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Vehicle Routing Problem:The Example Of Karatay Municipality, Konya

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Abstract

Vehicle routing problems are often seen in current life. The basic problem is that installed suitable capacity of vehicles should reach the centers within the shortest period of time and distance. The distribution network can be improved by solving this problem. With an efficient distribution network provides cost savings to businesses. In addition that business can get some benefit like customer pleasure, quality, competitiveness etc.

In this paper we examined distribution network of Folk Bread Factory of Konya Karatay Municipality. In this context 6 sales centers in the first region and 5 sales centers in the second region are taken into account. Linear model was established and this model has been solved with WINQSB Programme. According to the results 20% improvements have been achieved in the first region and 1% improvement has been achieved in the second region with the new routes.

Key Words: Vehicle routing problem, traveling salesman problem, linear programming

INTRODUCTION

Enterprises need to be innovative in order to remain in this new dimension of global competition has reached and to survive in a profitable way. In parallel to enterprises' continuing their existence as competitive; changing customer needs and demands, at minimum cost, must be provided by providing the maximum quality in the shortest time. During providing the customer demands, the impact of the distribution function on quality, cost, time and so on. Elements are quite large. Vehicle Routing Problem (ARP), on the distribution function of businesses, is a complex optimization problem used to solve problems such as cost, time and route minimization.

ARP is a complex problem and its solving is time-consuming. When the demand, capacity, distribution tool, and so on. Elements are taken into account on the distribution function of enterprises; many different types of ARP are faced with. For this reason, there isn’t an only ARP

approach that can be used in different areas and reach an exact solution. Different approaches for ARP’s solving and

for applying it to complex current life problems, different softwares have been developed.Traveling salesman problem is a very common type of ARP. In these problems, distribution center starts from a node. The purpose in traveling salesman problems is stopping by each necessary point at least one time after setting off and the minimization of the total distance during the course of distribution by returning to the center at the last stage. In the beginning of the study, the overall structure of the ARP, the ARP types and the possible solution methods were explained briefly. Later, during the applying process, the bread distribution problem of Public Bread Factory of Karatay Municipality, in Konya, was solved. Bread distribution problem is a typical traveling salesman problem. With the data taken from the enterprise, the problem was expressed as a linear programming model and solved with WINQSB program. According to the solution that we reached, for the enterprise, 20% improvement in total distance in the first distribution region and 1% improvement in the second distribution region were seen.

TRADITIONAL VEHICLE ROUTING PROBLEM (Vehicle Routing Problem) (VRP)

The design decision in multi-stage distribution network in supply chain is among critical, operational and logistical management decisions which an enterprise faces with. Such a decision should be analyzed carefully because it affects the cost, time and the quality of customer service. However, analyzing the issues related to the relationship between customer, warehouse and transportation is rather important for the success of an enterprise.

Enterprises use vehicle fleets consisting of a few vehicles in order to provide the transportation of products to customers' places of residence. The necessity of managing the vehicle fleets effectively raises some problems. These problems, which include the order of the places that the vehicles need to stop by, may be called routing problems.

A vehicle routing problem (ARP) was first studied in 1959 by Dantzig and Ramser. Clarke and Wright, in 1964, developed the method of Dantzig and Ramser and proposed classical saving method. Thereafter, hundreds of different models and algorithms were proposed to find solutions to different types of ARP. Due to the application area is very many and the problem is interesting, ARP has drawn the attention of many researchers.

Studies in literature are modeling of ARP problems that include different features, use of different solution algorithms in the search for the optimum solution for these problems and applications done for various problems in real life.

Vehicle routing problem, with the simplest expression, is the problem of identifying the shortest ways in accordance with capacity, distance, time and cost constraints in order to take products, services or individuals from certain supply points to specific demand or delivery points by a group of vehicles.

