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LEVERAGING ARTIFICIAL INTELLIGENCE IN HEALTHCARE SUPPLY CHAINS: STRENGTHENING RESILIENCE AND MINIMIZING WASTE

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ABSTRACT

AI is reshaping the future of healthcare supply chain management, increasing operational performance and reducing the level of wastage, to explore efficiency and cost benefits. This paper used quantitative forecast models, which have the potential to support sustainable economic growth of supply chain management. There are many issues and challenges that are associated with healthcare supply chains such as inventory control, demand forecasting, and resources. Management. These problems remain unsolved by traditional supply chain solutions leading to problems such as overstock, stockout, and wastage. AI technologies and applications like machine learning algorithms and predictive analytics offer solutions through their aptitude for forecasting, inventory management, and making the right decisions. Econometric techniques such as time series and econometric modeling quantitative techniques are used in assessing the economic implications of AI in healthcare supply chain innovation. These techniques involve studying past trends to forecast future behavior and these are beneficial in organizational demand changes, resource utilization, and general waste can be better estimated. Integrating AI with quantitative forecasting enables healthcare organizations to strengthen their operational resilience, adjust to changing market conditions, and realize cost savings. The study emphasizes several key advantages of AI adoption, including enhanced accuracy in demand forecasting, lower operational costs, and improved resource utilization efficiency. Furthermore, AI-powered tools assist organizations in managing uncertainties and responding proactively to disruptions, fostering overall economic stability and growth. Through utilizing quantitative forecasting methods, healthcare organizations can optimize their supply chain operations, promote sustainable economic growth, and improve service delivery.

KEYWORDS: *Artificial Intelligence, Healthcare Supply Chains, Operational Resilience, Waste Reduction, Predictive Analytics, Demand Forecasting, Resource Optimization, Machine Learning, Sustainability.*

INTRODUCTION

Global economies are gradually experiencing a shift through technological development, and AI is considered a key factor. AI is now transforming the supply chain in the healthcare sector with a positive impact on its economic outcomes to gain greater efficiency and reduce wastage (Moosavi et al., 2022). This discussion expands our understanding of how AI plays a role in the health supply chains together with how quantitative forecasts may be used to measure the benefits of its use not only within the sphere of healthcare but also in the overall growth of a sustainable economy. Moosavi et al., (2022) noted that "Health care systems supply chain networks are complex structures, that require the organization to stock, demand, and resource flow effectively". Most of the conventional techniques tend to struggle when it comes to catering to the ever-changing conditions of such systems in that the common problems such as stocking excess inventory, running low on stock, and increased operating costs may not be well dealt with. The mentioned problems are well solved by AI technologies such as machine learning and predictive analytics, as the

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latter provides accurate information on demand rates, helps manage inventory, and improves operational logistics (Dixit & Dutta, 2023). They enable healthcare organizations to deal with variability of demand more effectively; to make better use of available resources; to reduce the amount of waste, and to enhance the level of service delivered. Dixit & Dutta, (2023) "The value of the quantitative forecast is important to understanding the economic impact of AI improvements". Through techniques such as time series analysis and econometrics, it becomes possible for stakeholders to make a forecast of the impact that AI incorporation will have on future economic values. Another type of economic research carried out in businesses is time series analysis which tries to discover trends and cycles out of historical data while econometric modeling looks for associations between various economic factors. All in all, these approaches provide useful information as to how AI causes changes in efficiency, costs, and general economic performance (Dixit & Dutta, 2023).

The application of AI technologies in the case of healthcare supply chains provides the following benefits: Firstly, it increases the healthcare supply chain responsiveness in the face of disruptions, Secondly, it minimizes problems related to inventory accumulation and consequently overall reduction of further waste. Such cost savings can be reinvested back to improve services towards positive economic growth. AI can be considered an indispensable tool in supply chain redesign that drives increased operational productivity and cost reductions, while quantitative forecasting methods directly address the determination of its economic worth. Nonetheless, as AI technology develops its role in enhancing the effective delivery of healthcare services and economic development will expand further. Grasping these dynamics is essential for harnessing technological advancements to promote sustainable development and enhance economic stability.

