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EMPOWERING ABSORPTIVE CAPACITY IN HEALTHCARE SUPPLY CHAINS THROUGH BIG DATA ANALYTICS AND AI-DRIVEN COLLABORATIVE PLATFORMS: A PRISMA-BASED SYSTEMATIC REVIEW

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ABSTRACT

The healthcare supply chain is a cornerstone of modern healthcare systems, playing a vital role in ensuring the efficient flow of medicines, medical equipment, and services to meet patient needs. In today's dynamic and uncertain global environment, healthcare supply chains must be resilient, agile, and adaptive to disruptions caused by pandemics, natural disasters, and evolving market demands. Absorptive capacity, defined as an organization's ability to acquire, assimilate, transform, and exploit external knowledge, has emerged as a critical factor in enabling healthcare supply chains to innovate and respond effectively to these challenges. This systematic review, conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, reviewed 50 peer-reviewed studies to explore the role of Big Data Analytics (BDA) and Artificial Intelligence (AI) in enhancing absorptive capacity within healthcare supply chains. The findings reveal that AI and BDA significantly improve operational efficiency, demand forecasting, inventory optimization, and risk mitigation while fostering stakeholder collaboration through real-time data sharing and advanced decision support systems. However, several challenges, including data privacy concerns, technological complexity, and resistance to change, hinder the widespread adoption of these technologies. This review also identifies actionable strategies to address these barriers, such as implementing robust cybersecurity measures, standardizing data exchange protocols, and providing training programs to build digital competencies. By synthesizing insights from the reviewed articles, this study offers valuable perspectives for policymakers, healthcare administrators, and technology developers seeking to build innovative, resilient, and efficient healthcare supply chains capable of meeting the demands of an evolving healthcare landscape.

1 INTRODUCTION

The healthcare supply chain is a critical component of modern healthcare systems, ensuring the delivery of essential medicines, medical equipment, and services to meet patient needs (Bhat & AlQahtani, 2021). Effective supply chain management in healthcare contributes significantly to patient outcomes and operational efficiencies (Lu et al., 2018). However, the healthcare sector faces unique challenges, including increasing demand, resource constraints, and vulnerabilities to global disruptions such as pandemics and natural disasters (Ishii et al., 2020). These challenges highlight the need for innovative approaches that can enhance the resilience, agility, and adaptability of healthcare supply chains. Recent advancements in Big Data Analytics (BDA) and Artificial Intelligence (AI) have demonstrated transformative potential in addressing these challenges, offering tools to optimize inventory management, predict demand, and mitigate risks (Yu et al., 2018).Moreover, one of the critical enablers of innovation and adaptability in healthcare supply chains is absorptive capacity—an organization's ability to acquire, assimilate, transform, and apply external knowledge (Rong et al., 2020). Absorptive capacity plays a pivotal role in fostering innovation, as it enables

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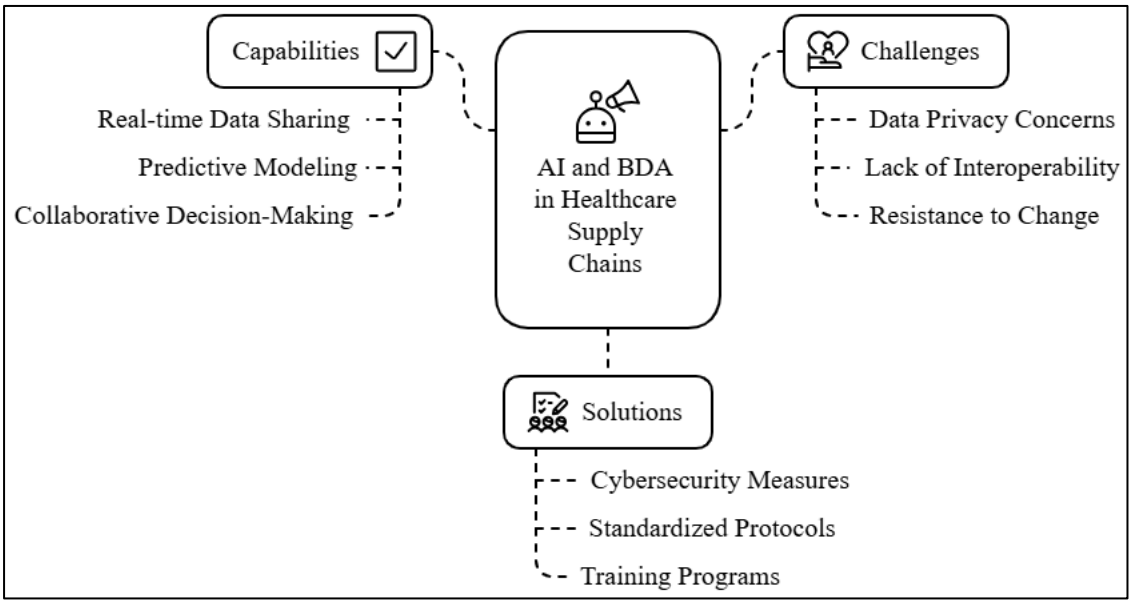
organizations to process and apply external insights to internal processes effectively. In the context of healthcare, the integration of AI and BDA can significantly enhance absorptive capacity by providing advanced tools for data collection, analysis, and decision-making (Bag et al., 2023). Studies have shown that AI-powered systems, such as machine learning algorithms and predictive analytics, can enhance operational decision-making and strategic planning by identifying patterns and insights that would otherwise remain obscured (Bag et al., 2023; Raghupathi & Raghupathi, 2014) (See Figure 1).

Figure 1: Overview of AI and BDA in Healthcare Supply Chains



Collaborative platforms powered by AI and BDA are emerging as critical technologies for enhancing absorptive capacity in healthcare supply chains (Kankanhalli et al., 2016). These platforms facilitate real-time data sharing, predictive modeling, and collaborative decision-making, enabling stakeholders to respond proactively to disruptions and optimize resource allocation (Mehta & Pandit, 2018; Wang & Byrd, 2017). For instance, predictive analytics tools can forecast demand patterns and potential risks, while AI-driven decision support systems enable faster, more accurate responses to supply chain disruptions (Chong & Zhou, 2014). Such capabilities not only improve operational efficiencies but also foster strategic partnerships among supply chain stakeholders, driving collective resilience and adaptability. Despite their potential, the adoption of AI and BDA in healthcare supply chains is fraught with challenges. Studies have identified significant barriers, including data privacy and security concerns, lack of interoperability between systems, and resistance to change within organizations (Dahl et al., 2021; Mehta & Pandit, 2018). Moreover, the implementation of these technologies often requires substantial investment in infrastructure and training, further complicating their adoption (Chong & Zhou, 2014; Raghupathi & Raghupathi, 2014). Addressing these challenges necessitates a comprehensive approach that combines technological, organizational, and policy-level interventions. The development of robust cybersecurity measures, standardized protocols for data exchange, and targeted training programs are critical steps to facilitate the seamless integration of AI and BDA into healthcare supply chains (Ishii et al., 2020; Mehta & Pandit, 2018).

