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The Impact of Artificial Intelligence on Healthcare Supply Chain Resilience and Waste Minimization

Muhammad Usman Iftikhar

Analytics Consultant, Ascend Solutions, Saudi Arabia.
Email: muhammadusmaniftikhar@gmail.com

Healthcare organisations operate under the dual constraints of waste minimisation and ensuring that supplies are always immediately accessible. Proper management of inventory is very important in order to ensure that the supply chain is constant and that facilities meet patient needs. This study focuses on identifying how Artificial Intelligence is integrated into inventory control for supply chain optimization in the healthcare industry. As a result of the use of machine learning and predictive analytics solutions, the healthcare organisations may improve the demand-side and supply-side analysis and minimize drug loss and use. These solutions harness artificial intelligence in solving classical issues like overstocking and resource misallocation, and therefore enhance organizational operating effectiveness and resourcefulness. The theoretical underpinnings of the research are the Resource-Based View and Systems Theory, which reveal the strategic and systematic values of using AI in inventory management. The Resource-Based View strongly emphasizes AI as a valuable organisational resource that supplies competitive advantages, while the Systems Theory highlights the interconnectedness of the healthcare chains of supply and AI as assets helping to improve flexibility. New evidence offers theoretical supports of AI in healthcare supply chains, typifying increased effectiveness and future patient care provisioning. A quantitative method was used to obtain data through questionnaire surveys administered at healthcare practitioners in the United States of America. The collected data, better known as big data, was then analysed with machine learning paradigms to identify trends and create business insights. Therefore, these findings afford a good starting point that can help enhance future approaches to inventory controls and supply chain robustness in healthcare facilities. By analysing AI-supported stock control and its strategic and systematic consequences, this work is useful for understanding how to improve the efficiency of healthcare supply chains and patient care outcomes. Supply chain optimization and sustainability initiatives were found to have an overwhelming effect on consumers' perceptions, emphasizing operational efficiency and environmental stewardship as fundamentally important determinants of success in achieving a competitive advantage in today's business environment.

Keywords: Sustainability, Artificial Intelligence, Inventory Management, Healthcare Supply Chain, Waste Reduction and Predictive Analytics.

1. Introduction

The management of inventory is important in the health sector for the purpose of availability of conducive pharmaceuticals and goods, with a purpose of reducing on excessive loss and expenses. In advancing operating efficiency, enhancing the quality of care delivered to patients, and ensuring compliance with regulatory requisites, this study points to an area of huge relevance: inventory management. In pursuing these objectives, the study wishes to provide actionable information and new ideas for the improvement of inventory operations based on method evaluation and identification of problems [1]. Inventory management is an essential component of healthcare and needs to be well managed so as to maintain quality health care at a reasonable price since disruptions in inventory can impact on the hospital functioning and hence the results.

This is a vital stock in health care systems, whose storage, regulation and optimization is crucial to avoid over or under stocking. Effective inventory management methods such as consignment inventory management helps to minimize on carrying costs while enhancing the efficiency of availability of medical devices and supplies. Optimal management of these inventories is very crucial in order to reduce the wastage especially with drugs whose expiry dates have been reached or drugs for which there have been no usage for a certain time is a big problem around the globe [2]. Studies show an unacceptably high percentage of medicine expiration due to poor stock control, leading to huge losses in both the developed and the developing world.

Peculiarities of inventory management, for example, improper storage conditions, lack of space, and low-skilled employees, enhance waste. Studies done in Ethiopian scenario show the consequences of poor storage infrastructure and; global data confirms the extent of loss of approximately billions of US dollars as a result of limited shelf life of drugs. Addressing these issues requires an integrated approach that combines modern methods of inventory management that include demand forecasting, inventory visibility and safety inventory [3].

The evolution of artificial intelligence (AI) science is turning the aspect of inventory into a complicated and evolving process. Two of the most crucial branches of AI, ML and DL enable healthcare organisations to analyze large data sets, enhance the accuracy of demand forecasting and increase inventory flexibility. Adoption of AI technology in operations makes them efficient, reduces the cost of business operations and provides a good response to supply chain disruptions. Through internal and external automation of low-value interaction [4], AI increases the ways of actually supply chain, by providing real-time analysis of its data and market trends. This technical development has put beyond doubt the role of AI in the disruption of the HC supply chain.

This study also highlighted the importance of inventory management in achieving its goal of costs control, reduction of wastage and timely delivery of healthcare products. The ongoing challenges may be addressed by healthcare organisations, which turn to AI and machine learning advancements to advance demand planning and guarantee the supply chain's sustainability [5]. In that regards the above improvements are believed to enhance the business operational effectiveness and enrich the patients' outcomes by assuring the appropriate medical supplies.

2. LITERATURE REVIEW

AI has turned into a powerful tool in inventory management, leveraging the wisdom to examine big data and identify differences and similarities. Using sales data, customer behaviour and past trends, AI assist businesses in predicting changes in demand and improving stock control. This capability ensures accurate understanding and control of inventory needs and therefore the risk of overstock or over supply or running out of stock is controlled. Furthermore, AI is experienced in the area of prescriptive analytics as it is used to predict future consumer demand by analysing past data accompanied by the shift in the market environment. These effective initiatives work proactively to control inventory levels, avoid overstocking, and encourage operational economy [6]. AI programs within inventory systems helps firms upgrade from a reactive style management by anticipating probable supply chain disruptions. The result is the most effective solution in terms of cost reduction enhancement of a more flexible and reliable supply chain with permanent performance and customer satisfaction. Such technological innovations points towards the central role of AI to transform primitive practices of inventory into smart systems.

Artificial Intelligence in Inventory Management

Over the last decade, particularly from the first years of the 2010s, most companies quickly implemented artificial intelligence (AI) tool in supply chain management, resulting in positive results and changing existing methods as well as improving decision-making processes. Business entities are gradually adopting the use of AI technologies to their broad supply chain management because of their effectiveness and dependability. Despite these enhancements, the literature on supply chain management continues to progress, and the initial methods used in the basic research of this field attempt to incorporate modern AI methods into its approach [7].

In all the traditional inventory capacity supply chain models, a "one for one" rule may sometimes be considered as optimal in situations characterised by deterministic demand. In this method, the buyer from every level of the supply chain issues an order with his or her supplier once they receive an order from the next lower level client. This makes the process reduce inventory holding costs while at the same time maintaining a proper supply chain management [8]. Hospitals' procurement of drug and therapeutics products is a function of random and complex variables and this complexity limits the applications of deterministic models. Stochastic characteristics that have been implemented into inbound conventional models of stock control include factors like unpredictability of patients' arrivals. AI solutions are crucial to dealing with this complexity since they can pinpoint operational issues, suggest better ways of transportation and predict disruptions before they happen. Applying AI helps supply chains to address different patterns of fluctuations in the demand, lead time, and the cost constraint. The computerized inventory management systems provide strategies for formulating right inventory strategies that will ensure that the right products are available at the right time without incurring on storage costs. These technologies are not only energy – time conserving but also resource saving as in their application approach lesser number of resources are consumed than in traditional methods [9].

Organising inventory and incorporating Ai makes it possible for firms to progress from the rigid models to using fluid approaches. This change enables the healthcare organisations and even other sectors to build efficient supply chain networks that can meet the additional requirements and work more effectively and sustainably [10]. The continuous integration of approaches within the supply chain AI is already determined to make supply chain management more malleable, effective, and green in the future.

Impact of AI on Reducing Medication Waste

AI integration in inventory management leads to great advantages for the medical institutions because it helps them improve inventory management and increase the level of the required demand for forecasting. The AI integration system can make precise prognostications on the necessary quantities of procurements of pharmaceuticals and medical supplies, thereby dramatically reducing overstocking. In this way, organisations do not spend excessive amounts of money on storage, and they avoid losses associated with unperformed items. This I have come to realize enhances efficiency and practically reduces operational costs as well as ensuring optimal utilization of available resources [11].

AI’s capacity to make forecasts is especially beneficial in avoiding the procurement of items critical to the storage of expired or unusable medical supplies and save on disposal costs. These challenges positively impact sustainable practice in the health care domain within the environmental efficiency, cost efficiency domains. Further, accurate demand forecast helps healthcare providers to ensure that required medical supplies are available on-time, for improved patients care and operational effectiveness [12].

This is an aspect that the producers of pharmaceutical products and the health care supply chain have to struggle with; fluctuations in market demand may lead to product obsolescence. These concerns are exercised by manufacturers offering their excess stock to the global market at cheaper prices before expiry of their products’ lifespan. This approach minimizes expanses and accentuates the need to apply AI in products’ ordering to contend with demand variations, fewer markdowns while promoting a sustainable stock management model [13]. Healthcare organisations can so complement or enhance the running of its operations, reduce wastage and ultimately enhance the provision of care to the patients.