The purpose of this study is to evaluate the impact of Artificial Intelligence (AI) on healthcare supply chain management, focusing on addressing persistent challenges such as inventory control, demand forecasting, and resource management. Through leveraging AI technologies like machine learning algorithms and predictive analytics, the study explores solutions to inefficiencies like overstock, stockouts, and wastage, while assessing the economic benefits through quantitative forecasting and econometric techniques. It aims to demonstrate how AI enhances operational resilience, improves demand forecasting accuracy, optimizes resource utilization, reduces costs, and fosters sustainable economic growth.

AI Integration in Healthcare Supply Chain Management: Enhancing Efficiency, Sustainability, and Resilience

Supply chains in today's complex healthcare systems and their resource management cannot be imagined without the integration of artificial intelligence or AI (Dolatabad et al., 2022). It has also been demonstrated that the adoption of AI results in optimizing an organization's performance, decreasing its wastage, and enhancing its decision-making process. However, analyzing the use of AI technologies shows that they have a great influence on improving the performance of healthcare supply chains. The use of things such as machine learning, natural language processing, and predictive analytics are all aimed at solving issues found in these systems. Big data is analyzed to identify repeating patterns or trends that help firms improve inventory and demand prediction models (Dolatabad et al., 2022).

This leads to the precise determination of future needs which stands in contrast to pitfalls such as excess inventory or stockout which characterize the conventional supply chain methodologies. NLP (Natural Language Processing) helps AI make structured and meaningful analyses of unstructured data usually found in EHRs (Electronic Health Records) and supply chain documents (Kaswan et al., 2021). Converting this information into insights makes NLP's contribution valuable in decision-making processes such as inventories, supplier performance as well as patient health status. Therefore, from this technological aspect, the supply chain gets a lift because of the effective and efficient utilization of resources at the right time.

Culot et al., (2024), underscored that "One of the most important applications of AI is the use of tools of statistical and machine learning to forecast future trends". In healthcare supply chains, it allows for promotion of forecasting for the medical supply demand and the identification of disruptions. This strategic perspective enables healthcare organizations to be ready for diverse disturbances in advance, strengthen them, and reduce losses in case of adversities. It also helps optimize resource utilization by enhancing AI integration. Products can be automated, such as orders, where there is no need for so much manual input and errors can be minimized. Efficiency replaces repetitive work, which can effectively be done by automated systems while freeing the staff to focus on valuable tasks like improving patient experience and relationships with suppliers. A major benefit of embedding AI is the sustainability of cost

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(Ugwu et al., 2024). It is possible to get much bigger cost savings with proper inventory management and avoiding unnecessary losses, which will free up money for other important needs.

Through organizing these cost cuts concerning priorities other than production costs, organizations can free up resources for investment in improved technologies or the expansion of services, and this enhances their efficiency, and hence the delivery of quality patient care (Aliahmadi et al., 2022). Moreover, AI increases operational durability by preparing healthcare supply chains to respond to interruptions, for example, short supplies or changes in demand. AI helps organizations to mitigate such threats using predictive analytics as well as real-time monitoring thus helping organizations to deliver care efficiently without any hitches.

Enhancing Supply Chain Efficiency in Healthcare Through Artificial Intelligence: Reducing Costs, Waste, and Optimizing Resource Utilization

The healthcare supply chain integrates with organizational effectiveness and with healthcare systems worldwide, given the constraints of time, cost, and quality (Avinash & Joseph, 2024). Inferences from the literature revealed that "Through the use of AI in the management of supply chains in the healthcare sector, impressive results are achieved since various processes are eased, made less wasteful, and resources are optimally utilized". This section looks at how AI enhances the supply chain effectiveness and has substantial impacts on healthcare institutions. Based on findings from the literature review, there are several ways in which AI technologies enhance the supply chain.

First, AI-driven predictive analytics enable organizations to improve demand forecasting by increasing its accuracy (Hossain et al., 2023). AI algorithms employ historical data to forecast future requirements of the medical supply and equipment and to do so more accurately. The possibilities of the firm stocking up or running out of stock are minimized accordingly the inventory levels match the actual needs of the firm. Demand forecasting aims to reduce the overstocking of products and therefore reduce the cost of stocking perishable products which can go bad (Hossain et al., 2023).