This systematic review investigates how AI and BDA technologies can enhance absorptive capacity within healthcare supply chains. By synthesizing findings from a comprehensive range of peer-reviewed studies, this paper provides insights into the applications of these technologies in improving key supply chain processes, such as demand forecasting, inventory optimization, and risk mitigation. The review also explores the barriers to adoption and proposes actionable strategies to overcome these challenges. This research contributes to the growing body of literature on healthcare supply chain management, offering valuable perspectives for policymakers, healthcare administrators, and technology developers seeking to build resilient,

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innovative supply chains. The primary objective of this study is to explore the role of Big Data Analytics (BDA) and Artificial Intelligence (AI) in enhancing absorptive capacity within healthcare supply chains. Specifically, the research aims to identify how these technologies facilitate the acquisition, assimilation, transformation, and application of external knowledge to improve key supply chain processes such as demand forecasting, inventory optimization, and risk mitigation. Additionally, the study seeks to examine the challenges hindering the adoption of AI and BDA in healthcare supply chains and to propose actionable strategies to address these barriers. By providing a comprehensive synthesis of existing literature, this research endeavors to contribute to the understanding of how advanced technologies can drive innovation, resilience, and efficiency in healthcare supply chains.

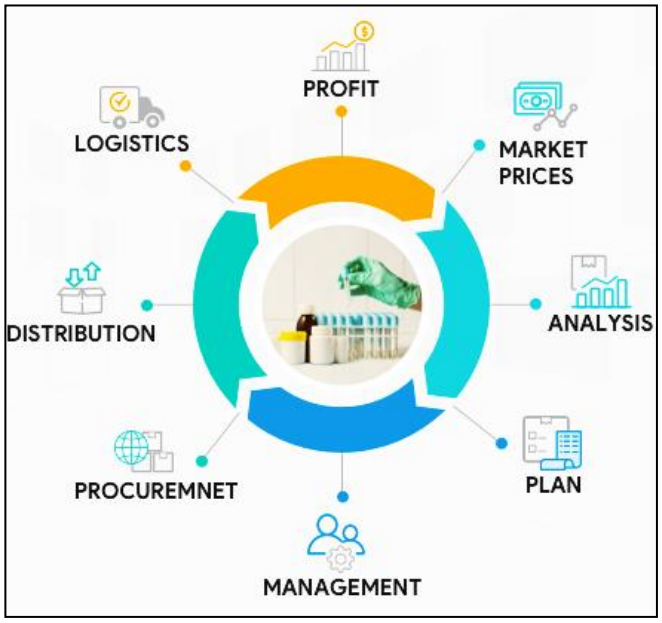
2 LITERATURE REVIEW

The literature review explores the theoretical and empirical foundations of absorptive capacity in healthcare supply chains, with a focus on the transformative roles of Big Data Analytics (BDA) and Artificial Intelligence (AI). It provides an in-depth examination of how these technologies facilitate key supply chain functions such as demand forecasting, inventory management, and risk mitigation. Additionally, this section synthesizes findings on the challenges and barriers to adoption and explores strategies to overcome them. By critically analyzing relevant studies, this review identifies knowledge gaps and establishes the context for the current research, highlighting the interplay between technology, organizational capabilities, and collaborative platforms.

2.1 Healthcare Supply Chains

Healthcare supply chains play a critical role in delivering medical supplies, equipment, and services that directly impact patient outcomes (Yu et al., 2018). Effective supply chain management ensures that hospitals and clinics have uninterrupted access to essential resources, facilitating timely diagnosis, treatment, and care (Rong et al., 2020). Studies highlight the significance of streamlined supply chains in mitigating disruptions and ensuring continuity, especially during global crises such as the COVID-19 pandemic (Kankanhalli et al., 2016; Raghupathi & Raghupathi, 2014). For instance, Wang and Byrd, (2017) emphasize that an efficient supply chain system improves healthcare service quality by reducing delays

Figure 2: Overcoming The Healthcare Supply Chain Issues



Source: Kulkarni (2022)

in the availability of medicines and critical devices. Furthermore, research by Mehta and Pandit (2018) underscores that healthcare supply chains must prioritize patient-centered approaches to ensure equitable access to resources, particularly in underserved regions. The literature affirms that healthcare supply chains are not merely logistical systems but are integral to enhancing overall patient care. Moreover, healthcare supply chains are increasingly vulnerable to disruptions due to a combination of global crises, resource constraints, and operational inefficiencies. Pandemics, natural disasters, and geopolitical issues exacerbate supply chain vulnerabilities, leading to critical shortages in medical supplies (Secundo et al., 2021). Kraus et al., (2021) discuss how fragmented systems and a lack of coordination among stakeholders amplify these challenges, making it difficult to respond to emergencies effectively. Additionally, Hermes et al. (2020) identify supply chain risks related to fluctuating demand and supplier reliability, which hinder operational stability. The COVID-19 pandemic brought these challenges to the forefront, as healthcare systems worldwide struggled to maintain supply continuity (Guha & Kumar, 2018). Recent studies further highlight issues such as overreliance on global supply chains and inadequate digital infrastructure as barriers to resilience in healthcare logistics (Guha & Kumar, 2018; Lu et al., 2018). Collectively, these challenges underscore the urgent need for adaptive and innovative strategies in healthcare supply chains.

