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Artificial Intelligence in Public Healthcare Supply Chains: Current Applications, and Future Policy Directions

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Abstract
Background: Despite the rapid advancements in digital transformation, Healthcare Supply Chain Management (HSCM) in the public sector faces systemic vulnerabilities, including demand fluctuations, inefficient resource distribution, and operational bottlenecks. While Artificial Intelligence (AI) presents transformative opportunities to mitigate these challenges, there remains a critical gap in the scientific understanding of how AI tools can be effectively integrated into public healthcare supply networks within appropriate policy and governance frameworks.
Objective: This study aims to evaluate the contributions of AI to HSCM in the public sector. Specifically, it seeks to identify current operational applications, analyse institutional and technological challenges, examine emerging AI techniques, and propose strategic policy directions to enhance the study and practice of public healthcare logistics.
Methods: A systematic literature review was conducted across major academic databases to analyse current scholarly contributions at the intersection of AI, public health management, and supply chain operations. The retrieved studies were critically appraised and synthesised to map existing AI integration stages, identify operational barriers, and formulate future policy recommendations.
Results: The findings reveal that AI applications significantly enhance public healthcare supply chains by optimising core operational dimensions, including predictive demand forecasting, automated inventory control, smart logistics routing, and proactive risk analysis. Furthermore, the synthesis demonstrates that AI-driven solutions improve resource allocation transparency, reduce waste, and strengthen operational resilience against unexpected public health crises.
Conclusions: Artificial Intelligence serves as a vital strategic instrument for building resilient, efficient, and cost-effective public healthcare supply chains. To fully capitalise on these technological advancements, healthcare authorities must establish robust policy frameworks, address data governance and institutional challenges, and promote cross-sectoral collaboration between public health institutions and technology providers.
Keywords: Artificial intelligence; supply chain; Public healthcare.

1. Introduction

The integration of advanced information technology has fundamentally transformed the healthcare sector, driving remarkable progress in both administrative operations and clinical decision-making processes. Historically, this digital evolution began with basic computerised record-keeping, progressed to standalone Electronic Medical Records (EMRs), and has now culminated in interconnected Electronic Health Record (EHR) networks. Modern healthcare infrastructure increasingly converges with cutting-edge technologies, such as the Internet of Things (IoT), blockchain, and Artificial Intelligence (AI), to optimise institutional performance and care delivery. Within this technological ecosystem, AI technologies simulate cognitive functions, offering unprecedented capabilities to process complex, multi-dimensional data encompassing clinical records, patient demographics, environmental variables, and pharmaceutical flows.

In the public health domain, the operational efficacy of healthcare delivery is intrinsically bound to the resilience of supply chain networks. Public Healthcare Supply Chain Management (HSCM) involves an intricate ecosystem of manufacturers, public procurement agencies, state warehouses, distribution networks, and medical facilities. Ensuring a seamless flow of materials and real-time information across these entities is vital for national health security. Advanced AI techniques, ranging from predictive analytics and machine learning to autonomous logistics, have emerged as crucial instruments for transforming public healthcare supply chains. By optimising demand forecasting, refining inventory control, mitigating disruption risks, and curbing fiscal inefficiencies, AI-driven solutions offer significant potential to enhance operational performance. However, scaling these technologies within public sector frameworks presents complex challenges, requiring strategic alignment between technological capability, regulatory oversight, and public policy directions

1.1. Study Problem

Despite the imperative for efficiency and transparency in public health governance, public healthcare supply chains frequently encounter structural vulnerabilities, including demand volatility, resource misallocation, and operational bottlenecks. While AI presents transformative potential to mitigate these operational inefficiencies, there remains a critical gap in systematically understanding how AI-driven tools can be effectively integrated within public health systems. From the preceding**,** the study problem can be identified and formulated in the following question:

- **How does the integration of Artificial Intelligence technologies contribute to optimising Supply Chain Management within the public healthcare sector?**

1.2. Sub-questions

To systematically address the central problem, this study seeks to answer the following sub-questions:

- What key operational tasks within public healthcare logistics display the highest potential for AI-driven enhancement?
- How can specific AI techniques be strategically adopted and integrated into public healthcare supply chain frameworks?
- What measurable operational and strategic supply chain outcomes are achieved through AI implementation in public health institutions?