Ethical Considerations of AI in Healthcare

GDPR, and GINA could be very useful in protecting data protection as well as individual privacy especially in the application of AI-DMI. Such regulations lay legal foundations of protecting sensitive data and maintaining ethical standards for which AI technologies are important in healthcare supply chains [14]. This EU legislation, known as General Data

Protection Regulation (GDPR), imposes strict requirements on data processors and controllers with regard to direct obtaining, holding, and using of personal data. The above restrictions apply to the international enterprises within the EU, which goes to a show that the personal data of persons need to be protected. Due to GDPR regulations, high standards of data management are provided to increase compliance of AI-DMI systems connected with companies of EU countries with privacy. This compliance is necessary for maintaining trust that is valuable and minimizing possibility of risks concerning data exploitation or leakage [15]. The Act has influences privacy rules in another country like the United States and Canada; therefore, the Act is significant on the global point of view.

Similarly, the GINA in USA prohibits workers and insurance companies to make discrimination decisions based on an individual's genetic information data. This regulation is particularly relevant in cases when the given AI system can process genetic data with regards to healthcare inventory. Compliance with GINA ensures application of AI-DMI does not indirectly foster discrimination of one group over the other by meeting the ethical standards and fostering fairness within use of technologies [16]. Not only legal requirements but also implementing GDPR and GINA concepts into the AI-DMI framework allows for proper and ethical AI usage in healthcare. These technologies, while optimising inventory and reducing waste through forecast demand for medical equipment and pharmaceuticals, must operate in a system that doesn't violate the privacy and dignity of people. Thus, GDPR and GINA also provide compliance to law but also enable stakeholders to trust artificial intelligence-driven solutions to enhance operational effectiveness with ethical compliance [17].

Future of AI-Driven Inventory Management

The healthcare sector has also felt the impact of Artificial Intelligence (AI), particularly, in management of vaccines in the supply chain. AI has the potential to significantly improve the vaccination logistic chains in the West African healthcare system, especially in Ghana. WHO's examples of case studies and activities carried out by WHO provide practical examples of how various AI capacities can change the mechanism of vaccines distribution. Rwanda has recorded impressive results in managing its immunization chain of supply through the use of artificial intelligence [18]. The use of such technologies as artificial intelligence has helped Rwanda in avoiding wastage, ensuring that vaccines get to the targeted persons and reaches them in the best conditions required. This accomplishment means that other countries, including Ghana, may also design other strategies with assistance of AI to improve their healthcare systems. The World Health Organization with the support of UNICEF and Gavi, the Vaccine Alliance today launched the innovation solution called Smart Vaccination Management System (SVMS). This platform employs AI algorithms including machine learning and predictive analyse for improvement of vaccination delivery with relation to the diseases in the society [19]. The SVMS use artificial intelligence in ensuring fair distribution of vaccinations making immunization programs and health outcomes better in the world.

This is a crucial aspect of vaccination as a means of keeping track of the actual shipment of the vaccines as they are transported across the country. Owning AI technology enables the governments and all health organizations to solve the problems of supply chain, avoid the wastage, and ensure the delivery of vaccines on time. Shipping container temperature condition monitoring is achieved through smart sensors and artificial intelligence algorithms placed inside the shipping containers constantly. This monitoring reduces vaccine deterioration due to poor handling, storage or transport hence reducing risk incidence associated with vaccines while at the same time curtailing losses [20]. There have been significant transformative effects of artificial intelligence in vaccination supply chains as Rwanda and the World Health Organization prove. By availing themselves of AI driven solutions, the countries, like Ghana would go a long way in creating easier access of the vaccines, simplifying the process of vaccine distribution, and guaranteeing the sustainability of vaccine programs. These accomplishments highlight that AI is crucial to our understanding of and solutions to big healthcare issues and improving public health systems [21].

Supply Chain Optimization in healthcare

It is broadly acknowledged that the optimisation of healthcare supply chains is a key means of increasing operating efficiency, lowering costs and producing better patient outcomes. According to the research, proficient SCM is able to relieve resource deficiencies, minimize waste and ensure timely delivery of vital medical supplies and pharmaceuticals [22]. The intricacies of healthcare operations, however, make the supply chain enhancement into a data informed and technology enabled exercise; and interest of HC providers to continue with these however lost in the transition from a CM at BIDMC to a vendor company it continues to compromise the product [23].

Artificial Intelligence (AI) and predictive analytics have become key instruments to optimize healthcare supply chain. According to research, AI can refine the accurate demand forecast, when it takes patient trends, historical consumption data and external factors like seasonal diseases and emergencies into consideration. The failure probability of stockouts or overstocking goes down and inventory management, and operation efficiency goes up [24]. In addition, ensuring that IoT devices are implemented within supply chains opens up the possibility for real time supply oversight, ensuring proper handling and storage especially for temperature sensitive products such as vaccines [25]. The introduction of these innovations reduces waste due to spoiling and the concomitant financial loss.

The subsequent research shows how the consignment inventory models and ecological logistics contribute to the attainment of sustainable optimisation of the supply chain. Healthcare facilities can minimise carrying cost while guaranteeing that critical goods are available through consignment inventory [26]. In the like way, green logistics comprising recycling initiatives and eco capacity transportation strategy deals with environmental issues, all the while keeping the cost feasible [27].

Despite these developments, problems remain such as high costs of implementation, difficulties in integrating data and reluctance of technology implementation in healthcare organisations. These obstacles are necessary to overcome in order to take full advantage of the potential that utilisation of supply chain optimisation technologies offers [28]. It is stressed in the literature that the AI and IoT need to be integrated with sustainability for improving the healthcare supply chains and thereby ensure smooth allocation of resources and better patient care.

Sustainable Healthcare Operations in healthcare

Advancements in sustainable healthcare operations have been brought into focus as a critical challenge of enhancing the delivery of quality patient services even as costs of service delivery as well as impact on the environment are of concern. The present study also finds that sustainability has become a crucial factor to be integrated into the healthcare systems to ensure the sustainability of future operations and the environment [29]. Managing health care operations sustainably requires the integration of green SCM systems, such as minimization of waste, reuse of medical products and use of energy sources in equipment. Several studies have confirmed that the adoption of circular economy principles, such as reusing and recycling of medical equipment reduces the environmental footprint of healthcare organisations [30]. Furthermore, green logistics which is a better way of transportation with an aim of preserving the environment also ensures that good are delivered on time [31].

Energy efficiency is a focal issue in most organizations. Health care organizations are among the biggest consumers of energy because they require constant availability and special devices. The literature shows that more organizations should spend resources in renewable power sources and green building design to reduce costs and CO2 emissions. These approaches are also compatible with the overall sustainable development agenda while at the same time creating financial savings for healthcare organizations. Also, waste management is an important part of sustainable healthcare. Disposal of hazardous medical waste should be done in the right manner and this has been explained by the World Health Organisation to help in preventing the adverse effects on the environment and the public's health. According to Xia et al. [32], new technologies that include AI and IoT can help improve the waste segregation and disposal systems hence increase the compliance of the environment standards.

Even though these techniques hold a lot of promise, there are challenges like high costs of implementation, resistance to change, and issues to do with compliance with set standards as major factors that hamper their uptake. In view of the above, there is need to employ a comprehensive approach that involves, the people, the policies and the tools. Therefore, sustainable healthcare operations are important as they help to advance environmental stewardship and business effectiveness [33]. The purpose of this study is to establish that healthcare organisations can achieve sustainability goals and provide excellent patient care based on the green supply chain practices, energy efficiency, and waste management.

Resilience and Sustainability in Supply Chains in healthcare

HCSM emphasizes resilience and sustainability as language SCM focuses on sustaining quality in healthcare setting affected by environmental, social, and economics challenges. The literature review increases knowledge of the importance of managing disturbances and maintaining the sustainability of HSCs [34]. Some aspects of HSC resilience include; the capability of anticipatory, responsive and recoverability from disruption events such as that caused by pandemics, natural disasters, or even geo-political disruptions. The literature reviews emphasize the application of modern technologies such as AI and IoTs to improve the supply chain. Enterprises leverage applications of AI to get real time updates, analytical insights based on which enterprises forecast future scenario and work out their strategies on how to address particular emergency without it getting out of hand. During the COVID-19 outbreak, forecasting models were used in order to identify surges in the demand for PPEs, and quickly supply the necessary amounts to healthcare facilities [35].