Traditional ARP, for vehicles with limited capacity in a central warehouse, is to find out the lowest cost routes to service to all customers scattered in different locations in a geographic area containing the store. The less cost requires the distance, which is the vehicle goes toward, to be the shortest. Studies indicate that the distribution costs are approximately 15-20% of the cost of product. On the other hand, traveling salesman problem, node for the n nodes, is the problem of finding the shortest route to returning to the starting node with the condition of visiting each node once.

According to another definition, the vehicle routing problem is the problem of determining the necessary routes that a fleet of vehicles, which is located in a central warehouse and each one has the same of different capacities, each one to a different settlement and to a set of customers which has a known set of demand by minimizing the total travel distance or time and go back to the warehouse.

Vehicle routing problems have an important and common application area. A vehicle fleet distributes products stocked in a single warehouse in line with customers' daily orders. In some businesses, customers declare their orders to the central warehouse at the beginning of each day and thus, a distribution program according to demands is prepared for the vehicles allocated by the warehouse. When the transporting routes are being determined, a route that the most minimizing the total distance is determined. Each allocated vehicle has a fixed capacity and the demands are specific, a fixed portion of the capacity of the vehicle is used for each order.

There are three unchangeable elements in ARP. These are the vehicles, the warehouses(vehicle starting point) and the customer(vehicle target points). The vehicles, the warehouses and the customers are assumed to have these following basic features:

The Vehicles;

- They all have the same features.

They have limited capacity.

- They have certain speed.
- They are all ready and waiting in storage garages.

The Warehouses;

- They have an unlimited stock of the product according to the demands.
- They are the areas where the vehicles are.

They are deployed on a node.

The customers;

- Each node represents a customer other than the node where the warehouse is.
- They may request a specific amount of product.

The simplest version of ARP is the traditional ARP and work with a set of basic assumptions. The assumptions of the traditional ARP;

- Zero-node is the warehouse, there are total n (1,2, ..., n) each customer.
- The distribution is made by the vehicles with q capacity to the n customer.
- Every customer is sure to be visited and provided the demand.
- Each vehicle route starts from and ends in the same warehouse.
- Each customer must take place in one of the vehicle routes and the amount of the total distribution of each vehicle that is assigned to a customer mustn't exceed the vehicle capacity.

When designing the distribution network; way of the distribution network, inventory-planning policy of each ring of the network, product distribution routes from different points of the network should be considered. A route in the ARP should be designed as every point is visited by a car once, all routes begin and end at the distribution point, and the total demand for all the points of a particular route does not exceed the capacity of the allocated vehicle to manage this route.

There are various optimization criteria for the literature of the ARP. The most common ones of these can be put in order as umber of routes, total route length, route time, customer satisfaction, and load balancing. Of these criteria, the number of routes and total route length, the most widely used in ARP objective function.

Vehicle routing problems are used in determining the most appropriate ways of 112 emergency ambulance service, taxis called by telephone, public transportation system, home delivery services, determining routes of garbage collecting vehicles and many other areas such as these.

Vehicle routing can be done in two ways in a network that has a single center (starting) point and a large number of destinations. These are the methods of single vehicle vehicle routing and multi-vehicle vehicle routing:

- **Single vehicle routing:** Needs of all customers on the network are tried to be provided by using only one vehicle. The first route starts after the vehicle is loaded enough to fill its own capacity and returns to the warehouse after it stops by all customers on the determined route. The demands of other customers that their demands not provided on the network, in the same way, the vehicle is loaded again in accordance with its capacity and the vehicle leaves for its second route. In this manner, the vehicle routing continues until the needs of the customers in the network are provided

.

Multi-vehicle Routing

Needs of the customers on the network are tried to be provided using many vehicles. After the vehicles are loaded in accordance with their capacity, demands of the customers on the network are provided by the vehicles through stopping by the points on the route determined at the same time and the vehicles return to the warehouse again. The vehicles are not loaded for a second route. The difference of the multi-vehicle routing from the single vehicle routing is that it is needed as many vehicle as the number of routes in the network. This method meets the demands This method meets the demands faster than the other method.