- What policy and institutional barriers hinder the effective deployment of AI in public healthcare supply chains

1.3. Study Objectives

This study aims to achieve the following objectives:

- To conceptualize the foundational paradigms of Artificial Intelligence (AI) and map its current applications within public healthcare operations.
- To identify and analyze high-impact supply chain functions that can be optimized through AI technologies.
- To evaluate specific AI techniques suitable for deployment in public healthcare supply chain architectures.
- To provide strategic guidance for policymakers and health administrative practitioners on navigating integration challenges, while establishing an analytical baseline for future research regarding critical success factors and algorithm selection in public sector contexts.

1.4. Study Hypotheses

In light of the study's subject matter and objectives, the study's hypotheses can be formulated as follows:

- The application of Artificial Intelligence (AI) technologies significantly enhances the operational efficiency, transparency, and resilience of public healthcare supply chains.
- The strategic adoption of targeted AI techniques positively correlates with improved inventory management, demand forecasting accuracy, and risk mitigation in public health logistics.

1.5. Methodology

To accomplish the objectives of this study, a Systematic Literature Review methodology paired with a descriptive-analytic framework was employed. The study critically synthesizes existing peer-reviewed literature and official institutional reports indexed in major scholarly databases (e.g., Web of Science, Scopus, PubMed). This analytical approach enables a rigorous evaluation of the current landscape, operational bottlenecks, and future policy trajectories regarding AI implementation in public healthcare supply chain management.

To achieve the study's objectives, it will be divided into the following axes:

The 1st axis: **AI in the healthcare sector**

The 2nd axis: **AI applications in supply chain management in the healthcare sector**

2. AI in the Healthcare Sector

AI is rapidly transforming the healthcare and medical sectors. With advancements in AI technology and its integration into routine tasks, the field of healthcare is rapidly evolving.

2.1. Concept of AI

There is no precise, globally accepted definition of AI. According to the High-Level Expert Group on AI is a scientific discipline that includes several approaches and techniques, such as machine learning (ML), reasoning, and robotics. To ensure legal certainty, the EC aims to define AI more clearly in the proposed AI Act as a “software that is developed with [specific] techniques and approaches and can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations or decisions influencing the environments they interact with”. This

broad definition covers AI systems that can be used on a standalone basis and those that can be used as product components. (Meszaros , Minari , & Huys, 2022, p. 06)

Artificial Intelligence (AI): AI refers to the development of computer systems that can perform tasks that typically require human intelligence, such as perception, reasoning, and decision-making. In healthcare, AI is used to analyze large amounts of patient data, such as medical records, imaging studies, and laboratory results, to support clinical decision-making and improve patient outcomes. (Dave & Patel, 2023, p. 761)

Artificial Intelligence (AI): denotes the science and engineering of creating intelligent machines using algorithms or rules, which the machine shadows to mimic human cognitive functions, namely, learning and problem-solving. (AI Kuwaiti & al, 2023, p. 3)

Fig.1. Word cloud indicating crucial keywords about AI

Source : (Secinaro, Calandra, & al, 2021, p. 13)

