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A SEMI-DYNAMIC SYSTEM FOR OPTIMIZING THE EFFICIENT ROAD PATH FOR COURIER SERVICE VEHICLES TO PROVIDE A SUSTAINABLE PARCEL DISTRIBUTION IN SRI LANKA

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ABSTRACT – Logistic management should be considered due to increasing the number of e-commerce businesses. Thus, parcel distribution and collection rely on transportation. This study aimed to provide an optimized route plan to reduce transportation costs and lead to reduce cost factor of parcel delivery. Primary data was collected from the courier service staff of Sri-Lanka via Focus group discussions and in-depth interviews. Secondary data were sourced through online search on to develop efficient road path for courier service vehicles. Most Sri Lankan courier services are needed to use low-cost route plan generation solutions to reduce transportation costs and leading to reductions in parcel drop-offs and collections. Prioritizing customer delivery needs, re-routing while vehicles are on the route and proper weight distribution models for delivery vehicles are identical requirements from the courier services. Integrating the GPS, and GIS custom Map with an optimization algorithmic solution as a web-based solution can generate a route plan for each vehicle. The proposed system has been considered to provide effective and efficient route plans for courier service companies in Sri Lanka.

Keywords: Global Positioning System (GPS); Geographic Information System (GIS); Route Planning; React Frameworks; Mapbox

1. INTRODUCTION

Management of the stream from the source to the destination of a good or item is logistic [1]. The distribution and collection of parcels is one of the major clusters in the logistics industry. One of the main reasons to demand these services is an expansion of e-commerce and online shopping. It is a vital factor to supply chain operations [2]. Covid-19 impacted to e commerce growth specially parcel distribution due to increasing the parcel volume, last-mile delivery focus, changing customer expectations and sustainability initiatives. “Sustainable Logistics Management” aims to balance three areas including economic, environmental and social dimensions [3]. This study aims to reduce transportation costs, greenhouse gas emissions, and labor practices by optimizing routes, using eco-friendly packaging materials, and promoting fair wages, safe working conditions, and professional growth for logistics staff. Integration and incubation of digital technologies with the courier industry became empowered service quality and performance [4]. The cost of distribution and express delivery is crucial for courier service firms, including sub-factors like fuel, vehicle maintenance, and human resources. Express delivery relies on short route plans to overcome traffic, affecting sustainability and improving profit and customer satisfaction. These factors directly impact the organization’s overall performance [5]. This will lead to a win-win situation for both the logistics companies and the customers.

According to the literature, novel route planning systems were introduced around the world such as Context-Based Social Networks and Multi-Criteria Decision Analysis [6], Optimal Delivery Routing in Road Network with Occupancy Detection [7] Car4Pac: Last Mile Parcel Delivery Through Intelligent Car Trip Sharing [8] and so on. But Lack of study was conducted for the Sri Lankan logistic companies [9] [10] and they have

considered the totally dynamic route plan for delivery in urban areas. Hence, it is needed to consider both delivery and collection including in rural area also. Re-routing is crucial for cost reduction and sustainable service. An optimization model for parcel/cargo weight distribution is essential. Prioritizing customer delivery based on requests is crucial. This study proposes a semi-dynamic route plan to achieve these points and parameters. This is because third-party delivery service providers are highly concerned about sustainability in parcel delivery.

2. MATERIALS AND METHODS

2.1. Research Design

A qualitative research approach was used to gather primary data on courier service challenges in Sri Lanka. Focus group discussions and in-depth interviews with key stakeholders, including branch managers and delivery staff, provided valuable insights into the industry's current challenges and identified requirements for a proposed route planning system.

2.2. Proposed Route Planning System

The proposed route planning system that given in the Figure 1, is designed to optimize the delivery process and reduce transportation costs for courier service vehicles. Several key components are included in this proposed system.

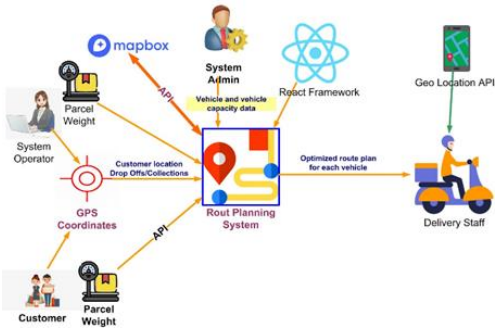

Figure 1. Proposed route planning system

The system uses GPS technology to track real-time delivery vehicle locations and integrates it with the Geographic Information System (GIS) for efficient route planning. Advanced optimization algorithms consider factors like distance, traffic conditions, delivery time windows, and priority customer requests. This helps determine the most efficient routes for each vehicle, minimizing travel time and fuel consumption. The system also integrates with courier service companies' packaging systems, enabling data exchange between planning and packaging, ensuring optimal alignment with parcels.

