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CARGO DISTRIBUTION PROBLEMS: A CASE STUDY OF ISPARTA CITY

Kenan Karagul
Dept. of Logistics,
Pamukkale University, Honaz Vocational School, Denizli
Turkiye

Erdal Aydemir
Dept. of Industrial Engineering,
Suleyman Demirel University,
Engineering Faculty, Isparta,
Turkiye

ABSTRACT
The vehicle routing problem (vrp) is related to service a number of customers with a fleet of vehicles. In real life, the applications of transportation, distribution and logistics are mostly studied as a research area for scientists and industrial practioners.
In this study, the cargo distribution problem has been presented by using vrp procedures for a cargo company in Isparta City, Turkiye. The 400 customer points and their requirements are only served from two branch offices of a cargo company. Firstly, the customer points are clustered to Euclidean distance matrices and in the second phase, the distribution plans are computed via vrp approach. As a result, the solutions are obtained and the distribution plans are offered to the cargo company under cost and fleet minimization.
Keywords: Vehicle routing problems, Cargo distribution problems, clustering, optimization

1. INTRODUCTION

The aim of logistics is to get the right materials to the right place at right time, while optimizing a given performance measure and satisfying a given a set of constraints. Supply chain management includes the planning and management of all activities involved in sourcing, procurement, conversion, and logistics management, as well as crucial components of coordination and collaboration. In logistics, several types of problems could come up; one of the most remarkable is the set of route planning problems [1].
The Vehicle Routing Problem (VRP) dates back to the end of the fifties of the last century when Dantzig and Ramser set the mathematical programming formulation and algorithmic approach to solve the problem of delivering gasoline to the service stations. Since then the interest in VRP evolved from a small group of mathematicians to the broad range of researchers and practitioners, from different disciplines, involved in this field [2]. Consider a depot with a fleet of vehicles of limited capacity and a set of customers, each with a certain demand for goods to be dispatched. The problem is to determine optimal routings for the vehicles to visit every customer exactly once in order to satisfy the demand. Usually, the goal for optimization is to minimize the route distance of the vehicles.
Many applications of the VRP have been utilized, but all are based on a single depot. Although this problem is the most attractive among researchers in the field, it is not appropriate for companies with more than one depot. In these cases, it is necessary to solve the Multi-Depot Vehicle Routing Problem (MDVRP). In these problems, the decision makers must also determine which clients will be served by which depots. For this, it is necessary that the clients be allocated to the depots according to the objective of optimizing the overall cost. The MDVRP has been observed to support the three decision making processes which are assignment, routing and programming [3].

For a more detailed learning about the subject of VRP, [4] [5] [6] [7] may be suggested as an elementary literary work and [8] may be suggested to the interested people for the classical intuitive ones.

2. ANALYSIS OF CARGO DISTRIBUTION PROBLEM IN ISPARTA CITY OF TURKIYE

Daily distribution data of a cargo firm operating in Isparta (in Turkey) have been handeled. There are two branches (warehouses) of this cargo firm. The number of the customers to be distributed is 400 and the total distribution demand is 17831units. There are 3 vehicles having the same capacity positioned in the each branch (warehouse) of the firm. The capacity of the each vehicle is 3000 units. The coordinates of the customers and the branches have been determined. The aim of this is to suggest a suitable distribution plan for the firm. The distribution of the branches and the warehouses has been shown in Figure 1.