Types of ARP

The traditional ARP is based on some certain assumptions. However, when The ARP's application areas is examined in daily life, some exceptions different from these basic assumptions are noteworthy. According to these situations, diversifying of the ARP and developing appropriate solutions to the nature of the problem is quite needed in terms of the accuracy the solution. Considering these requirements, the ARP in literture can be diversified under following headings:

Mixed-Capacity Vehicle Routing Problem

The state of having different capacity of each vehicle engaged in the distribution on the vehicle routing problem.

Vehicle Routing Problem with multi-warehouse

The state of having more than one store of distribution company to serve customers. If the places of customers and stores are mixed with each other, multi-warehouse vehicle routing problem needs to be solved. In this problem, the vehicles are allocated to the warehouses and each vehicle serves the customer leaving the warehouse and returns to the warehouse.

Vehicle Routing Problem with Split Demand

A vehicle routing problem allowing more than one vehicle to serve the same customer.

Vehicle Routing Problem with Uncertain Demand

This kind of problem is the vehicle routing problem that is the demand is uncertain. The demand of the customer become obvious only when the vehicle arrives to the customer.

The Vehicle Routing Problem with Re-collect

A vehicle routing problem in case of the customer have the state of returning deposit, some parts of the products such as packaging and pallets. In this case, the capacity of the vehicle should be calculated taking into account the parts to be returned from the customers.

Vehicle Routing Problem with Time Windows

A vehicle routing problem that there is time interval constraint belongs to each customer. In this problem, distribution vehicle has to serve each customer in a a specific time interval.

Asymmetric Vehicle Routing Problem

A vehicle routing problem that the arrival distance of the vehicle to the customer and the distance from the same customer to the warehouse is different. In this case, cost (distance) matrix is not symmetric.

Solution Methods of the Traditional ARP(Traveling Salesman Problem)

Finding suitable solutions for vehicle routing problems are getting challenging day by day. This is because adding more and more constraints in routing problems due to the conditions of increasing competition and changing environmental conditions.

Routing problem of a vehicle in a network can be solved by the method or the technique that is specially designed for it. The best known and the simplest of these methods is the method of shortest path. In addition, other commonly used methods in the literature as "sweep method", "traveling salesman method" and "gain method". Outside of these methods, there are a large number of the vehicles routing methods derived from them.

Vehicle routing problems can be solved by some mathematical and intuitive methods. While the ARPs are being solved, it is found through taking into account the best route sets providing service to the all customers, vehicle capacity, time constraints, the maximum working time of drivers.

ARP solution methods are divided into two as exact solution methods and heuristic methods according to if they reach the optimal solution or not. The main solution methods used for ARP are shown in Figure 1

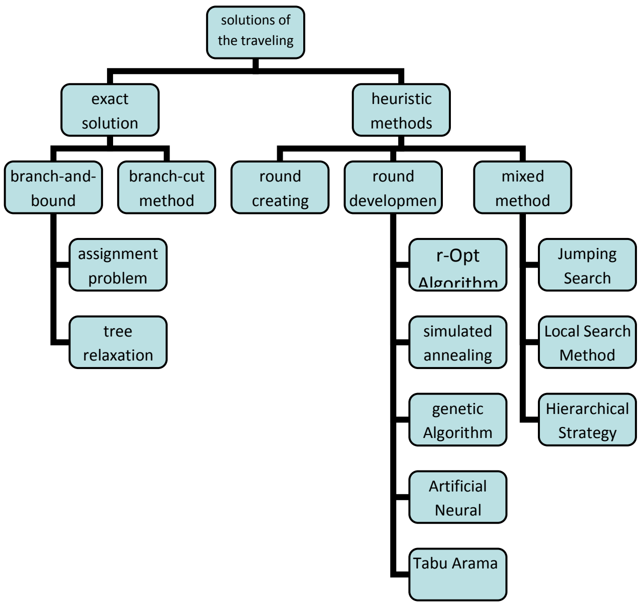


Figure 1. Traditional ARP Solution Methods

Linear Programming Formulation of Traveling Salesman Problems

Traveling salesman problem is a network model. It is tried to optimize purpose under certain constraints in network models. Optimization can be shaped as minimization or maximization according to the problem. When these aspects of the network models are examined it is possible to express the problem in the form of a linear programming model. In this way, the problem can be solved by using linear programming solution methods and software. The network structure of the examined problem is shown in Figure 2:

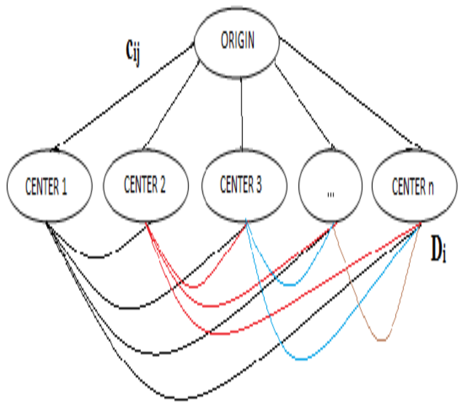


Figure 2. Network Structure of the Travelling Salesman Problem

Linear programming formulation of traveling salesman problem can be written as follows in general:

c_{ij}: The distance between the centers of i and j

K: Total number of vehicles engaged in the distribution

Q: Vehicle capacity

n: The total number of centers except the starting point

D_i: as The amount of demand of i center

The objective function;

$$\min Z = \sum_{i=0}^{n}\sum_{j=0}^{n} C_{ij} X_{ij}$$

a) Constraints;

Totally, vehicles in total K number leave from the start.

$$\sum_{j=1}^{n} X_{0j} = K$$

b) Vehicles in total K number return to the start.

$$\sum_{i=1}^{n} X_{i0} = K$$

c) You can go from a center to only one center.

$$\sum_{j=0}^{n} X_{ij} = 1 \ni i \neq j; i = 1,2,3,...,n$$

d) You can come to only one center from a center.

$$\sum_{i=0}^{n} X_{ij} = 1 \ni i \neq j; j = 1,2,3,...,n$$

e) Between centers should not consist of sub-routes. All routes must start with the starting point and must end with the starting point again.

$$X_{ij} + X_{ji} \leq 1$$

$$X_{ij} + X_{jk} + X_{ki} \leq 2$$

$$...$$

$$X_{ij} + X_{jk} + ... + X_{si} \leq n-1$$

f) The sum of demands on a route must not exceed the vehicle capacity.

$$\sum_{i=1}^{n} D_i X_{ij} \leq Q \ni i \neq j; j = 1,2,3,...,n$$

APPLICATION

In the application section of the study, one of the most common methods used for the vehicle routing problem, traveling salesman problem will be examined. Purpose of traveling salesman problem is to minimize the total distance stopping only once to each node in the network through starting from the central node and definitely going to all nodes.

Traveling salesman problem was applied for determining a daily bread delivery route of Public Bread Factory of Karatay Municipality, Konya.

Karatay Public Bread Factory has the characteristics of the first public bread factory founded in Konya. However, it uses only the name right of Karatay Municipality. Karatay Public Bread is intended to meet Karatay people's needs of regular, cheap, bread from healthy flour and products made from flour. The factory's production unit, especially in comparison to 2004 and before, has gained a very great distance and gained incomparable success by working in coordination with other units. Karatay Public Bread factory personnel were checked for health and sanitation by the Food Engineers and they work in the form of double shifts 24 hours accompanied by the camera under control. The factory has begun to produce more quickly and delicious bread with tunnel system developed as a result of R & D activities. The factory has Food Production Permission Certificate, Work Permit Belongs to the Establishments Producing Food, Food Registration Certificate and Hygiene Training Certificate.

