MODEL THE VEHICLE ROUTING PROBLEM TO OPTIMIZE FREIGHT LOGISTICS MULTIPLE ECHELON NETWORK

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Degree of Master of Science

Department of Transport and Logistics Management

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Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree Master of Science

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STATEMENT OF THE SUPERVISOR

The above candidate has carried out research for the Degree of Master of Science under my supervision.

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Signature of the Supervisor: Date: 25th October 2022

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Abstract

The air freight supply chain is a crucial aspect of global trade. The freight forwarders act as the linking agents between the airside and the customers. The freight distribution strategies can be single-echelon distribution or multi-echelon distribution. Intermediate facilities like satellites are involved in the multi-echelon distribution and usually have several services which are utilized to reduce the transportation cost or travel distance and improve the level of service. Vehicle Routing Problem (VRP) is one of the most important combinatorial optimization problems and concerned with creating an optimal route to be used by a fleet of vehicles that served a set of customers. The literature study provides the basis for the study reviewing the development of the vehicle routing problem (VRP), its applicability in three-echelon distribution networks, solution methods, the importance of air freight distribution, and its application using VRP. Therefore, we developed a mathematical model for three echelon air freight distribution networks to minimize the total transportation cost. We discuss mixed integer linear programming formulations for this three-echelon capacitated vehicle routing problem with time windows (3E-CVRPTW) in the arc-based formulation. The connectivity between the three echelons has been made using demand as the connecting variable. Based on a case study at a freight forwarding company in Sri Lanka we developed hypothetical data set for the study with the support of expert knowledge. The 3E-CVRPTW problem was solved using a clustering-based heuristic approach and python programming language used to gain solutions. For ease of use, it was formed three zones using clustering analysis. It obtained the total transportation cost for the network and costs for each zone. Furthermore, it has calculated the delivery starting times for the 100 customers. Finally, the study has done a scenario analysis of varying vehicle fleet sizes, the number of customers served, and time windows of delivery. This research has opened a new path to develop the solution approaches for vehicle routing problems in a multi-echelon network associated with air freight distribution.

Keywords: Air freight, vehicle routing problem, logistics systems, freight transport, transport management

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LIST OF ABBREVIATION

Abbreviation	*Description*
VRP	Vehicle Routing Problem
CVRP	Capacitated Vehicle Routing Problem
VRPTW	Vehicle Routing Problem with Time Windows
MDHFVRP	Multi-Depot Heterogeneous Fleet Vehicle Routing Problem
CMDVRPTW	Collaborative Multi-Depot Vehicle Routing Problems with Time Windows
MDVRP	Multi- Depot VRP
OVRP	Open VRP
TS	Tabu Search

LIST OF APPENDICES