2.2. Techniques of AI Relevant to Healthcare

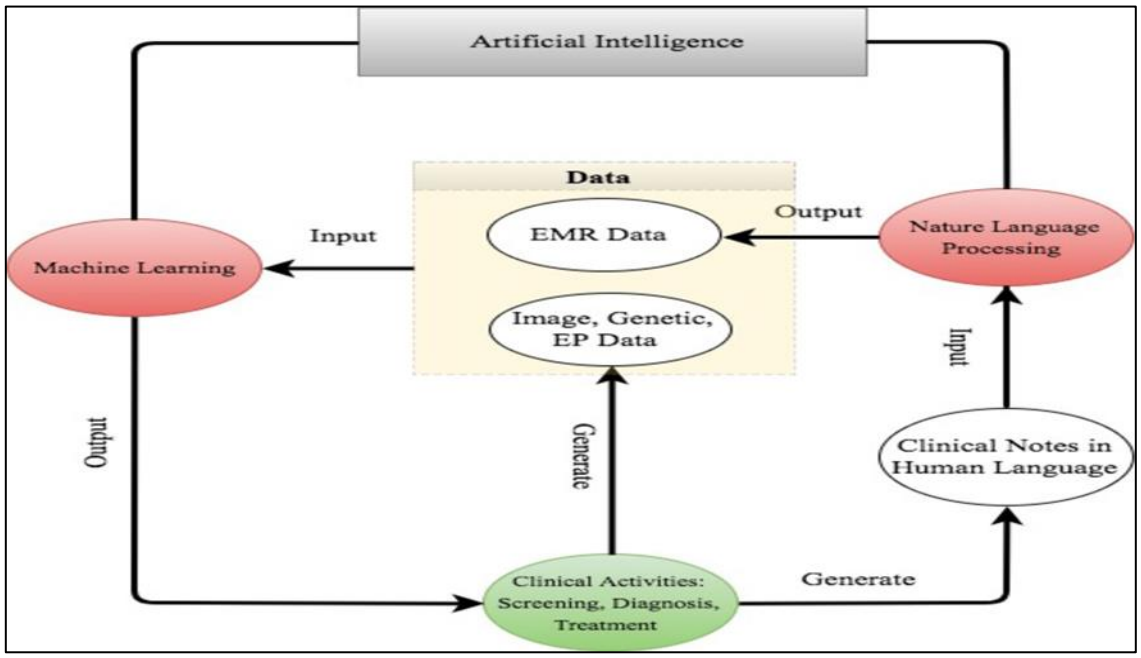
Artificial intelligence is not one technology, but rather a collection of technologies. Although most of these technologies are immediately relevant to the healthcare field, the specific processes and tasks they support vary greatly. Some specific AI technologies of high importance to healthcare are defined and described below.

- **Machine Learning (ML) in Healthcare**: it involves using known quantities from data to make predictions. Categories of ML generally include supervised learning, unsupervised learning, reinforcement learning, active learning, and semi-supervised learning. Machine learning models, such as support vector machines (SVMs) and neural networks, were applied to tasks like disease prediction, patient risk stratification, and treatment optimization. (Anderson, 2019, p. 128).
- **Deep Learning (DL)** is also increasingly used for speech recognition and, as such, is a form of natural language processing (NLP), described below. Unlike earlier forms of statistical analysis, each feature in a deep learning model typically has little meaning to a human observer. As a

result, the explanation of the model's outcomes may be very difficult or impossible to interpret. (Davenport & Kalakota, 2019, pp. 94-95).

- **Natural Language Processing (NLP) in Healthcare**: Advancements in natural language processing (NLP) have facilitated the extraction of valuable insights from unstructured medical data, such as clinical notes and research literature. NLP-powered applications have been deployed to support clinical decision-making, automate medical coding, and enhance clinical documentation. (Jeyaraj & Narayanan, 2023, p. 2).
- **Electronic Medical Record Systems (EMRs):** According to WHO, an EMR is a computerized medical record used to gather, preserve, and share information among healthcare providers in an organization, enabling the delivery of health services to patients. (Walle & al, 2023, p. 2).