Sustainability in supply chains focuses on reducing the negative environmental footprint.

Green SCM (GSCM) elements which include circular economy, green transportation and medical waste management are crucial for healthcare sustainability. Research has it that renewable energy system integration and efficient logistics management can greatly minimize carbon footprint while at the same time increase profitability [36]. Also, the management of waste and especially hazardous medical waste, is important in reducing the impacts of waste on the environment. The relationship between resilience and sustainability is complementary and promotes the improvement of the supply chain. Some basic tenets of sustainable operations, including sourcing and inventory management from local suppliers, naturally provide resilience through minimizing long supply chains and the risks from applying disruptions. Nonetheless, the major challenges that have to be met to balance the two include costs, compliance, and the barriers to technology. As a result, HSC managers need to design their supply chains in a way that they are both more resilient and sustainable to provide healthcare services in the future and at the same time act as good stewards of the environment [37]. Therefore it is important for healthcare organizations to use technology and green SCM to build supply chain that can meet the current needs and the future needs of their organizations.

Inventory Management Challenges in Healthcare

Waste management is a major problem for healthcare organisations in relation to traditional inventory management. This paper shows that ineffective inventory management results in overstocking of medical supplies, expired stock, and poor tracking systems. These challenges lead to excess costs, increased operational costs, and late delivery of essential medical supplies hence a compromise on the quality of patient care. These are some of the ever-recurring problems that need to be addressed in order to enhance the effectiveness of HSCs [38]. Every organization must work to manage its inventory effectively because it helps to maintain the right stock levels, prevent stock-outs, and avoid mistakes in documentation. Inventory turnover, a measure that captures how often stock is bought, used and restocked is an important metric in the management of inventory. The procedure entails the division of the total expenditure on goods sold by the average stock within a given period. This information is useful in the analysis of the effective use of inventory and the possibilities of its improvement [39].

In healthcare, inventory management is the act of managing the stock, purchase, orders and payments to ensure that business runs smoothly. Such organization that deals with primary care, drug dispensing, or even supply of other health products must have a good way of managing their inventory. This paper argues that major healthcare organizations, particularly hospitals, can minimize their financial and material losses through proper record keeping of inventory and supply. Literature shows that there is an imperative need to build on quality management systems, expand client satisfaction, and reduce on wastes in healthcare organizations especially in the developing countries [40]. These gaps can be addressed and their improvement can significantly improve the effectiveness and efficiency of the health care systems.

Theoretical Review

In the healthcare sector inventory management is important since it minimizes waste, reduces costs, and guarantees that vital medical supplies to maintain ongoing patient care are always available. AI brings a fresh approach for solving age old problems such as over stocking, supply expiration and limited tracking methods. AI is powering technologies that apply forecasting accuracy through intelligence to automate supply chain activities and optimise resource distribution with the aim of enhancing the efficiency and sustainability of healthcare functions. Theoretical impetuses drawn from the Resources Based View (RBV) and Systems Theory are used to theoretically scrutinize the strategic and systemic effects of AI-enabled inventory management. As is discussed in the Resource Based View, competitive advantage can be achieved by leveraging organisational resources, including people, data and technology expertise. Here, the integration of the AI technology in inventory management is regarded as an actual organisational asset in terms of operational efficiency and resilience.

The understanding of interactions among interrelated components in the HSC for meeting to shared goals is the aim of Systems Theory. Using AI, health care organizations can set up adaptive systems that are sensitive to real time demand and resource constraints, and accordingly adapt inventory procedures. Integration of this improves supply chain efficiency and facilitates on time delivery of medical goods, thus improving patient outcomes.

By applying RBV and Systems Theory frameworks, this study critically examines the transformation of healthcare operations through AI driven, inventory management, placing strategic advantages and constraints as well as sustainability ramifications for healthcare delivery.

Resource-Based View (RBV) Theory

RBV theory furnishes a major framework for determining whether the strategy importance of AI driven inventory management has value in healthcare. RBV theory contends that competitive advantage of an organization lies in its internal resources and competencies that are valuable, rare, inimitable and non-substitutable (VRIN). Meeting these standards, AI is an awesome technology of inventory management that has the ability to enhance the operational efficiency with reducing waste [41]. Inventory solutions driven by AI are priceless because they create accurate demand forecasts, enhance stock optimisation and automate replenishment operations. These capabilities reduce the risk of overstocking as well as the risk of stockouts and ensure uninterrupted availability of life saving medical supplies. The inclusion of machine learning algorithms and predictive analysis helps these systems optimise a decision process, thus allowing healthcare organisations to best allocate resources in terms of patient care [42].

The strategic significance of AI systems becomes even stronger because of the scarcity of powerful AI systems in the healthcare sector. To develop and maintain the AI driven inventory system are not many organisations with the appropriate skills, finances, and infrastructure. These solutions give early adopters a competitive advantage by gaining an advantage in optimising supply chain operations or lowering cost efficiency in the industry. These things are unrivalled because they are scarce and this leads to a huge time out of stock. Coordinating the disciplines of specialized knowledge with extensive advanced data evaluation and artificial intelligence creates complex, evolutionary systems that are challenging for participants to imitate [43]. These systems improve and gain more importance as organizations collect, evaluate and absorb more information. Reinforcing the strategically important role of AI driven inventory systems in healthcare operations is their irreplaceability. But there are unique benefits they have real time tracking, predictive powers, etc.—which cannot easily be replicated by other technology or old fashioned inventory management methods. This assures that AI will remain an indispensable resource for your organizations which are trying everything possible to streamline, reduce expenses and maintain leadership edge in the healthcare industry [44].

Systems Theory

Using Systems Theory, we analyse the HSC as a complex and an interrelated system in which every component contributes to the overall functioning and efficiency. The conceptual framework presented here argues that in order to achieve systemic flexibility and resilience, it is necessary to understand the relationships and interactions among the many elements: suppliers, inventory systems, and distribution networks, and healthcare providers [45]. The HSC is becoming a better reflection of Systems Theory using AI driven inventory management. By augmenting communication between many components through real time data and predictive analytics, AI helps organisations respond quickly to supply and demand changes. By monitoring consumption patterns, supply inventory and predicting the future needs, healthcare providers can change the procurement strategy in real time with the help of AI systems. The ability of this dynamic capability ensures the timely availability of the necessary medical supplies helping avoid or reduce the risk of shortages or excess inventory [46].

Feedback loops are a huge contribution of AI to the supply chain, it creates a continuous data flow and insights across the system. These loops empower healthcare organisations to predictively strengthen operations. Inventory inefficiencies are watched by an AI that detects and suggests ways to update things to optimize future processes. This repeated input improves the resilience of the supply chain and give organisations an insight and opportunity to avert potential interruptions. AI driven systems like these are especially useful in crisis times like Pandemics, where systems can analyze immediate changes in demand and help with prompt responses [47]. These systems may learn from real time data from many supply chain nodes to adjust inventory levels, prioritize critical supplies and synchronize distribution activities. It enhances the adaptability of the system as it helps healthcare system respond to poke full it can pop up at any given moment without stopping the care service and cutting disruption. Finally, Systems Theory applied to the logistical aspects of healthcare when AI drives inventory management is a precursor to promoting interconnectivity and continuous feedback within the HSC [48]. AI may be used to assist organisations in developing flexible, resourceful systems that are better suited to tackle the myriads of healthcare delivery demands.

Integration of Theories

Using the combination of the RBV and Systems Theory, the revolutionary capabilities of AI based inventory management within HSCs are subject to the scope of a comprehensive framework. In terms of excellence, RBV observes AI as a strategic asset that is both valuable, rare, inimitable, and non-substitutable. When it comes to these features, AI becomes an absolute necessity to be an internal competence that helps healthcare organisations to stay competitive. Among various assets, the capacity of AI to optimise inventory levels, forecast demand precisely, and automate replenishment procedures is a valuable and unique asset [49]. Additionally, these systems are hard to follow, and cannot be duplicated, cements them strategic relevance due to their unique amalgamation of advanced analytics, machine learning and specific domain knowledge [50].

Furthermore, AI systems' systemic implications are central to Systems Theory and discussing how integration and robustness of supply chain elements can be enhanced by AI systems. Instantaneous data exchange, anticipatory analytics, and adaptive feedback mechanisms made by artificial intelligence has increased the supply chain's responsiveness and flexibility. AI helps the HSC stay nimble by detecting possible disruptions as early as possible and shares actionable insights on how to quickly and appropriately adjust when circumstances change suddenly, like a sudden increase in demand or a supply constraint [42]. Together, these ideas demonstrate the dual role of AI-driven inventory management as an internal strategic asset and a systemic enabler of efficiency and resilience. Operationally, AI keeps the inventory minimum so that there is no waste, and ensures that all necessary goods are in stock immediately. From a systemic perspective, it makes the HSC more resilient, helping organisations deliver consistent high-quality care while dealing with the intricacies [44]. The combination of RBV and Systems Theory allows us to better contextualize the role of AI driven solutions in the sustainable transformation of HSCs [49].

