Optimization of Vehicle Routine Problem of Using Saving Matrix Approach

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Abstract-- *D*ominos is a company that engages in the delivering of pizza. Recently it also had to meet the high demand of domestic consumption. Transportation is the movement of pizza from one location to another so, that the good reach up into the hands of consumers. There are 12 distribution centres including one production centre in a city. Dominos want to determine the best transportation route in a city in Jaipur, It is used to determine delivery routes or paths pass by any vehicle that will distribute these items by considering consumer demand from the sub-centres. This paper discussed the vehicle routine problem using Saving matrix

Keywords: Route, Saving matrix, Saving, Distance, Transportation

INTRODUCTION

Dominos is a company engaged in the supply of pizza located in Jaipur city. The company delivered of variety of pizzas, it also has delivered most of the areas in Jaipur. The company still experience problems. It is delaying in shipping goods to consumers, which can alter the customer satisfaction with the company. As a company affianced in the delivery, they will aware that the determination of the delivery route used by their vehicle in shipping activities is very important for the company. Taking into account the many alternative routes that can be passed by the vehicle at the time of shipping, the company can obtain the best route may be used. The best route is the route with the shortest distance, which it certainly will affect the incurred transportation costs. The shorter the mileage of the vehicle means lower transportation cost. Distribution is an activity has done to move product from supplier to consumer in a supply chain. Distribution is a key that can provide benefits for the company, because it can directly impact the cost of the supply chain and consumer needs. The important thing and must be considered in determining on distribution management is determining delivery schedule and route from one location to some other locations that become a destination. The company is still having limitations in providing solutions to the problem of distribution of goods. It is long distance required by the vehicle in shipping goods to consumers and higher cost of transportation. The problem identification. Is how to determine the best route to minimize transportation costs by processing the available data using matrix, saving methods and to determine which is the best procedure between the nearest neighbor, And the research objective of this study. Is to obtain the best distribution route to minimize transportation costs by using matrix saving.

Methododlogy

Saving matrix method will used in the calculation to get good’s delivery route on good’s distribution activity to consumer. In saving matrix method, there are several steps that must be done first to get the best route. These several phases are:

1. Identify distance matrix
2. Identify savings Matrix
3. Rank savings
4. Assign customers to vehicles
5. Sequence customers within routes

Problem Description:

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There are 12 Pizza Centre in a city of Jaipur including one production centre. 11 centres selling pizza. As mentioned in the introduction VRP is confined to big companies when it comes to the goods to a customer. It helps to improve the service to the customers and maximize the profit of company.

Solution methodology

The distance matrix of 12 pizza centre initially for optimization.

The algorithm for optimizing the route is savings Matrix Algorithm. Following are the steps of the Savings Matrix Method:

1.Identify distance matrix.

The distance matrix of twelve pizza centres is calculated using eqn.1, given below and Table 1. The table one is obtained from a drawing based on distance and the road map of the area. It is shown in figure 1. The first stage should be done in determining the best delivery route is to get the position and location of the company's warehouse throughout the consumers' the companies. The company is not used separate warehouse, so the location of company's warehouse is the location of the company itself. Consumers are used in this study amounted to 12 consumers, as a sample. The position of each location is obtained by using the map. In this study used Google Earth application as a map. From existing maps, it can be obtained the position of each location that are presented on the scale of the X and Y axes, with center coordinates (0.0) which is the location of the company (K0).

Table 1. Consumer Location

NO.		X COORDINATES	Y COORDINATES	Demand at Each Centre
1	Vaishali nagar	0	0	0
2	VDN	6	8	300
3	Mansarover	4	-13	200
4	Malviya nagar	14	-9	400
5	Pink square	14	-3	150
6	Jhotwara	4	8	120
7	Triton	5	6	100
8	Wtp	13	-8	100
9	GT	13	-7	350
10	MGF	3	-12	80
11	VIVEK VIHAR	4	3	200
12	Rajmandir	6	-3	350

The Distances between locations, such as the location of A($X_{A,}\, Y_A$) and B($X_{B\,,}Y_B$), to be searched by using the formula:

D(A, B)= $\sqrt{(X_A - X_B)^2 + (Y_A - Y_B)^2}$................(1)

D(1,2)= $\sqrt{(6-0)^2 + (8-0)^2}$

D(1,2)= $\sqrt{36+64}$

D(1, 2)= $\sqrt{100}$

D(1,2)= 10

Distance of Mansarover and Jhotwara (D(3,6):

Distance of Vaishali nagar and VDN D(1,2):

D(1,2)= $\sqrt{(X_1 - X2)^2 + (Y_1 - Y_2)^2}$

D(3,6)= $\sqrt{(X_3 - X_6)^2 + (Y_3 - Y_6)^2}$...

