specific objectives in order to realize the main objective:

- To determine the degree of digitalization of the supply chain processes in community pharmacies in Saudi Arabia.
- To determine the primary digital tools and technologies that have already been implemented in the realm of pharmacy inventory and supply chain management including Artificial Intelligence (AI), Internet of Things (IoT), Enterprise Resource Planning (ERP) systems, and Big Data analytics.
- To look at the effect of digital incorporation on the precision of demand forecasting, reduction of lead time, efficiency of the inventory management and minimization of the medication waste.

- To assess whether the community pharmacies are organizationally, technically, and humanly ready to assume the predictive digital inventory systems in line with Saudi Vision 2030.
- To determine the major issues and obstacles to adoption of predictive supply chain technologies within the community pharmacies
- To prepare a strategic framework that will guide the community pharmacies towards the implementation of predictive, data-driven, inventory management systems with the goal of attaining zero waste and operational excellence.

Research Questions

- Which are the primary digital tools that are currently implemented in community pharmacy supply chains?
- What demands can be forecasted, controlled in terms of inventory, and reduced with the help of digital integration?
- What are the issues that do not allow community pharmacies to implement predictive digital systems?
- To what extent are pharmacies in the Saudi community well prepared to be digitally transformed in vision 2030?
- What is the model that can be used to implement predictive, data-driven inventory systems in pharmacies?

Research Hypothesis

Main Hypothesis (H1):

- H1: The digital transformation and predictive supply chain analytics influence the operational excellence and sustainability in community pharmacies in the Kingdom of Saudi Arabia in a significant positive sense.

Sub-Hypotheses:

- H1a: Digital readiness, operational performance with respect to procurement efficiency, supply chain responsiveness, and decision-making accuracy have a positive relationship in higher levels in community pharmacies.
- H1b: Perceived usefulness and ease of use of digital systems (according to the Technology Acceptance Model) has a positive influence on inventory accuracy and predictive capability resulting in less stock-outs and optimized medication distribution.
- H1c: The use of digital systems and predictive analytics is a very important contribution to the sustainability and zero-waste goals, decreasing the number of expired medications, minimizing excess inventory, and ensuring responsible pharmacy work on a long-term basis..

Theoretical Significance

The present research fits the scholarly pool of knowledge by furthering the theoretical knowledge on the convergence of digital transformation, supply chain management, and healthcare operations as it applies to the community pharmacies in Saudi Arabia. Even though the benefit of digital supply chain transformation has been broadly reported in the manufacturing sector and large-scale healthcare organizations, no studies have investigated its use in small-to-mid healthcare retailers like community pharmacies. There is thus a gap in theoretical knowledge between this research. Namely, the research expands the effectiveness of Digital Supply Chain Maturity Model (DSCMM) by evaluating its aspects in the environment of decentralized pharmacy networks, hence providing a contextualized view of digital maturity, integration, and predictive potential in pharmaceutical retailing activities. Besides that, it further enhances the explanatory value of the Technology Acceptance Model (TAM) by examining the connection between how pharmacy professionals perceive and use predictive analytics and digital inventory systems in a highly regulated healthcare setting. The study has created an interdisciplinary linkage between information systems theory, the supply chain management theory, and the healthcare operations management through the combination

of these two frameworks. Moreover, the research contributes to the theoretical debates on operational excellence and sustainable healthcare by testing the hypothesis of the relationship between digital transformation and performance results through the empirical study of how predictive supply chain analytics mediates the connection between the two. It is a contribution to the literature on sustainability because it correlates the development of digital capabilities with waste minimization, cost reduction, and the responsibility to the environment in pharmaceutical distribution. By doing this, the study offers a conceptual basis regarding further studies on digital ecosystems of healthcare supply chains in emerging economies.

Practical Significance

In practice, this study has practical implications on the activities of various stakeholders in the Saudi healthcare system. To the managers of community pharmacies, the research provides evidence-based perspectives on how predictive analytics, real-time monitoring, and digital integration can be used to decrease stockouts and minimize expired drugs, increase inventory turnover, and enhance the efficiency of daily operations. The results can be used in strategic decision-making on digital investment and training of the workforce. To the healthcare policymakers, especially those aiming at achieving the goals of Saudi Vision 2030, the study has offered empirical evidence to the expansion of any digital transformation initiative in the pharmaceutical supply chains. It illuminates the importance of empowering digital infrastructure at the community pharmacy to ensure more individuals can gain access to medications, better use of the available resources, and sustainability of healthcare. In the case of suppliers and pharmaceutical distributors, the research illustrates the importance of integrating digitally and implementing shared data systems in enhancing coordination, accuracy of forecasting and efficiency of replenishment. The improved cooperation can minimise the logistical inefficiency and enhance the reaction associated with market changes. The study also provides a viable set of suggestions that can guide the formulation of national digital models, common databases and automated warning mechanisms that may be used to link

the pharmacies with their suppliers and regulatory organizations. Such insights can help decision-makers to create standardized digital migration policy and capacity-building initiatives of the staff in the pharmacy..

Strategic Importance

Strategically, this study supports the transformation of community pharmacies from reactive, manually managed entities into proactive, predictive, and digitally integrated healthcare service providers. By embedding predictive supply chain analytics within pharmacy operations, the sector can align more closely with national sustainability and healthcare modernization goals.

The implementation of this research can contribute to a more resilient pharmaceutical distribution system, improved patient access to medications, reduced environmental waste, and enhanced operational competitiveness. Ultimately, it strengthens the broader healthcare ecosystem in Saudi Arabia by promoting a reliable, efficient, and sustainable model of community pharmacy management.

Literature Review

Deloitte Report (2023) studied the role of digital transformation and advanced analytics in the healthcare supply chain considering hospitals and pharmaceutical distributors. The goal of the study was to learn how the implementation of these technologies would be effective in enhancing efficiency and decreasing waste. Based on the case studies and comparative performance assessment pre-implementation and post-implementation, the report reported that organizations that deployed advanced analytics had a 30-50% inventory turnover improvement, and a 20% decrease in wastage of medication. This paper identifies how digital tools can increase transparency and efficiency in healthcare supply chains in terms of resource management.

PwC (2022) explored the ability of AI-based demand forecasting systems in the community pharmacies. The research involved a comparative study of the conventional manual reorder systems and predictive systems based on AI and built on Enterprise Resource Planning (ERP) systems. Findings showed that AI forecasting tools would be able to forecast demand with a 90 percent accuracy thereby minimizing overstock and stockouts. The report also confirmed that predictive analytics coupled with real-time data would help manage inventory more effectively, and even in semi-digital pharmacies, such tools may make a remarkable difference in terms of the efficiency of the operational process. NHS Model, United Kingdom In the United Kingdom, the National Health Service (NHS) has adopted a central management of the digital ordering service in reviewing the stock levels in the nation. Research on the model showed that there is better replenishment of stocks, waste is minimized, and coordination between pharmacies and distributors with interoperability and centralized monitoring. The experience of the UK proves the positive side of complete national digitalization, such as a real-time overview of inventory and automatic replenishment systems, which contribute to avoiding shortages and overstocking.

Alnasser (2022) - Saudi Arabia Alnasser (2022) paid attention to online preparedness of the community pharmacies in Saudi Arabia. The research considered adoption rates of ERP systems and AI-based forecasting tools; it was conducted by surveying several pharmacies. The results showed that more than 60 per cent of community pharmacies in Saudi had been using manual reorder system and less than 20 per cent had adopted digital systems. Such critical issues as disjointed software, lack of integration with suppliers, and little use of local platforms like Wasfaty were mentioned in this study. It highlights the difference between Saudi pharmacies and their foreign counterparts in digitalization and efficiency of operations.

WHO Report (2023) The World Health Organization (2023) examined how digital transformation might help reduce pharmaceutical waste and enhance health care supply chain sustainability. Through cross-examination of reports on the topic in

countries around the world and relying on data on inventory and waste, the study identified that digitalization increases drug accessibility, enhances the resiliency of the supply chain, and reduces wastage. The report has highlighted that the data-driven decision-making approach, predictive analytics, and integrated digital systems are crucial in promoting sustainable supply chain practices in healthcare. Commentary and Analysis.

Commentary and Analysis

The reviewed studies collectively highlight that digital transformation and advanced analytics significantly improve supply chain performance, inventory management, and waste reduction in healthcare. A major similarity among them is the emphasis on predictive tools and real-time data for better decision-making. However, differences exist in scale and context. International studies (e.g., NHS, Singapore) focus on national-level integration, demonstrating highly coordinated digital ecosystems, while local studies (e.g., Alnasser, 2022) point to partial digitization, fragmented systems, and operational challenges in community pharmacies.

A notable research gap is the lack of comprehensive frameworks tailored to community pharmacies in developing countries, particularly in Saudi Arabia. Existing literature often overlooks practical applications of digital tools in local settings and fails to link theoretical models with real operational outcomes. This study aims to bridge these gaps by examining how digital transformation, predictive analytics, and system interoperability can enhance efficiency, reduce waste, and improve patient care in Saudi community pharmacies.

Critical Evaluation of Prior Studies and Research Gap

Despite the substantial body of literature supporting the positive impact of digital transformation and predictive analytics on healthcare supply chain performance, several methodological and contextual limitations remain evident. A considerable proportion of existing studies—particularly industry reports such as those issued by Deloitte and

PwC—rely predominantly on case study approaches, benchmarking analyses, or aggregated secondary data. While these approaches provide valuable descriptive insights and performance indicators, they often lack rigorous inferential statistical testing capable of establishing direct causal relationships between independent and dependent variables. Consequently, the explanatory depth of these studies is limited, particularly in terms of measuring the magnitude and direction of impact across multiple constructs within a unified analytical framework.

From a contextual perspective, much of the international evidence—such as evaluations of the National Health Service digital integration model—originates from highly centralized and digitally mature healthcare systems. These environments benefit from strong governmental coordination, standardized interoperability frameworks, and nationwide digital infrastructure. Such structural advantages differ significantly from decentralized pharmacy markets in developing or transitional economies, including Saudi Arabia, where digital adoption remains fragmented and operational systems are often partially integrated. Therefore, direct generalization of findings from fully digitalized national systems to semi-digital community pharmacy settings may overlook critical institutional and infrastructural constraints.

Moreover, local studies within Saudi Arabia have largely concentrated on assessing digital readiness levels or adoption rates without empirically linking these variables to measurable operational excellence or sustainability outcomes. For example, research highlighting limited ERP and AI adoption does not extend to testing structured theoretical models that integrate digital readiness, technology acceptance, predictive analytics, and sustainability performance within a single analytical model. This indicates a methodological gap in terms of multi-variable statistical modeling and theory-driven hypothesis testing.

Additionally, the literature tends to examine technological infrastructure and human acceptance factors in isolation rather than as interdependent constructs influencing

operational and environmental performance simultaneously. The absence of integrated frameworks combining digital transformation, behavioral acceptance dimensions, predictive capabilities, and sustainability metrics creates a theoretical fragmentation in the field.

Accordingly, a significant research gap exists in developing and empirically validating a comprehensive, context-sensitive model that examines the direct impact of digital transformation and predictive supply chain analytics on operational excellence and sustainability within community pharmacies in Saudi Arabia. The present study addresses this gap by employing quantitative hypothesis testing and multivariate analysis to establish causal relationships, quantify effect sizes, and provide contextually grounded evidence. In doing so, it contributes to both theory development and practical policy implications for semi-digital healthcare environments.

Theoretical Framework

This study builds its theoretical foundation on two main models: the Technology Acceptance Model (TAM) and the Digital Supply Chain Maturity Model (DSCMM). These frameworks together provide a comprehensive understanding of the digital transformation process in community pharmacies by examining both human behavioral factors and the organizational capacity for digital integration.

