

ALTERNATIVE ROUTE OPTIMIZATION FOR EMERGENCY SERVICES DURING FLOODS IN JOHOR BAHRU USING DIJKSTRA ALGORITHM

Amira Shaffiqa Binti Razif, Sharifah Fhahriyah Binti Syed Abas

Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA Perlis Branch, Malaysia

e-mail: amira12shaffiqa@gmail.com, sfhahriyah@uitm.edu.my

Abstract

During floods in Johor Bahru, transportation systems are often disrupted, causing delays in emergency supply deliveries to Pusat Pemindahan Sementara (PPS). This study aims to identify alternative delivery routes using Dijkstra's algorithm and compare delivery distances before and after flooding across four designated zones involving 27 PPS. Flood conditions were simulated by extending distances or blocking access to affected roads. The results showed that 17 out of 27 PPS (63%) experienced increased delivery distances after the flood. Zone A was unaffected, Zone B experienced up to a 140% increase, Zone C up to 297.83%, and Zone D recorded the highest increase of 842.42%. These findings highlight the importance of route optimization in disaster logistics, helping maintain connectivity and ensure timely aid delivery during emergencies.

Keywords: *Flood Disaster, Dijkstra's Algorithm, Route Optimization, Emergency Logistics, Johor Bahru*

1. Introduction

Flooding in Johor Bahru, Malaysia, frequently disrupts transportation networks and delays emergency response, particularly during the monsoon season (Rosmadi et al., 2023). This study aims to optimize vehicle transportation routes during flood events using Dijkstra's algorithm to identify safe and efficient alternatives. It analyses flood-affected zones, blocked roads, and evacuation centre locations, comparing delivery distances before and after flood events across four designated zones. Traditional navigation tools such as Google Maps and Waze are not designed for disaster scenarios (Mao et al., 2017), highlighting the need for flood-aware routing systems. By incorporating real-time conditions, the study enhances emergency logistics, improves response times, and supports uninterrupted delivery of essential services (Tian et al., 2025). Although limited to vehicle routes and based on 2025 data, the findings contribute to disaster preparedness and strengthen public safety and resilience in flood-prone urban settings (Boakye et al., 2022).

2. Methodology

This chapter outlines the methodology used to optimize emergency vehicle routes during flood events in Johor Bahru, Malaysia. Adopting a quantitative approach, the study integrates geospatial flood data, road network structures, and evacuation centre locations sourced from the Department of Irrigation and Drainage (2025). The road network is modelled as a weighted graph, with junctions and PPS centres represented as nodes and road distances as edge weights. Dijkstra's algorithm was applied due to its effectiveness in calculating the shortest path in a network (Tian et al., 2025). The simulation was implemented in Python using adjacency lists for efficient processing. The study categorizes 27 evacuation centres into four zones to manage routing scope and improve emergency response during simulated flood scenarios. Fundamental graph theory terms were defined to support understanding of the algorithmic process. This methodology ensures accurate modelling of real-world flood conditions and contributes to more efficient disaster response planning (Boakye et al., 2022).

3. Results / Findings

This chapter presents the simulation results of route optimization using Dijkstra's algorithm for emergency delivery to 27 Pusat Pemindahan Sementara (PPS) across four zones in Johor Bahru. The study evaluates delivery distances before and after simulated flooding. Under normal conditions, all PPS were reachable via the shortest paths. However, after introducing flood-based disruptions, 17 out of 27 PPS experienced increased delivery distances. Zone A remained unaffected, while Zones B, C, and D faced varying impacts. Notably, Zone C experienced consistent route extensions, and Zone D recorded the highest increase of 842.42% for PPS22. These findings highlight critical vulnerabilities in Johor Bahru's Road network during flood events and underscore the importance of adaptive routing algorithms in disaster scenarios (Tian et al., 2025). The results provide essential insights for emergency planners and authorities to enhance delivery logistics and ensure resilient response systems during floods.

4. Novelty of Research / Product / Project

This research presents a novel integration of flood-aware geospatial data with Dijkstra's algorithm to optimize emergency delivery routes during disaster scenarios in Johor Bahru, Malaysia. Unlike traditional routing tools such as Google Maps and Waze, which do not account for dynamic disaster conditions, this project simulates real-time road disruptions caused by flooding. It introduces a zone-based approach by categorizing 27 Pusat Pemindahan Sementara (PPS) into four strategic zones, enabling efficient resource allocation and delivery logistics. The simulation includes adjusted road weights to represent flood-affected segments, providing a realistic and data-driven model for emergency planning. By combining real flood data from the Department of Irrigation and Drainage with network modelling in Python, the project produces actionable insights for disaster response teams.

5. Conclusion or Future Work

This study used Dijkstra's algorithm to optimize emergency routes in Johor Bahru during floods, revealing major disruptions in Zones B, C, and D. Future work may include real-time data integration, alternative algorithms, and expanded coverage to improve dynamic routing, emergency response, and disaster preparedness across broader flood-prone areas.

REFERENCE LIST

- Boakye, J., Guidotti, R., Gardoni, P., & Murphy, C. (2022). *The role of transportation infrastructure on the impact of natural hazards on communities*. Reliability Engineering & System Safety, 219, 108184. <https://doi.org/10.1016/j.ress.2021.108184>
- Mao, Z., Jiang, Y., Min, G., Leng, S., Jin, X., & Yang, K. (2017). *Mobile social networks: Design requirements, architecture, and state-of-the-art technology*. Computer Communications, 100, 1–19. <https://doi.org/10.1016/j.comcom.2016.11.006>
- Rosmadi, H. S., Ahmed, M. F., Mokhtar, M. B., & Lim, C. K. (2023). *Reviewing challenges of flood risk management in Malaysia*. Water, 15(13), 2390. <https://doi.org/10.3390/w15132390>
- Tian, T., Wu, H., Wei, H., Wu, F., & Xu, M. (2025). *An Efficient Route Planning Algorithm for Special Vehicles with Large-Scale Road Network Data*. ISPRS International Journal of Geo-Information, 14(2), 71–71. <https://doi.org/10.3390/ijgi14020071>