D(3,6)= $\sqrt{(4-6)^2 + (8-8)^2}$

D(3,6)= $\sqrt{4+0}$

D(3,6)= 2

Distance of Pink square and MGF (D(5,10):

D(5,10)= $\sqrt{(X_5 - X_{10})^2 + (Y_5 - Y_{10})^2}$

D(5,10)= $\sqrt{(3-14)^2 + (-12-(-3))^2}$

D(5,10)= $\sqrt{121-225}$

D(5,10)= 18.6

Here are some of results of distance calculations (1 to 12) were obtained by using the formula above:

Distance matrix (1 to 12)

	Vaishali Nagar	VDN	Mansa-rover	Mal-nagar	P.square	Jho-twara	Triton	wtp	GT	mgf	Vivek vihar	Raj-mandir
Vaishali nagar												
VDN	10	0										
Mansarover	13.6	21.8	0									
Mal.nagar	16.1	18.8	24.1	0								
P.square	14.3	13.6	14.2	6	0							
Jhotwara	8.1	2	20	19.5	14.8	0						
Triton	7.8	1.7	19.01	19..4	12.7	1.7	0					
Wtp	15.2	17.4	10.2	1.4	26.1	16.4	16.1	0				
GT	14.7	16.6	10.06	2.2	4.1	13.1	15.2	1	0			
MGF	12.3	20.2	1.4	5	14.2	20.1	18.1	10.4	11.1	0		
Vivek vihar	5	5	1.79	22.6	15.3	9.4	9.4	20.2	19.7	15.2	0	
Rajmandir	6.8	11	5	10	8	11.1	9.05	8.5	8.05	9.4	6.3	0

2.**Identify savings Matrix:** From the distance matrix calculation that has been done before, we will calculate the value of saving matrix. If visiting some consumes every single delivery of goods. Value of the savings obtained by using the formula:

S(x,y)= D(0,x)+ D(0, y)- D(x,y)………..(2)

Here are some of calculating savings:

Saving matrix S (Vaishali nagar ,Vidyadhar nagar):

S(1,2)= D(0,1) + D(0,2) –D(1,2)

S(1,2)= 10 + 13.6 – 21.8 =2.52

Saving matrix S(Mansarover, Jhotwara):

S(3,6)= D(0,3) + D(0,6) - D(3,6)

S(3,6)= 16.1 + 7.8+ 19.4 =4.5

Saving matrix S(Pink square, MGF):

S(5,10)= D(0,5)+ D(0,10) –D(5,10)

S(5,10)= 8.1+12.3-20.1=3.7

Value of savings (Vaishali nagar to Rajmandir) were obtained by using the (1) formula:

	Vidhyada r nagar 1	Mansarov er 2	Malviy a nagar 3	Pink squaer e 4	Jhotwar a 5	Trito n mall 6	Worl d trade park 7	Gaura v tower 8	Mg f 9	Vive k vihar 10	Rajmandi r 11
Vidyadhar nagar	0	2.52	7.5	18.3	16.1	16.1	7.8	8.1	2.1	5	5.8

Mansarover		0	10.9	13.7	1.7	2.39	18.6	18.24	24.1	16.81	15.5
Malviya nagar			0	24.4	4.7	4.5	29.9	28.6	23.4		12.8
Pink square				0	7.6	9.4	3.4	24.9	12.4	4	13.1
Jhotwara					0	14.2	6.9	9.7	.3	3.7	3.8
Triton mall						0	6.9	8.3	2	3.4	7.55
World trde park							0	28.9	17.1	0	13.5
Gaurav tower								0	15.9	.1	12.55
Mgf									0	2.1	9.7
Vivek vihar										0	5.5
Raj mandir											0