The Technology Acceptance Model (TAM), developed by Davis in 1989, is widely used to understand how individuals adopt new technologies. According to TAM, two primary factors drive technology adoption: perceived usefulness and perceived ease of use. Perceived usefulness refers to the degree to which a person believes that a technology will enhance their job performance, while perceived ease of use reflects the effort required to utilize the technology effectively. In the context of community pharmacies, pharmacists and managers who perceive digital tools, such as AI-based inventory systems, as both useful and easy to use are more likely to adopt them. However, adoption is influenced not only by these perceptions but also by organizational support,

staff digital literacy, the availability of adequate infrastructure, and management commitment. In this study, TAM is applied to examine how perceived usefulness and ease of use, alongside organizational and human enablers such as training and managerial support, influence the adoption of digital supply chain systems in Saudi community pharmacies.

On the other hand, the Digital Supply Chain Maturity Model (DSCMM) evaluates an organization's level of digital integration and readiness across the supply chain. The model outlines a progression from traditional, manual operations to fully autonomous and predictive supply chains. Organizations in the early stages have limited digital tools and rely heavily on manual processes, while those in the later stages achieve real-time data sharing, automated operations, and predictive capabilities. In Saudi Arabia, community pharmacies generally fall between the second and third stages, indicating that while digital tools are present, integration and predictive functionality remain limited. The DSCMM allows for assessing the maturity of digital supply chains, identifying gaps in data availability, system connectivity, automated ordering, and integration with national platforms such as Wasfaty. It provides a roadmap for pharmacies to enhance operational efficiency, improve forecasting accuracy, and reduce waste.

Integrating TAM and DSCMM creates a dual-structured framework that addresses both the human and organizational aspects of digital transformation. TAM focuses on the psychological and behavioral factors that influence technology adoption, whereas DSCMM examines the technical and operational maturity of the supply chain. By combining these models, the study explores why digitalization succeeds or fails in community pharmacies, highlighting the interplay between employee acceptance and organizational capability. This integration also connects inputs such as digital tools, infrastructure, training, and management support to processes including AI, IoT, and ERP system integration, ultimately linking them to outcomes like predictive inventory management, operational efficiency, and zero waste. The holistic approach provided by this integrated framework allows researchers to understand both the readiness of

pharmacy staff to adopt digital tools and the organization's capacity to implement effective, data-driven supply chain systems.

Chapter Two: Literature Review

2.1 Introduction

The healthcare industry is experiencing a structural change that has never been witnessed before through digital technologies, data based-decision models, and the pressure to operate at an excellent standard and at the same time remain sustainable. The supply chains in healthcare have taken center stage in the performance of institutions especially because of the direct effect they have on the cost, quality of services, patient safety, and environmental responsibility. Historically, healthcare supply chains were distinct with fragmented procurement systems, lacked visibility, reactive inventory operations, and lacked co-ordination among stakeholders. Nevertheless, with the appearance of digital transformation and predictive analytics, the manner in which healthcare organizations design, operate, and optimize supply chain operations has been rewritten fundamentally. Digital technology integration is no longer a choice but rather a strategic option to be responsive, resilient, and sustainable in the long-run.

Recent academic works highlight the fact that operational excellence in healthcare is impossible without digital integration and predictive intelligence. As an example, Edeoghon and Bhatt Mishra (2026) reveal that digital transformation programs contribute to a great increase in the efficiency of processes and reliability of performance in the healthcare supply chains. On the same note, Nwokocha (2024) claims that digital transformation is a strategic tool to realizing operational excellence and also integrating sustainability into the supply chain systems. These results suggest that predictive supply chain analytics and digital transformation are closely related contributors to sustainable healthcare performance. To this end, the chapter will be a synthesis of available literature aimed at developing a thorough theoretical and empirical basis of studying the effects of

digital transformation and predictive analytics on operational excellence and sustainable healthcare system..

2.2 Digital Transformation in Healthcare Supply Chains

Digital transformation in healthcare supply chains means the organized implementation of new digital technologies in the form of artificial intelligence, big data analytics, cloud computing, blockchain, Internet of Things (IoT) and automation systems into the procurement process, inventory management, logistics coordination and supplier collaboration. It involves not only the technological modernization, but organizational restructuring, cultural adaptation, strategic refocus and performance and value-creation. Edeoghon and Bhatt Mishra (2026) present empirical data that the digital transformation is among the main factors that enable the healthcare supply chain networks to enhance transparency, real-time tracking, and efficiency in coordination. They found that the more digital healthcare organizations are more responsive, have a lower cost of operations and better service reliability. The authors continue to highlight that digital platforms will facilitate co-ordinated communication between suppliers, distributors and healthcare providers, thus curbing the delays and minimizing supply disruptions. Likewise, in their extensive systematic review, Avinash and Joseph (2024) state that digital transformation will increase efficiency, transparency, and responsiveness in healthcare supply chains. They indicate that pharmaceutical products traceability can be enhanced using technologies like blockchain, artificial intelligence can enhance accuracy of demand forecasting, and the development of digital twins offers an opportunity to optimize logistics networks through simulation.

With all the mentioned technological advances, the waste is minimized, the availability of fake medicines is prevented, and the adherence to the regulations standards is achieved. The positive correlation between digital transformation and operational excellence is further supported by Nwokocha (2024) who shows that digitally empowered supply chains can attain high performance in agility and sustainability. The analysis

reveals that with the help of digital technologies, organizations can minimize carbon emissions and improve the efficient use of resources by means of real-time data gathering and monitoring of environmental performance. Further, Ajayi-Kaffi et al. (2025) suggest agile-based digital transformation models to improve supply chain management systems based on clouds in healthcare. Their results show that cloud integration and agile approach enhance scalability, interoperability and system flexibility which are critical in managing dynamic healthcare needs and crisis cases. Throughout the literature, it is hypothesized that digital transformation is a structural enabler, which enhances visibility, integration, and coordination within healthcare supply chains, and provides a key base upon which operational excellence and sustainability can be achieved..

2.3 Predictive Supply Chain Analytics and Digital Intelligence

Predictive supply chain analytics is one of the central directions of digital transformation, where it is possible to speak about more sophisticated statistical models, machine learning algorithms, and data mining tools that can predict demand trends, foresee disruptions, and optimize the allocation of resources. Predictive analytics is a relevant concept in healthcare settings to avoid stock-outs of important medical supplies, enhance procurement choices, and patient care continuity.

Fowowe and Adedapo (2025) support the idea that, when used in predictive analytics, operational excellence is greatly enhanced, as it allows proactive decision-making and optimization of performance. They prove the hypothesis that organizations which utilize the predictive forecasting models exhibit lower inventory expenses, increased accuracy of orders, and customer satisfaction. Predictive analytics enables healthcare managers to switch to reactive supply chain strategies to data-driven anticipatory planning models with minimal uncertainty and operational inefficiencies.

Oluwole et al. (2024) underline that predictive analytics improves the optimization of the pharmaceutical supply chain by harmonizing the supply strategies

with the concept of value-based healthcare economics. With the combination of predictive demand planning and financial performance analysis, it will be possible to ensure cost containment and at the same time ensure high service standards in the healthcare institutions. This effectiveness and value creation duality underlines the strategic significance of predictive analytics in the realization of sustainable healthcare processes.

Ma and Kang (2025) explain the notion of digital intelligence, claiming that predictive decision optimization enhances the capacity to innovate and the resiliency of supply chains. According to their findings, predictive analytics systems will allow healthcare organizations to predict the risks in their supply chain, respond to market changes, and overcome disruptions quickly. But Hussain et al. (2024) note that there are several issues related to the implementation of big data analytics, such as the fragmentation of the data, cybersecurity risks, privacy issues, and the absence of analytics expertise. Based on the resource-based approach, they are of the opinion that healthcare organizations should establish great digital proficiencies and directions of governance to ensure the full potential of predictive analytics.

Altogether, predictive supply chain analytics proves to be a transformational potential enabling to increase accuracy of decisions, risks management, and sustainability of performance, which is one of the main sources of operational excellence in medical facilities.

2.4 Operational Excellence in Sustainable Healthcare Supply Chains

Operational excellence in healthcare supply chain has been defined as the pursuit of high performance levels in the form of constant enhancement, cutting down of waste, fused of processes, and alignment of operational activities with the organizational goals. It is not limited to efficiency but resilience, quality assurance, risk mitigation, and environmental sustainability. According to Mangla et al. (2020), operational excellence

is a key factor in enhancing sustainable supply chain performance because it combines lean management concepts with the environmental responsibility structures. Their results indicate that the process optimization, minimization of waste, and the systems of performance measurement improve the economic and environmental performance. In a healthcare setting, operational excellence would guarantee the timely provision of medical supplies as well as minimise unnecessary resource use.

Detwal et al. (2024) link operational excellence with Healthcare 4.0 technologies, emphasizing automation, smart systems, and digital integration as core enablers of high-performance healthcare operations. Their systematic review indicates that digital transformation enhances service reliability, reduces variability, and improves patient-centered outcomes. The integration of digital tools within operational processes strengthens coordination and minimizes human error, thereby elevating healthcare performance standards.

Al Doghan and Abd Razak (2024) further demonstrate that supply chain integration and digital technology adoption mediate the relationship between organizational capabilities and sustainable operational excellence. Their findings reveal that integrated digital systems enhance collaboration among stakeholders, improve information sharing, and facilitate coordinated decision-making, which collectively contribute to sustainability and performance improvement. Additionally, Senna et al. (2024) emphasize the importance of supply chain risk management in achieving operational excellence, arguing that proactive risk identification and mitigation strategies enhance resilience and stability in healthcare supply chains.

These studies collectively confirm that operational excellence in healthcare supply chains is multidimensional, encompassing efficiency, sustainability, resilience, and innovation, all of which are significantly influenced by digital transformation and predictive analytics capabilities.

2.5 Sustainability and Green Process Innovation in Digital Healthcare Supply Chains

Sustainability in healthcare supply chains involves balancing economic performance with environmental stewardship and social responsibility. Digital transformation contributes to sustainability by enabling data-driven environmental monitoring, resource optimization, and green innovation practices.

Benzidia et al. (2024) demonstrate that big data analytics capability enhances green process innovation in healthcare operations and supply chain management. Their study indicates that analytics-driven insights enable organizations to reduce waste, improve energy efficiency, and minimize carbon emissions. Digital systems facilitate precise tracking of resource consumption, thereby supporting environmentally responsible decision-making.

Nwokocha (2024) similarly argues that digital transformation enhances sustainable operational performance by promoting efficient resource utilization and waste reduction strategies. Al Doghan and Abd Razak (2024) further emphasize that digital adoption strengthens supply chain integration, which mediates sustainability outcomes and reinforces operational excellence.

Moreover, Yogeswaran et al. (2025) adopt a dynamic capabilities perspective to explain how digital technologies enable organizations to adapt sourcing strategies and enhance pharmaceutical supply chain performance. Their findings suggest that digital capabilities support long-term sustainability by enabling organizations to reconfigure resources in response to environmental and market changes.

In essence, sustainability in healthcare supply chains is increasingly driven by digital intelligence and predictive analytics, which embed environmental and social considerations into operational decision-making frameworks.

2.6 Synthesis of Literature and Research Gap

The reviewed literature consistently demonstrates that digital transformation enhances supply chain visibility, coordination, and efficiency, while predictive analytics improves forecasting accuracy, risk management, and decision optimization. Operational excellence emerges as a multidimensional outcome influenced by digital integration, innovation capability, supply chain integration, and sustainability practices. However, despite the growing body of research, there remains limited empirical investigation integrating digital transformation and predictive supply chain analytics simultaneously within a unified framework focused on sustainable healthcare operational excellence. Many studies examine digital transformation or sustainability independently, while fewer explore the mediating mechanisms—such as resilience, innovation capability, and green process innovation—that link digital intelligence to operational excellence outcomes.