Empirical Review

The studies jointly attest to the revolutionary effect of AI in SCM, particularly in the healthcare case [62,66,65]. The effects of AI on supply chain resilience (SCRes) and supply chain performance (SCP) under dynamics and uncertainty are studied in [61]. Structural equation modelling (SEM), based on survey data from 279 organisations operating in diverse industries and nations, is used to show that AI increases short term performance and longer-term resilience via better information processing capabilities. The study concludes that the ability to efficiently process and analyse data is what makes AI important to keep supply chain performance and resiliency, advocating additional longitudinal research to gain a better understanding of AI's longer-term impact. The pape gives an exhaustive analysis on the convergence of AI and Supply Chain Risk Management (SCRM). This article looks at how machine learning, mathematical programming, big data analytics could make decisions more effective regarding supply chain hazards [63]. It then studies how current research classifies and highlights the role of AI in hazard recognition, evaluation using extensive multi-dimensional data sources. In addition, it identifies gaps in the currently available literature on SCRM and AI intersection and offers directions for future enquiry for SCRM and AI convergence to emphasize the need for agile and timely decision-making competencies in supply chain risk management.

The imperfection and higher expenses involved in Healthcare Supply Chains (HSCs) and suggests that AI systems can be used for mode selection whenever there is change in the economy or a healthcare calamity [64]. The study also shows that it might be possible for deep reinforcement learning methods to enable AI to select modes that look like target modes and outcompete conventional approaches. Drawing on the economic, social, and environmental benefits of AI, this paper analyses applied and theoretical insights into the sustainable future of HSC management [67]. The adoption of advanced technologies of AI and Industry 4.0, in emerging economies targeting healthcare supply chains (HSCs) [68]. The Rough SWARA approach is applied to recognize and rank the CSFs which are crucial for an optimal AI execution. This evidence shows that the components of technology have the largest impact, followed by Institutional, Human, and Organizational variables. There is significant focus on technical solutions for managing the supply chain risks, especially those highlighted by the COVID-19 pandemic this paper offers guidance on the strategic factors that facilitate the use of AI in conditions of scarcity [69].

Artificial intelligence approaches are reviewed to strengthen HSCR against interferences for example the current COVID-19 break out. The study leverages data from the Indian healthcare ecosystem to explain how AI increases adaptability and coordination in supply chains, a concept labelled as antifragility, as it enhances their capacity based on the likely disruptions. This study carried out using Partial Least Squares Structural Equation Modelling (PLS-SEM) shows that while supply chain dynamism mediates the relationship between cooperation and resilience, adoption of AI does not significantly impact supply chain resilience [70]. The study also has fuzzy impact in asserting that sufficient benefits of the AI-uniformed systems can help in improving the adaptivity and fractional work of the HSCs in enrichen their responses to crisis situations [64]. Together they show the strong effect of AI on contemporary SCM. Moreover, real time insights are provided through which they illustrate the improvement in efficiency, resilience and responses to be made by decision makers through the use of Artificial intelligence. [72] and [66] specifically analyse how AI is applied in HSC, while [71] and [65] analyse how AI broadly affects HSC resilience and performance. The work of Study [73] follows and extends the analysis by considering risk management in supply chains using AI. Together, these studies offer making of the theoretical and practical ramifications of AI adoption for supply chain sustainability and efficiency that can inform future research and implementation techniques towards better supply chain sustainability and efficiency.

3. GAPS IN LITERATURE

While there are many studies that attempt to examine the managerial influence of AI on the mode selection decisions in supply chains, or to identify the essential success factors for AI adoption, and its capability to enhance supply chain resilience, they often provide a large data gap in actual utilization of the AI in inventory management in healthcare. Specifically, there hasn't been enough focus on how AI driven systems can do systematically decreasing waste and strengthening the resilience of HSCs. Inventory management is essential to supply chain's operation, more specifically in healthcare, where inefficiency in these terms may lead to resource shortage, additional costs and finally patient care shortage. This study attempts to fill this gap and understands the deployment of AI based inventory management methods in the health sector. Our focus is on how AI can optimize resource efficiency, decrease waste, and enhance the resilience of a supply chain of healthcare to disruption, from pandemics, to abrupt spikes in demand. By using the modern AI methods such as machine learning and the predictive analytics, this research provides the actionable insights to healthcare organisations to improve the inventory accuracy, enhance the demand forecasting and build the resilient, adaptable supply chain. In this study, we strive to contribute to an enhanced theory as well as a practice of how AI will transform HSC management.

4. METHODOLOGY

Survey research design is used in the study to obtain a holistic view of how relevant stakeholders in HSC management view their current realities. This method makes the data acceptable for analytical applications, and facilitates the quantification of these responses. The study is cross sectional as it attempts to enhance SCM techniques within the healthcare sector. It is crucial for their varied composition in order to have the precise and direct insights from professional experience in healthcare spend chain management. The principal data gathering tool of the study will be the use of an online questionnaire. This method ensures the involvement of a geographically diverse population yet ensures accessibility and convenience for participants for the researcher. This strategy of stratified sampling gives representative and complete sample. This approach ensures that views from a variety of professional categories are taken into account to collect ideas. It seeks to derive important knowledge to which there are no distinct gaps and which fall within its remit. This stratified sampling method ensures enough of each professional category influences the study's output, so that it can help achieve the main aim of improving inventory management and supply chain resilience in healthcare.

Table 1: Demographic profile of participants

Professionals	Expected Participants
HSC Consultants,	129
Inventory Managers	142
Healthcare Administrators,	156
Procurement Officers	80
Vendors and Suppliers of Healthcare Products	107
Logistics Coordinator	108
Total	722

Source: Primary Data

The sample frame for this study has been constructed to encompass a varied cohort of professionals engaged in HSC management, hence assuring a thorough and representative dataset. A total of 722 participants are anticipated, categorised into six principal professional sectors, each offering distinct perspectives on supply chain and inventory management issues. This methodical stratification guarantees that the study encompasses the viewpoints of individuals with diverse positions and responsibilities, thereby enriching the depth and relevance of the research outcomes. The largest category comprises healthcare administrators, including 156 participants. These experts handle the strategic and operational dimensions of healthcare organisations, equipping them to offer insights into administrative issues, policy ramifications, and executive decision-making processes concerning inventory and SCM. Their contributions will aid in identifying systemic issues that affect the effectiveness and efficiency of HSCs.

HSC consultants, including 129 individuals, provide specialised expertise and experience in enhancing supply chain operations. Their expertise in best practices and innovative solutions will yield essential insights into contemporary trends and prospective enhancements in supply chain resilience and efficiency. Consultants provide an outsider viewpoint, aiding in the identification of deficiencies and inefficiencies within current processes. Healthcare product vendors and suppliers, totalling 107 players, are essential to the supply chain by guaranteeing the prompt delivery of medical supplies and equipment. Their input will underscore problems associated with procurement, distribution, and supplier relationships, which are essential to efficient inventory management. Their viewpoint is crucial for comprehending exterior influences on HSCs, including supplier dependability and market volatility. Procurement officers, including 56 members, are tasked with overseeing purchase operations and ensuring that healthcare institutions possess the requisite supplies as needed. Their work offers essential insights into procurement strategy, supplier negotiations, and cost management, which are vital for optimising resource utilisation and minimising waste. Logistics coordinators, representing 108 participants, oversee the transportation of items within the supply chain, guaranteeing effective delivery to designated destinations. Their viewpoint is crucial for comprehending logistical concerns, like transportation delays, distribution inefficiencies, and storage problems, which directly affect inventory management and supply chain efficacy.

