Vehicle Routing Problem under uncertainty: Case of pharmaceutical supply chain

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Abstract
The enhancement of logistics distribution performance and the optimization of transportation have emerged as critical concerns in recent years. The pharmaceutical distribution sector faces significant challenges in route planning and transport network optimization, with uncertainties often leading to delays and losses. The multifaceted challenges encompass the imperative to elevate product quality, reduce costs, minimize total travel distance, and streamline transportation time for effective planning. Within this context, the Vehicle Routing Problem (VRP) stands out as one of the extensively analysed problems in the realms of transportation, distribution, and logistics. Achieving a delicate equilibrium between cost considerations and delivering high-quality pharmaceutical products is a primary objective in pharmaceutical distribution. This research delves into both the Static Vehicle Routing Problem (SVRP) and the Dynamic Vehicle Routing Problem (DVRP). Real-world logistical planning frequently encounters uncertainties at the outset, including uncertain customer demand, delivery quantities, time constraints, and more. This thesis introduces the "temperature condition" as a fundamental constraint in pharmaceutical distribution, representing a source of uncertainty that directly impacts drug quality, thereby influencing logistics distribution and overall supply chain performance. Furthermore, the thesis incorporates uncertainty quantification for modelling uncertain travel times in both recurrent and non-recurrent congestion scenarios. The methodology employed for this purpose is the collocation method, initially validated through Monte Carlo Simulation (MCS). By addressing these multifaceted challenges and uncertainties, this research seeks to contribute to the development of robust strategies in pharmaceutical distribution, ensuring the optimization of routes, reduction of costs, and maintenance of high-quality product standards. The findings of this study offer valuable insights for logistics managers and planners aiming to navigate the complexities of pharmaceutical distribution, fostering efficiency and resilience in the face of uncertainties.