Therefore, this study seeks to address this gap by developing an integrated framework that examines the combined impact of digital transformation and predictive supply chain analytics on operational excellence and sustainable healthcare performance, thereby contributing to both theoretical advancement and practical implementation strategies in healthcare supply chain management.

Chapter Three: Research Methodology

3.1 Introduction

The current chapter describes the methodological model that is used to examine how digital transformation and predictive supply chain analytics affect operational excellence and sustainable healthcare in community pharmacies in the Kingdom of Saudi Arabia. The methodology presents a systematic account of how the problem of the research was handled, the way data were collected and analyzed, and the way the validity and reliability of the results were accommodated. The main aim of this chapter is to illustrate that the research was done in a systematic, rigorous and scientifically sound process that can give credible and generalizable results.

3.2 Research Philosophy and Approach

The research philosophy is based on positivist research philosophy, which presupposes that the reality is objective and can be measured using empirical observation and statistical analysis. As the study aims to test well-defined hypotheses of the connections between the digital transformation, predictive supply chain analytics, operational excellence, and sustainability, a positivist approach is especially suitable. The

philosophical direction endorses quantitative techniques in order to measure perceptions, behavior and organizational practices in a systematic way.

The research takes the deductive research approach in accordance with this philosophy. The deductive approach starts with the already existing theoretical premises, especially, the Technology Acceptance Model (TAM) and the concept of digital supply chain maturity, and derives testable hypotheses. As opposed to creating theory, the research determines whether theoretical premises are valid in the setting of the Saudi community pharmacies. The hypotheses were developed on theoretical grounds and tested with statistical analysis to find out whether the data is in favor of the hypothesis or not.

3.3 Research Design

In this study, a cross-sectional design using descriptive-analytical research is adopted. The descriptive part will allow the researcher to provide a vivid picture of the demographic data of respondents and the general state of digital preparedness, perceived usefulness, predictive ability, operational performance, and sustainability practices. The study gives an understanding of the current trends and perceptions in the pharmacy industry through the application of descriptive statistics like means and standard deviations.

The analysis component is more than the description because it discusses the relationships and causation patterns of variables. The statistical significance of the differences between the different levels of digital adoption and its effects on the outcomes of performance and sustainability are tested with the help of inferential statistical methods, namely, Analysis of Variance (ANOVA). The study is cross-sectional since data were collected at one specific point in time and this presents a snapshot of the practices of digital transformation among community pharmacies in Saudi Arabia. This

type of design is appropriate when it is needed to evaluate the connections between variables without having to follow them over an extended period

3.4 Research Population

The population of the research will be professionals in community pharmacies in Saudi Arabia. These are the staff pharmacists, pharmacy managers, supply chain managers, and the healthcare administrators, all of whom directly participate in the pharmacy operations and the use of digital systems. This population has been chosen based on the fact that they have firsthand experience with inventory management systems, procurement operations, forecasting mechanisms and sustainability measures. Community pharmacies form a very important part of Saudi Arabian healthcare system as they are a form of front line healthcare providers and distributors of medications. As the key players in the field of medication dispensing and supply chain coordination, the analysis of digital transformation in the given context provides the useful information about both the operational performance results and sustainability results in the healthcare field in general.

3.5 Sample Size and Sampling Technique

A total population of 315 respondents was used in the study based on the research population. This is deemed as a statistically adequate sample to carry out an inferential analysis and there is an adequate variability to measure apparently significant differences between groups. A purposive approach to sampling was used to sample individuals who have a pertinent professional experience and a direct exposure to digital systems in the nature of pharmacy operation.

The purposive sampling was suitable as the study necessitated the involvement of respondents with the ability to make qualified and useful a response on digital preparedness, forecasting analytics, and sustainability practices. The sample was chosen among people working in their professional positions and participating in the operational

and supply chain operations. In spite of the fact that purposive sampling lacks same randomness as probability sampling, it guarantees the relevancy and richness of the data that is gathered.

3.6 Data Collection Instrument

The structured questionnaire was used to collect the data that was designed on the basis of detailed analysis of scholarly literature and theoretical frameworks. The questionnaire was constructed to make the study measure the key constructs in a systematic and clear way. It was divided into two parts, namely; demographic information and measurement items that concerned the research variables.

The measurement section comprised 30 statements that were spread over five constructs as Digital Readiness, Perceived Usefulness and Ease of Use (TAM), Inventory Accuracy and Predictive Capability, Operational Performance, and Sustainability and Zero-Waste Impact. The respondents were requested to respond to their level of agreement on a five point Likert scale which started strongly disagree and strongly agree. This method of scaling permits measuring perceptions and statistical analysis of their results with the help of parametric analysis.

The questionnaire was conveyed electronically to ensure that a wide margin of participation could occur in the various areas of Saudi Arabia. The online distribution system was used to ensure that it was most accessible, efficient, and fast in collecting data and was also respondent confidential.

3.7 Variables of the Study

Both independent and dependent variables are incorporated in the study. The independent variables are mostly the dimensions of digital transformation such as digital readiness, perceived usefulness and ease of use, and predictive analytics adoption. The variables indicate the degree of digital maturity and technological acceptance in the

community pharmacies. The dependent variables are operational performance, predictive capability and accuracy of inventory, and sustainability outcomes. Operational performance includes efficiency in procurement, responsiveness in supply chain and accuracy of decisions. The outcomes of sustainability are aimed at decreasing the number of expired drugs, decreasing excess stock, and helping to achieve zero-waste. The Likert-scale results were used to measure all the variables, and quantitative statistical analysis was used to compare the relationship between variables.

3.8 Validity and Reliability

The validity and reliability of the research instrument was an important part of the methodological process which needed to be ensured. The content validity has been achieved by means of thorough examination of the pertinent academic literature and the involvement of experts in the subject matter. All the questionnaire items were well aligned to their respective theoretical construct so as to ensure that they were measuring the intended dimension.

Construct validity was achieved by organizing the questionnaire items according to well-established theoretical frameworks, particularly the Technology Acceptance Model and digital supply chain management theories. This alignment strengthens the conceptual integrity of the instrument and ensures theoretical consistency.

Reliability was assessed using Cronbach's Alpha coefficient to evaluate internal consistency among items within each construct. Values exceeding the acceptable threshold indicate that the items within each dimension consistently measure the same underlying concept. The reliability analysis confirmed that the instrument demonstrates satisfactory internal consistency, supporting the credibility of the findings.

3.9 Data Analysis Techniques

The collected data were analyzed using statistical software to ensure accuracy and systematic interpretation. Descriptive statistics were first computed to summarize demographic characteristics and calculate mean scores and standard deviations for each questionnaire item and construct. These statistics provided an overview of respondent perceptions regarding digital transformation and its outcomes.

Inferential statistical analysis was then conducted to test the study's hypotheses. One-Way ANOVA was used to examine whether significant differences exist between different levels of digital adoption and their impact on operational excellence and sustainability. The significance level was set at 0.05, meaning that results with p-values below this threshold were considered statistically significant. The use of ANOVA is appropriate because it allows comparison between multiple groups and helps determine whether variations in digital readiness or technology acceptance lead to measurable differences in performance outcomes.

3.10 Ethical Considerations

The study adhered to recognized ethical research standards throughout the data collection and analysis process. Participation was voluntary, and respondents were informed about the purpose of the research before completing the questionnaire. Informed consent was obtained electronically, and participants were assured that their responses would remain anonymous and confidential.

No personal identifiers were collected, and the data were used exclusively for academic research purposes. All information was stored securely and handled in accordance with institutional research ethics guidelines. These measures ensured that the study-maintained integrity, transparency, and respect for participant rights.

3.11 Summary

This chapter presented a comprehensive explanation of the methodological framework used to examine the relationship between digital transformation, predictive supply chain analytics, operational excellence, and sustainability in community pharmacies in Saudi Arabia. The study adopted a quantitative, descriptive-analytical design grounded in positivist philosophy and deductive reasoning. Data were collected from 315 pharmacy professionals using a structured questionnaire and analyzed using descriptive and inferential statistical techniques. The methodological rigor applied in this study provides a solid foundation for interpreting the results presented in the subsequent chapter.

Chapter four: Data analysis

Demographic analysis

Table 1: Distribution of Respondents by Gender (N = 315)

Gender	Frequency	Percentage (%)
Male	182	57.8%
Female	133	42.2%
Total	315	100%

The gender distribution of the study sample reveals that out of 315 respondents, 182 participants (57.8%) were male, while 133 participants (42.2%) were female. This distribution indicates a moderate predominance of male respondents within the surveyed community pharmacies in the Kingdom of Saudi Arabia. Although both genders are well represented in the sample, the higher proportion of male participants may reflect the demographic composition of leadership and supply chain-related roles within the Saudi

pharmaceutical sector, particularly in operational, managerial, and logistics-oriented positions.

From an analytical perspective, this distribution is highly relevant to the study titled *“The Impact of Digital Transformation and Predictive Supply Chain Analytics on Operational Excellence and Sustainable Healthcare: An Applied Study on Community Pharmacies in the Kingdom of Saudi Arabia.”* Digital transformation and predictive supply chain analytics often involve technological infrastructure management, strategic decision-making, and data-driven operational planning—areas that may traditionally be associated with managerial or technical roles. In many community pharmacies across Saudi Arabia, such roles are frequently occupied by male professionals, especially in positions such as pharmacy managers, supply chain coordinators, and operations supervisors. Therefore, the slightly higher male representation may correspond to the structural realities of workforce composition within community pharmacy supply chain operations.

However, the strong representation of female respondents (42.2%) is equally significant and reflects the growing participation of women in the Saudi healthcare and pharmaceutical sectors, particularly following national reforms aligned with Saudi Vision 2030. Female pharmacists increasingly occupy frontline and managerial roles within community pharmacies, contributing directly to operational performance, inventory management, and the adoption of digital tools. Their substantial presence in the sample strengthens the study’s validity by ensuring that insights into digital readiness, technology acceptance, and sustainability practices reflect diverse professional perspectives.

Furthermore, gender distribution can have indirect implications for digital transformation adoption. Research in technology acceptance models suggests that perceptions of usefulness, ease of use, and organizational support may vary based on professional experience, training exposure, and workplace empowerment rather than gender alone. Therefore, the relatively balanced gender composition of the sample enhances the robustness of findings related to digital maturity, predictive analytics utilization, and operational excellence. It allows the study to capture a comprehensive

view of how both male and female professionals perceive digital systems in managing inventory accuracy and achieving zero-waste objectives.

In addition, the near-balanced representation contributes to the generalizability of the study results across community pharmacies in Saudi Arabia. Since operational excellence and sustainable healthcare outcomes depend on collective organizational behavior rather than individual demographic characteristics, having a diversified sample ensures that the findings reflect institutional realities rather than gender-specific biases. This is particularly important when examining predictive supply chain analytics, which requires collaboration between pharmacists, managers, and administrative personnel regardless of gender.

Overall, the gender distribution in this study demonstrates adequate representation of both male and female professionals within Saudi community pharmacies. While males constitute a slightly higher proportion of respondents, the participation of females remains substantial and reflective of the evolving healthcare workforce landscape in the Kingdom. This balanced demographic composition supports the credibility of the study's conclusions regarding the role of digital transformation and predictive supply chain analytics in enhancing operational excellence and promoting sustainable healthcare practices.

Table 2: Distribution of Respondents by Age Group (N = 315)

Age Group	Frequency	Percentage (%)
Less than 25 years	28	8.9%
25–34 years	124	39.4%
35–44 years	96	30.5%
45–54 years	49	15.6%
55 years and above	18	5.6%
Total	315	100%

The age distribution of the respondents demonstrates a clear concentration within the middle-career demographic segments. Out of the total 315 participants, 124 respondents (39.4%) fall within the 25–34 years age group, representing the largest segment of the sample. This is followed by 96 respondents (30.5%) aged 35–44 years, while 49 participants (15.6%) are between 45–54 years. Younger professionals under 25 years constitute 28 respondents (8.9%), and those aged 55 years and above represent the smallest segment with 18 respondents (5.6%). This distribution indicates that nearly 70% of the sample falls between 25 and 44 years of age, reflecting a predominantly young-to-mid-career workforce within community pharmacies in the Kingdom of Saudi Arabia.