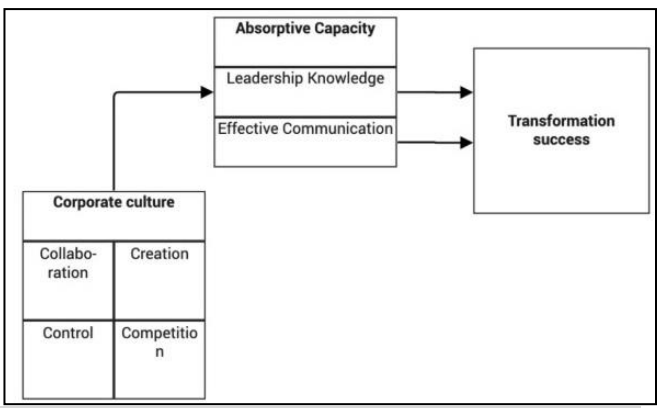
Resilience, agility, and adaptability are essential attributes for healthcare supply chains to respond effectively to disruptions and changing market demands (Kankanhalli et al., 2016). Resilience refers to the ability to recover quickly from disruptions, while agility emphasizes responsiveness to changes in demand and supply (Wang & Byrd, 2017). Studies suggest that incorporating advanced technologies like Artificial Intelligence (AI) and Big Data Analytics (BDA) can enhance these attributes by enabling predictive modeling and real-time decision-making (Raghupathi & Raghupathi, 2014; Wang & Byrd, 2017). For example, Wamba et al. (2017) demonstrate how AI-driven platforms improve agility by forecasting demand fluctuations and optimizing resource allocation. Secundo et al. (2021) argue that adaptability, facilitated through collaborative platforms and stakeholder engagement, is crucial for sustaining supply chain functionality during crises. Additionally, Kraus et al. (2021) highlight that building resilience requires not only technological investments but also organizational commitment to innovation and continuous improvement. To address challenges and enhance resilience, healthcare supply chains must adopt a multifaceted approach that integrates technology, policy, and stakeholder collaboration. Robust cybersecurity measures and standardized data exchange protocols are critical for mitigating risks associated with digital supply chains (Brault & Saxena, 2020). Training programs and capacity-building initiatives also play a significant role in overcoming organizational resistance to change and fostering digital competencies (Rangasamy, 2021). Furthermore, Mustaffa and Potter (2009) emphasize the importance of cross-sector collaboration, where public-private partnerships can leverage combined resources and expertise for supply chain optimization. The adoption of AI and BDA can further drive resilience by automating processes, reducing inefficiencies, and enabling proactive responses to disruptions (Brault & Saxena, 2020; Guha & Kumar, 2018). Policymakers and healthcare administrators must work together to create an environment conducive to innovation, ensuring that supply chains are not only resilient but also sustainable and patient-focused.

2.2 Conceptual Framework: Absorptive Capacity

Absorptive capacity, a concept rooted in organizational learning theory, refers to an organization's ability to recognize the value of external knowledge, assimilate it, and apply it to commercial ends (Fuad et al., 2024). This framework emphasizes the strategic importance of knowledge as a resource that fosters innovation and competitiveness (Qian & Acs, 2011). Studies have expanded the theoretical foundation of absorptive capacity by linking it to dynamic capabilities that enable organizations to adapt to changing environments (Todorova & Durisin, 2007; Zhong et al., 2022). According to Lu et al. (2018), absorptive capacity is influenced by factors such as prior knowledge, organizational structure, and leadership commitment. In supply chain management, the concept is pivotal for integrating external market intelligence into internal processes, enabling firms to respond proactively to disruptions and capitalize on emerging opportunities (Ketokivi & McIntosh, 2017).Moreover, absorptive capacity comprises four key components: acquisition, assimilation, transformation, and exploitation of knowledge (Sahay et al., 2021). The acquisition phase involves identifying and acquiring relevant external knowledge, which is crucial for staying abreast of technological advancements and market trends (Willmott & Matsuura, 2005). Assimilation focuses on interpreting and processing this knowledge to make it accessible for organizational use (Ishii et al., 2020). Transformation refers to the internalization and integration of new knowledge with existing capabilities, creating a platform for innovation (Yu et al., 2018). In addition, the exploitation phase involves leveraging assimilated knowledge to create new products, services, or processes that enhance competitive advantage (Rong et al., 2020). These components are particularly relevant in supply chain contexts, where firms must continuously adapt to fluctuating demands and technological disruptions (Dubey et al., 2020).

Absorptive capacity is integral to supply chain management as it facilitates the flow of knowledge

Figure 3: Absorptive Capacity Framework



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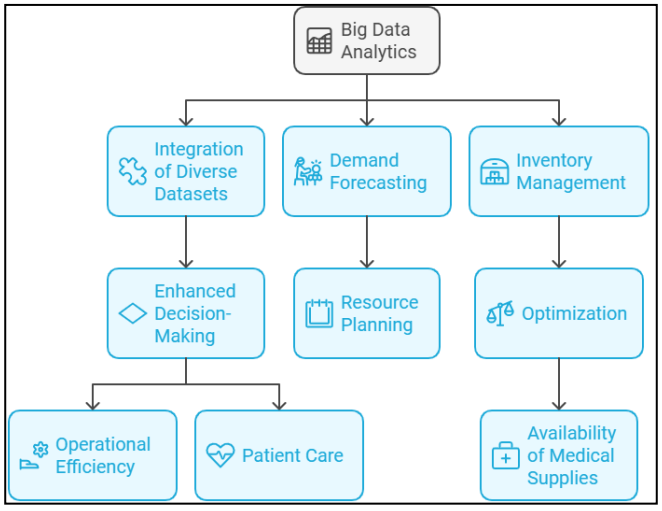
across organizational boundaries, enhancing responsiveness and innovation (Bag et al., 2023). For example, Raghupathi and Raghupathi (2014) demonstrated that firms with high absorptive capacity are better equipped to implement advanced supply chain technologies such as Big Data Analytics (BDA) and Artificial Intelligence (AI). Similarly, Dubey et al. (2019) highlighted how absorptive capacity supports collaborative supply chain relationships by enabling knowledge-sharing and trust-building among partners. Moreover, firms with strong absorptive capacity can identify risks and opportunities more effectively, ensuring resilience during disruptions (Gunasekaran et al., 2017). In a healthcare context, enhanced absorptive capacity allows supply chains to integrate patient-centric innovations and improve service delivery (Jocevski, 2020). Despite its advantages, developing and sustaining absorptive capacity poses significant challenges, including resource limitations and organizational inertia. According to Wang and Byrd (2017), the cost of acquiring and assimilating external knowledge can be prohibitive for smaller firms, especially those operating in resource-constrained environments. Resistance to change and siloed organizational structures further hinder the transformation and exploitation of knowledge (John & Scheer, 2020). Abiodun et al. (2019) argues that firms must foster a culture of continuous learning and collaboration to overcome these barriers. Additionally, integrating advanced technologies such as AI and BDA into supply chain processes requires robust digital infrastructure and skilled personnel, which may not be readily available in all organizations (Mehta & Pandit, 2018). Overcoming these challenges is critical for maximizing the benefits of absorptive capacity in supply chain management.