Ultimately, inventory managers, including 142 individuals, supervise stock levels and guarantee the availability of critical medical goods while reducing waste. Their contributions are essential for discerning existing inventory management procedures, inefficiencies, and the prospective advantages of AI-driven solutions. Their direct experience with inventory difficulties renders them essential contributors to the study. By engaging experts from these six categories, the study guarantees a fair and thorough comprehension of HSC and inventory management. The stratified sampling strategy improves data representativeness by ensuring proportional inclusion of each professional category. The variety of viewpoints is crucial for recognising systemic difficulties and possibilities, as well as for suggesting practical solutions to enhance inventory management and supply chain resilience in the healthcare industry.

a. Reliability of the Research Instruments

The research tools used in this study have been validated by performing a pilot test on a sample of 50 respondents, who were representative of the target demographic. The aim of this initial assessment was to ensure the internal consistency and reliability of the survey instrument to collect reliable data within the healthcare industry regarding the inventory management and supply chain resilience driven by artificial intelligence. Cronbach's alpha value was 0.85; Internal consistency of the survey was assessed. This result indicates a high level of dependability which indicates that the items in the questionnaire are highly related and well gauge the constructs that are sought after. Sometimes Cronbach's alpha values over 0.7 are deemed to be satisfactory, while in other words values approaching 1.0 indicate good reliability. The questionnaire's internal structure is motivated a rating of 0.85, strong enough to consistently record the needed data. Test-retest reliability was also used to assess the temporal stability of the survey. The pilot group completed the identical survey two weeks following the first assessment and produced a correlation coefficient between the two response sets of 0.82. This verifies that use of the survey instrument affords the findings to be consistent over different time periods thus improving the trustworthiness of the survey instrument. Together, these reliability metrics collectively verify the reliability of the research instrument specifically that it reliably and repeatedly provides us with accurate and meaningful data. These results provide a robust basis for broadening the survey to investigate how AI driven supply inventory management enables supply chain resilience in the healthcare sector.

b. Data Analysis

Using power machine learning algorithms, the data of the poll will be processed to extract important insights about inventory management using AI driven mechanisms in waste reduction and supply chain resilience in the healthcare industry. A robust data pretreatment pipeline was created to assure the integrity and quality of the dataset. To that end, the data was cleaned by removing duplicates, standardizing formats, and resolving outstanding issues. For addressing of missing values, appropriate imputation methods such as mean imputation for numerical variables and mode imputation for categorical variables were used. To avoid introducing bias, high missing data columns were eliminated. For scaling purposes and to feed Machine Learning models, one-hot encoded categorical variables and put numbers into standard proportions were used, which makes both sets of columns interoperable.

A descriptive statistics of respondent demographics and important factors that we are interested in will summarize the data before bulk using machine learning techniques. Patterns and correlations amongst AI driven inventory management methods, waste reduction and supply chain resilience will be discerned by implementing methods such as decision trees and random forests. These offer strong capabilities to handle complex, non-linear interactions, and the resulting solutions are often interpretable using feature importance analysis. We will use accuracy, precision, recall and F1 score to evaluate the efficacy of the machine learning models. They will give us a complete picture of model efficacy, by counting both false positives and false negatives. The feature significance analysis will also provide a deeper insight to feature that most significantly affects the correlations found in the study to highlight key variables to improve efficient range of AI driven inventory management. Implementation of various machine learning approaches was done using Python as the principal programming platform. The regression is used by using Python and linear regression is used to find the impact of factors on the implementation of AI in healthcare supply chains. By applying this comprehensive analytical method, the aim to find out how AI could help in improving inventory management, decreasing waste, and strengthening supply chain resiliency in healthcare sector is realized; furthermore, it ensures the dependability of the results.

5. RESULTS

The results of figure 1 was to provide a total summary of research participants' socio demographics based on their professional title, organisational affiliation, and level of health care SCM experience. It focuses on the different professional positions and organisational type that are involved, offering a comprehensive view of supply chain issues and opportunities in the healthcare sector itself. Logistics Coordinators, with 21.47%, are by far the predominant professional designation of participants, reflecting their critical function of overseeing how goods travel and how supply chains function efficiently. A major component of that group, of which 18.84% are Inventory Managers, indicates the importance of focus on inventory management procedures. They also represent HSC consultants with 19.94% years of experience in analysis, procurement officers with 12.74% experience and healthcare administrators with 13.02% experience on procurement strategies and administrative control respectively. But this distribution highlights the inclusion of experts with diverse roles and responsibilities throughout HSCs. The vast majority of responses (75.35%) came from hospitals indicating healthcare related supply chain challenges to which hospitals play crucial role in inventory and resource management. A significant part of sample is constituted by pharmaceutical companies (24.65%), which are a key segment of HSC. It also assures as cohesive a view of supply chain dynamics among participating healthcare entities as possible.

The figure 1 breaks down participants by size of organization with large organizations (41.83%) the largest group. This points to plenty of operations, which have a tendency to deal with more involved supply chain issues. The study also covers viewpoints of entities with varied resource size and operational scope, by representing entities of medium size organisations (31.99%) as well as entities of small organisations (26.18%). They have plenty of professional experience, a rich representation of seasoned experts. Majority of respondents (41 %) have 7 to 10 years of experience, followed by 32.83 % who have 3 to 7 years, thus indicating that a sizeable number of sample respondents have achieved a substantial mastery of HSC management. Participants with a minority of less than 3 years of experience (15.51%) and only an even smaller minority over 10 years (10.66%) present a combination of novices and seasoned perspectives.

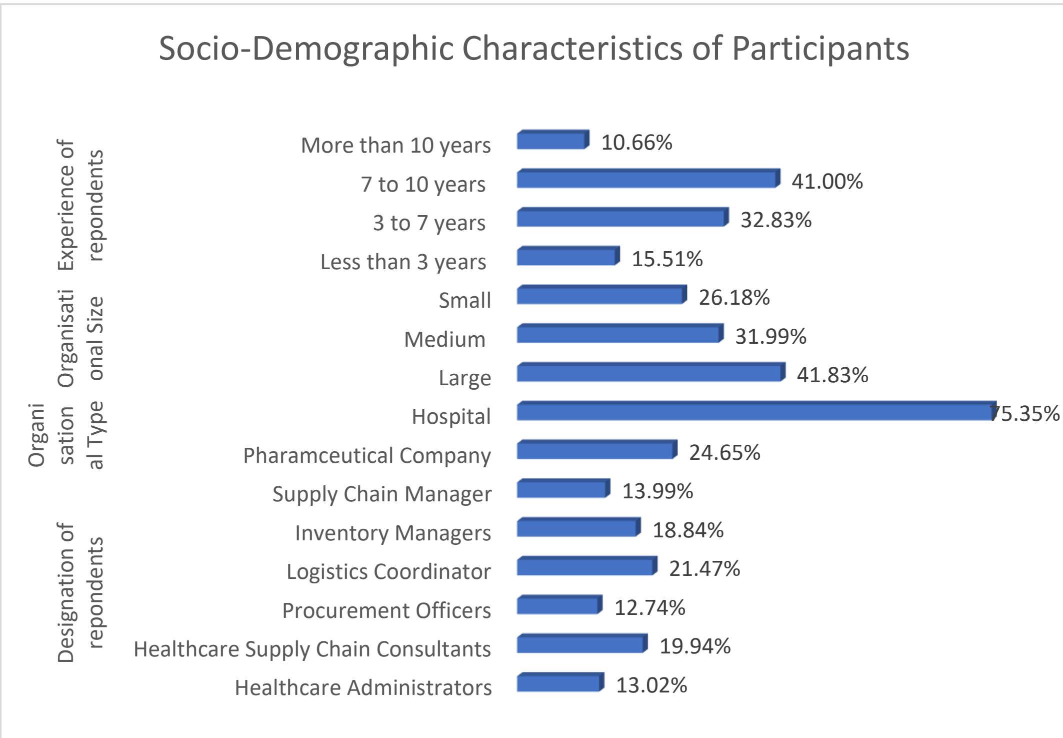

Figure – 1: Socio-Demographics of Participants

The structure of the participation pool also shows the diversity and representativeness. The diverse set of contributors guarantees that the ideas this study encompasses span a wide range of ideas from people in various jobs, organisational types, and experience levels, making the results applicable far and wide in the HSC setting. The study provides a clear perspective on the problems and possible solutions for HSC and inventory management, focusing mostly on hospital-based experts while involving participants of different spatial sizes from pharmaceutical companies and organizations.