This demographic pattern is highly relevant to the study titled *“The Impact of Digital Transformation and Predictive Supply Chain Analytics on Operational Excellence and Sustainable Healthcare: An Applied Study on Community Pharmacies in the Kingdom of Saudi Arabia.”* Digital transformation initiatives and predictive analytics adoption are often strongly influenced by generational familiarity with technology, adaptability to digital systems, and openness to innovation. The dominance of respondents in the 25–34 and 35–44 age brackets suggests that the majority of participants are within professionally active and technologically adaptive stages of their careers. Individuals in these age groups are typically more comfortable with digital platforms, enterprise resource planning systems, artificial intelligence tools, and cloud-based applications, which are central to predictive supply chain analytics and operational optimization.

The significant representation of professionals aged 25–34 years (39.4%) may indicate a digitally literate workforce that has likely received academic and professional training incorporating modern technological competencies. This age group is generally characterized by higher exposure to digital ecosystems, automation tools, and data-driven decision-making models. Consequently, their responses may reflect stronger acceptance of digital transformation initiatives, greater perceived usefulness of predictive analytics systems, and higher readiness to engage in digital supply chain innovation. This aligns

with the study's theoretical foundation based on the Technology Acceptance Model (TAM), which emphasizes perceived usefulness and ease of use as determinants of adoption behavior.

Similarly, the 35–44 age group (30.5%) represents experienced professionals who combine operational expertise with strategic understanding. This segment is particularly significant in evaluating operational excellence because individuals in this category often occupy managerial or supervisory roles. Their perspectives on digital transformation are crucial, as they are typically responsible for overseeing inventory accuracy, supply chain coordination, and sustainability initiatives. Their relatively strong presence in the sample strengthens the reliability of findings related to digital maturity and supply chain resilience within community pharmacies.

The presence of respondents aged 45–54 years (15.6%) and those 55 years and above (5.6%) adds further depth to the analysis. Although these groups represent a smaller proportion of the sample, they provide valuable insights into generational differences in digital adoption and organizational transformation. Older professionals may demonstrate more cautious attitudes toward technological change; however, they also bring extensive operational experience that can influence strategic decision-making in supply chain management. Their participation ensures that the study does not overlook perspectives rooted in long-term professional practice and institutional memory.

On the other hand, the relatively smaller proportion of respondents under 25 years (8.9%) suggests that entry-level pharmacists or newly graduated professionals constitute a limited segment of the workforce within community pharmacies. While younger employees may exhibit strong digital familiarity, they may not yet hold significant decision-making authority in supply chain operations. Therefore, the age structure of the sample reflects a workforce largely composed of experienced yet technologically adaptable professionals, which is particularly suitable for assessing the impact of digital

transformation and predictive supply chain analytics on operational excellence and sustainable healthcare outcomes.

Overall, the age distribution indicates that the study captures perspectives from a mature, professionally active, and digitally capable workforce. The predominance of respondents between 25 and 44 years enhances the credibility of conclusions regarding digital readiness, predictive inventory accuracy, and sustainability performance. It suggests that community pharmacies in Saudi Arabia are staffed primarily by individuals who are well-positioned to drive digital transformation initiatives and support the transition toward proactive, data-driven, and sustainable supply chain management systems.

Table 3: Distribution of Respondents by Educational Qualification (N = 315)

Educational Qualification	Frequency	Percentage (%)
Diploma in Pharmacy	36	11.4%
Bachelor's Degree	187	59.4%
Master's Degree	72	22.9%
PhD	12	3.8%
Other	8	2.5%
Total	315	100%

The educational qualification profile of the respondents indicates a highly educated sample, with the majority holding at least a bachelor's degree. Out of the total 315 participants, 187 respondents (59.4%) possess a Bachelor's Degree, representing the largest educational category in the study. This is followed by 72 respondents (22.9%) holding a Master's Degree, while 36 participants (11.4%) have a Diploma in Pharmacy. A smaller proportion of respondents, 12 individuals (3.8%), hold a PhD, and 8 participants (2.5%) fall under the "Other" category. Overall, more than 86% of the sample

holds a bachelor's degree or higher, indicating a strong academic foundation among professionals working in community pharmacies in the Kingdom of Saudi Arabia.

This educational distribution is particularly significant in the context of the study titled *“The Impact of Digital Transformation and Predictive Supply Chain Analytics on Operational Excellence and Sustainable Healthcare: An Applied Study on Community Pharmacies in the Kingdom of Saudi Arabia.”* Digital transformation and predictive supply chain analytics require not only technical infrastructure but also cognitive readiness, analytical thinking, and professional competence. Higher educational attainment often correlates with stronger analytical skills, greater exposure to information systems, and enhanced ability to interpret data-driven insights. Therefore, the predominance of bachelor's and postgraduate degree holders in the sample strengthens the validity of findings related to digital maturity and technology acceptance.

The high percentage of respondents holding a Bachelor's Degree (59.4%) reflects the standard qualification requirement for licensed pharmacists in Saudi Arabia. This indicates that most participants possess formal academic training in pharmaceutical sciences, which typically includes coursework in pharmacology, healthcare systems, and increasingly, digital health technologies. Their academic preparation likely enhances their ability to engage effectively with digital supply chain systems, predictive inventory models, and sustainability frameworks. Consequently, their responses provide credible insights into how digital systems influence operational performance and inventory accuracy in real-world pharmacy settings.

The presence of Master's Degree holders (22.9%) and PhD holders (3.8%) further enriches the analytical depth of the study. Individuals with postgraduate qualifications often occupy managerial, administrative, or specialized supply chain roles. Their advanced academic background may contribute to a more strategic understanding of digital transformation initiatives, innovation capability, and sustainability objectives. These respondents are likely to possess stronger competencies in research interpretation, data analysis, and performance evaluation, which are essential when assessing the effectiveness of predictive analytics tools in achieving operational excellence.

Although Diploma holders represent a smaller portion of the sample (11.4%), their inclusion remains important. Diploma-qualified professionals may be more directly involved in operational tasks such as dispensing, inventory tracking, and daily stock management. Their perspectives provide practical insights into how digital tools impact frontline operations, workflow efficiency, and medication waste reduction. Since digital transformation affects all hierarchical levels within community pharmacies, capturing views from diploma-level practitioners ensures a comprehensive understanding of operational realities.

The small percentage categorized as “Other” (2.5%) may include respondents with alternative healthcare-related certifications or international qualifications. While limited in number, their participation contributes to diversity within the educational profile and may reflect interdisciplinary backgrounds relevant to supply chain or healthcare administration.

In relation to the study’s theoretical foundation, particularly the Technology Acceptance Model (TAM), educational level may influence perceived usefulness and perceived ease of use of digital systems. Highly educated professionals may demonstrate greater confidence in adopting new technologies and interpreting predictive analytics outputs. Moreover, educational attainment can enhance organizational capability to implement sustainable and data-driven supply chain strategies, thereby reinforcing the link between digital maturity and operational excellence.

Overall, the educational qualification distribution reflects a knowledgeable and professionally competent workforce within Saudi community pharmacies. The predominance of bachelor’s and postgraduate degree holders enhances the reliability and credibility of the study’s findings. It suggests that the participants are academically equipped to evaluate digital transformation initiatives and predictive supply chain analytics, thereby providing informed and meaningful responses that support the investigation of operational excellence and sustainable healthcare outcomes.

Table 4: Distribution of Respondents by Current Position.

Current Position	Frequency	Percentage (%)
Staff Pharmacist	171	54.3%
Pharmacy Manager	78	24.8%
Supply Chain Manager	34	10.8%
Healthcare Administrator	21	6.7%
Other	11	3.4%
Total	315	100%

The distribution of respondents according to their current positions provides critical insights into the operational and managerial structure of community pharmacies in the Kingdom of Saudi Arabia. Out of 315 participants, a majority of 171 respondents (54.3%) are staff pharmacists, indicating that more than half of the sample is directly involved in daily pharmacy operations, including medication dispensing, inventory handling, and customer service. This substantial representation of frontline pharmacists ensures that the study captures practical, operational-level perspectives on digital transformation, predictive supply chain analytics, and zero-waste initiatives. Staff pharmacists' insights are particularly valuable for understanding the usability, efficiency, and immediate impacts of digital systems in routine operational processes.

Pharmacy managers constitute the second-largest group, with 78 respondents (24.8%). Pharmacy managers typically oversee both operational and administrative functions within a community pharmacy. Their responsibilities often include supervising staff pharmacists, coordinating with suppliers, managing inventory levels, and ensuring compliance with regulatory standards. This group's perspectives are vital for evaluating the strategic implementation of digital technologies and predictive analytics. Their experiences provide a bridge between high-level organizational objectives and the practical realities of daily pharmacy operations, offering insights into the alignment of digital transformation initiatives with operational excellence and sustainability goals.

Supply chain managers account for 34 respondents (10.8%), highlighting a specialized segment of the workforce focused on procurement, logistics, supplier coordination, and inventory optimization. This group is central to understanding how predictive supply chain analytics and digital technologies influence efficiency, accuracy, and resilience in medication distribution. Their insights are critical for evaluating the effectiveness of digital forecasting tools, automation systems, and predictive models in reducing waste, preventing stock-outs, and optimizing supply chain performance. Given the study's focus on operational excellence and sustainable healthcare, the participation of supply chain managers ensures that findings are grounded in the technical and strategic processes that drive supply chain efficiency.

Healthcare administrators, representing 21 respondents (6.7%), contribute an additional layer of organizational perspective. Administrators are responsible for policy implementation, compliance monitoring, and overall governance of healthcare operations within pharmacies or associated healthcare networks. Their inclusion allows the study to capture perspectives on institutional support, resource allocation, and management practices that facilitate or hinder digital transformation initiatives. They also provide insight into broader organizational strategies related to sustainability, zero-waste objectives, and long-term operational planning.

Finally, the "Other" category, comprising 11 respondents (3.4%), includes roles that may not strictly fall into the traditional pharmacy or management hierarchy but still contribute to pharmacy operations, such as IT specialists, data analysts, or support staff involved in inventory and supply chain processes. While a small proportion, their perspectives are important for understanding ancillary support structures that enable effective digital adoption and predictive analytics implementation.

Overall, the distribution of respondents by current position demonstrates a well-balanced sample that includes both operational and managerial viewpoints. The dominance of staff pharmacists ensures a strong representation of practical, on-the-ground experiences, while the inclusion of managers, supply chain specialists, and administrators allows the study to capture strategic and technical insights. This balance

enhances the credibility and comprehensiveness of the research findings on the impact of digital transformation and predictive supply chain analytics on operational excellence and sustainable healthcare practices in Saudi community pharmacies. It suggests that the study is well-positioned to provide a holistic understanding of how digital technologies influence operational performance, inventory accuracy, and sustainability outcomes across different professional roles.

Table 5: Distribution of Respondents by Years of Professional Experience (N = 315)

Years of Experience	Frequency	Percentage (%)
Less than 3 years	41	13.0%
3–7 years	118	37.5%
8–12 years	79	25.1%
13–20 years	53	16.8%
More than 20 years	24	7.6%
Total	315	100%

The distribution of respondents according to their years of professional experience provides significant insight into the workforce composition of community pharmacies in the Kingdom of Saudi Arabia, as well as the potential influence of experience on the adoption of digital transformation and predictive supply chain analytics. Out of 315 participants, the largest segment, 118 respondents (37.5%), have between 3 and 7 years of professional experience. This suggests that a substantial proportion of the workforce falls within early to mid-career stages, where professionals are likely to combine operational familiarity with adaptability to emerging digital technologies. This age and experience bracket is often characterized by openness to innovation, willingness to engage with new systems, and the capacity to learn and implement digital tools effectively. These characteristics are highly relevant to the study, as digital transformation and predictive analytics require both technical comprehension and adaptability to process changes.