Fig.1. Artificial Intelligence types in healthcare



Source: (Jiang, Jiang, Zhi, & al, 2017, p. 232)

2.3. Uses of AI in Healthcare

The Healthcare field benefits from AI in a number of ways, such as (AI Kuwaiti & al, 2023, pp. 4-10):

- **Medical Imaging and Diagnostic Services:** AI is a powerful tool for image analysis that is increasingly being used by radiology professionals for the early diagnosis of different diseases and for reducing diagnostic errors in the context of prevention
- **Virtual Patient Care:** The advancement of wearable technology and the potential of using ML and AI in healthcare is an idea that has already been explored. Thus, patient monitoring and management via virtual care with active and sensitive wearable technology solutions have become a reality and part of the standards of care
- **Medical Research and Drug Discovery:** AI is ideally suited to analyze the large and complex datasets used in medical research. In addition, it can be applied to hunt for scientific research works, integrates various types of data, and support drug innovation. Pharmaceutical agencies

are focusing on AI to streamline drug development. Scientists can utilize predictive analytics to recognize appropriate aspirants for clinical trials and develop exact models of biological processes

- **Treatment Recommendations:** AI-powered decision support systems analyze a patient's health data and medical history to recommend the most appropriate treatment options. These systems consider individual patient characteristics to optimize treatment plans and guide clinical decision-making.
- **Rehabilitation:** AI has innovative applications in the field of rehabilitation. It is an idea that includes physical (robotics) and virtual (informatics) branches. Additionally, a subset of AI known as ML refers to precise methods for building algorithms that naturally improve with practice. In rehabilitation, ML is used for perioperative medicine, brain–computer interface technology, myoelectric control, symbiotic neuroprosthetics, etc. ML methods have also been applied in the field of the musculoskeletal system, e.g., in the evaluation of patient data, clinical decision support, and diagnostic imaging. In therapy, an artificial cognitive application was used to judge rehabilitation exercises based on the signals from the machine. (Anderson, 2019, p. 128)
- **Administrative Applications**

AI can reduce administrative burdens by automatically populating structured data areas from therapeutic notes, retrieving key data from past medical records, and collecting documented patient encounters. It can be used for a variety of applications in healthcare, including claims processing, clinical documentation, revenue cycle management, and medical records management. (Davenport & Kalakota, 2019, p. 96)

3. Artificial intelligence applications in supply chain management in the healthcare sector

The healthcare supply chain entails the production and delivery of medications at the appropriate time, location, and quantity. In the face of uncertainty, particularly lethal pandemics, the digitization of healthcare and the use of artificial intelligence in the supply chain have emerged as critical issues to address.

3.1. Healthcare Supply Chain Management

A supply chain is the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the ultimate consumer. (Raihi , Saikou, & al, 2021, p. 1).

Supply chain management (SCM) is an integrating function that primarily links significant functions and practices of businesses within or between organizations. As introduced by Keith Oliver in 1982, SCM involves a huge exchange of materials and information on healthcare requirements. Largely, the healthcare supply chain (HSC) has more or less a similar structure, wherein it constitutes the input, processing, and output of varied associated processes. In its context of its nature, the healthcare supply chain is a complex network of various sub-units, which are highly involved in taking care of patients struggling with different health ailments. Further, the HSC forms a core element of the healthcare industry. However, the HSC is not positioned well compared to the generic SC mechanism. To improve the performance of the healthcare supply chain, eminent researchers have highlighted the

significance of digitalization techniques that can be used in the healthcare supply chain. The digitalization of the healthcare supply chain ensures that the organizations utilize the potential of traditional information technologies along with the involvement of contemporary technological interventions, such as big data analytics and artificial intelligence, to have more flexible and efficient healthcare supply chains. In the world of uncertainties, especially deadly pandemics (like Spanish flu, COVID19), the organizations twine the physical and digital mechanisms like big data analytics and artificial intelligence to restructure the healthcare supply chain, which further systematizes and manages the order of treatment for both nurses and patients at healthcare units. Now, to receive effective outcomes of the omnichannel healthcare approach, it becomes crucial for organizations dealing with healthcare requirements to recognize the significance of absorptive capacity. The concept of absorptive capacity expects organizations to understand the value of new information generation (from digitalization of the healthcare supply chain) by using big data analytics and artificial intelligence (BDA-AI), followed by assembling and eventually deploying it for commercial purposes. (Bag , Dhamija, & al, 2023, pp. 1-2).