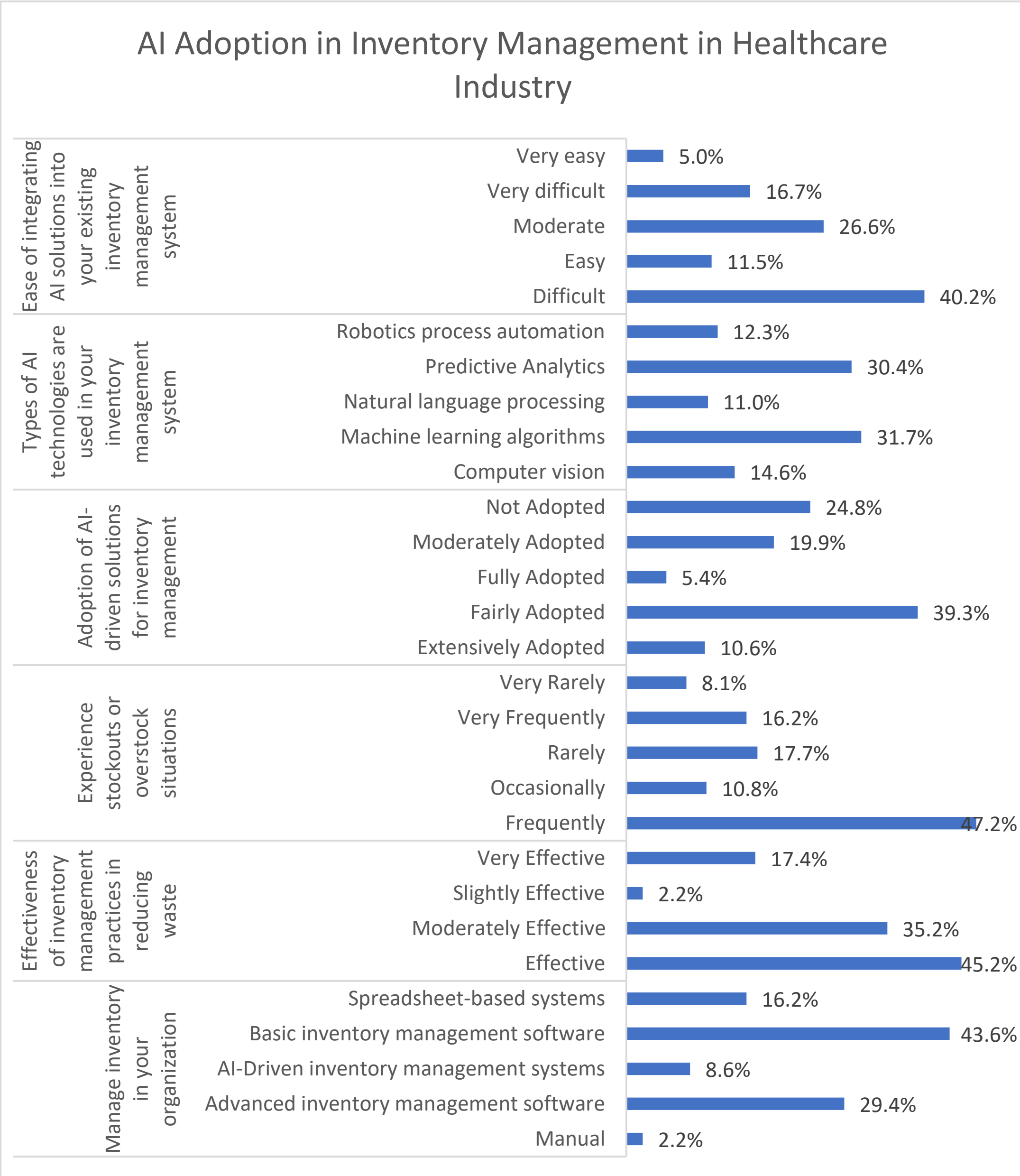

Figure 2: Inventory Management Practices

The figure 2 depicts the use and effectiveness of AI driven inventory management systems in the healthcare landscape highlighting integration ease, technical multitude, appropriation rates, and also how they help reduce waste and optimize inventory management. 41.1% of respondents believed that putting AI solutions into present day inventory systems was tough, 5% found the process very smooth. What this shows is the need for customized solutions and AI assist for the easy incorporation of AI in healthcare. This indicated that machine learning algorithms (31.7%) and predictive analytics (30.4%) top the list of AI applications used most widely in inventory management. On the other hand, 11% of total reliance was assigned to natural language processing (11%) because of its limited direct use in inventory procedures. On adoption levels, respondents said 39.3% of them adopted AI solutions ‘fairly’ and 24.8% ‘not at all’. That indicates various levels of acceptance of the adoption of these technologies within organisations. Moreover, 47.2% of participants reported that they typically use AI technology to minimize overstock and waste. A second round of effectiveness assessments confirms the value of AI, as an impressive 45.2% think it is 'effective' and 35.2% 'moderately effective.' Conversely, however, these run the risk of being outdated since conventional methods including spreadsheet-based tools (16.2%) are still used widely. This figure shows the increasing influence of AI, and the integration and adoption obstacles that must be overcome to make widespread use.

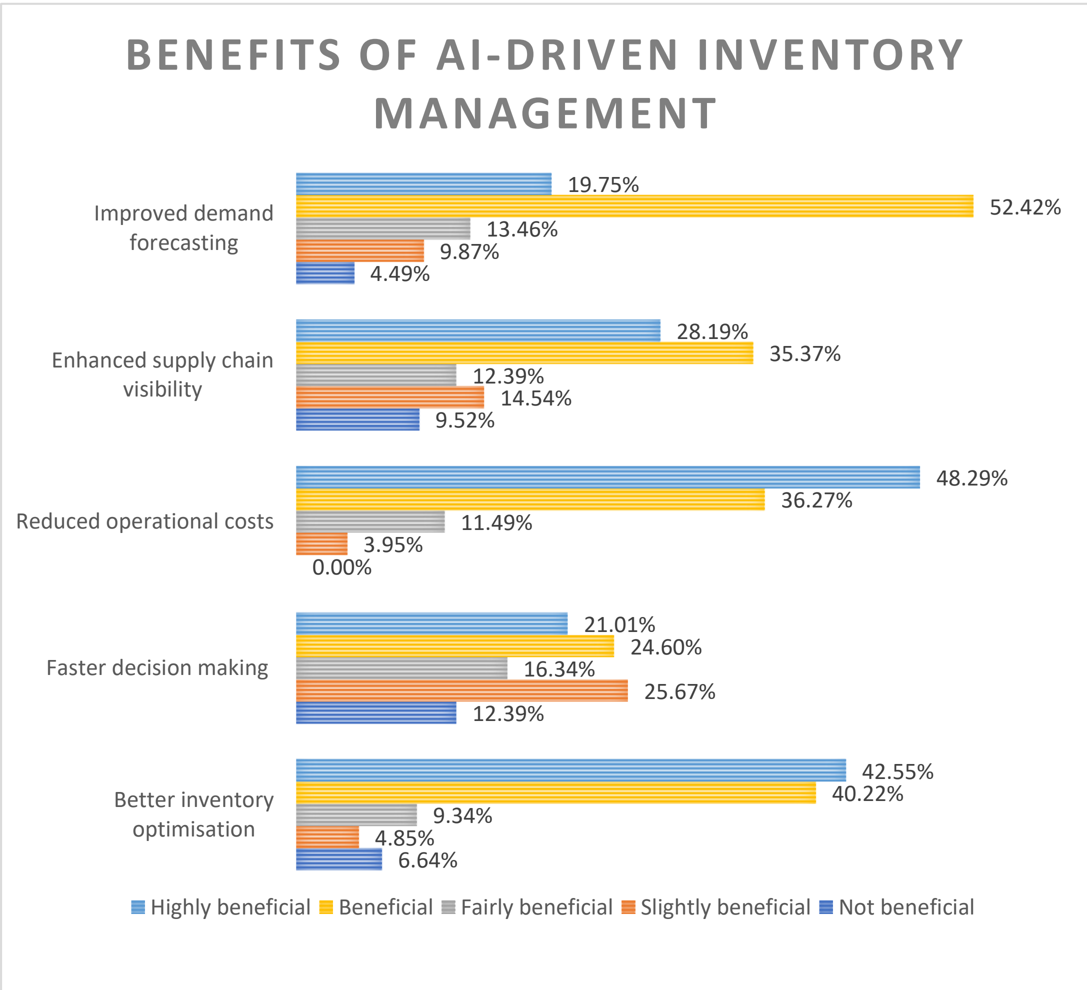

Figure 3: AI-Driven Inventory Management

The figure 3 illustrates the expected advantages of AI-driven inventory management in five principal domains: They enable increased demand forecasting, expanded supply chain visibility, decreased operating costs, expedited decision making, and improved inventory optimisation. Results show a large agreement on AI's transformative impact, with most respondents describing these as 'highly beneficial' or 'beneficial'. The most sought-after benefit is the ability to enhance forecasting of demand, which was acclaimed high value for 52.42% of participants, and beneficial for 19.75%. This provides a proof of the power of AI to forecast demand trends with precision, reducing waste and assuring the availability of resource. Supply chain visibility is also rated high with 35.37% of respondents rating it 'beneficial' and 28.19% as 'highly beneficial. This further support the potential of AI to provide real time insights, optimise operations and increase coordination among supply chain participants.