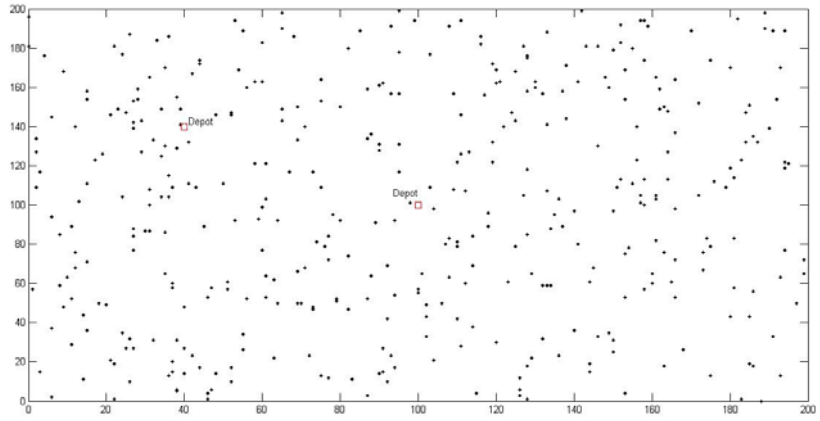


Figure 1. Geographic Distributions of Customers and Depots in Isparta

3. SOLUTION APPROACH

The problem handled is MDVRP problem. For this reason, the problem has been solved in two phases. In the first phase, The customers have been divided into two clusters including the warehouses. As a result of this clustering, one of the warehouses has been piled up being included to a cluster and the other has been piled up being included to the other. By this way, which warehouse will serve to a specific customer has been determined. In the second phase, routing algorithms has been applied in order to form a suitable distribution plan. Savings and Sweep Algorithms have been employed in search of solution. Matlog software [9] has been employed for the analysis. The distribution of the customers and the warehouses has been shown in Figure 2 below which has been formed as a result of clustering.

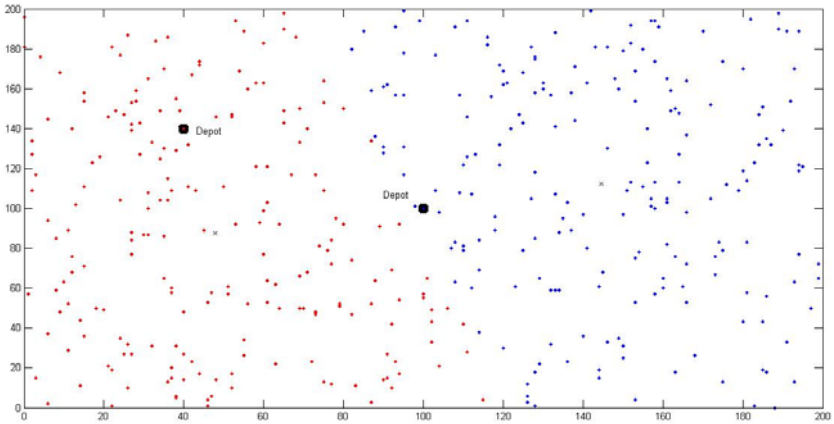


Figure 2. After the clustering algorithm, Geographic Distributions of Customers and Depots in Isparta

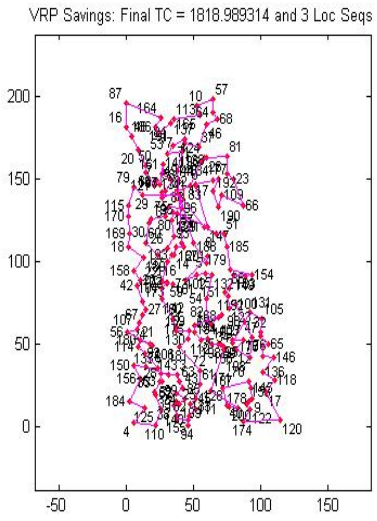
4. COMPUTATIONAL RESULTS

The results regarding Savings and Sweep Algorithms have been shown in Table 1.

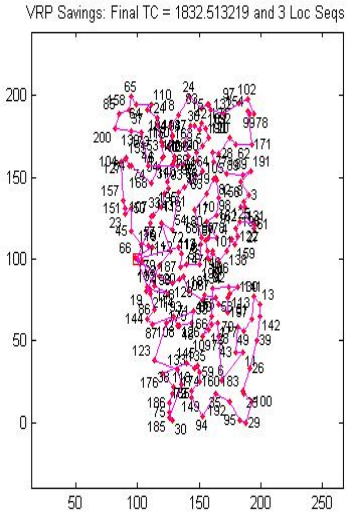
Table 1. Solutions Summary of Savings and Sweep Algortihms

		Cluster1		Cluster2	
Savings Solutions	Routes	Cost	Customers	Cost	Customers
	R1	636,06	65 Points	588,64	73 Points
	R2	600,85	64 points	716,01	69 Points
	R3	582,06	72 points	527,84	57 Points
	Total Cost	1819,0		1832,5	
	Solution Time	9,27 seconds		7,12 seconds	
Sweep Solutions		Cluster1		Cluster2	
	Routes	Cost	Customers	Cost	Customers
	R1	593,35	66 Points	653,15	71 Points
	R2	543,56	72 Points	598,19	66 Points
	R3	573,56	63 Points	489,97	62 Points
	Total Cost	1710,5		1741,3	
	Solution Time	17259,87 seconds		17526,92 seconds	
	Cluster 1, 202 points, include depots				
	Cluster 2, 200 points, include depots				