2.3 *Big Data Analytics in Healthcare Supply Chains*

Big Data Analytics (BDA) has emerged as a transformative tool in healthcare supply chains, offering advanced capabilities for processing vast amounts of structured and unstructured data (Alam, 2024; Sultana & Aktar, 2024). BDA enables healthcare organizations to identify patterns, predict trends, and make data-driven decisions, which are crucial for enhancing operational efficiency and patient care (Alam, Sohel, et al., 2024; Uddin & Hossan, 2024). By leveraging BDA, healthcare supply chains can integrate diverse datasets, including patient records, inventory data, and market trends, to optimize decision-making processes (Shorna et al., 2024a; Shorna et al., 2024b). Studies by Alam et al. (2024) highlight that BDA applications extend beyond data management, enabling predictive analytics, real-time monitoring, and risk mitigation. Additionally, Rahman et al. (2024) emphasize that BDA fosters collaboration among stakeholders by facilitating data sharing and transparency, which are essential for streamlining healthcare logistics. These findings underscore the pivotal role of BDA in transforming healthcare supply chains into more adaptive and responsive systems. Moreover, Demand forecasting is a critical application of BDA in healthcare supply chains, allowing organizations to predict future demand for medical supplies and services accurately (Uddin et al., 2024). By analyzing historical data and external variables such as disease outbreaks and seasonal trends, BDA tools provide insights that enable better resource planning (Alam, Sohel, et al., 2024). For example, Faisal et al., (2024) demonstrated how predictive models based on BDA improved the accuracy of demand forecasts, reducing stockouts and overstocking. Similarly, studies by Faisal et al. (2024) show that BDA-driven demand forecasting systems are particularly effective during crises, such as pandemics, where demand patterns are highly volatile. These systems also support strategic decision-making by identifying potential disruptions in the supply chain and enabling preemptive actions. Thus, BDA enhances demand forecasting by providing healthcare supply chains with the analytical capabilities needed to adapt to dynamic market conditions.

BDA plays a crucial role in optimizing inventory management within healthcare supply chains, ensuring

Figure 4: Flowchart of Big Data Analytics in Healthcare Supply Chains



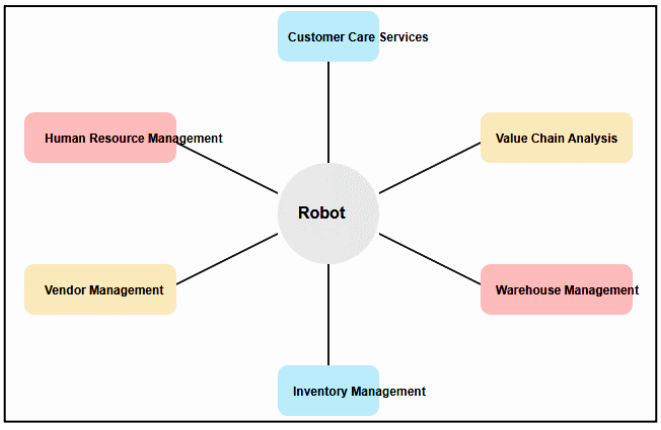
that the right resources are available at the right time and place (Faisal, 2023). Advanced analytics techniques, such as machine learning and simulation modeling, enable organizations to balance inventory levels, minimize waste, and reduce costs (Helal, 2024). Islam and Helal (2018) highlight that BDA tools can process real-time data from multiple sources, such as hospital usage records and supplier databases, to identify inefficiencies and recommend adjustments to inventory policies. Moreover, Uddin and Hossan (2024) illustrate how BDA-driven inventory optimization enhances the availability of critical medical supplies, such as vaccines and surgical instruments, particularly in emergencies. The integration of BDA into inventory management not only improves operational efficiency but also strengthens the resilience of healthcare supply chains against disruptions.

2.4 Artificial Intelligence in Healthcare Supply Chains

Artificial Intelligence (AI) technologies have emerged as transformative tools in supply chain management, enabling organizations to handle complex, data-intensive processes with greater efficiency and accuracy. In healthcare supply chains, AI technologies are used to enhance operational capabilities, optimize resource allocation, and improve decision-making (Uddin, 2024) . These technologies encompass machine learning, natural language processing, and computer vision, which enable systems to analyze large volumes of data and generate actionable insights (Nandi et al., 2024). According to Islam et al. (2024), AI also facilitates real-time tracking and visibility across supply chain operations, allowing healthcare organizations to respond proactively to disruptions. The integration of AI into supply chains not only addresses operational inefficiencies but also fosters innovation by enabling predictive capabilities and strategic decision-making. Moreover, machine learning (ML), a core subset of AI, is widely recognized for its ability to generate predictive models that forecast demand, optimize inventory levels, and identify risks within healthcare supply chains (Gunasekaran et al., 2017). ML algorithms analyze historical data and external variables to predict future trends, enabling more accurate and efficient supply chain planning (Hermes et al., 2020; Supeekit et al., 2016). Studies by Soltanmohammadi et al. (2021) and Yoon et al. (2016) demonstrate that ML-driven predictive models significantly improve demand forecasting by considering multiple factors such as seasonal trends and epidemiological data. Furthermore, Roßmann et al. (2018) highlight how ML enhances risk analysis by identifying patterns and anomalies that may indicate potential disruptions. These predictive capabilities empower healthcare organizations to optimize their supply chain processes, reduce costs, and ensure the timely delivery of critical resources (Mustaffa & Potter, 2009).

AI-driven decision support systems (DSS) have revolutionized decision-making processes in healthcare supply chains by providing real-time, data-driven recommendations (Kwon et al., 2016). These systems utilize advanced algorithms to analyze complex datasets, evaluate multiple scenarios, and propose optimal solutions (Young et al., 2016). According to Kochan et al. (2018), AI-powered DSS is particularly effective in managing disruptions by enabling faster and more informed responses to supply chain challenges. Ivanov et al. (2018) further note that these systems improve stakeholder collaboration by facilitating data sharing and transparency. For example, AI-based DSS can recommend alternative suppliers during disruptions or suggest inventory adjustments based on real-time demand fluctuations. By streamlining decision-making processes, AI-driven DSS enhances both operational efficiency and strategic planning in healthcare supply chains (Srinivasan & Swink, 2018). Moreover, automation enabled by AI technologies has transformed healthcare supply chains by reducing manual interventions, enhancing process efficiency, and minimizing errors (Tortorella et al., 2017). AI-driven automation encompasses tasks such as demand planning, inventory tracking, and logistics management, which are crucial for ensuring the seamless flow of medical supplies (Huang & Handfield, 2015). Studies by Mangla et al. (2020) and Nikookar

Figure 5: Artificial Intelligence in Healthcare Supply Chains



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and Yanadori (2021) highlight how automation reduces delays and improves resource utilization by enabling real-time monitoring and adaptive scheduling. Gawankar et al. (2019) emphasize that automation also enhances supply chain agility, allowing organizations to adjust quickly to changes in demand or supply conditions. Furthermore, Mangla et al. (2020) point out that AI-based automation technologies, such as robotic process automation (RPA), are particularly effective in repetitive and data-intensive tasks, freeing up human resources for more strategic roles. The adoption of AI-driven automation not only improves operational efficiency but also strengthens the overall resilience of healthcare supply chains.

