AI-Based Framework for Optimizing Ripple Effects in Healthcare Supply Chains

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Abstract

Healthcare supply chains for critical medical equipment—such as ventilators and personal protective equipment (PPE)—are highly vulnerable to disruptions that can propagate as ripple effects, compromising patient care and emergency preparedness. Traditional management approaches often struggle to anticipate and respond to these cascading disruptions, leading to shortages, increased costs, and operational inefficiencies.

To address this challenge, this paper proposes an AI-based framework designed to predict, simulate, and mitigate ripple effects in medical supply chains. The framework integrates machine learning–based demand forecasting, ripple effect simulation, and optimization algorithms. Key features include automated model retraining, real-time alerts, and an interactive dashboard that provides insights into supply chain dynamics, enabling proactive and informed decision-making. Implementation demonstrates improved supply chain resilience, operational efficiency, and reduced risk of shortages, confirming the framework's robustness, scalability, and applicability in healthcare settings. This work contributes to sustainable and resilient healthcare logistics by offering an AI-enhanced approach for proactive supply chain management. Future directions include IoT integration and advanced prescriptive analytics to enable real-time adaptive decision-making and further strengthen the system's resilience to disruptions.

Keywords

Artificial Intelligence, Supply Chain Resilience, Ripple Effects, Healthcare Logistics, Demand Forecasting.