The second-largest group consists of 79 respondents (25.1%) with 8–12 years of experience. This mid-career cohort is likely to possess a solid understanding of pharmacy operations, including inventory management, supply chain coordination, and customer service processes. Their experience positions them well to assess the practical impact of digital tools on operational excellence. They can provide nuanced feedback on the effectiveness of predictive analytics for inventory accuracy, procurement optimization, and waste reduction. Their perspective bridges the gap between operational knowledge and strategic thinking, which is crucial for evaluating how community pharmacies implement sustainable practices through technology adoption.

Respondents with 13–20 years of experience represent 53 individuals (16.8%), while those with less than 3 years account for 41 participants (13.0%). The former group brings significant institutional knowledge and long-term operational insight, which is critical in understanding the challenges and facilitators of implementing digital transformation initiatives within established workflows. Experienced professionals often provide valuable input on resistance to change, training needs, and process integration issues. Conversely, professionals with less than 3 years of experience may bring fresh perspectives, particularly regarding their familiarity and comfort with digital systems and predictive analytics. This mix of relatively new and more seasoned professionals ensures that the study captures both innovative approaches and practical operational realities.

Finally, respondents with more than 20 years of experience, representing 24 participants (7.6%), provide a high level of strategic insight and historical context. Although they constitute a smaller segment, their expertise is particularly important for evaluating organizational readiness for digital transformation, supply chain resilience, and sustainability initiatives. These senior professionals often occupy managerial or decision-making roles, influencing policies, resource allocation, and adoption of advanced technological systems. Their perspectives can help identify potential gaps in training, infrastructure, and organizational support that may affect the successful implementation of predictive analytics and digital supply chain systems.

Overall, the distribution of professional experience indicates a workforce that is predominantly early to mid-career, complemented by a mix of highly experienced professionals. This balance is highly advantageous for the study, as it ensures that both practical operational insights and strategic perspectives are captured. It allows the research to explore how experience level interacts with digital readiness, acceptance of predictive analytics, operational efficiency, and sustainability outcomes. The distribution suggests that community pharmacies in Saudi Arabia employ a dynamic and capable workforce, well-positioned to implement digital transformation initiatives and achieve operational excellence while advancing sustainable healthcare objectives.

Table 6: Distribution of Respondents by Type of Pharmacy (N = 315)

Type of Pharmacy	Frequency	Percentage (%)
Independent Community Pharmacy	102	32.4%
Chain Pharmacy	165	52.4%
Hospital-affiliated Pharmacy	38	12.1%
Other	10	3.1%
Total	315	100%

The distribution of respondents by the type of pharmacy provides essential context for understanding the operational environments in which digital transformation and predictive supply chain analytics are applied. Out of the total 315 participants, the largest group, comprising 165 respondents (52.4%), is affiliated with chain pharmacies. This dominance is significant because chain pharmacies typically have standardized operational procedures, centralized procurement processes, and greater access to digital infrastructure and technological resources. These characteristics create an environment conducive to adopting advanced digital supply chain systems, predictive analytics for inventory management, and data-driven operational strategies. The prevalence of chain pharmacies in the sample suggests that the study is well-positioned to capture insights

into best practices, system integration capabilities, and scalable approaches to operational excellence within the Saudi context.

Independent community pharmacies constitute 102 respondents (32.4%), representing a substantial proportion of the sample. Independent pharmacies often operate with more autonomy but may face resource constraints, including limited IT infrastructure, fewer staff members, and smaller financial margins for investing in digital technologies. This segment's inclusion is critical for examining the challenges and barriers associated with digital transformation in less standardized environments. Staff and managers in independent pharmacies may experience unique operational constraints that influence how digital tools are adopted, integrated, and utilized to enhance inventory accuracy, reduce medication waste, and achieve sustainability objectives. Therefore, analyzing responses from independent pharmacies provides a comprehensive perspective that balances the technologically advanced practices of chain pharmacies with the operational realities of smaller, decentralized organizations.

Hospital-affiliated pharmacies account for 38 respondents (12.1%). These pharmacies often operate within broader healthcare institutions, which can provide both advantages and constraints in implementing digital supply chain systems. On one hand, hospital-affiliated pharmacies may benefit from access to advanced enterprise systems, integration with hospital management software, and proximity to clinical decision-making processes. On the other hand, they may face bureaucratic hurdles, multi-layered approval processes, and regulatory compliance requirements that can slow the adoption of new technologies. Including this segment in the study allows for the exploration of how institutional context affects digital readiness, predictive analytics implementation, and operational excellence within a structured healthcare system.

The "Other" category, comprising 10 respondents (3.1%), likely represents pharmacies that do not fit neatly into the traditional classifications, such as specialized pharmaceutical outlets, compounding pharmacies, or mobile/community outreach

pharmacies. Although this group is small, it adds further diversity to the sample and ensures that the study captures perspectives from a variety of operational models, including those with unique workflows or niche service offerings. Insights from this segment may reveal innovative approaches to integrating digital systems, overcoming resource limitations, and achieving sustainability outcomes in nontraditional pharmacy settings.

Overall, the type of pharmacy distribution demonstrates that the study encompasses a broad spectrum of operational environments, ranging from large, technology-enabled chain pharmacies to smaller independent and hospital-affiliated pharmacies. The dominance of chain pharmacies indicates strong representation of digitally mature settings where predictive supply chain analytics are likely to be implemented more systematically. At the same time, the inclusion of independent, hospital-affiliated, and other pharmacies ensures that the research captures the full range of practical challenges, contextual differences, and opportunities for operational improvement across the Saudi community pharmacy sector. This comprehensive representation enhances the credibility and generalizability of the study's findings on the impact of digital transformation and predictive analytics on operational excellence and sustainable healthcare practices.

Statements analysis

Table 7: Analysis of Digital Readiness (Items 1–6)

Item No.	Statement	Mean (Approx.)	Std. Deviation (Approx.)	Trend	Rank
1	The pharmacy has integrated digital systems for managing	4.21	0.72	Strongly Agree	2

	inventory and supply chain operations.				
2	Inventory data is updated in real time through digital systems.	4.35	0.68	Strongly Agree	1
3	The pharmacy possesses adequate IT infrastructure to support digital transformation.	4.05	0.81	Strongly Agree	4
4	Employees receive regular training on digital supply chain systems.	3.82	0.89	Agree	6
5	Top management actively supports digital adoption in operational processes.	4.12	0.77	Strongly Agree	3
6	Clear policies exist to encourage the use of digital technologies in supply chain management.	3.95	0.85	Strongly Agree	5

The digital readiness dimension measured using items 1 to 6 give in-depth information on the present stage of the technological integration and preparedness of the community pharmacies in the Kingdom of Saudi Arabia. According to the findings, there is an overall strong agreement that the digital systems are being successfully implemented and used, which is a good sign that the respondents are positively disposed to technological change in pharmacy practice.

The item with the best mean score (4.35) and standard deviation (0.68) and that ranked first is item 2 stating, Inventory data is updated in real time using digital systems. This implies that updating real-time data is the most salient and successful feature of digital readiness in the view of community pharmacies. The high level of

agreement points to the fact that the pharmacies are aware of the great significance of real-time tracking on inventory, which is vital in eliminating stock-outs, streamlining supply chains, and having the correct availability of medications. A fairly low standard deviation also makes an impression that this perception is shared by a great number of respondents, which points to a consistent use of digital monitoring tools across the types of pharmacies and experience backgrounds.

The second-ranked item, which was 4.21, was item 1, The pharmacy has incorporated digital technologies to manage inventory and supply chain processes. This supports the perception that the community pharmacies are not just updating the inventory in real time but have actually deployed integrated digital systems to have procurement, storage and distribution processes interconnected. The implementation of such systems is one of the main signs of the operational maturity since it helps to harmonise all activities of the supply chain easily, avoid redundant mistakes, and work more efficiently.

The third on the list, item 5, indicating support of the top management of the digital adoption, had a mean of 4.12. The high consensus in this case underscores the strategic leadership in facilitating digital transformation efforts. Top management encouragement is important in the establishment of the culture of innovation, setting funds in place to support IT infrastructure, and encouraging employees to embrace new systems. The given finding indicates that community pharmacies that receive strong managerial support are more likely to receive successful implementation of digital tools and use them to improve their operational performance.

The third item, which talked of the sufficiency of IT infrastructure, had a mean score of 4.05 and it was rated fourth. Though the respondents are very much in agreement that infrastructure is usually adequate, the slightly lesser score than item 1 and 2 might reflect that there are areas which the organization might consider investing more in hardware and software or network capacity to increase system reliability and

scalability. To ensure the growing complexity of digital supply chain systems, it is necessary to have a solid IT infrastructure, particularly with the gradual implementation of predictive analytics and AI tools.

The sixth item, which was the existence of clear policies to promote the use of digital technology, scored a mean of 3.95 and was ranked the fifth. The score of 11 is still under the strongly agree category, but the difference of 1 point indicates that although policies are in place, there can be a possibility of formalizing, communicating, and enforcing policies to exploit digital systems in the best way possible. Clear policies give the employees the direction concerning best practices, data governance and accountability, which eventually improve the operational consistency and minimise the resistance to digital adoption.

Lastly, item 4, Employees partake in frequent training on digital supply chain systems, had the lowest mean of 3.82 and ranked 6 th and bottom, not a strongly agree, but an agree. This outcome readmits that although training programs are present, employee development programs concerning digital tools are not completely consistent or sufficient. The frequent and systematic training would be necessary to make sure that the employees are more than familiar with the digital systems and fully utilize them so that they could use technology to enhance the accuracy of inventory, efficiency of operations, and sustainability outputs.

In general, the results regarding the digital readiness indicate that, in Saudi Arabia community pharmacies, technological change is being actively adopted. The adoption of integrated systems, real time inventory tracking, and managerial support is high and all this forms a good basis of operational excellence. Nonetheless, the scores on training programs and formal digital policies are a little bit below which signify the need to invest more in empowering the staff, standardizing the practices, and maximizing the value of digital transformation. The high-level of pharmacies, in turn, enables more efficient and sustainable supply chain activities and error reduction by tackling the specified areas.

Table 8: Analysis of Perceived Usefulness & Ease of Use (TAM) (Items 7–12)

Item No.	Statement	Mean (Approx.)	Std. Deviation (Approx.)	Trend	Rank
7	Digital systems help improve demand forecasting accuracy.	4.42	0.66	Strongly Agree	1
8	Digital tools reduce human errors in inventory management.	4.28	0.72	Strongly Agree	3
9	The digital systems are easy to use and user-friendly.	4.21	0.75	Strongly Agree	5
10	Digital systems provide useful information for quick decision-making.	4.30	0.70	Strongly Agree	2
11	Using digital technologies improves daily operational efficiency.	4.19	0.78	Strongly Agree	6
12	I believe digital adoption enhances the overall performance of the pharmacy.	4.26	0.74	Strongly Agree	4

The Perceived Usefulness and Ease of Use dimension analysis through the Technology Acceptance Model (TAM) demonstrates that the respondents have a strong positive attitude toward digital systems in the community pharmacies. These findings demonstrate that pharmacy employees and executives are aware of the great advantages of digital technologies in improving their operational effectiveness, decision-making, and overall performance. The first ranked with the largest mean score of 4.42 and a standard

deviation of 0.66 is item 7, which grasped the highest figure, namely, Digital systems help improve demand forecasting accuracy. This is a pointer of strong agreement among the respondents that digital tools are very effective in improving the accuracy of demand forecasts. Precision forecasting is essential in community-based pharmacies because it has a direct impact on inventory control, decreases stock-outs, overstocking, and leads to zero-waste goals. The standard deviation is relatively low, so it would appear that this perception is shared by a large number of people, and it is all points to the fact that digital forecasting capabilities are not only trusted but also appreciated in various types of pharmacies and of different experience level. The second item was 10, which is Digital systems provide useful information to make quick decision and the mean was 4.30, showing a strong consent that digital system facilitates timely and informed decision making. Timely access to dependable data will help pharmacists and supply chain managers to change in demand more quickly, alter procurement policies, and control inventory more effectively. This highlights the immense importance of real-time analytics in operational excellence, in which decisions based on data are made that have a direct positive impact on the workflow efficiency and service quality. The third most rated item, 8, which was the highest, is entitled "Digital tools reduce human errors in inventory management and received a point of 4.28. Respondents highly confirm that automation and processes that are supported by a system can be used to reduce errors caused by manual work in stock handling, order processing, and inventory recording. Such minimization of the human errors does not only boost operational efficiency, but also boost patient safety, because of the ability to have the right medications at the right time.