45 staff work in shifts, bread production takes place twice a day as night and day in the Public Bread Factory. According to the communiqué in force, the bread is 300 g standard weight. Under these conditions, the factory has the capacity of producing totally 100,000 pieces of bread in a day. However, in line with current demands and agreements, the factory produces on average 25 000 bread in a day and uses only ¼ of its capacity actively. Unlike other popular bread factories, the factory presents its bread for sale not in buffets but in contracted grocery store, market, and so on points of sale. Although the factory is the first public bread factory founded in Konya, contracted owned retail outlets are only in the district of Karatay and the factory serve the people of Karatay.

DATA

Karatay Public Bread Factory has 70 sales points where it presents bread to sale. However, because one of these sales points is at the entrance of the factory, it is excluded from the problem. Distribution takes place with two vehicles with 240 box (240 x 20 = 4800 units) capacity to each of these sales points. Vehicles for distribution of bread come out of the factory twice a day as at 06:30 in the morning and at 15:30 in the afternoon.

Karatay region is divided into two considering the demands of sales points and positions relative to each other. There are 34 sales points in the first region and the total demand for these sales points is 7240 pieces of bread a day. Half of this demand, (3620 units) is met in the morning, the other half is met in the afternoon service. Similarly, there are 35 sales points in the second region and the total demand for these sales points is 8.640 pieces of bread. Half of this demand, (4.320 units) is met in the morning, the other half is met in the afternoon service.

Because the positions of the majority of sales points in the regions are very close to each other, in this study, the sales points that have less than 1 km between each other were evaluated as a single sales center and the total demands of sales points including this center were accepted as the demand of the sales center. In addition, the distances of cales centers to the factory were found by taking the arithmetic average of distances of sales points that belong to this center. Accordingly, there are 6 sales centers in the first region which is distributed bread and there are 6 sales centers in the second region. Half-day demands of sales centers (S.M.i; i=1,2,3,4,5,6) by region are shown in Table 1.

Table 1. Amount of Half Day Demand of Sales Centers According to Regions]

	S.M.1	**S.M.2**	**S.M.3**	**S.M.4**	**S.M.5**	**S.M.6**	**TOTAL**
1. Region	840	1300	560	380	280	260	3620
2. Region	640	720	1140	200	1620	-	4320

According to the information received from the distributing vehicle drivers, distances between the sales centers and the factory are given as kilometers in Table 2 and Table 3.(M represents a very large positive number.)

Table 2. Distances Between First Regional Sales Centers (km)

	Factory (S.M. 0)	**S.M. 1**	**S.M. 2**	**S.M. 3**	**S.M. 4**	**S.M. 5**	**S.M. 6**
Factory	M	1.33	3.64	6.14	8.75	13	18.25
S.M. 1	1.33	M	2.31	4.81	7.42	11.67	16.92
S.M. 2	3.64	2.31	M	2.5	5.11	9.36	14.61
S.M. 3	6.14	4.81	2.5	M	2.61	6.86	12.11
S.M. 4	8.75	7.42	5.11	2.61	M	4.25	9.5
S.M. 5	13	11.67	9.36	6.86	4.25	M	5.25
S.M. 6	18.25	16.92	14.61	12.11	9.5	5.25	M

Table 3. Distances Between Second Regional Sales Centers (km)

	Factory (S.M. 0)	**S.M. 1**	**S.M. 2**	**S.M. 3**	**S.M. 4**	**S.M. 5**
Factory	M	7.13	8.15	9.24	6.9	8.28
S.M. 1	7.13	M	1.02	2.11	0.23	1.15
S.M. 2	8.15	1.02	M	1.09	1.25	0.13
S.M. 3	9.24	2.11	1.09	M	2.34	0.96
S.M. 4	6.9	0.23	1.25	2.34	M	1.38
S.M. 5	8.28	1.15	0.13	0.96	1.38	M

In the light of the information given in Table 1, Table 2 and Table 3, a half day(one shift) bread delivery routes of Karatay Public Bread Factory will be determined by region.