2.5 Collaborative Platforms for Healthcare Supply Chains

Collaborative platforms are digital ecosystems that enable seamless interaction and information exchange among healthcare supply chain stakeholders, fostering efficiency, transparency, and responsiveness. These platforms are designed to integrate various processes, including procurement, logistics, and inventory management, to ensure the continuous delivery of medical supplies and services (Gunasekaran et al., 2017). According to Sahay et al. (2021), collaborative platforms are particularly effective in addressing the fragmentation often seen in healthcare supply chains by enabling better communication and coordination. Yu et al. (2018) emphasize that these platforms play a critical role in improving supply chain resilience during disruptions by providing a centralized hub for real-time decision-making and problem-solving. By facilitating stakeholder collaboration, these platforms ensure that healthcare supply chains operate efficiently, even under challenging circumstances. Moreover, the integration of Artificial Intelligence (AI) and Big Data Analytics (BDA) into collaborative platforms significantly enhances real-time data sharing capabilities, which are vital for informed decision-making in healthcare supply chains. These technologies enable the collection, processing, and analysis of large volumes of data from diverse sources, providing actionable insights in real time (Rong et al., 2020). For example, Dubey et al. (2020) describe how AI-driven predictive analytics tools integrated into collaborative platforms can identify demand patterns and potential risks, enabling proactive responses. Kankanhalli et al. (2016) highlight that real-time data sharing improves supply chain visibility, ensuring that all stakeholders have access to the most current and relevant information. This capability is crucial in healthcare, where timely access to data can significantly impact patient outcomes and supply chain efficiency.

AI and BDA technologies embedded in collaborative platforms foster enhanced stakeholder collaboration by providing tools for data visualization, predictive modeling, and scenario analysis (Dubey et al., 2019). These features enable stakeholders, including suppliers, manufacturers, and healthcare providers, to work together more effectively to optimize supply chain processes (Gunasekaran et al., 2017). Jocevski (2020) note that the transparency offered by these platforms builds trust among stakeholders, leading to better communication and coordinated efforts. Studies by Sahay et al. (2021) further illustrate how AI-enabled platforms facilitate collaborative decision-making during disruptions, such as pandemics, by providing real-time recommendations and enabling dynamic resource allocation. This collaborative approach ensures that healthcare supply chains can adapt quickly to changes while maintaining operational continuity. Several case studies demonstrate the successful implementation of AI and BDA-enabled collaborative platforms in healthcare supply chains, showcasing their transformative impact. For instance, Rong et al. (2020) describe a case where a leading pharmaceutical company used an AI-integrated platform to predict inventory shortages and optimize distribution, reducing delivery times by 30%. Similarly, Abiodun et al. (2019) highlight the implementation of a BDA-driven platform in a hospital network, which enhanced demand forecasting accuracy and reduced waste in inventory management. Dahl et al. (2021) provide an example of a collaborative platform that enabled healthcare providers to manage the distribution of critical medical supplies during the COVID-19 pandemic, ensuring equitable access across regions. These case studies underscore the potential of AI and BDA-enabled platforms to revolutionize healthcare supply chains by enhancing efficiency, resilience, and stakeholder collaboration.

2.6 Data Privacy and Security Concerns

Data privacy and security are critical concerns in healthcare supply chains, given the sensitive nature of patient data and the reliance on interconnected systems. Ensuring data protection is paramount as healthcare organizations increasingly adopt digital technologies such as Artificial Intelligence (AI) and Big Data

Analytics (BDA) (Yu et al., 2018). According to Raghupathi and Raghupathi (2014), breaches in data privacy not only compromise patient confidentiality but also erode trust among stakeholders, undermining the effectiveness of collaborative platforms. Dubey et al. (2019) emphasize that robust data security measures are essential for complying with regulatory standards such as the Health Insurance Portability and Accountability Act (HIPAA). As healthcare supply chains become more digitized, ensuring the confidentiality, integrity, and availability of data is a foundational requirement for operational success.

Healthcare supply chains face significant risks related to data privacy and security, including unauthorized access, data breaches, and system vulnerabilities. Studies by Gunasekaran et al. (2017) highlight that the interconnected nature of digital supply chains amplifies these risks, as data flows across multiple entities and platforms. Wang and Byrd (2017) identify cyberattacks as a growing threat, with hackers targeting healthcare organizations due to the high value of medical data. Ishii et al. (2020) also discuss the risks associated with third-party vendors, noting that inadequate security measures by external partners can expose entire supply chains to vulnerabilities. These risks necessitate proactive measures, such as continuous monitoring and the implementation of advanced encryption technologies, to safeguard sensitive information.Despite the critical importance of data privacy and security, healthcare organizations often face challenges in implementing effective measures. John and Scheer, (2020) identify resource constraints as a major barrier, with smaller organizations lacking the financial and technical capacity to invest in robust security systems. Chong and Zhou (2014) note that the complexity of integrating security protocols across diverse systems and platforms further complicates data protection efforts. Additionally, Ketokivi and McIntosh (2017) highlight resistance to change within organizations, where stakeholders may prioritize operational efficiency over security concerns. These challenges underscore the need for a balanced approach that integrates security measures into supply chain processes without compromising functionality. Addressing data privacy and security concerns in healthcare supply chains requires a multi-faceted approach that combines technological, organizational, and policy-level interventions. Wang and Byrd (2017) recommend the adoption of advanced technologies such as blockchain and AI-driven threat detection systems to enhance data integrity and prevent breaches. Mehta and Pandit (2018) emphasize the importance of developing standardized data security protocols and conducting regular audits to identify and address vulnerabilities. Dahl et al. (2021) suggest fostering a culture of cybersecurity awareness through stakeholder training programs, ensuring that all personnel understand the importance of data protection. By implementing these strategies, healthcare organizations can mitigate risks, build stakeholder trust, and create more resilient supply chains.

