Chapter 14
Optimization and Implementation of Drone-Assisted Blood Bag Delivery Models and Algorithms

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ABSTRACT

The integrated use of drones, particularly in delivering blood bags in the healthcare sector, presents an innovative solution to challenges like congestion and geographical barriers in land transport. This chapter examines improvements and expanded applications of drone-assisted blood transportation, focusing on models, algorithms, and infrastructures. These include Mixed Integer Linear Programming (MILP), Dynamic Programming (DP), and heuristic control policies, all of which have proven to enhance the effectiveness and resilience of healthcare systems. These models help minimize costs, time, and resources, ensuring timely delivery of essential medical supplies. The chapter also delves into technological aspects such as battery life, load capacity, and communication connectivity, which are vital for drones to operate efficiently. Additionally, it highlights examples from Rwanda and Ghana, showing the viability of scaling drone delivery systems in different settings, while exploring current trends and future directions for integrating drones into healthcare supply chains.

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1. INTRODUCTION

Drones have mostly been used for recreational and military uses, but in recent years, they have been employed for a wide range of commercial and humanitarian logistics purposes (Ayamga et al., 2021). This emerging application has prompted interest, especially in medical supplies such as blood bags (Amukele, 2017). It is therefore important to assess the efficiency of blood transport in situations where normal transport might be costly, especially under circumstances that may include bottlenecks, disasters, or terrains that are difficult to handle (Ghelichi et al., 2021). Drones have become prevalent in the healthcare sector since there is a need to rely on swift and effective delivery (Ackerman & Koziol, 2019). There is a need to counter some of these challenges, such as traffic jams and late transportation of delicate items such as blood bags through drones (Nisingizwe et al., 2022). In addition to flexibility, the use of drones in healthcare transportation, therefore, goes beyond speed and efficiency but also chain reliability in healthcare (Rashidzadeh, 2021). This chapter determines the models, algorithms, and infrastructure that may be useful for supporting the operational effectiveness of drone-based blood bag delivery systems. The conceptual map of the drone-based healthcare delivery system, which includes the drone attributes, charging and landing sites, health facilities and control centers, is shown in **Figure 1**. Delivery routes are shown by green lines and show drones transporting medical equipment from depots to hospitals. Charging is represented by blue arrows joining drones with charging stations. The red arrow depicts the flow of information, providing real-time data and operations between the drones and the control center. The purple arrows represent the supply requests where the various health care facilities send their requests to the control center. It also helps in the proper demarcation of the groupings, which in turn helps to state the structural relationships among the various components that constitute a coherent body of an efficient logistics network for both urban and remote healthcare (Ghelichi et al., 2021).

Figure 1. Components of assisted drone delivery systems