METHOD AND SOLUTION

The bread distribution problem of Karatay Publich Bread Factory is a typical traveling salesman problem. Because the total demand of sales centers in both regions is smaller than the capacity of the distributor vehicle, the distribution of bread in all the centers in the region can be carried out a single vehicle at a time. Although a variety of solutions to traveling salesman problem, it can be solved mainly in two ways:

- **i.** By determining possible routes, finding the total distance for each route and preferring the route that the chosen path is the smallest.
- **ii.** Solving the network problem with a linear programming model expressing that the aim is minimization.

In this study, mentioned bread distribution problem was solved with linear programming model.

Linear Programming Formulation of the Problem

Under the current limit for the first region, the linear model of the problem is given below:

Objective Function

$$MinZ = MX_{00}+1.33X_{01}+3.64X_{02}+6.14X_{03}+8.75X_{04}+13X_{05}+18.25X_{06}+1.33X_{10}+MX_{11}+2.31X_{12}+4.81X_{13}+7.42X_{14}+11.67X_{15}+16.92X_{16}+3.64X_{20}+2.31X_{21}+MX_{22}+2.5X_{23}+5.11X_{24}+9.36X_{25}+14.61X_{26}+6.14X_{30}+4.81X_{31}+2.5X_{32}+MX_{33}+2.61X_{34}+6.86X_{35}+12.11X_{36}+8.75X_{40}+7.42X_{41}+5.11X_{42}+2.61X_{43}+MX_{44}+4.25X_{45}+9.5X_{46}+13X_{50}+11.67X_{51}+9.36X_{52}+6.86X_{53}+4.25X_{54}+MX_{55}+5.25X_{56}+18.25X_{60}+16.92X_{61}+14.61X_{62}+12.11X_{63}+9.5X_{64}+5.25X_{65}+MX_{66}$$

Constraints

a) A vehicle starts off distribution from the factory.

$$X_{01}+X_{02}+X_{03}+X_{04}+X_{05}+X_{06}=1$$

b) A vehicle returns to the factory.

$$X_{10}+X_{20}+X_{30}+X_{40}+X_{50}+X_{60}=1$$

c) You can go to only one sales center from a sales center.

$X_{10}+X_{12}+X_{13}+X_{14}+X_{15}+X_{16}=1$
$X_{20}+X_{21}+X_{23}+X_{24}+X_{25}+X_{26}=1$
$X_{30}+X_{31}+X_{32}+X_{34}+X_{35}+X_{36}=1$
$X_{40}+X_{41}+X_{42}+X_{43}+X_{45}+X_{46}=1$
$X_{50}+X_{51}+X_{52}+X_{53}+X_{54}+X_{56}=1$
$X_{60}+X_{61}+X_{62}+X_{63}+X_{64}+X_{65}=1$

d) You can come to only one sales center from a sales center.

$X_{01}+X_{21}+X_{31}+X_{41}+X_{51}+X_{61}=1$
$X_{02}+X_{12}+X_{32}+X_{42}+X_{52}+X_{62}=1$
$X_{03}+X_{13}+X_{23}+X_{43}+X_{53}+X_{63}=1$
$X_{04}+X_{14}+X_{24}+X_{34}+X_{54}+X_{64}=1$
$X_{05}+X_{15}+X_{25}+X_{35}+X_{45}+X_{65}=1$
$X_{06}+X_{16}+X_{26}+X_{36}+X_{46}+X_{56}=1$

e) Between sales centers should not consist of sub-routes.

$X_{ij}+X_{ji}\leq 1$
$X_{ij}+X_{jk}+X_{ki}\leq 2$
$X_{ij}+X_{jk}+X_{kl}+X_{li}\leq 3$
$X_{ij}+X_{jk}+X_{kl}+X_{lm}+X_{mi}\leq 4$
$X_{ij}+X_{jk}+X_{kl}+X_{lm}+X_{mn}+X_{ni}\leq 5$

f) The sum of demands of the sales centers on a route, which are a vehicle travels to, must not exceed the vehicle capacity.

