

# ABSTRACT

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In the ever-evolving landscape of healthcare, the intricate dance of supply chain dynamics plays a pivotal role in shaping the accessibility, efficiency, and quality of medical services. As we embark on this intellectual journey, the fundamental exploration of Healthcare Supply Chain Management (HSCM) becomes the cornerstone of our pursuit. The convergence of diverse elements—ranging from the mobility of healthcare delivery through Mobile Medical Units (MMUs) to the intricate problem-solving of Route Optimization—sets the stage for an in-depth investigation into the challenges and opportunities inherent in modern healthcare systems. The nascent phase of this exploration immerses us in the realm of Healthcare Supply Chain Management, a critical linchpin in the orchestration of medical resources. As we navigate this complex landscape, the focus is on deciphering the nuances of HSCM, understanding its role in resource allocation, and unraveling the intricate web of interconnected processes that influence patient outcomes and healthcare accessibility.

Venturing into the sphere of healthcare delivery, Mobile Medical Units emerge as transformative agents, challenging the conventional notions of stationary healthcare facilities. In our quest to comprehend the evolving paradigm of healthcare access, we scrutinize the impact and potential of Mobile Medical Units. These dynamic, on-the-go healthcare facilities cater to underserved populations, traversing diverse terrains to bring medical services to remote corners of the world. The exploration of MMUs becomes an integral part of our journey, emphasizing their role in amplifying healthcare accessibility and reshaping the traditional boundaries of medical service delivery.

As Mobile Medical Units navigate complex geographies, the optimization of their routes becomes a critical imperative. The intricacies of the Vehicle Routing Problem (VRP) take center stage in our investigation. Here, we delve into advanced Optimization Algorithms and Machine Learning techniques, seeking to streamline the paths of MMUs. This phase of the exploration aims to unravel the complexities of route optimization, with the overarching goal of enhancing the efficiency and effectiveness of healthcare delivery through mobile units.

Transitioning seamlessly, our exploration extends into the realm of Pharmaceutical Supply Chain Management, a domain where timely and accurate distribution of pharmaceutical products is paramount. The integration of Optimization Algorithms and Machine Learning techniques into the pharmaceutical supply chain becomes a focal point, addressing challenges such as inventory management, demand forecasting, and distribution logistics. In doing so, we aim to unlock the potential of technology in optimizing the flow of pharmaceuticals, ensuring that critical medical supplies reach their destination in a timely manner.

The crescendo of our exploration culminates in the revolutionary potential of Blockchain Technology within Pharmaceutical Supply Chain Management. This cutting-edge technology offers a decentralized and transparent framework, promising to mitigate challenges like counterfeit drugs and ensuring traceability throughout the pharmaceutical supply chain. Through the examination of real-world applications and case studies, we unravel the transformative impact of blockchain, envisioning a future where transparency and authenticity redefine the pharmaceutical landscape.

In essence, this preface sets the stage for a comprehensive journey into the realms of Healthcare Supply Chain Management, Mobile Medical Units, Route Optimization, and the transformative potential of technology within the pharmaceutical domain. As we

navigate the intricacies of these interconnected elements, the pursuit is not only academic but practical, seeking to contribute solutions that resonate in the real-world challenges of healthcare delivery and pharmaceutical distribution.

In an era marked by unprecedented advancements in technology, the realm of healthcare has undergone transformative changes, reshaping the landscape of patient care, treatment modalities, and the intricate network that supports the delivery of medical services. The focus of this doctoral thesis revolves around the intersection of two critical domains—Healthcare Supply Chain Management and Pharmaceutical Supply Chain Management—with a particular emphasis on innovative approaches such as Mobile Medical Units, Route Optimization, and Blockchain Technology.

The contemporary healthcare ecosystem is confronted with multifaceted challenges, ranging from the optimization of resource utilization to ensuring the timely and efficient delivery of healthcare services. The role of supply chain management in healthcare has emerged as a pivotal factor in addressing these challenges. This thesis delves into the nuances of Healthcare Supply Chain Management, exploring strategies and technologies that enhance the resilience and responsiveness of the healthcare supply chain.

Mobile Medical Units (MMUs) stand out as a beacon of innovation in healthcare delivery, especially in regions with limited access to traditional healthcare facilities. These units, equipped with state-of-the-art medical technologies, provide a flexible and dynamic means of reaching underserved populations. The first part of this thesis is dedicated to the exploration of Mobile Medical Units and their integration into the broader healthcare supply chain. Through comprehensive case studies and analyses, we aim to discern the impact of MMUs on healthcare accessibility and the overall improvement of public health. Route optimization plays a pivotal role in maximizing the efficiency of Mobile Medical Units. As these units traverse diverse geographic terrains to reach remote areas,

the challenge lies in determining the most efficient routes that minimize travel time and resource consumption. The second segment of this thesis focuses on the intricacies of Route Optimization for Mobile Medical Units, employing advanced algorithms and technologies to streamline their path and enhance their effectiveness in delivering healthcare services. The pharmaceutical sector, as an integral component of the broader healthcare spectrum, faces its own set of challenges. The thesis delves into the complexities of Pharmaceutical Supply Chain Management, exploring strategies to ensure the seamless flow of pharmaceutical products from manufacturers to end-users. With a specific emphasis on leveraging technology, we investigate how innovative solutions can be employed to address issues such as inventory management, demand forecasting, and distribution logistics.

One of the groundbreaking technologies that have garnered attention in recent years is Blockchain. Its decentralized and transparent nature holds immense promise in revolutionizing various industries, including healthcare and pharmaceuticals. The latter part of this thesis is devoted to the exploration of Blockchain Technology in the context of Pharmaceutical Supply Chain Management. By employing blockchain-based solutions, we aim to enhance traceability, reduce the risk of counterfeit drugs, and optimize the overall efficiency of pharmaceutical supply chains.

As we embark on this academic journey, the interplay between Healthcare Supply Chain Management, Mobile Medical Units, Route Optimization, Pharmaceutical Supply Chain Management, and Blockchain Technology unfolds. Through rigorous research, data analysis, and the exploration of real-world applications, this thesis endeavors to contribute to the growing body of knowledge that shapes the future of healthcare delivery and pharmaceutical distribution. It is my sincere hope that the insights presented herein will

not only contribute to academic discourse but also find practical applications in improving the quality and accessibility of healthcare services worldwide.