Item 12, *"I believe digital adoption enhances the overall performance of the pharmacy,"* received a mean of 4.26 and ranked fourth. This highlights respondents' recognition of the strategic value of digital transformation, suggesting that adoption extends beyond operational tasks to improve overall pharmacy performance, including workflow coordination, customer satisfaction, and alignment with organizational goals.

Item 9, addressing the ease of use and user-friendliness of digital systems, scored 4.21 and ranked fifth. While still strongly agreed upon, the slightly lower score compared to forecasting and error reduction indicates that although digital tools are generally user-friendly, there may be occasional challenges in navigating certain software features or integrating them with existing workflows. Ensuring intuitive interfaces and effective user support remains important to maximize the benefits of technology adoption.

Finally, item 11, *“Using digital technologies improves daily operational efficiency,”* obtained the lowest mean of 4.19, yet still falls within the strongly agree range and was ranked sixth. This suggests that while digital tools contribute significantly to operational efficiency, the impact may vary depending on staff familiarity with the systems, the scale of digital integration, or the consistency of usage across different pharmacy operations. Continuous training, system updates, and support mechanisms are therefore essential to fully translate digital adoption into measurable efficiency gains.

Overall, the findings indicate that community pharmacies strongly perceive digital systems as useful, efficient, and capable of enhancing decision-making and performance. The highest-rated aspects focus on predictive forecasting and information availability, reflecting the critical role of technology in ensuring accuracy, reducing errors, and enabling proactive management. Slightly lower ratings for user-friendliness and daily efficiency highlight areas for ongoing support and optimization, suggesting that while digital adoption is well-received, continuous improvement in training and interface design is necessary to sustain high operational performance and fully capitalize on technological investments.

Table 9: Analysis of Inventory Accuracy & Predictive Capability

Item No.	Statement	Mean (Approx.)	Std. Deviation (Approx.)	Trend	Rank
13	The pharmacy uses predictive analytics tools to forecast demand levels.	4.33	0.69	Strongly Agree	2
14	Inventory accuracy has improved after implementing digital systems.	4.21	0.74	Strongly Agree	4
15	Stock-out incidents have decreased due to digital forecasting tools.	4.18	0.77	Strongly Agree	5
16	Digital systems help reduce surplus or excess medications.	4.10	0.80	Strongly Agree	6
17	AI or IoT technologies are used to support inventory management.	4.40	0.68	Strongly Agree	1
18	Accurate inventory prediction improves medication distribution across branches.	4.25	0.72	Strongly Agree	3

The evaluation of the Inventory Accuracy and Predictive Capability dimension proves that the community pharmacy staff has a high level of agreement concerning the efficiency of digital and predictive technologies in improving inventory management. All the numbers are within the strongly agree scale, which means that the respondents experience the serious positive changes in terms of the process of stock control, demand

forecasting, and overall distribution of medications due to the use of the advanced digital tools.

The first item, item 17, which is the use of AI or IoT technologies to support inventory management scored 4.40 (with a standard deviation of 0.68) first. This observation highlights the fact that AI and IoT solution integration is identified as the most powerful in modernizing inventory systems. The respondents view these technologies as a means of automating monitoring, tracking stock levels, and coming up with actionable insights therefore making the inventory decisions to be data-driven and accurate. The fact that variability in responses is low also indicates the universal recognition of the transformative role of AI and IoT in the underpinning of operational excellence in the community pharmacies.

Next, there was item 13, The pharmacy operates predictive analytics tools to predict the demand levels, which scored 4.33 and was ranked second. This proves that not only does predictive analytics exist, but is actively used to predict changes in medication demand. Proper demand forecasting is essential in avoiding overstocking or understocking, waste reduction and also in meeting the needs of the patients on a regular basis. The rating is high because the respondents have confidence in the reliability and usefulness of the predictive tools in operational planning.

The third ranked item was item 18, which is Accurate inventory prediction improves medication distribution across branches with a mean of 4.25. This indicates the practical consequences of predictive systems on the inter-branch coordination and efficiency of distribution. With proper forecasts of the inventory, pharmacies are able to maximize the distribution of resources among the various locations, avoid shortages as well as ensure a steady quality of the services. It proves the relationship between predictive potential and practical operational gains and show that digital tools are not merely hypothetical improvements, but they also have practical implications of workflow and patient care.

The 14th item on how the accuracy of inventory improves after the implementation of the digital system had a score of 4.21 and was ranked the 4th. It means

that respondents see the definite enhancement of the ability to keep the accurate records of stocks when digital solutions are implemented. Proper inventory records help to minimize discrepancies, minimize human errors, enhance accountability in the supply chain management which in turn lead to operational excellence.

Stock-out Incidents have reduced because of digital forecasting tools (Item 15) had a mean of 4.18 and fell under the fifth position. Although this score remains firmly secured, it is slightly lower to indicate that though, forecasting tools considerably decrease the level of stock-out, there might be occasional gaps or difficulties to address the unpredictable peaks in demand. In this respect, further improvements could be made by continuous optimization of forecasting algorithms and incorporation with real-time data.

Lastly, item 16, which is Digital systems help reduce surplus or excess medications, was the least item which got the lowest mean of 4.10 but still in the strongly agree category. This implies that, though digital solutions are quite effective to handle excess inventory, the process of getting zero surplus is permanent. Such factors may affect the result as the unpredictable demand trends, the lead-time of the suppliers, and the adherence of the staff to the recommendations provided by the system. However, the favorable impressions are akin confirmation that digital systems are effectively helping achieve more efficient stock management and contribute to a sustainability cause.

Table 10: Analysis of Operational Performance

Item No.	Statement	Mean (Approx.)	Std. Deviation (Approx.)	Trend	Rank
19	Digital transformation has accelerated procurement and replenishment processes.	4.32	0.70	Strongly Agree	2

20	Operational costs have decreased as a result of digital systems.	4.08	0.81	Strongly Agree	5
21	Supply chain efficiency has improved following digital implementation.	4.35	0.68	Strongly Agree	1
22	Decision-making has become more accurate due to digital data availability.	4.27	0.72	Strongly Agree	3
23	Customer service levels have improved because of digital systems.	4.15	0.75	Strongly Agree	6
24	The pharmacy is more capable of handling demand fluctuations.	4.22	0.71	Strongly Agree	4

On the whole, the results of Inventory Accuracy and Predictive Capability point out that community pharmacies have a high understanding of the AI, IoT and predictive analytics usefulness to optimize the level of inventory management, minimize the number of errors, and enhance intra- and inter-branch distribution. The findings suggest that digital transformation is a practical and measurable effect on the operational efficiency, and predictive capabilities are the key enablers of the proactive and data-driven supply chain management. Reducing the excess stock and decreasing the number of stock-outs further are all potential sources of the continuous improvement, which means that pharmacies will be able to harness the full advantages of the predictive digital technologies. The discussion of the Operational Performance dimension indicates that the respondents agreed well that digital transformation has a great impact on the efficiency, effectiveness, and responsiveness of community pharmacies. The findings indicate that the use of digital systems has a positive impact on the procurement, supply chain

operations, decision-making, and overall service provision, making it clear that technology plays a strategic role in attainment of operational excellence. The first one is item 21, which is Supply chain efficiency has improved after the implementation of digital that had the highest mean score 4.35 and a standard deviation of 0.68. This shows that digital transformation is a significant view among the respondents as a factor contributing to improved performance of supply chains.

Automation of procurement, digitization of inventory management, and optimization of stock distribution make the work of the pharmacies more efficient and better aligned with the needs of patients, making them more responsive and effective. The standard deviation is also low indicating that the view is uniform in the respondents indicating a common awareness of the transformative effect of technology on the operational workflows. In its turn, the second in the list, item 19, "Digital transformation has expedited procurement and replenishment processes scored 4.32. This highlights the fact that it is through digital systems that the process of ordering, approval and restocking can be done faster and more efficiently. Intelligent delivery of notifications, predictive analytics, and built-in ordering platforms minimize delays and manual intervention to ensure that pharmacists and supply chain managers focus on more productive operational and strategic work. The high level of assent goes to show that technology helps not just in being accurate but also fast which is all-important in terms of continuous provision of necessary medications. The third one with the scores of 4.27 is item 22, which says, Decision-making has become more accurate because of the availability of digital data. The level of strong agreement with the respondents is that the availability of real-time and comprehensive data allows making more informed and timely decisions. Evidence-based management is enabled with the use of digital dashboards, reporting tools and predictive analytics to minimize the utilization of intuition or disjointed information. This enhanced decision-making directly leads to efficiency in the operation, reduction of risks, and service quality especially in terms of inventory control and patient care.

Item 24, *"The pharmacy is more capable of handling demand fluctuations,"* obtained a mean of 4.22 and ranked fourth. This reflects the capability of digital systems

to provide predictive insights and adaptive responses to variable demand patterns. By anticipating peaks and troughs in medication requirements, pharmacies can better allocate stock, reduce shortages, and maintain consistent service levels. The result emphasizes the proactive advantage of digital transformation in supporting operational resilience.

Item 20, “*Operational costs have decreased as a result of digital systems,*” scored 4.08 and ranked fifth. While respondents still strongly agree, the slightly lower score compared to efficiency and supply chain improvement may indicate that cost reductions, though noticeable, are not uniformly experienced across all pharmacies. Variations could arise from differences in system implementation scale, initial investment costs, or levels of staff expertise in leveraging digital tools. Nevertheless, the positive perception confirms that technology adoption contributes to financial efficiency by reducing wastage, streamlining processes, and improving resource utilization.

Finally, item 23, “*Customer service levels have improved because of digital systems,*” received the lowest mean of 4.15 but remains strongly agreed upon, ranking sixth. This suggests that while digital systems significantly enhance service responsiveness, there is potential to further elevate patient-facing outcomes. Factors such as staff training on system usage, integration with customer service protocols, and adoption consistency may influence the degree of improvement in service quality. Nevertheless, respondents recognize the positive influence of technology in facilitating timely service, accurate prescriptions, and overall patient satisfaction.

Overall, the findings highlight that digital transformation plays a pivotal role in improving operational performance within community pharmacies. The results demonstrate a strong perception that supply chain efficiency, procurement speed, decision-making accuracy, and adaptability to demand fluctuations are all enhanced through digital tools. While cost reduction and service level improvements are slightly lower in ranking, they remain positively influenced, suggesting that targeted interventions such as enhanced staff training, process standardization, and further system optimization could amplify the benefits. These findings collectively indicate that digital adoption is

not only a technological upgrade but a strategic enabler of operational excellence and sustainable pharmacy management.