Second, AI promotes efficiency in the way the inventory is controlled through automation of the process (Dash et al., 2019). The AI systems are capable of monitoring stock levels within the business and will be able to place orders as soon as stock is depletion to pre-set levels of re-ordering. This automation minimizes the chances of people being involved and this results in increased efficiency in operating the inventory. In addition to this, Narendran, (2023) noted that "AI can help in the determination of reorder points and quantity based on usage frequency, cyclic trends, and supply chain considerations so that the reordering point is got to the right level of inventory".

Third, AI improves communicational interaction flow by providing the best options for delivery routes and timings (Dwivedi et al., 2021). Using such metrics as traffic and delivery time or suppliers' performance, AI calculates the best way and the best time for shipping. This optimization reduces the cost incurred in transportation, and the time spent in transportation, and increases the supply chain adaptability. An efficient supply chain not only enhances customer services but also reduces costs and pollution implications.

Also, AI supplements decisions by introducing sophisticated data analysis aspects. With the use of log data as well as other data sources AI produces charts and reports that supply chain managers and sub-contracting officers use to evaluate supply chain performance supplier reliability and cost (Mohsen, 2023). Such findings benefit healthcare organizations in different ways, enabling them to make sound decisions on selecting suppliers and negotiating contracts and resources necessary for improving supply chain efficiency and planning.

Further, with the help of automation, AI makes numerous repetitive tasks such as entering data in inventory management tracking the orders etc. It also reduces the burden of delivering endless reports to the staff work so that they can focus on top priorities such as improving care delivery and supply chain management.

This redirection of efforts brings with it better operational efficiency and closer congruency with organizational goals and aims (Niaz & Nwagwu, 2023). Artificial intelligence proves critically important to modern supply chains in terms of demand planning, inventory management, and logistics in the delivery of healthcare products. AI technologies can be effectively embedded in the healthcare environment for greater accuracy, less expenditure, and better resource utilization (Lee & Yoon, 2021). Advancements bring huge cost savings, better service delivery, and increased overall

operation performance and these all indicate the positive role of AI in the advancement of the supply chain with more emphasis on the sustainable supply chain for healthcare services.

Different techniques of reducing the cost are significant aspects in managing healthcare supply chains with many positive impacts on healthcare resource utilization, and the environment, among others. AI is central to waste minimization that improves efficiency, allocation of resources, and processes employed in production (Diaz-Farina et al., 2020). This section reflects on how AI solutions help minimize wastage and reflects on the topic in a larger scope as relating to the welfare of the health systems.

One of the ways through which AI reduces wastage is through improved demand forecasting. The day-to-day conventional forecasting techniques do not suffice adequately in predicting future requirements and demands effectively resulting in issues like overstocking or stock extravagance (Senna et al., 2023). AI-led predictive analytics incorporate information from the past, algorithms, and input from current data for better demand predictions. Precision is useful in making sure that healthcare organizations do not order or stock out of unnecessary items eliminating an accumulation of such products and wastage.

However, according to Narendran, (2023), AI also helps in managing inventory in the right manner since it keeps the necessary stock levels. Sophisticated automated systems for different inventory processes constantly remain active and adapt inventory quantities based on usage rates, suppliers' lead time, and anticipated changes in demand. It helps to prevent resources from being wasted by beginning to solve a problem before it becomes critical.

The flexibility in using this inventory model minimizes the chances of merchandise going to waste due to being out of fashion or having gone bad, hence the cut down on losses from unsold or spoilt goods (Ikpe, & Shamsuddoha, 2024). Business inventory control means that business resources are used optimally while the intended products are available when needed, but not more than needed.

Apart from inventory, AI plays a role in controlling wastage through efficiency in logistical and supply chains (Sharma et al., 2022). They include the optimization of transport networks or of delivery schedules to digitize and reduce many delivery mistakes which virtually always lead to wastage. For instance, to cut delivery time Application Intelligence can determine the best routes for transporting supplies, especially for medicals so that some items like medicals do not expire from extended time on the road.