The finding of the largest benefit consisted of decreased operational expenses, with 48.29% stating highly advantageous and the remainder stating advantages. This shows the power of AI to optimize the resource allocation, minimize inventory cost, and optimize the overall efficiency. When it comes to the issues of expedited decision making the advantages are more evenly spread out with 24.60% of people saying beneficial and 21.01% saying highly beneficial. This reaffirms the use of AI as an enabler in supporting data driven timely decisions for the reason of increasing supply chain agility. The bulk of inventory optimisation is ultimately felt to be highly beneficial by 42.55% and beneficial by 40.22%. This corroborates AI’s ability to hold ideal inventory levels and prevent stock outs, as well as minimize stockouts and overstock. The benefits of AI driven inventory management as shown by the figure are tremendous, with consensus across all to improve operational efficiency, cut costs, and enhance decision-making in healthcare. This is a key takeaway for AI in solving its increasingly knotty supply chain problems.

Table 1 Validity and Reliability of the Data

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.894
Bartlett's Test of Sphericity	Approx. Chi-Square	3.0286748
	df	185
	Sig.	.000

Source: Primary data

The Kaiser-Meyer-Olkin (KMO) Test and Bartlett’s Test of Sphericity are presented in table 1 along with the finding that the data is appropriate for factor analysis. KMO (Kaiser's Measure Of Sampling Adequacy) provides sample adequacy score that varies from 0 to 1; values greater than 0.6 indicate that the data is suitable for factor analysis. Table 1 shows a high KMO value indicating that the dataset has adequate data to share similar variance of the variables for significant factor extraction. Moreover, the Bartlett's Test of Sphericity is shown statistically significant because it tests whether a correlation matrix is an identity matrix. In other words, the variables are correlated, and applying principal components analysis will be equivalent to dimensionality reduction.

Table 2 Extraction of factors affecting AI in Healthcare Applications

Sr No	Factor name	No of items	Factor Loadings	Cronbach alpha	Eigen Values
1	Supply Chain Optimization	5	.807 to .898	. 895	7.452
2	Sustainable Healthcare Operations	6	.769 to .895	.901	5.589
3	AI in Healthcare Applications	6	.866 to .909	.911	4.021
4	Resilience and Sustainability in Supply Chains	6	.859 to .901	.902	3.212
5	Ethical Considerations of AI in Healthcare	5	.824 to .921	.892	2.017
6	Impact of AI on Reducing Medication Waste	7	.684 to .801	.878	1.236
7	Artificial Intelligence in Inventory Management	4	.798 to .901	.921	1.022
8	Future of AI-Driven Inventory Management	4	.702 to .858	.861	1.001

Source: Primary data

Factor analysis extracted the factors which affect AI in healthcare applications are delineated in Table 2. It assesses each component by the number of items, factor loadings, Cronbach's alpha and eigenvalues to provide a reliability and importance of each component. The most powerful component was defined by Supply Chain Optimisation, which had eigenvalue 7.452 and robust factor loadings between 0.807 and 0.898. This gives a very high Cronbach's alpha of 0.895 showing great internal consistency which is so vital to its reliance on improving efficiency in HSC. Among all the constructs, Sustainable Healthcare Operations possesses the second highest eigenvalue (5.589) and factor loadings (0.769-0.895) with a Cronbach's alpha of 0.901 which further illustrates its strong effect on environmental and operational efficiency. AI in Healthcare Applications demonstrate the most reliable (Cronbach's alpha = 0.911), most robust factor loadings (0.866 to 0.909) and eigenvalue of 4.021, indicating that it is one of the most important contributions to healthcare advancements.

Reliability of constructs of Resilience and Sustainability in Supply Chains and Ethical Considerations of AI in Healthcare are supported by Cronbach's alpha values of 0.902 and 0.892 respectively, while factor loadings are strong. Eigenvalues of 1.236 and 1.022 were found for the influence of AI on diminished medication waste, with 0.878 and 0.921 for Cronbach's alpha, indicating significant influence on waste reduction and resource optimisation. Its Cronbach's alpha of 0.861 is sufficiently reliable but the Future of AI Driven Inventory Management exhibits the lowest eigenvalue (1.001) and moderate factor loadings (0.702 to 0.858). These results prove these characteristics are essential in determining the reliability and significance of AI applications in healthcare with increased eigenvalues and Cronbach's alpha ratings illustrating their reliability.

Table 3 Model summary of regression model of factors affecting AI in Healthcare Applications

Model Summary											
Model		R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin Watson
						R Square Change	F Change	f1	f2	Sig. F Change	
		.760	.577	.567	.616	.979	4803.715	7	472	.000	1.410

a. Predictors: (Constant), Supply Chain Optimization, Sustainable Healthcare Operations, Resilience and Sustainability in Supply Chains, Ethical Considerations of AI in Healthcare, Impact of AI on Reducing Medication Waste, Artificial Intelligence in Inventory Management and Future of AI-Driven Inventory Management
b. Dependent Variable: AI in Healthcare Applications

Source Primary Data (SPSS 18.0)

This model summary shows strong correlations between all predictors and the dependent variable, as confirmed by a R value of 0.760. This is a strong association between the healthcare AI parameters and consumer impressions of AI in healthcare. An R Square score of 0.577 indicates that 57.7 percent of the variation in consumer perceptions is explained by the predictors, a value of less than .999 indicates the model to be effective. This Adjusted R Square stresses the model’s dependability as the number of predictors considered. The Adjusted R Square is 0.567. The model's statistical integrity is validated with the high F Change value of 4803.715 and the corresponding (Sig. F Change = 0.000 value). With a Durbin–Watson score of 1.410 (indicating no strong autocorrelation) we can accept the model.

Table 4 Linear regression result for factors affecting AI in Healthcare Applications

Coefficients							
Model		Unstandardized Coefficients		T	Sig.	Collinearity Statistics	
		B	Std. Error			Tolerance	VIF
	(Constant)	.916	.041	-.384	.000		
	Supply Chain Optimization	.510	.006	4.825	.000	.899	1.124
	Sustainable Healthcare Operations	.423	.003	-3.438	.000	.758	1.329
	Resilience and Sustainability in Supply Chains	.351	.014	4.076	.000	.811	1.434
	Artificial Intelligence in Inventory Management	.308	.021	3.021	.000	.901	1.119
	Impact of AI on Reducing Medication Waste	.298	.033	1.345	.000	.921	1.547
	Future of AI-Driven Inventory Management	.254	.019	2.568	.000	.899	1.235
	Ethical Considerations of AI in Healthcare	.209	.037	2.695	.000	.887	1.109
a. Dependent Variable: AI in Healthcare Applications							

Source Primary Data (SPSS 18.0)

(Regression equation: P= a + b Q + e, where P =dependent variable, Q = independent variable, b=coefficient of Q , a = P-intercept/ constant and e= error term)

The Linear Regression Equation for participant’s perception towards AI in Healthcare Applications will be as based on the regression equation P= a + b Q + e. In the current study, AI in Healthcare Applications (P) is taken as dependent factors whereas other factors such as Supply Chain Optimization (Q1), Sustainable Healthcare Operations (Q2), Resilience and Sustainability in Supply Chains (Q3), Artificial Intelligence in Inventory Management (Q4), Impact of AI on Reducing Medication Waste (Q5), Future of AI-Driven Inventory Management (Q6) and Ethical Considerations of AI in Healthcare (Q7) are independent factors. The value of beta coefficient for factors affecting participants’ perception towards the adoption and use of AI in Healthcare Applications is represented in table 4. Finally, the model can be defined based on following equation:

P= a + b1 Q1 + b2 Q2 + b3 Q3 + b4 Q4 + b5 Q5 + b6 Q6 + b7 Q7 + e

Table 4 explains the comparative impact of on several parameters on customer attitudes to the utilization of AI in healthcare apps. The significance levels (Sig.) establish the statistical verity of the results, not the unstandardized coefficients (B), which measure the effect. Additionally, collinearity statistics (tolerance and variance inflation factor, or VIF) perform to show the absence of multicollinearity between predictors, guaranteeing a sound interpretation. The biggest effect (B = 0.510, T = 4.825, Sig. = 0.000) is shown with Supply Chain Optimization. This indicates that customer views of AI in healthcare are significantly influenced by how well supply chain can be optimized. Robust coefficient indicates that supply chain process has to be optimized, for example, by minimizing operational inefficiencies or by prompt delivery of medical supplies. This echoes prior work revealing how AI is essential to the improvement of supply chain efficiency through predictive analytics and real time monitoring.

