AN OPTIMIZATION MODEL FOR MULTI-OBJECTIVE VEHICLE ROUTING PROBLEM FOR PERISHABLE GOODS DISTRIBUTION

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Degree of Master of Science

Department of Transport and Logistics Management

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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.

Names of supervisors: Dr. Amila Thibbotuwawa

Dr. H.N. Perera

Signatures of Supervisors: Date: 22nd August 2022

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Abstract

Vehicle Routing Problem (VRP) is a well-studied area of operations research that has resulted in significant cost savings in global transportation. The primary goal of the VRP is to find the best route plan that minimizes the total distance traveled. The current study used VRP to solve the problem of fresh Agri products distribution in retail chains. With the advancement of computation power, researchers pay more attention to incorporating real-world characteristics when developing VRP, making it more practical for use in real-world applications. Existing literature identifies a research gap in richer problems that use real-world characteristics concurrently. This study created an integrated bi-objective VRP model that focused on resource optimization, order scheduling, and route optimization all at the same time. Two objectives aim to minimize distribution costs while ensuring product deliveries to retail outlets on time. To improve real-world applicability, the model incorporated multiple real-world characteristics simultaneously. All the algorithms were developed using an open-source optimization library called OR-tools.

This research compared several heuristics and metaheuristic methods respectively, to obtain the IBFS (Initial Basic Feasible Solutions) and iterative improvements. Thereafter, best performing heuristic method (savings algorithms) and metaheuristic method (guided local search) were hybridized to develop the proposed two-phase solution method. All the solution algorithms and the developed VRP model were tested using the data obtained from one of the largest retail chains in Sri Lanka. Numerical experiments show the efficiency of the proposed solution algorithm in solving a real-world VRP problem. Further, numerical experiments show that the proposed VRP model has achieved a 16% saving in daily distribution cost while ensuring on-time deliveries to 95% of the retail outlets. Further, on-time deliveries of fresh Agri products ensure the freshness conditions. The developed VRP model is efficient to use as an operational planning tool for planning distribution operations in retail chains.

Keywords:

Vehicle Routing Problem, Perishable goods distribution, Retail supply chain**,** Heuristic methods, Metaheuristic methods, Real-world application

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

COMVRP - Closed Open Mixed Vehicle Routing Problem

CVRP - Capacitated Vehicle Routing Problem

GLS - Guided Local Search

HFVRP - Heterogenous Fleet Vehicle Routing Problem

IBFS - Initial Basic Feasible Solutions

MDVRP - Multiple Depot Vehicle Routing Problem

MOVRP - Muti Objective Vehicle Routing Problem

OR - Operations Research

OSRM - Open-Source Routing Machine

SA - Simulated Annealing

SDVRP - Split Delivery Vehicle Routing Problem

TS - Tabu Search

VRP - Vehicle Routing Problem

VRPFPG - Vehicle Routing Problem for Perishable Goods

VRPTW - Vehicle Routing Problem with Time Windows