$1300X_{21}+560X_{31}+380X_{41}+280X_{51}+260X_{61}\leq 4800$
$840X_{12}+560X_{32}+380X_{42}+280X_{52}+260X_{62}\leq 4800$
$840X_{13}+1300X_{23}+380X_{43}+280X_{53}+260X_{63}\leq 4800$
$840X_{14}+1300X_{24}+560X_{34}+280X_{54}+260X_{64}\leq 4800$
$840X_{15}+1300X_{25}+560X_{35}+380X_{45}+260X_{65}\leq 4800$
$840X_{16}+1300X_{26}+560X_{36}+380X_{46}+280X_{56}\leq 4800$

g) You can go to a sales center from another or not.

$X_{i,j}=0$ veya $X_{i,j}=1$ $i,j=0,1,2,3,4,5,6$

The linear model of the problem for the second region is given below:

Objective Function

$MinZ = MX_{00}+7.13X_{01}+ 8.15X_{02}+9.24X_{03}+ 6.9X_{04}+ 8.28X_{05}+7.13X_{10}+ MX_{11}+1.02X_{12}+2.11X_{13}+0.23X_{14}+1.15X_{15}+8.15X_{20}+1.02X_{21}+MX_{22}+1.09X_{23}+1.25X_{24}+0.13X_{25}+9.24X_{30}+2.11X_{31}+1.09X_{32}+MX_{33}+2.34X_{34}+0.96X_{35}+6.9X_{40}+0.23X_{41}+1.25X_{42}+2.34X_{43}+MX_{44}+1.38X_{45}+8.28X_{50}+1.15X_{51}+0.13X_{52}+0.96X_{53}+1.38X_{54}+ MX_{55}$

Constraints

a) A vehicle starts off distribution from the factory.

$X_{01}+ X_{02}+ X_{03}+ X_{04}+ X_{05} =1$

b) A vehicle returns to the factory.

$X_{10}+ X_{20}+ X_{30}+ X_{40}+ X_{50} =1$

c) You can go to only one sales center from a sales center.

$X_{10}+X_{12}+X_{13}+X_{14}+X_{15} =1$
$X_{20}+X_{21}+X_{23}+X_{24}+X_{25} =1$
$X_{30}+X_{31}+X_{32}+X_{34}+X_{35} =1$
$X_{40}+X_{41}+X_{42}+X_{43}+X_{45} =1$
$X_{50}+X_{51}+X_{52}+X_{53}+X_{54} =1$

d) You can come to only one sales center from a sales center.

$X_{01}+X_{21}+X_{31}+X_{41}+X_{51} =1$
$X_{02}+X_{12}+X_{32}+X_{42}+X_{52} =1$
$X_{03}+X_{13}+X_{23}+X_{43}+X_{53} =1$
$X_{04}+X_{14}+X_{24}+X_{34}+X_{54} =1$
$X_{05}+X_{15}+X_{25}+X_{35}+X_{45}+ =1$

e) Between sales centers should not consist of sub-routes.

$X_{ij}+X_{ji}\leq 1$
$X_{ij}+X_{jk}+X_{ki}\leq 2$
$X_{ij}+X_{jk}+X_{kl}+X_{li}\leq 3$
$X_{ij}+X_{jk}+X_{kl}+X_{lm}+X_{mi}\leq 4$

f) The sum of demands of the sales centers on a route, which are a vehicle travels to, must not exceed the vehicle capacity.

$720X_{21}+1140X_{31}+200X_{41}+1620X_{51}\leq 4800$
$640X_{12}+1140X_{32}+200X_{42}+1620X_{52}\leq 4800$
$640X_{13}+720X_{23}+200X_{43}+1620X_{53}\leq 4800$
$640X_{14}+720X_{24}+1140X_{34}+1620X_{54}\leq 4800$
$640X_{15}+720X_{25}+1140X_{35}+200X_{45}\leq 4800$

g) You can go to a sales center from another or not.