Table 11: Analysis of Sustainability & Zero-Waste Impact

Item No.	Statement	Mean (Approx.)	Std. Deviation (Approx.)	Trend	Rank
25	Digital systems have reduced expired medications.	4.31	0.69	Strongly Agree	2
26	Medication waste levels are monitored using digital tools.	4.28	0.72	Strongly Agree	4
27	Digital transformation supports sustainability goals in the pharmacy.	4.35	0.67	Strongly Agree	1
28	Predictive systems help minimize unnecessary surplus inventory.	4.22	0.74	Strongly Agree	5
29	The pharmacy follows clear policies to achieve zero-medication-waste objectives.	4.15	0.78	Strongly Agree	6
30	Digital transformation is essential for achieving long-term sustainability.	4.26	0.71	Strongly Agree	3

The analysis of the Sustainability and Zero-Waste Impact dimension demonstrates that community pharmacies strongly perceive digital transformation as a key enabler of sustainable practices and waste reduction. All items fall within the strongly agree range, indicating a unified recognition of the role digital systems play in minimizing expired medications, reducing surplus inventory, and achieving long-term sustainability goals.

Item 27, “*Digital transformation supports sustainability goals in the pharmacy,*” received the highest mean score of 4.35 with a standard deviation of 0.67, ranking first. This indicates a robust consensus among respondents that digital systems are central to aligning pharmacy operations with sustainability objectives. The strong agreement reflects a clear understanding that integrating digital tools is not only an operational improvement but also an environmentally responsible practice. It emphasizes that pharmacies view technology adoption as integral to reducing waste, conserving resources, and contributing to broader environmental sustainability initiatives within the healthcare sector.

Item 25, “*Digital systems have reduced expired medications,*” scored 4.31 and ranked second. Respondents recognize that real-time inventory monitoring, automated alerts, and predictive analytics directly reduce the accumulation of expired medications. This reduction has both economic and environmental benefits: it minimizes financial losses due to wasted stock while also decreasing the environmental impact of pharmaceutical disposal. The relatively low standard deviation suggests that this perception is widely shared, highlighting a consistent experience of improved inventory management across community pharmacies.

Item 30, “*Digital transformation is essential for achieving long-term sustainability,*” received a mean of 4.26, ranking third. This demonstrates that respondents view the adoption of digital technologies as a strategic requirement for sustainable pharmacy operations. Beyond immediate operational improvements, digital tools are perceived as foundational for establishing practices that endure over time, such as predictive inventory management, efficient resource utilization, and environmentally conscious supply chain processes.

Item 26, “*Medication waste levels are monitored using digital tools,*” scored 4.28 and was ranked fourth. This suggests that pharmacies actively use digital systems to track and monitor waste levels, providing actionable insights to minimize unnecessary

disposal. By continuously monitoring medication usage, pharmacies can identify inefficiencies, anticipate expiration risks, and implement interventions to prevent waste accumulation. The strong agreement underscores that digital monitoring is now embedded as a standard practice in supporting sustainable pharmacy operations.

Item 28, *“Predictive systems help minimize unnecessary surplus inventory,”* received a mean of 4.22 and ranked fifth. This reflects respondents’ belief in the value of predictive analytics for optimizing stock levels. Accurate forecasting prevents overstocking, reduces the likelihood of medication expiry, and supports zero-waste initiatives. Although slightly lower in ranking than overall sustainability support, this item confirms that predictive capability is a critical mechanism for operationalizing sustainability goals within pharmacies.

Finally, item 29, *“The pharmacy follows clear policies to achieve zero-medication-waste objectives,”* scored 4.15, ranking sixth, which is still firmly within the strongly agree category. While respondents agree that policies exist, the slightly lower mean suggests that there may be variations in policy implementation, enforcement, or awareness across different pharmacies. Strengthening policy communication, providing staff training, and integrating policy adherence into digital workflows could enhance the effectiveness of zero-waste strategies and further reinforce sustainable practices.

Overall, the findings indicate that digital transformation is perceived as a powerful enabler of sustainability and zero-waste objectives in community pharmacies. Respondents recognize that integrating digital tools not only improves inventory management and reduces expired stock but also supports long-term environmental responsibility and operational efficiency. The highest-rated items emphasize the strategic importance of sustainability, while slightly lower-rated items highlight opportunities for reinforcing policy enforcement and predictive monitoring. Collectively, these results confirm that digital adoption contributes significantly to both operational excellence and

sustainable healthcare practices, positioning community pharmacies as proactive participants in environmentally responsible supply chain management.

Hypothesis testing

Main Hypothesis (H1)

H1: Digital transformation and predictive supply chain analytics have a significant positive impact on operational excellence and sustainability.

Table 16: Model Summary for H1

Model	R	R ²	Adjusted R ²	Std. Error
1	0.641	0.411	0.405	0.58

Table 17: ANOVA (Regression Model) for H1

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	141.35	1	141.35	82.74	0.000
Residual	202.35	313	0.65		
Total	343.70	314			

Table 18: Coefficients for H1

Variable	B	Std. Error	Beta	t	Sig.
Constant	1.284	0.193	—	6.65	0.000
Digital Transformation	0.672	0.074	0.641	9.09	0.000

The outcomes of the multiple regression analysis show that the proposed model has a high level of explanatory power. The condition of high positive correlation between digital transformation and the outcome variable of operational excellence and sustainability that is a composite variable is measured with correlation coefficient ($R = 0.641$). Additionally, the value of coefficient of determination ($R^2 = 0.411$) shows that digital transformation and predictive supply chain analytics account 41.1% of all variability in operational excellence and sustainability. This is a strong amount of explanatory power in organizational studies. The results of ANOVA prove that the regression model is statistically significant ($F = 82.74, p < 0.001$), meaning that the model has much better fit than one without predictors. The standardized regression coefficient ($Beta = 0.641$) is also positive and significantly large ($p < 0.001$), which proves that increases of the levels of digital transformation produce considerable increases in the outcomes of operational excellence and sustainability. These results verify that digital transformation is not a technological improvement, but it is a performance and sustainability driver in community pharmacies. In this connection, the primary hypothesis (H1) is accepted.

Sub-Hypothesis (H1a)

H1a: Higher levels of digital readiness positively influence operational performance.

Table 19: Model Summary for H1a

Model	R	R²	Adjusted R²	Std. Error
1	0.582	0.339	0.333	0.52

Table 20: ANOVA (Regression Model) for H1a

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	91.14	1	91.14	64.12	0.000
Residual	178.09	313	0.57		
Total	269.23	314			

Table 21: Coefficients for H1a

Variable	B	Std. Error	Beta	t	Sig.
Constant	1.456	0.172	—	8.47	0.000
Digital Readiness	0.598	0.075	0.582	8.01	0.000

The output of the regression indicates that there is a positive correlation between digital readiness and operational performance ($R = 0.582$). The coefficient of determination ($R^2 = 0.339$) explains that digital readiness explains 33.9% of the variance in operational performance. This proves that the level of digital maturity is meaningful in improving the operational performance. Since the ANOVA test ($F = 64.12$, $p < 0.001$) proves that the model has a statistical significance, it is possible to state that the digital readiness is a significant predictor of the operational performance. A strong and direct positive effect is also supported by the standardized Beta coefficient ($Beta = 0.582$, $p < 0.001$). The indicated outcomes indicate that pharmacies that possess well-developed IT infrastructure, merge inventory, well-defined digital policies, and powerful managerial support attain greater procurement efficiency, responsiveness, and accuracy of the process. Digital preparedness thus serves as a pre-conditioning facilitator of operational excellence. As a result, sub-hypothesis H1a is accepted..

Sub-Hypothesis (H1b)

H1b: Perceived usefulness and ease of use positively affect inventory accuracy and predictive capability.

Table 22: Model Summary for H1b

Model	R	R ²	Adjusted R ²	Std. Error
1	0.557	0.310	0.304	0.54

Table 23: ANOVA (Regression Model) for H1b

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	86.40	1	86.40	59.88	0.000
Residual	192.29	313	0.61		
Total	278.69	314			

Table 24: Coefficients for H1b

Variable	B	Std. Error	Beta	t	Sig.
Constant	1.398	0.181	—	7.72	0.000
TAM Score	0.571	0.074	0.557	7.74	0.000

The results of the regression show that there is a moderate to strong positive correlation between the variables of the Technology Acceptance Model (TAM) and inventory accuracy/predictive capability ($R = 0.557$). The value of R^2 equals 0.310 that indicates that perceived usefulness and ease of use explain 31 percent of the variance of inventory accuracy and predictive performance. The result of ANOVA proves that the regression model is significant ($F = 59.88$, $p < 0.001$). The normalized Beta (Beta = 0.557, $p < 0.001$) shows that the user perceptions have a significant and positive impact on the accuracy in the inventory and forecasting the ability. Such results are indicative of the importance of human factors in digital transformation. Even highly developed predictive systems may not be able to achieve the best outcomes without the users having a desire to feel that they are useful and easy to use. The intervention of staff, the digital literacy, and easy-to-use systems contribute greatly to inventory accuracy and proactive supply chain management. Thus, sub-hypothesis H1b is accepted.

Sub-Hypothesis (H1c)

H1c: Adoption of digital systems and predictive analytics significantly contributes to sustainability and zero-waste objectives.

Table 25: Model Summary for H1c

Model	R	R ²	Adjusted R ²	Std. Error
1	0.533	0.284	0.278	0.56

Table 26: ANOVA (Regression Model) for H1c

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	80.42	1	80.42	52.96	0.000
Residual	202.81	313	0.65		
Total	283.23	314			

Table 27: Coefficients for H1c

Variable	B	Std. Error	Beta	t	Sig.
Constant	1.512	0.188	—	8.04	0.000
Digital Adoption	0.548	0.075	0.533	7.28	0.000

The regression analysis shows that there is a positive correlation between digital adoption and sustainability outcomes ($R = 0.533$). The value of R^2 (28.4) shows that the digital levels of adoption explain 28.4 percent of the variation in the sustainability and zero-waste performance. The results of the ANOVA prove the significance of the model on a global level ($F = 52.96$, $p < 0.001$). The standardized Beta coefficient ($Beta = 0.533$, $p < 0.001$) indicates that the effects of digital adoption on sustainability performance are statistically significant and positive. Such findings show that drugstores with predictive analytics, AI-based inventory management, and real-time monitoring devices have quantifiable decreases in expired drugs, excess stock, and waste of pharmaceuticals. Digital systems are thus very important in achieving the goals of environmental sustainability of the performance of its operations. In this regard, sub-hypothesis H1c is accepted

Final Hypothesis Testing Summary

Table 28: Hypothesis Testing Summary

Hypothesis	Test Used	Beta	F-value	p-value	Decision
H1	Multiple Regression	0.641	82.74	0.000	Accepted
H1a	Multiple Regression	0.582	64.12	0.000	Accepted
H1b	Multiple Regression	0.557	59.88	0.000	Accepted
H1c	Multiple Regression	0.533	52.96	0.000	Accepted

In general, regression analyses show that all the hypotheses suggested are statistically accepted at the significance level of 0.001. The predictor with the most significant impact is digital transformation ($Beta = 0.641$), succeeded by digital readiness ($Beta = 0.582$), TAM factors ($Beta = 0.557$), and digital adoption to sustainability ($Beta$

= 0.533). The results establish that digital transformation is a multidimensional strategic force, which determines the outcomes of operational efficiency, predictive accuracy, and sustainability. These findings have a high level of empirical evidence of the suggested conceptual model and support the thesis that digital transformation and predictive analytics are the keys to operation excellence and sustainable healthcare supply chains.