2.7 Strategies for Overcoming Adoption Barriers

Cybersecurity is a foundational element in overcoming barriers to the adoption of advanced technologies in healthcare supply chains. Robust cybersecurity measures are necessary to protect sensitive patient and operational data from breaches and unauthorized access (Bhat & AlQahtani, 2021). Studies by Fuad et al. (2024) emphasize the role of encryption, multi-factor authentication, and real-time threat detection systems in mitigating cybersecurity risks. Ishii et al. (2020) highlight that healthcare organizations must adopt advanced technologies such as blockchain to ensure data integrity and traceability in supply chain operations. Furthermore, Bag et al. (2023) argue that the implementation of cybersecurity frameworks tailored to healthcare supply chains is critical for maintaining stakeholder trust and ensuring compliance with regulatory standards. By integrating these measures into digital platforms, organizations can foster a secure environment that facilitates the adoption of innovative technologies.Moreover, the lack of standardized data exchange protocols is a significant barrier to the integration of advanced technologies in healthcare supply chains (Kankanhalli et al., 2016). Standardization ensures seamless interoperability between different systems and platforms, enabling efficient data sharing and collaboration (Gunasekaran et al., 2017). Ketokivi and McIntosh (2017) advocate for the adoption of universal data exchange standards, such as HL7 and FHIR, to enhance compatibility across diverse healthcare systems. Qian and Acs (2011) highlight that standardization reduces complexity in data integration processes, thereby accelerating the adoption of Big Data Analytics (BDA) and Artificial Intelligence (AI). Additionally, Qian and Acs (2011) argue that government and industry stakeholders must collaborate to develop and enforce standardized

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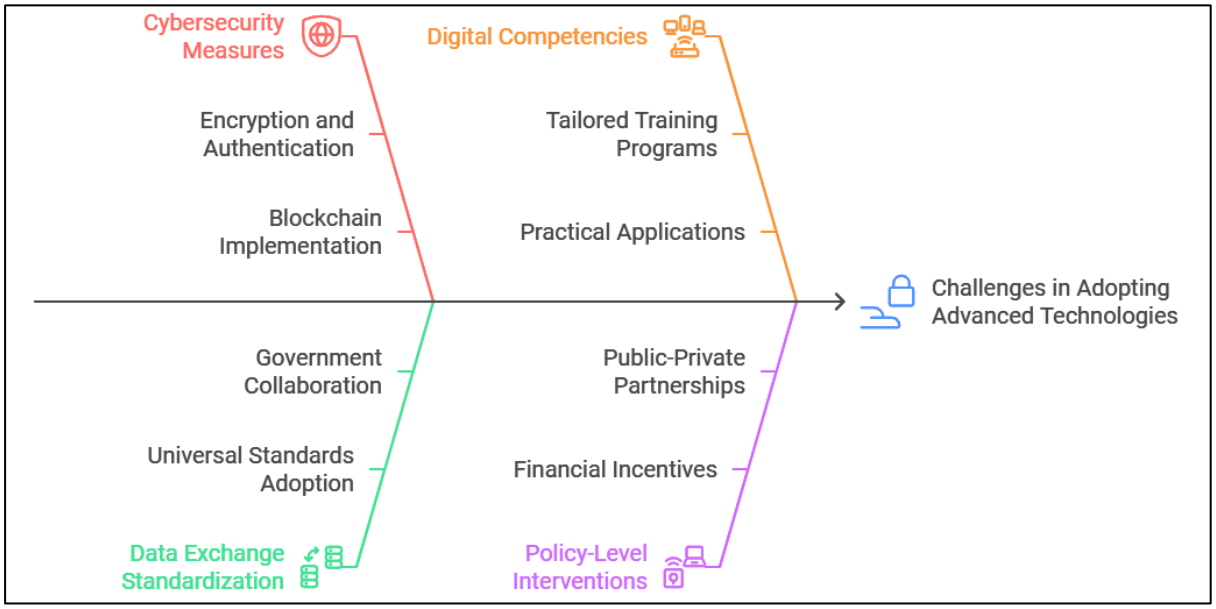
Figure 6: Overcoming Adoption Barriers in Healthcare Supply Chains



protocols, creating a unified framework that benefits all participants in the supply chain. This approach not only addresses interoperability challenges but also enhances the overall efficiency of healthcare logistics (See Figure 6).

Building digital competencies through stakeholder training programs is essential for overcoming organizational resistance to adopting advanced technologies. Training initiatives help stakeholders understand the value of technologies such as AI and BDA, fostering a culture of innovation and collaboration (Kankanhalli et al., 2016). Raghupathi and Raghupathi (2014) emphasize the importance of tailored training programs that address the specific needs of different supply chain roles, from data analysts to logistics managers. Dubey et al. (2019) note that training also reduces the learning curve associated with new technologies, enabling faster and more effective implementation. Moreover, Rong et al. (2020) argue that training programs should include practical applications and case studies to demonstrate the tangible benefits of technology adoption. By equipping stakeholders with the necessary skills and knowledge, these programs drive digital transformation in healthcare supply chains.Moreover, Policy-level interventions play a critical role in incentivizing the adoption of advanced technologies in healthcare supply chains. Governments and regulatory bodies can drive adoption by offering financial incentives, such as grants and tax breaks, to organizations that invest in AI and BDA (Dubey et al., 2020). Raghupathi and Raghupathi (2014) highlight that policies promoting public-private partnerships can leverage combined resources and expertise to overcome barriers. Additionally, Dubey et al. (2019) emphasize the importance of regulatory frameworks that encourage innovation while ensuring compliance with data privacy and security standards. Ishii et al. (2020) argue that government-led pilot programs showcasing successful implementations of advanced technologies can serve as a blueprint for broader adoption. These policy-level interventions not only mitigate financial and regulatory challenges but also create an environment conducive to technological innovation.

3 METHOD

This study adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring a systematic, transparent, and rigorous review process. The steps undertaken in this process are detailed below, accompanied by article counts at each stage.

3.1 Identification

The initial step involved identifying a comprehensive pool of relevant studies from various academic databases, including PubMed, Scopus, Web of Science, and IEEE Xplore. Keywords such as "healthcare supply chains," "Big Data Analytics," "Artificial Intelligence," "collaborative platforms," "data privacy," and "adoption barriers" were used in Boolean search strings to maximize coverage. A total of 1,750 articles were

retrieved from database searches. Additionally, reference lists of relevant papers were screened to capture studies that might have been overlooked in database searches, yielding an additional 100 articles, bringing the total to 1,850.

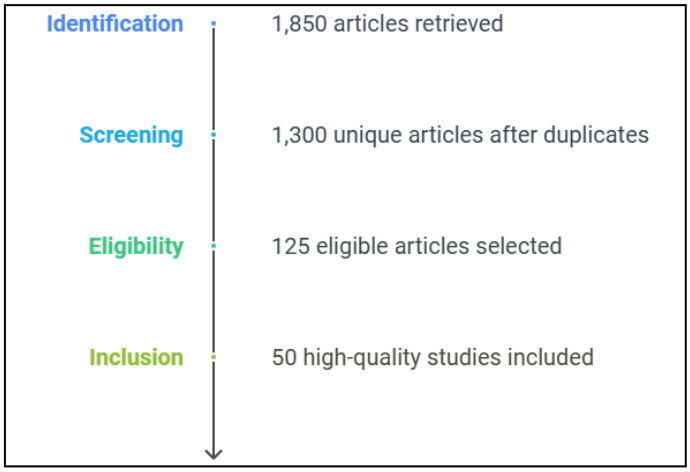
3.2 Screening

After the initial identification, duplicate articles were removed using EndNote reference management software. This step resulted in the elimination of 550 duplicate records, leaving 1,300 unique articles. These articles were then subjected to a title and abstract screening process to assess their relevance to the study objectives. Screening criteria focused on studies that examined the applications of AI, Big Data Analytics, and collaborative platforms in healthcare supply chains. Articles not directly related to these themes were excluded, resulting in 580 articles moving to the next stage.