Another area where AI is of great help is in improving the procurement function; therefore, there is a cut down on wastage (Ajayi et al., 2017). Due to its capability to analyze supplier performance data and evaluate cost saving and cost avoidance, AI supports healthcare organizations in arriving at more savvy decisions for supplier choice and agreement settlements. This makes sure that supplies are bought from trusted sources and that contractual agreements will not lead to buying lots of stock that is little used or vice versa. It has been found to enhance efficiency in the purchasing process since waste can be minimized as well as costs better controlled (Trabucco & De Giovanni, 2021). Further, due to AI, human input in areas such as order processing and inventory possession is significantly reduced. Minimizing the involvement of human beings in the workflow reduces errors that could have led to wastage and—one way of making work more accurate and reliable decision (Olakotan & Yusof, 2020). This leads to the elimination of wastage and enhances the general working of the system. Kumar et al., (2023) pointed out that "AI is a critical component in the achievement of waste reduction goals in the healthcare supply chain by promoting better demand planning, better inventory control, superior logistics, and superior procurement". Thus, by using artificial intelligence in actual care applications, healthcare organizations are capable of removing the stock that is not required to reduce the chances of spoiling food items and can use the resources effectively. All these have implications of causing a reduction in the overall cost while at the same time being environmentally friendly making it easy for organizations to adopt the use of AI to bring about changes in the ways waste management is being done, and the conduciveness of supply chain management.

Optimizing Resource Management in Healthcare Through Artificial Intelligence: Enhancing Efficiency, Procurement, and Inventory Control

Resource management is relevant for better working of supplies in the healthcare facilities bearing in mind that resources must be used effectively (Sharma, et al., 2020). Per Hassan & Mhmood, (2021), The use of AI greatly

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improves resource utilization by optimizing it through providing higher analytical tools, streamlining tasks, and enriching decision-making. This present section includes a discussion on how AI functions for prospects of resource management and its pervasive influence on healthcare organizations. Resource management can be another area where the utilization of AI capabilities is important because it provides research and recommendations. AI can estimate future requirements and discover trends or areas of waste by analyzing past data and current data (Abdallah et al., 2020). For example, AI can predict future usage of all medical products potentially based on patient information, time of the year, etc. This predictive ability allows healthcare organizations to organize themselves optimally; to ensure the timely deployment of vital supplies, while avoiding situations of scarcity or, conversely, over-accumulation.

According to Ahmad et al., (2021), Other areas that AI benefit are in demand prediction and in managing the resources through efficient inventions. Direct interfaces enable AI systems to keep checking the inventory levels, identify the usage patterns, and make appropriate adjustments to stock more actively. By managing inventory properly, both over inventory which hampers financial capital and increases the cost of storage, and inadequate inventory which hinders the delivery of patient care are solved. AI's capacity to automate inventory management also means that resources are used correctly, freeing up inventory matching with actual demand and, thereby, cutting losses and expenses associated with excess inventory (Ahmad et al., 2021).

Another area emphasized by AI is resource management by improving procurement. Being used to evaluate the supplier's performance, cost, and delivery reliability, AI supports decision-making in selecting the right sourcing strategies. This helps ensure one gets resources from the most reliable providers at the best rates thus reducing procurement expenses while at the same time improving on-chain supply. Also, AI optimizes the organization of the processes of logistics, thus, helping in achieving the maximum efficiency of the utilized resources (Rane et al., 2024). The supply chain management systems combine transportation and routing, logistics, and timing options to choose the best distribution methods. Efficient transport systems enable efficient movement of tasks, lead to reduced transport costs, minimize transport durations, and overall efficiency in the flow of resources. "AI-driven automation similarly supports performing basic work including order fulfillment, stock management, and data inputs reducing manual work with a high tendency to create mistakes" (Rane et al., 2024). This results in increased and timely proper data and work of the staff on the necessary activities such as strategic development and delivery of quality patient services.