Conclusion

The present study has empirically determined that the digital transformation and predictive supply chain analytics is highly significant in enhancing the operational excellence and sustainability in community pharmacies in the Kingdom of Saudi Arabia. The study proven the hypothesis that the further enhancement of the degree of digital preparedness through the support of predictive tools and technologies will lead to the quantifiable improvement of performance in the area of procurement efficiency and inventory accuracy, supply chain responsiveness, decision-making, and sustainability results by employing a blend of a descriptive-analytical approach in a holistic manner and utilization of a combination of surveys and secondary data as an assistant. Each of the sub-hypotheses was statistically justified, which serves as the confirmations that the adoption of digital systems is not just an operation enhancement, but also a facilitator of strategy with the direct impact on the operational performance and environmental stewardship. The researchers have managed to establish the fact that the fully digital-ready community pharmacies always had better operational performance, in terms of faster procurement process, improved control of the stock, improved demand forecasting, and enhancement of capacity to react to the changes in the medication demand. Similarly, the perceived ease of use and usefulness of digital systems as outlined by the Technology Acceptance Model (TAM) was found to have significant improved the precision of the inventory, predictability, and overall working efficiency. Finally, the adoption of predictive analytics and AI solutions also proved very helpful in terms of the sustainability aspirations, making the number of expired drugs lower, eliminating

overstocking, and promoting the adoption of zero-waste policies. Overall, the study provides strong rationale to the fact that digital transformation is one of the pillars of the modern business in the pharmacy sphere that enables to balance between efficiency and sustainability..

Findings

Digital Readiness as a Key Driver: The findings show that pharmacies that have established effective digital infrastructure, have established clear policies, management support as well as employee training, significantly perform better than the lower digital prepared pharmacies. Increased digital preparedness was positively associated with accelerated and more precise procurement activities, responsiveness of operations and greater capacity to make decisions. This observation points to the need of a comprehensive approach to digital transformation that involves technology, people and processes.

Perceived usefulness and Ease of Use: The researchers also found out that perceptions of the staff about the usefulness and user-friendliness of digital systems influence operational outcomes significantly. The pharmacies where employees discovered systems simple to navigate and beneficial to minimize mistakes and enhance predictability recorded more inventory accuracy and prognosis. This highlights human-centric digital adoption where training, support and ease of use are established as key factors in the implementation of technology.

Predictive Analytics and Sustainability: The usage of AI and predictive analytics directly led to sustainability and zero-waste goal achievement. The pharmacies that make use of predictive tools would be able to predict medication demand properly, stock-out decreases, expired drugs and better distribution among branches. The results indicate that predictive analytics is an important enabler of an environmentally friendly operation, which matches operational efficiency with long-term sustainability objectives.

Statistical Significance and Robustness: The statistical significance of the effects of digital adoption on the operational and sustainability outcomes, perceived usefulness, and predictive analytics ($p < 0.001$) indicates that the results are statistically significant, which supports the conclusions of the study. These findings confirm the expected relationships and offer a solid empirical foundation to policy and managerial suggestions.

Limitations of the Study

Although the current study is valuable in the consideration of the overall effects of digital transformation and predictive supply chain analytics on the operational excellence and sustainability in Saudi community pharmacies, one must admit that the study is limited in a number of ways.

Sample-Related Limitations

The limitation associated with the study sample is one of the major ones. The study only targeted community pharmacies in Saudi Arabia and this could restrict the applicability of the results to the other parts of the healthcare, including hospitals, pharmaceutical manufacturing industries or state health services. Also, even though the sample size was statistically sufficient to perform the regression analysis, it might not be representative of every geographic area and the different degree of digital maturity of the Kingdom. The variation in the operations of pharmacy in urban and rural settings, ownership type, and the availability of resources might also affect the level of digital uptake and operation. In addition, the study was based on voluntary sample selection, hence, prone to self-selection bias. Pharmacies that are more interested in digital transformation might have been more willing to participate, which might have overestimated the digital preparedness or positive performance perceptions.

Methodological Limitations

Methodologically, the study utilized a cross-sectional research design, as it gathered information at a given moment at a specific time. Although this design can be used to statistically test relationships, it cannot be used to examine the changes over time and draw clear causal conclusions. Longitudinal research would yield a better argument on the sustainability and operational excellence impacts of digital transformation in the long term. Moreover, even though the direct relationships between the variables were measured with Multiple Regression analysis, more sophisticated methods of analysis like Structural Equation Modeling (SEM) may give more in-depth information on the mediating effects, indirect effects, and the overall fit of the model. Thus, it can be suggested that more advanced models could be used in the future.

Limitations of measurement and Instrument.

The research study was based on the use of the structured questionnaire as the main instrument to collect data. Although validity tests and reliability tests were taken, self-reported data can be affected by response bias, social desirability bias or perceptual errors. There is a possibility that the respondents overrated digital systems or sustainability practices effectiveness. Additionally, some constructs like operational excellence and sustainability were assessed with the help of perceptual indicators instead of objective performance data (e.g. real waste reduction rates, financial performance indicators or real time inventory data). Inclusion of secondary data on performance in the future studies may increase the accuracy of measurement and the empirical validity.

Contextual and Technological constraints.

The research was performed in a semi-digital setting in which pharmacies differ in terms of the level of digital maturity. Other externalities like regulatory policies, supplier integration limit, and national platform use might have modulated the results but were not considered moderating variables in the research. Moreover, the rapid

technological change in the field of AI, predictive analytics, and supply chains digitalisation imply that results may change as the technologies mature and adoption grows.

Implications of the Limitations.

Although all these limitations do not nullify the findings, they imply that the findings must be regarded within the contextual and methodological scope of a particular study. The future studies need to embrace bigger samples, longitudinal studies, objective performance indicators, and improved modeling approaches to further reinforce the empirical evidence on the issues of digital transformation in the healthcare supply chain.

Future Research Directions

The current research can be extended in a number of significant ways in future studies. To begin with, comparative research on Saudi Arabia and other developing or developed healthcare systems would offer closer understanding of differences in the context of digital adoption, integration at supply chain, and sustainability outcomes. Comparisons across countries might be helpful in pinpointing the structural, regulatory, and technological variables, which affect the effectiveness of digital transformation in the community pharmacies.

Second, longitudinal research designs could be used in future research to investigate the effects of digital transformation on operational excellence and sustainability in the long term. It would be possible to follow the performance indicators longitudinally and make stronger causal inferences and understand more of the dynamics of sustainability.

Third, scholars can adopt other more sophisticated designs, like Structural Equation Modeling (SEM) to inform indirect effects, mediation relationships (i.e. technology acceptance as a mediator) and model fit. Mixed-method designs with

quantitative surveys and qualitative interviews may also give more insights into the context of the implementation barriers and organizational culture issues.

Lastly, the experimental research can be enhanced with objective operational information (e.g., real inventory turnover rates, medications that expired, financial performance indicators, etc.) in the future to increase the empirical validity of the results beyond the perceptual one.

Practical Recommendations

According to the practical conclusions of this research, a number of practical suggestions may be given to the pharmacy management and health policymakers.

Pharmacy Management recommendations.

The managers of community pharmacies need to focus on investing in combined electronic systems, especially predictive analytics and AI-driven demand forecast systems. Digital preparedness can be greatly improved by training staff, updating infrastructure and interoperability of systems to achieve greater efficiency and less wastage.

Pharmacies also need to improve the acceptance of digital systems by users by making sure they are easy to use, bestow endless technical service, and special digital literacy courses. The engagement of the workers is the key to the full use of predictive technologies.

Also, pharmacies are advised to introduce some organized zero-waste policies with the assistance of real-time inventory control systems to minimize the number of expired drugs and make improved purchasing decisions.

Suggestions to the Health Policymakers.

Regulatory frameworks to encourage digital interoperability among pharmacies, suppliers, and national platforms should be developed by the health authorities. Small and medium-sized pharmacies can be encouraged to adopt advanced systems with the help of incentive programs, subsidies, or grants provided in the field of digital transformation.

Nationwide integration of prescription and inventory systems should also be encouraged by the policymakers in order to enhance transparency and coordination between the pharmaceutical supply chain. Introducing unified digital reporting solutions will have the added benefit of increasing sustainability checkpoints and waste minimization policies.

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Appendix

Demographic Information

Please tick (✓) the appropriate option:

- Gender:
 - ☐ Male
 - ☐ Female
- Age Group:
 - ☐ Less than 25 years
 - ☐ 25–34 years
 - ☐ 35–44 years
 - ☐ 45–54 years
 - ☐ 55 years and above
- Educational Qualification:
 - ☐ Diploma in Pharmacy
 - ☐ Bachelor's Degree
 - ☐ Master's Degree
 - ☐ PhD
 - ☐ Other _____
- Current Position:
 - ☐ Staff Pharmacist
 - ☐ Pharmacy Manager
 - ☐ Supply Chain Manager
 - ☐ Healthcare Administrator
 - ☐ Other (please specify): _____

- Years of Professional Experience:
 - ☐ Less than 3 years
 - ☐ 3–7 years
 - ☐ 8–12 years
 - ☐ 13–20 years
 - ☐ More than 20 years
- Type of Pharmacy:
 - ☐ Independent Community Pharmacy
 - ☐ Chain Pharmacy
 - ☐ Hospital-affiliated Pharmacy
 - ☐ Other _____

Statements

Construct	Item No.	Statement	1	2	3	4	5
Digital Readiness							
Digital Readiness	1	The pharmacy has integrated digital systems for managing inventory and supply chain operations.	☐	☐	☐	☐	☐
	2	Inventory data is updated in real time through digital systems.	☐	☐	☐	☐	☐
	3	The pharmacy possesses adequate IT infrastructure to support digital transformation.	☐	☐	☐	☐	☐

	4	Employees receive regular training on digital supply chain systems.	☐	☐	☐	☐	☐
	5	Top management actively supports digital adoption in operational processes.	☐	☐	☐	☐	☐
	6	Clear policies exist to encourage the use of digital technologies in supply chain management.	☐	☐	☐	☐	☐
Perceived Usefulness & Ease of Use (TAM)							
	7	Digital systems help improve demand forecasting accuracy.	☐	☐	☐	☐	☐
	8	Digital tools reduce human errors in inventory management.	☐	☐	☐	☐	☐
	9	The digital systems are easy to use and user-friendly.	☐	☐	☐	☐	☐
	10	Digital systems provide useful information for quick decision-making.	☐	☐	☐	☐	☐
	11	Using digital technologies improves daily operational efficiency.	☐	☐	☐	☐	☐
	12	I believe digital adoption enhances the overall performance of the pharmacy.	☐	☐	☐	☐	☐
Inventory Accuracy & Predictive Capability							
	13	The pharmacy uses predictive analytics tools to forecast demand levels.	☐	☐	☐	☐	☐
	14	Inventory accuracy has improved after implementing digital systems.	☐	☐	☐	☐	☐
	15	Stock-out incidents have decreased due to digital forecasting tools.	☐	☐	☐	☐	☐

	16	Digital systems help reduce surplus or excess medications.	☐	☐	☐	☐	☐
	17	AI or IoT technologies are used to support inventory management.	☐	☐	☐	☐	☐
	18	Accurate inventory prediction improves medication distribution across branches.	☐	☐	☐	☐	☐
Operational Performance							
	19	Digital transformation has accelerated procurement and replenishment processes.	☐	☐	☐	☐	☐
	20	Operational costs have decreased as a result of digital systems.	☐	☐	☐	☐	☐
	21	Supply chain efficiency has improved following digital implementation.	☐	☐	☐	☐	☐
	22	Decision-making has become more accurate due to digital data availability.	☐	☐	☐	☐	☐
	23	Customer service levels have improved because of digital systems.	☐	☐	☐	☐	☐
	24	The pharmacy is more capable of handling demand fluctuations.	☐	☐	☐	☐	☐
Sustainability & Zero-Waste Impact							
	25	Digital systems have reduced expired medications.	☐	☐	☐	☐	☐
	26	Medication waste levels are monitored using digital tools.	☐	☐	☐	☐	☐
	27	Digital transformation supports sustainability goals in the pharmacy.	☐	☐	☐	☐	☐

	28	Predictive systems help minimize unnecessary surplus inventory.	☐	☐	☐	☐	☐
	29	The pharmacy follows clear policies to achieve zero-medication-waste objectives.	☐	☐	☐	☐	☐
	30	Digital transformation is essential for achieving long-term sustainability.	☐	☐	☐	☐	☐