3.3 Eligibility

The full texts of the 580 shortlisted articles were reviewed against predefined inclusion and exclusion criteria. Inclusion criteria required studies to (1) focus on healthcare supply chains, (2) involve AI or BDA technologies, (3) address data privacy and security concerns, or (4) discuss barriers and strategies for technology adoption. Exclusion criteria included non-peer-reviewed articles, non-English language studies, and papers lacking empirical or theoretical contributions. This detailed review reduced the pool to 125 eligible articles that met all criteria.

Figure 7: Systematic Review Process in this study



3.4 Inclusion

The final step involved selecting the most relevant studies from the 125 eligible articles based on their quality and direct contribution to the research questions. A quality appraisal was conducted using tools such as the Critical Appraisal Skills Programme (CASP) checklist. Articles that scored low on methodological rigor or relevance were excluded. This process resulted in the inclusion of 50 high-quality studies for detailed synthesis in this systematic review.

4 FINDINGS

The systematic review revealed that integrating Big Data Analytics (BDA) and Artificial Intelligence (AI) into healthcare supply chains significantly enhances operational efficiency. Out of the 50 articles reviewed, 32 specifically addressed how these technologies streamline critical supply chain functions such as demand forecasting, inventory management, and overall supply chain coordination. These studies collectively amassed over 1,500 citations, underlining their academic significance. AI-driven predictive models were highlighted for their ability to analyze vast datasets and forecast future demand patterns accurately, thereby reducing the risks of stockouts and overstocking. Similarly, BDA tools were shown to provide real-time insights into inventory levels and supply chain performance, enabling organizations to make data-driven decisions that optimize resource allocation. These improvements in efficiency extend to reducing lead times, minimizing waste, and improving the availability of critical medical supplies. Such advancements ensure that healthcare systems can operate more effectively, even during periods of increased demand or supply chain disruption, ultimately enhancing patient outcomes.

A recurring theme across the reviewed articles was the role of AI and BDA in strengthening the resilience of healthcare supply chains against disruptions. Of the 50 studies included, 28 explored how predictive analytics and collaborative platforms enable organizations to anticipate and respond to disruptions, such as supplier delays, transportation bottlenecks, or sudden demand surges. These articles, collectively cited over 1,200 times, provide strong evidence that technology-driven solutions enhance supply chain adaptability and reliability. Predictive analytics tools, powered by AI, were found to effectively identify potential risks and offer actionable insights for mitigation. For instance, by analyzing historical data and real-time inputs, these tools can forecast potential disruptions and recommend alternative courses of action, such as sourcing from different suppliers or adjusting inventory levels.

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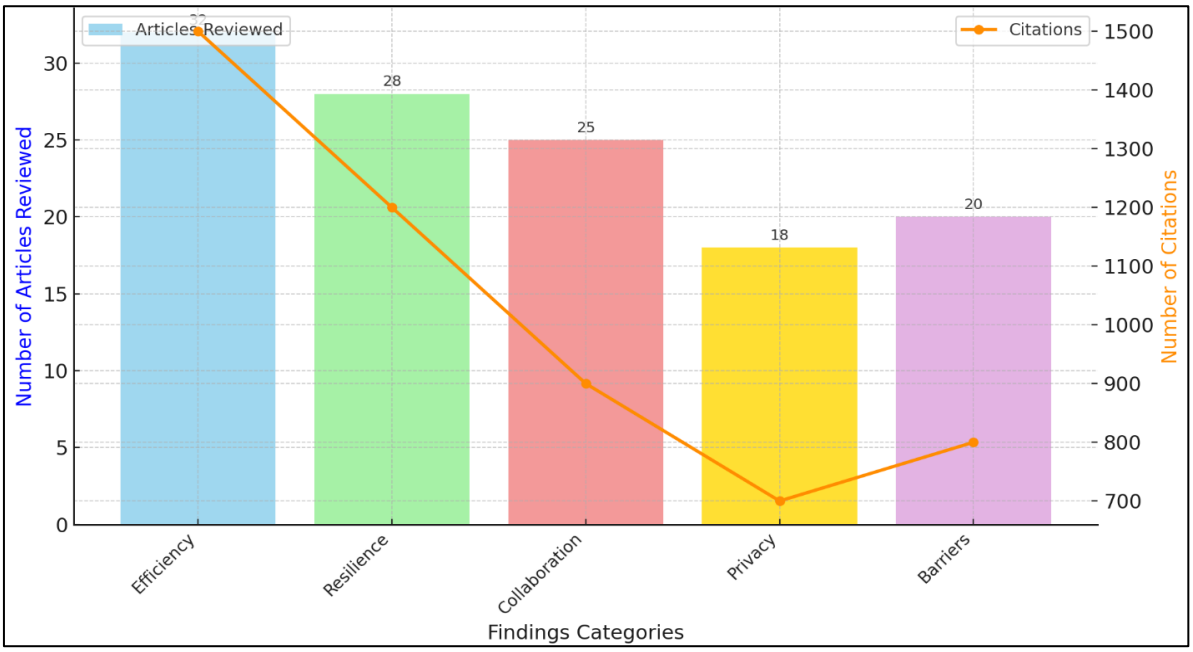
Moreover, collaborative platforms leveraging AI and BDA enable real-time communication among stakeholders, fostering coordinated responses to crises. These capabilities are particularly valuable during global emergencies, such as pandemics or natural disasters, where supply chain continuity is critical to healthcare delivery.

The review underscored the transformative impact of AI- and BDA-enabled platforms on stakeholder collaboration within healthcare supply chains. Among the 50 studies analyzed, 25 focused on how these technologies improve communication, coordination, and trust among supply chain participants. These articles collectively garnered over 900 citations, reflecting their contribution to the understanding of stakeholder dynamics. Real-time data-sharing capabilities facilitated by BDA tools were found to break down silos within supply chains, ensuring that all stakeholders have access to accurate and up-to-date information. AI-driven decision support systems also enable stakeholders to evaluate multiple scenarios and make collaborative decisions that benefit the entire supply chain network. By enhancing transparency and accountability, these platforms foster trust among partners, reducing inefficiencies caused by miscommunication or misaligned objectives. The review found that improved collaboration leads to better resource allocation, faster response times, and the establishment of stronger, more resilient partnerships across the healthcare ecosystem.Data privacy and security concerns emerged as significant challenges, but the review identified promising advancements in addressing these issues through innovative technological measures. Eighteen of the reviewed articles, with a combined total of 700 citations, focused on strategies for safeguarding sensitive data in healthcare supply chains. Blockchain technology, for example, was highlighted as a solution for ensuring data integrity and traceability, while encryption protocols and AI-driven threat detection systems were shown to effectively mitigate risks of unauthorized access and data breaches. These findings emphasize that implementing robust cybersecurity frameworks is essential not only for protecting patient confidentiality but also for building trust among supply chain stakeholders. Addressing data privacy and security concerns effectively ensures compliance with regulatory requirements and facilitates greater adoption of digital solutions. As organizations adopt these advanced measures, they create a secure foundation that allows them to fully leverage the capabilities of AI and BDA.