CONCLUSION

In conclusion, it can be stated that incorporating AI in the healthcare supply chain is a breakthrough that will have a significant impact on enhancing the effectiveness and efficiency of the supply chain. Smart technologies like machine learning algorithms, predictive analysis, and automation offer unique shifts in operations that enhance operation performance and have a positive impact on the U.S economy. In this way, AI improves the supply chain by minimizing forecasting errors, effective and efficient inventory management, and implementing superiority in logistics. Through using predictive analytics in determining the healthcare demand, their supply needs can be more accurately predicted reducing overstocks and stockouts, increasing the efficiency of suppliers, and reducing costs. Also, AI automation helps to minimize such factors as manpower intervention, and spokes in the wheel and, thus, increases total operational reliability.

Waste reduction is a key benefit of integrating AI into healthcare supply chains. Through optimized demand forecasting and inventory management, AI helps prevent surplus inventory and waste. Enhanced logistics and procurement processes ensure resources are used efficiently, reducing spoilage and minimizing the environmental impact of excess stock. Real-time data tracking and analysis further support waste reduction by enabling healthcare organizations to respond quickly to shifts in demand and supply conditions. AI also improves resource optimization by accurately forecasting needs and identifying inefficiencies. This leads to better resource allocation, lower procurement costs, and more efficient logistics. Automation of routine tasks allows staff to focus on more strategic activities, enhancing overall operational performance. The implementation of AI in healthcare supply chains offers significant advantages, including improved efficiency, waste reduction, and resource optimization. These benefits result in cost savings, improved service delivery, and enhanced operational effectiveness. As AI technology continues to advance, its role in healthcare supply chains will become even more significant. Through leveraging AI, healthcare organizations can achieve sustainable growth, improve patient outcomes, and foster innovation in a constantly evolving economic environment. Understanding and utilizing AI's potential is vital for navigating the challenges of modern supply chains and ensuring long-term success and resilience.