$X_{i,j}=0$ veya $X_{i,j}=1$ $i,j=0,1,2,3,4,5,6$

The linear programming models of the regions are solved with the help of WINQSB software package. The results achieved according to the program outcomes and the existing routes of the business are given Table 4:

Table 4. Optimal and Current Sales Routes According to Region

1. REGION	***Optimal Route*** S.M.0 – S.M.1 – S.M.2 – S.M.3 – S.M.4 – S.M.5 – S.M.6 – S.M.0 ***Total Distance*** = 36.50 km
	Current Route S.M.0 – S.M.2 – S.M.3 – S.M.1 – S.M.4 – S.M.5 – S.M.6 – S.M.0 ***Total Distance*** = 46.12 km
2. REGION	***Optimal Route*** S.M.0 – S.M.4 – S.M.1 – S.M.3 – S.M.5 – S.M.2 – S.M.0 ***Total Distance*** = 18.48 km
	Current Route S.M.0 – S.M.1 – S.M.5 – S.M.2 – S.M.3 – S.M.4 – S.M.0 ***Total Distance*** = 18.73 km

When the results in Table 4 are examined, improvement has been seen in both regions on the distribution network of the business. If the business follows the optimal route in the first region, it will gain an improvement of about 20% based on the current situation. The network structure of the optimal distribution network according to the regions is seen in Figures 3 and 4.

Figure 3. Optimal Distribution Route for 1st Region

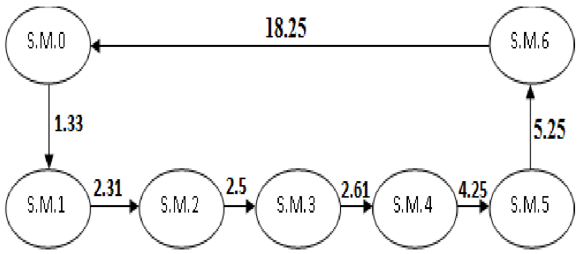
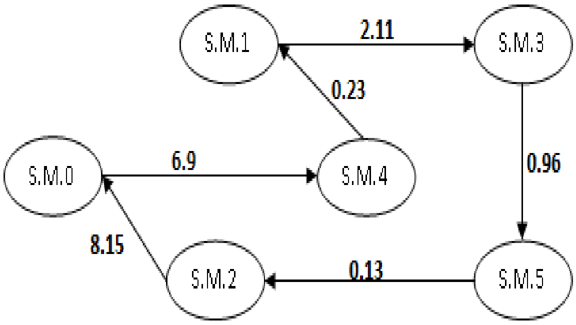


Figure 4. Optimal Distribution Route for 2.Region



CONCLUSION

Businesses look for ways to cut costs to survive in all activities. Delivering the produced goods and services to the customer and / or distribution activities involving procurement of raw materials are the activities that businesses must especially plan and carefully work on.

The planning process of the distribution activities includes the operations of providing the needs of customers fully, on time by enduring the minimum cost. Optimal vehicle loading and routing are one of the most important issues in the creation of this plan.

Customers and their positions, vehicles and stores are the key elements of the vehicle routing problem. An effective distribution route is tried to be created under the appropriate constraints according to the characteristics and expectations of these elements. If an active route isn't created, businesses face with extra cost and risks such as cannot lasting in the competitive environment.

A typical example of traveling salesman problem appears on the bread distribution network of Public Bread Factory of Karatay Municipality in Konya. The problem has been expressed as a linear model by using data from the factory. In this model, constraints related to both the distribution network and the factory, the vehicles, the sales centers are taken into consideration. As a result of solving the established model with WINQSB program, the optimal route for the first distribution region was found as 36.50 km and for the second distribution region was found as 18.48 km. In the event of the existing distribution networks of the businesses are taken into account, if the business uses the new routes, it will gain improvement of 20% in the first region and 1% in the second region. In following studies, it can be examined if alternative active distribution networks can be established through combining the two regions the business makes distribution.

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