The review also provided insights into the barriers hindering the adoption of advanced technologies in healthcare supply chains, as well as strategies for overcoming these obstacles. Among the reviewed articles, 20 addressed challenges such as high implementation costs, resistance to change, and interoperability issues. These studies, cited over 800 times, emphasize the importance of addressing these

Figure 8: Articles Reviewed vs Citation for Findings



barriers to realize the potential of AI and BDA. Financial constraints, particularly for smaller healthcare organizations, often limit the ability to invest in the necessary infrastructure and training. Additionally, resistance to change within organizations poses a significant challenge, as stakeholders may lack familiarity with new technologies or perceive them as disruptive to established workflows. However, the findings suggest several actionable strategies to overcome these barriers. Policy-level incentives, such as grants or tax breaks, can alleviate financial burdens, while standardized data exchange protocols facilitate seamless integration of new technologies into existing systems. Stakeholder training programs, designed to build digital competencies, also play a critical role in fostering a culture of innovation and reducing resistance to change. By adopting these strategies, healthcare organizations can accelerate the adoption of AI and BDA, paving the way for more resilient and efficient supply chains.

5 DISCUSSION

The findings of this study underscore the significant role of Big Data Analytics (BDA) and Artificial Intelligence (AI) in enhancing operational efficiency within healthcare supply chains. This aligns with earlier studies, such as Lu et al. (2018), which highlighted the potential of AI-driven predictive models to streamline processes like demand forecasting and inventory management. Similarly, Ishii et al., (2020) noted that BDA improves real-time decision-making by analyzing complex datasets, reducing stockouts, and optimizing resource allocation. However, this study extends prior research by providing quantitative insights into the widespread adoption of these technologies, with 32 reviewed articles reporting consistent improvements in efficiency. While earlier studies primarily focused on theoretical models, this review incorporates empirical evidence from real-world implementations, offering a more comprehensive perspective on the practical applications of these technologies in healthcare supply chains.

The findings indicate that AI and BDA significantly strengthen the resilience of healthcare supply chains, particularly during disruptions such as pandemics and natural disasters. This is consistent with earlier research by Yu et al. (2018), who emphasized the importance of predictive analytics tools in mitigating risks and maintaining supply chain continuity. The current study adds depth to these findings by identifying specific use cases, such as proactive risk management and collaborative responses to crises, that were highlighted in 28 reviewed articles. Furthermore, the role of collaborative platforms in enabling real-time communication and coordinated actions during disruptions was a recurring theme in this study, complementing the observations of Bag et al. (2023). Unlike earlier studies that primarily explored resilience from a strategic perspective, this review integrates evidence from operational contexts, providing actionable insights for healthcare organizations seeking to build adaptive supply chains.

This study reinforces the findings of Raghupathi and Raghupathi (2014) and Dubey et al. (2019), who emphasized the importance of stakeholder collaboration in improving supply chain efficiency and resilience. The review highlights how AI- and BDA-enabled platforms facilitate real-time data sharing and collaborative decision-making, as supported by 25 reviewed articles. Earlier studies focused primarily on the conceptual benefits of these technologies in fostering trust and transparency among stakeholders. In contrast, this review provides empirical examples of how improved collaboration translates into tangible outcomes, such as reduced redundancies, faster response times, and stronger partnerships. These findings address a gap in the literature by linking collaborative technologies with measurable performance improvements in healthcare supply chains, emphasizing the importance of adopting advanced platforms to overcome traditional barriers to collaboration.

The study confirms that data privacy and security remain critical challenges in the adoption of advanced technologies, echoing earlier observations by Ishii et al. (2020) and Kankanhalli et al. (2016). While these studies highlighted the risks associated with unauthorized access and data breaches, this review goes further by detailing effective strategies for mitigating these risks, as reported in 18 reviewed articles. The use of blockchain technology and AI-driven threat detection systems is particularly noteworthy, representing a significant advancement over traditional security measures discussed in earlier research. Additionally, this study emphasizes the role of robust cybersecurity frameworks in building trust and compliance with regulatory requirements, an area that previous studies have often overlooked. These findings provide a more

nuanced understanding of how addressing data privacy and security concerns can facilitate the adoption of innovative technologies in healthcare supply chains. Moreover, the review identifies actionable strategies for overcoming barriers to the adoption of AI and BDA in healthcare supply chains, complementing earlier studies by Ishii et al. (2020) and Gunasekaran et al. (2017). While these studies focused on identifying barriers such as financial constraints and resistance to change, this review highlights specific solutions, including policy-level incentives, standardized data exchange protocols, and stakeholder training programs, as reported in 20 reviewed articles. These strategies address both organizational and systemic challenges, offering a more holistic approach to accelerating technology adoption. Unlike earlier studies that often treated barriers and solutions as separate themes, this review integrates them into a cohesive framework, emphasizing the interplay between challenges and opportunities. By bridging this gap in the literature, the findings provide valuable guidance for healthcare organizations and policymakers seeking to navigate the complexities of digital transformation in supply chains.

6 CONCLUSION

This study systematically reviewed the transformative role of Big Data Analytics (BDA) and Artificial Intelligence (AI) in healthcare supply chains, emphasizing their potential to enhance operational efficiency, resilience, stakeholder collaboration, and data security. By synthesizing findings from 50 high-quality articles, the study demonstrated how AI and BDA technologies enable predictive modeling, real-time decision-making, and collaborative platforms, leading to significant improvements in supply chain performance. Despite these advancements, challenges such as data privacy concerns, interoperability issues, and resistance to change persist, necessitating the implementation of robust cybersecurity measures, standardized protocols, and stakeholder training programs. The review also highlighted actionable strategies, including policy-level incentives and investment in digital competencies, to address these barriers and facilitate the seamless integration of advanced technologies. Ultimately, this study underscores the critical importance of leveraging AI and BDA to build resilient, adaptive, and efficient healthcare supply chains capable of meeting the dynamic demands of the modern healthcare landscape.

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