

# **Building Robust Food Supply Chains through Routing Optimization: A Case Study of KDD in Kuwait**

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## **Abstract**

This research investigates supply chain resilience through simulation-based optimization, focusing on the Capacitated Vehicle Routing Problem (CVRP) using Kuwait Danish Dairy Company (KDD) as a case study. It aims to enhance logistic robustness against disruptions such as demand spikes, traffic congestion, and regulatory restrictions. Using Google OR-Tools implemented in Python, scenarios representing baseline operations, urban congestion, demand surges, Ramadan operational constraints, and lockdown scenarios were simulated. The CVRP model minimizes total travel cost, considering vehicle capacity and route constraints to maintain cold chain integrity. Results highlighted significant impacts from compounded disruptions; traffic congestion increased total travel distance by 13%, while demand surges stretched operational limits. Ramadan scenarios required precise routing to meet delivery constraints within shorter timeframes. Lockdown scenarios showed reduced operational costs but potential revenue losses from inaccessible nodes. The comparative analysis demonstrated that optimized routing significantly mitigates disruption effects, improving efficiency by up to 20%. Recommendations include adaptive logistics strategies, real-time data integration, diversified supplier networks, and preemptive inventory management. The findings offer practical insights applicable broadly to food supply chains facing similar vulnerabilities in the Gulf region. This research advances the application of CVRP for enhancing supply chain resilience, offering a robust methodology and actionable solutions for managing logistic vulnerabilities. Future research directions include real-time route adjustments, multi-depot scenarios, and environmental sustainability considerations.

## **Keywords**

Supply Chain Resilience, Simulation Optimization Models, CVRP, Cold Chain Logistics, Disruption Management.

## **Biographies**

**Fay Yousef AlMaatouq** is an industrial engineering student at the American University of the Middle East (AUM) with a strong interest in systems optimization and practical problem-solving. Her academic focus lies in supply chain management and operations, where she seeks to drive innovative solutions that support Kuwait's industrial development..

**Fouz Fawaz Jassim Alshehab** is pursuing bachelor's degree in industrial engineering at the American University of the Middle East (AUM). She is particularly interested in simplifying complex systems and enhancing operational processes. Fouz is passionate about the role of supply chain and operations management in improving business performance across Kuwait.

**Yasmeen Khaled Mohammad AlMuhaini** studies industrial engineering at the American University of the Middle East (AUM), with a commitment to driving innovation and efficiency in industrial operations. Her academic work emphasizes supply chain optimization and strategic process improvement to address key challenges in Kuwait's evolving industrial landscape.

**Alperen Bal** is currently an Assistant Professor at the American University of the Middle East in Kuwait. He earned his Ph.D. in Industrial Engineering from Istanbul Technical University in 2019. His research interests include the circular economy, sustainable logistics, supply chain optimization, and simulation-based optimization. He has published numerous articles in peer-reviewed international journals such as the International Journal of Production Economics, International Journal of Cleaner Production, and Simulation Modeling Practice and Theory, among others.