The proposed system faces challenges in data accuracy, real-time adaptability, and vehicle re-routing. Regular updates and advanced GPS devices are essential for its effectiveness in Sri Lanka's courier service industry.

3. RESULTS AND DISCUSSION

The system input GPS coordinates on parcel drop-off addresses and collections. This can be fulfilled manually by entering the system operator (for drop-offs) and/or integrating customer requests via the existing system (collections). Another optimization of this study is relevant to the weight distribution optimization model within vehicles. The system will optimize parcels based on weight considering both drop-offs and collections. The collection factor would be needed to realize based on customer entries and estimation.

The simulated Route planning system will generate optimized separate routes for each vehicle (on MapBox Platform). The system supports prioritizing customer drop-off and collection needs. And the system will support re-route collections when orders are made by customers during vehicles are on the road.

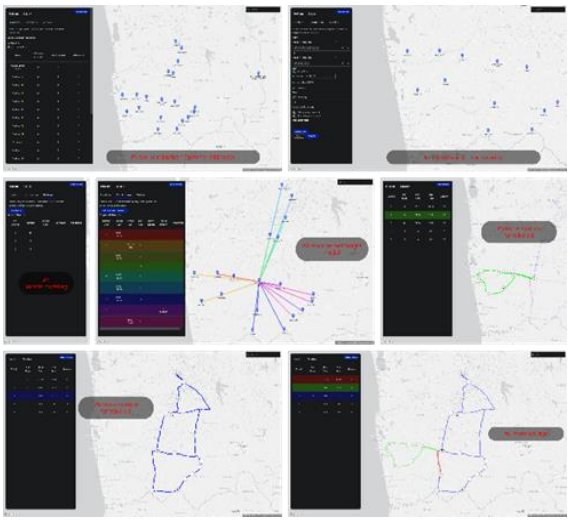

Figure 2. Simulated system outputs

4. CONCLUSION

The study shows the semi-dynamic route planning system in Sri Lanka effectively optimizes parcel distribution, achieving cost savings, increased efficiency, and customer satisfaction. Continuous efforts are ongoing to address challenges and explore potential improvements. Real-time traffic updates, intelligent delivery prioritization, blockchain integration, user customization, and autonomous vehicle integration are essential for future improvement.

REFERENCES

1. T. Niels, M. T. Hof, and K. Bogenberger, (2018). 'Design and Operation of an Urban Electric Courier Cargo Bike System', 2531–2537
2. N. Izzah, F. Dilaila, and L. Yao, (2021). 'The growth of reliance towards courier services through e-business verified during COVID-19: 1874(1)
3. M. Soysal, M. Çimen, S. Belbağ, and E. Toğrul, (2019). 'A review on sustainable inventory routing', 132, 395–411
4. M. Titilayo Grace, A. Olabisi, O. Banji Riddwan, and T. Olabode, (2022). 'Express Parcel Market Innovation and the Performance of Nigeria Postal Services', 1(1), 207–219
5. A. V. Nobre et al., (2022). 'Analysis of Decision Parameters for Route Plans and Their Importance for Sustainability: An Exploratory Study Using the TOPSIS Technique', 6(2), doi: 10.3390/logistics6020032.
6. M. Y. Wu, C. K. Ke, and S. C. Lai, (2022). 'Optimizing the Routing of Urban Logistics by Context-Based Social Network and Multi-Criteria Decision Analysis', Symmetry (Basel)., 14(9), 1–17
7. F. Wang, Y. Zhu, F. Wang, J. Liu, X. Ma, and X. Fan, (2020) 'Car4Pac: Last Mile Parcel Delivery through Intelligent Car Trip Sharing', 21(10) ,4410–4424
8. S. Y. Teng, S. C. Wu, and K. T. Chuang, (2019). 'Optimal delivery routing in road network with occupancy detection', 575–580, doi: 10.1109/MDM.2019.00122.
9. M. F. M. Firdhous, D. L. Basnayake, K. H. L. Kodithuwakku, N. K. Haththalla, N. W. Charlin, and P. M. R. I. K. Bandara, (2012). 'Route Planning Made Easy – An Automated System for Sri Lanka'
10. D. T. Dayaratne and S. Gunasekara, (2020). 'Dynamic Route Planning (DRP) Module for Distribution Business', 4(1), p. 26