The second most important factor (B = 0.423, T = -3.438, Sig. = 0.000) is Sustainable Healthcare Operations. It’s particularly noteworthy given the growing consumer focus on sustainable healthcare methods. The robust correlation suggests that green logistics and waste minimization initiatives are favourable to AI adoption too. In parallel with public desire for ethical and responsible healthcare, these techniques both reduce environmental effect and increase operational efficiency. The relationship of resilience and sustainability within the supply chains is substantial (B = 0.351, T = 4.076, Sig. = 0.000), which reflects that their integration significantly influences customer perceptions. Finding this is very crucial and the implications are for resilient, flexible supply chains that use artificial intelligence to manage disruptions and promote frames of reference for sustainable behavior including minimizing overshoot and optimizing use of limited resources. Inventory Management in conjunction with Artificial Intelligence (B = 0.308, T = 3.021, Sig = 0.000) is significant, confirming the importance of AI in inventory optimization, and waste minimization. Accurate demand forecasting and effective inventory management near consumer expectations result from an increase in supply chain efficiency where AI is involved.

Somewhat lower is the impact of AI regarding its reducing medication waste (B = 0.298, T = 1.345, Sig. = 0.000), still quite significant, however. This demonstrates that customers are well aware of the economic as well as the environmental benefits that can be brought about by AI in slashing pharma expiries and waste disposal costs. Similarly, Future of AI Driven Inventory Management also has a positive outlook on the efficacy of AI technologies in catering to future healthcare needs as B (0.254) and T (2.568) Sig (0.000) also signify a positive future. Nevertheless, the Ethical Considerations of AI in Healthcare turns out to exert the least influence on the components (B = 0.209, T = 2.695, Sig. = 0.000), although it is statistically significant. This implies that when contrasted with operational and sustainability factors, ethics has a rather small impact on consumer perception. That's all about developing confidence with AI applications: addressing ethical concerns like data privacy and justice. Therefore, the data reveals trust as the most influential and intention to use as the least influential factor. The regression equation can be derived as

AI in Healthcare Applications (P) = a + b1 (0.510) + b2 (0.423) + b3 (0.351) + b4 (0.308) +

b5 (0.298) + b6 (0.254) + b7 (0.209) + e

Supply chain optimization and sustainability initiatives were found to have an overwhelming effect on consumers' perceptions, emphasizing operational efficiency and environmental stewardship as fundamentally important determinants of success in achieving a competitive advantage in today's business environment. In comparison, ethical issues exert less impact, visible evidence of the influence of operational and sustainability outcome on consumer attitudes towards AI in health.

6. DISCUSSION AND CONCLUSION

It is this analysis of the influence of AI driven inventory management in supply chain resilience in healthcare in reducing waste of inventory. The study shows that many organisations are at different stages of AI implementation. We are in a transitional phase, with a large number of organisations 'fairly adopted' AI solutions, whilst others are lagging behind. Consistent with these views that [74] also espouse, this insight relates to the way AI technologies are continually adopted in steps by various sectors. Organisations that have utilised AI based inventory systems to its fullest extent consistently gain significant advantages like better demand forecasting, better transparency in supply chain and reduced operational costs. It comes down to enhanced inventory optimization, which demonstrates willingness of AI to supercharge procedures and remove inefficiencies. Although these apparent benefits are available, the problem that AI is incorporated into existing inventory management systems presents many organizations [33]. There were small percentage of respondents who mentioned challenges with integration which confirms an absolute need for a strategic planning and resource source so that their transition is eased. Ideally, a smaller yet important group perceives that it might work, that a prepared procedure, training and assistance can mitigate these problems. The barriers to adoption are primary data integration challenges, increased implementation costs, organisational reluctance to change and regulatory apprehensions. These challenges must be overcome with investment in comprehensive data management systems, and this investment in combination with AI suppliers and consultants, tactics that have proven especially successful in enabling the move. Overall, AI driven inventory management is perceived favourably, with most respondents expressing a readiness to promote AI solutions to other healthcare institutions. This is a broad recognition of the potential gains that AI has to offer, recognition of the challenges in adopting AI though. In order to realise AI's full promise for HSC management, it will be necessary to overcome integration and acceptance obstacles. Machine learning was found to be more powerful in minimizing resource waste and improving supply chain resilience when analysing data via machine learning algorithms. Our conclusions correspond with the empirical results described in [15], which show a substantial machine learning impact in improving supply chain efficiency. These show the importance of such technologies in helping foster sustainable and resilient healthcare supply networks.

Suggestions

The findings of this study show the transformative impact of inventory management using AI on enhance the supply chain resiliency in the healthcare sector. To maximise these advantages and tackle the related obstacles, the following recommendations are suggested: Strategic Planning for AI Integration: Companies need to outline in depth strategies on how to utilize AI with their current inventory management systems. It involves, first, doing feasibility analyses, pinpointing what integration opportunities are available, and second, distributing the requisite resources that support a fluid transition. Investment in Infrastructure: Data integration challenges are resolved with the help of effective data management solutions. To leverage the potential of AI algorithms, however, healthcare organisations must invest in sophisticated IT infrastructure that allows disconnects and bottlenecks in data transfer to be reduced as well as making AI algorithms more accurate. Cooperation with Specialists: Furnishing of the technical acumen for effective adoption could be done with collaboration from AI suppliers, consultants, and technology providers. The customisation of AI solutions to the specific need of HSC is facilitated with this cooperation. Training and Change Management: There is clear resistance to change when it comes to the adoption of AI. To implement AI technology, they must also prioritise the training and change management initiatives to educate employees about the technology and address their concerns against its use. Economical Implementation: Healthcare organisations can mitigate elevated implementation cost by rolling out AI solutions in stages, beginning with implementing in smaller, high-impact sectors first and later to launch at scale. One possible solution to reduce the financial barriers to implementation could be investigating funding avenues such as government grants or public private partnerships. Concentrate on High-Impact Artificial Intelligence Methods: Implementation of high impact technologies like robotic process automation and machine learning algorithms can make optimal use of AI implementation's advantages, to highlight. However, these methodologies have proven to be successful as an means through which to augment supply chain resilience, minimise waste in the supply chain and improve operational efficiency. Regulatory Compliance: Deploying the AI driven inventory system, Organisations should guarantee that the system adhere to pertinent rules. Proactive addressing of regulatory issues occurs when regulatory organisations are early engaged during the adoption process. Facilitate Knowledge Exchange: It can expand the space for promoting inter-organizational knowledge exchange toward effective AI deployments in order to speed up sector-wide adoption. Organisations starting out with an implementation can learn a great deal from disseminating best practices and lessons learnt. Ongoing Assessment and Enhancement: Frameworks to assess the performance of AI systems are then instituted in order to identify points where the system can be further improved. Assessments will be guaranteed to be consistent and thereby systems will be consistent to evolving requirements and continue to provide optimal outcomes. Healthcare organisations can create more robust, efficient and sustainable supply chains by developing a more robust implementation of AI and harnessing its capacity for more accurate forecasting of demand, transparency of the supply chain and optimization of inventory. These initiatives won't just eliminate waste, it will also pull healthcare services upward and out into the communities that need it most.

7. FUTURE RESEARCH

Future research should incorporate advanced AI methodologies, such as deep learning and reinforcement learning, to leverage on existing AI methods such as machine learning, to come up with a better inventory management framework within HSCs. Using these sophisticated methodologies, your data patterns and fluctuating supply chain context becomes manageable thereby increasing your prediction precision and decision making. Since systems will be more resilient and responsive peripherally, reinforced learning could allow systems to independently adjust to fluctuating demand and supply conditions.

Further exploration is necessary into supply chain resilience and waste reduction brought about by real time data analytics and and the internet of things (IoT). Gaining real time data analytics of such information can lead to actionable insights that enable instant decision making, while IoT devices could add on the supply chain visibility by monitoring the inventory and environmental variables like temperature and humidity of the delicate medical goods. There is much work to be done in the future with respect to how ethical and privacy worthy is AI in healthcare supply networks. The ethical execution of such concerns as data security, patient privacy, and algorithmic bias must be rigorously checked against regulatory norms. Finally, longitudinal studies will be necessary for assessing the long-term advantages, barriers, and sustainability of AI driven inventory management platforms. Research of this sort could shed valuable light on the path of AI adoption, its enduring effectiveness, and its overall influence on the health care industry over time.

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