Fig.3. Word cloud indicating important keywords about (HSCM)

Source: (Kassa, Kitaw, Stache, & al, 2023, p. 8)

3.2. AI Applications and Techniques in Healthcare Supply Chain Management

AI's emergence in the supply chain context has caused a radical change in the organization of work processes. Any sector can benefit from the right integration of AI in its processes and become a more proactive, predictive, automated, and personalized sector. Some of the common tools and AI techniques to use in healthcare supply chain management include:

3.2.1. Artificial Neural Networks (ANNs)

ANNs are a type of AI algorithm inspired by the structure and function of the human brain. In the context of supply chain management, ANNs can be used for demand forecasting, inventory optimization, logistics planning, and anomaly detection. ANNs help companies to optimize

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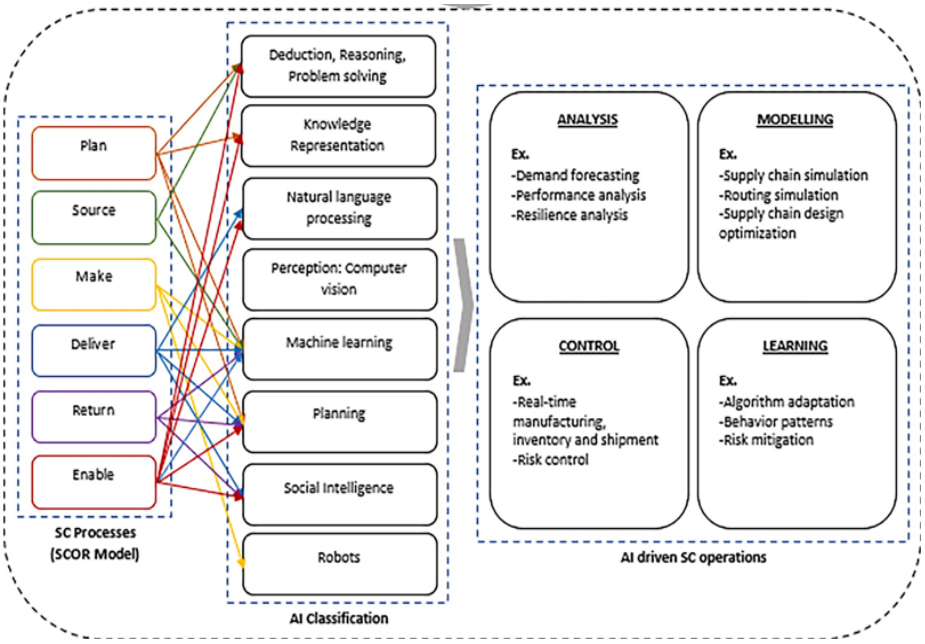
their inventory levels, production schedules, and procurement activities in terms of productivity enhancement of part production. By considering multiple variables and constraints, ANNs can identify the most efficient routes, allocate resources effectively, and reduce costs. Furthermore, ANNs can identify anomalies as well as abnormalities in supply chain data, such as unexpected demand patterns, quality issues and disruptions in logistics operations in order to minimize their impact on the supply chain. ANNs can also analyze supplier performance data, including quality, delivery times, and pricing, in order to assess the reliability and effectiveness of suppliers. This information can support decision-making processes in supplier evaluation and selection processes. Moreover, ANNs can continuously monitor supplier performance, raising alerts for deviations from predefined criteria to provide a safe and secure supply chain in part production processes. By analyzing various data sources, including weather conditions and political instability, ANNs can identify and mitigate risks in terms of safety enhancement of supply chain processes. (Soori, Behrooz, & Dastres, 2023, p. 1)