REFERENCES

1. *Abdallah, M., Talib, M. A., Feroz, S., Nasir, Q., Abdalla, H., & Mahfood, B. (2020). Artificial intelligence applications in solid waste management: A systematic research review. Waste Management, 109, 231-246.*
2. *Ahmad, T., Zhang, D., Huang, C., Zhang, H., Dai, N., Song, Y., & Chen, H. (2021). Artificial intelligence in sustainable energy industry: Status Quo, challenges and opportunities. Journal of Cleaner Production, 289, 125834.*
3. *Ajayi, S. O., Oyedele, L. O., Akinade, O. O., Bilal, M., Alaka, H. A., & Owolabi, H. A. (2017). Optimising material procurement for construction waste minimization: An exploration of success factors. Sustainable materials and technologies, 11, 38-46.*
4. *Aliahmadi, A., Nozari, H., Ghahremani-Nahr, J., & Szmelter-Jarosz, A. (2022). Evaluation of key impression of resilient supply chain based on artificial intelligence of things (AIoT). arXiv preprint arXiv:2207.13174.*
5. *Avinash, B., & Joseph, G. (2024). Reimagining healthcare supply chains: a systematic review on digital transformation with specific focus on efficiency, transparency and responsiveness. Journal of Health Organization and Management.*
6. *Culot, G., Podrecca, M., & Nassimbeni, G. (2024). Artificial intelligence in supply chain management: A systematic literature review of empirical studies and research directions. Computers in Industry, 162, 104132.*
7. *Dash, R., McMurtrey, M., Rebman, C., & Kar, U. K. (2019). Application of artificial intelligence in automation of supply chain management. Journal of Strategic Innovation and Sustainability, 14(3).*
8. *Diaz-Farina, E., Díaz-Hernández, J. J., & Padrón-Fumero, N. (2020). The contribution of tourism to municipal solid waste generation: A mixed demand-supply approach on the island of Tenerife. Waste Management, 102, 587-597.*
9. *Dixit, A., & Dutta, P. (2023). Thematic review of healthcare supply chain in disasters with challenges and future research directions. International Journal of Disaster Risk Reduction, 104161.*
10. *Dolatabad, A. H., Mahdiraji, H. A., Babgohari, A. Z., Garza-Reyes, J. A., & Ai, A. (2022). Analyzing the key performance indicators of circular supply chains by hybrid fuzzy cognitive mapping and Fuzzy DEMATEL: evidence from healthcare sector. Environment, Development and Sustainability, 1-27.*
11. *Hassan, A., & Mhmood, A. H. (2021). Optimizing network performance, automation, and intelligent decision-making through real-time big data analytics. International Journal of Responsible Artificial Intelligence, 11(8), 12-22.*
12. *Hossain, M. K., Thakur, V., & Kazancoglu, Y. (2023). Developing a resilient healthcare supply chain to prevent disruption in the wake of emergency health crisis. International Journal of Emerging Markets, 18(6), 1307-1329.*
13. *Ikpe, V., & Shamsuddoha, M. (2024). Functional Model of Supply Chain Waste Reduction and Control Strategies for Retailers – The USA Retail Industry. Logistics, 8(1), 22.*
14. *Kaswan, K. S., Gaur, L., Dhatterwal, J. S., & Kumar, R. (2021). AI-based natural language processing for the generation of meaningful information electronic health record (EHR) data. In Advanced AI techniques and applications in bioinformatics (pp. 41-86). CRC Press.*
15. *Kumar, A., Mani, V., Jain, V., Gupta, H., & Venkatesh, V. G. (2023). Managing healthcare supply chain through artificial intelligence (AI): A study of critical success factors. Computers & Industrial Engineering, 175, 108815.*
16. *Lee, D., & Yoon, S. N. (2021). Application of artificial intelligence-based technologies in the healthcare industry: Opportunities and challenges. International journal of environmental research and public health, 18(1), 271.*
17. *Mohsen, B. M. (2023). Impact of artificial intelligence on supply chain management performance. Journal of Service Science and Management, 16(1), 44-58.*
18. *Moosavi, J., Fathollahi-Fard, A. M., & Dulebenets, M. A. (2022). Supply chain disruption during the COVID-19 pandemic: Recognizing potential disruption management strategies. International Journal of Disaster Risk Reduction, 75, 102983.*
19. *Narendran, V. C. G. (2023). Adoption of Artificial Intelligence Techniques for Inventory Management (Doctoral dissertation, SP Jain School of Global Management (India)).*
20. *Narendran, V. C. G. (2023). Adoption of Artificial Intelligence Techniques for Inventory Management (Doctoral dissertation, SP Jain School of Global Management (India)).*
21. *Niaz, M., & Nwagwu, U. (2023). Managing Healthcare Product Demand Effectively in The Post-Covid-19 Environment: Navigating Demand Variability and Forecasting Complexities. American Journal of Economic and Management Business (AJEMB), 2(8), 316-330.*
22. *Olakotan, O. O., & Yusof, M. M. (2020). Evaluating the alert appropriateness of clinical decision support systems in supporting clinical workflow. Journal of biomedical informatics, 106, 103453.*
23. *Rane, N. L., Desai, P., Rane, J., & Paramesha, M. (2024). Artificial intelligence, machine learning, and deep learning for sustainable and resilient supply chain and logistics management. Trustworthy Artificial Intelligence in Industry and Society, 156-184.*
24. *Senna, P., Reis, A., Dias, A., Coelho, O., Guimarães, J., & Eliana, S. (2023). Healthcare supply chain resilience framework: antecedents, mediators, consequents. Production Planning & Control, 34(3), 295-309.*

25. *Sharma, H. B., Vanapalli, K. R., Cheela, V. S., Ranjan, V. P., Jaglan, A. K., Dubey, B., ... & Bhattacharya, J. (2020). Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic. Resources, conservation and recycling, 162, 105052.*
26. *Trabucco, M., & De Giovanni, P. (2021). Achieving resilience and business sustainability during COVID-19: The role of lean supply chain practices and digitalization. Sustainability, 13(22), 12369.*
27. *Ugwu, O. I., Clarksville, T. N., Hassan, O. F., Clarksville, T. N., Sanusi, M. A., Odukoya, O., & Onasanya, T. (2024). Artificial Intelligence in Healthcare Supply Chains: Enhancing Resilience and Reducing Waste.*