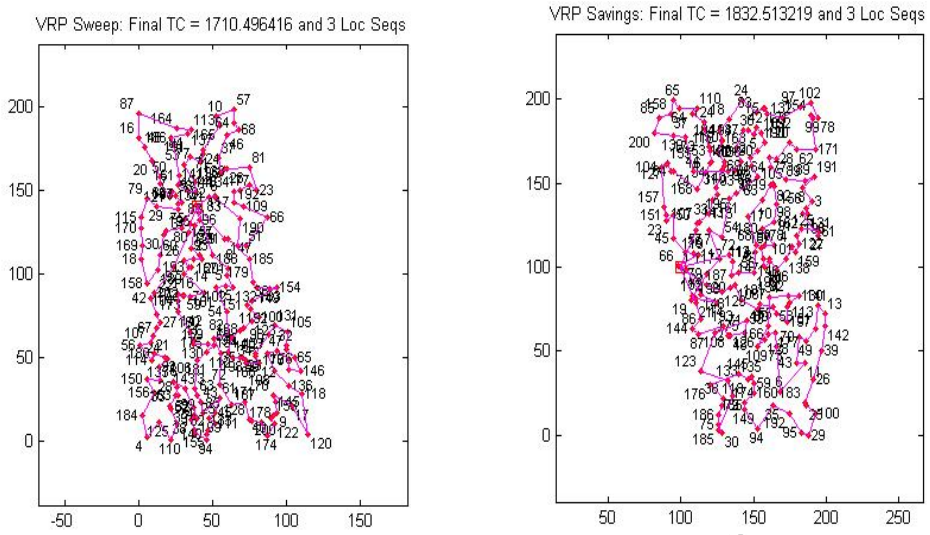
Savings Algorithm produces solutions in a shorter time when it is compared with Sweep Algorithm in terms of time. However, when these are compared in terms of total costs gained for the firm, the solution of Savings Algorithm is 3651 while the solution of Sweep Algorithm is 3451. Sweep Algorithm is quite effective in terms of costs, on the other hand, it requires a long time for the solution period. The routes which have been produced by Savings and Sweep Algorithms can be seen in Figure 3 below.



(a)



(b)



(c) (d)

Figure 3. Savings and Sweep Algorithms' Route Construction Solutions

5. CONCLUSIONS AND FURTHER RESEARCH

In this study, we aimed to determine the optimal number of vehicles for fleet and cost. In terms of costs, Sweep Algorithm solution is more effective than Savings Algorithm solutions. In terms of solution time, Savings Algorithm is more effective than other. Fleet size is equal for both algorithms.

About the further research, the meta-heuristics methods can be applied for solving this cargo distribution problem in order to minimize the cost and solution time.

6. REFERENCES

[1] A. Kiraly ve J. Abonyi: «A Google Maps based novel approach to the optimization of multiple Travelling Salesman problem for limited distribution systems,» Acta Agraria Kaposvariensis, cilt 14, no. 3, pp. 1-14, 2010.

[2] T. Caric ve H. Gold: Vehicle Routing Problem, Croatia: In-Teh, 2008.

[3] O. S. d. S. Junior: «A Free Geographic Information System as a Tool for Multi-Depot Vehicle Routing,» Brazilian Journal of Operations & Production Management, cilt 8, no. 1, pp. 103-120, 2011.

[4] P. Toth ve D. Vigo: The Vehicle Routing Problem, Philadelphia: SIAM Monographs on Discrete Mathematics and Applications, 2002.

[5] M. Paolucci: «Vehicle Routing Problems-Lecture Notes,» Genova, 2011.

[6] G. Laporte: «Transportation Logistics Lecture Notes,» 2004. Available: http://neumann.hec.ca/chairedistributique/common/transportationlogistics.pdf. [14 12 2012].

[7] G. Laporte: What You Should Know About the Vehicle Routing Problem, Les Cahiers du GERAD, 2007.

[8] G. Laporte ve F. Semet: «Classical Heuristics for the Vehicle Routing Problem,» Montreal, 1998: Revised 1999.

[9] M. G. Kay: «Matlog: Logistics Engineering Matlab Toolbox,» 1 1 2013. Available: http://www.ise.ncsu.edu/kay/matlog/. [16 2 2013].

[10] G. Laporte: «Fifty Years of Vehicle Routing,» Transportation Science, cilt 43, no. 4, pp. 408-416, 2009.