3.2.2. Machine Learning (ML)

Machine learning is employed to analyze the supply chain in the healthcare sector and forecast demand, improve planning, and identify improvement opportunities. Machine learning relies on data analysis and the application of models and algorithms to enable machines to learn patterns, make predictions, and make data-driven decisions. In the supply chain, machine learning can be used to analyze data related to supplies, previous demands, and other factors such as weather conditions and economic forecasts to provide accurate predictions of future demand. This enables healthcare organizations to plan better for their needs and optimize inventory management, resulting in higher efficiency in the supply chain. Additionally, machine learning can be used to identify improvement opportunities in the supply chain by analyzing data and identifying areas that can be enhanced, streamlining processes, increasing efficiency, and reducing. (Raihi , Saikou, & al, 2021, p. 12)

Fig4. AI techniques in HSC processes



Source: (Raihi , Saikou, & al, 2021, p. 14)

Fig4. illustrates the conceptual integration of Artificial Intelligence (AI) technologies into Supply Chain Management (SCM) processes, mapping them directly to operational outcomes. Anchored in the Supply Chain Operations Reference (SCOR) framework, encompassing Plan, Source, Make, Deliver, Return, and Enable, the model demonstrates how core supply chain functions interact with a multifaceted spectrum of AI capabilities. These technological classifications, ranging from Machine Learning and Natural Language Processing to Computer Vision and Automated Robotics, act as functional enablers across the supply chain lifecycle. As depicted in the right panel, this technological interface translates complex process inputs into four strategic operational dimensions: Analysis (e.g., predictive demand forecasting and resilience evaluation), Modelling (e.g., supply chain network simulation and routing optimization), Control (e.g., real-time inventory tracking and dynamic risk control), and Learning (e.g., continuous algorithm adaptation and behavior pattern identification). Consequently, the framework underlines that AI adoption extends beyond mere technical automation; it fosters a self-learning, agile, and resilient supply chain ecosystem capable of real-time responsiveness and proactive risk mitigation. Within the context of public healthcare, this systemic alignment ensures that inventory governance, pharmaceutical distribution, and emergency response mechanisms remain transparent, cost-effective, and resilient against unexpected supply chain disruptions.

4. Conclusion

In an era characterized by data ubiquity, public healthcare organizations increasingly seek to leverage data assets to improve operational efficacy and achieve system resilience. Despite the burgeoning potential of Artificial Intelligence (AI), its institutional adoption within Public Healthcare Supply Chain Management (HSCM) remains in its emerging stages compared to other industrial sectors. Nevertheless, the strategic deployment of AI models represents a paradigm shift for public healthcare logistics. By seamlessly integrating AI methodologies across supply chain networks, public health authorities can achieve substantial gains in forecasting precision, resource allocation, operational transparency, and fiscal efficiency, ultimately elevating patient care quality and bolstering national health security.

4.1. Finding:

Crucial results can be listed in the following:

- AI applications are increasingly recognized not merely as technical upgrades, but as strategic solutions to both systemic and novel operational bottlenecks in public healthcare logistics.
- AI integration spans the entire supply chain spectrum; however, current implementation remains fragmented, with only a fraction of available algorithms and machine learning techniques fully exploited in public health settings.
- Beyond incremental improvements in cost containment and waste reduction, AI deployment fosters structural agility, dynamic adaptability, and long-term resilience across public healthcare supply chains.

4.2. Future Perspectives & Policy Recommendations

To transition from sporadic AI applications to a fully integrated, smart public healthcare supply chain ecosystem, future policy frameworks and strategic research should prioritize the following domains:

- Strategic integration of predictive analytics and machine learning to evaluate historical consumption, disease trends, and demographic patterns. This enables precise demand forecasting, minimizes stockouts of critical medical supplies, and reduces public fiscal waste.
- Combining AI algorithms with distributed ledger technology (Blockchain) to guarantee end-to-end transparency, preserve product authenticity, prevent counterfeit pharmaceuticals from entering the public supply chain, and ensure strict compliance with national regulatory standards.
- Utilizing IoT-enabled AI models to continuously monitor critical medical infrastructure, enabling predictive maintenance schedules that prevent operational downtime and safeguard health service delivery.
- Implementing advanced anomaly detection algorithms to identify irregular procurement activities, unauthorized access, and supply chain fraud, thereby enhancing governance integrity and protecting public healthcare resources.

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