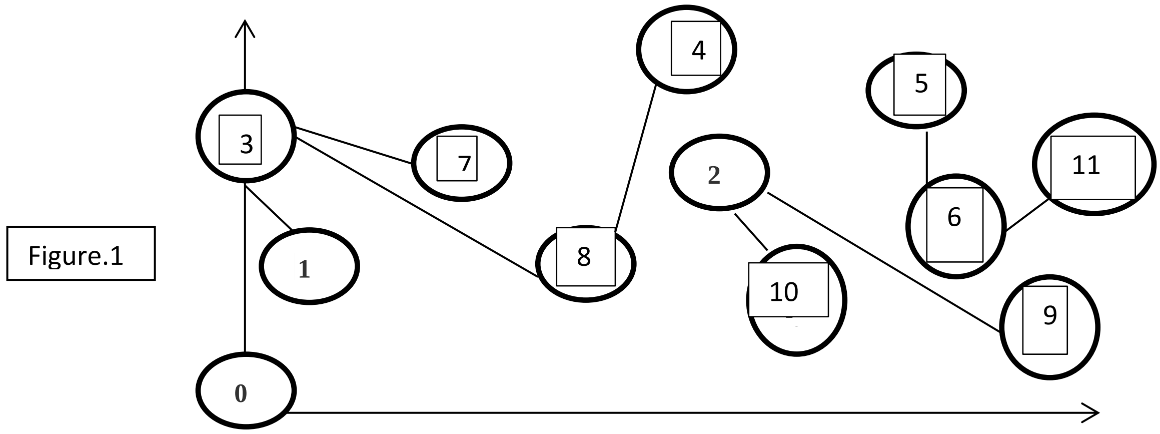
3. Rank Savings

- The next step is to rank the savings. The idea is to merge those two customers to the same vehicle, whose merging gives the highest savings.
- The savings are ranked from high to low. From the savings matrix shown on the previous slide, the highest savings of 29.9 is obtained by merging Customers Malviya nagar and WTP to the same vehicle.
- Next highest savings of 28.9 is obtained by merging Customers WTP and GT to the same vehicle.
- Similarly the other savings are ranked and shown on the next slide.

(Malviya nagar,wtp)	(WTP,GT)	(GT, Malviya nagar)	(GT, Pink square)	(Malviya nagar, pink square)	(Mansarover,MGF)	(Mansarover,WTP)	(Vidyadhar nnagar, pink square)	(Malviya nnagar, gaurav tower)	(World trade park, MGF)	Vidyadhar nagar,Jhotwara)
(Vidyadhar nagar,Triton)	(Vdn,triton)	(Mansarover,vivek vihar)	(mansarover,rajmandir)	(GT,MGF)	(Jhotwra,Triton)	(pink square,rajmandir)	(WTP,rjmandir)	(Mansarover,pink square)	(Pink square,MGF)	(GT,Raj mandir)
Malviya nagar,rajmandir)	(Mansarover,Malviya nagar)	(Pink square, Triton)	(Jhotwara, GT)	(MGF, Rajmandir)	(Triton, GT)	(Vdn,GT)	(Vdn, WTP)	(Pink square, Jhotwara)	(Vdn, Malviya nagar)	(Triton, Rajmandir)
(Jhotwara,WTP)	(Triton, WTP)	(Vdn,Rajmandir)	(Vivek vihar,Raj mandir)	(Vdn,Vivek vihar)	(Malviya nagar,Jhotwara)	(Malviya nagar,Triton)	(Pink square, Vivek vihar)	(Jhotwara,Vivek vihar)	(Triton,Vivek vihar)	(Pink square, WTP)
(Vdn,Mansarover)	(Mansarover,Triton)	(Vidyadhar nagar,Mansarover)	(Mansarover,Triton)	(Vdn,MGF)	(MGF,Vivek vihar)	(Mansarover,Jhotwara)	(Jhotwara,MGF)	(GT,Vivek vihar)		

4.Assign customer to vehicle

Next, merge the customers. The pair giving the highest savings is merged first if the capacity is available.



Location of Vaishali Nagar to other dominos pizza centres in Jaipur.

Rank	(Malviya nagar,w [redacted]	(WTP,G [redacted]	(GT, Malviya [redacted]	(GT, Pink square) [redacted]	(Malviya nagar, [redacted] square)	(Mansar [redacted] F)	(Mansarover,WTP)	(Vidyadhar nnagar, pink square)	(Malviya nnagar, gaurav tower)	(World trade park, MGF)	Vidyadhar nagar,Jhotwara)
	(Vidyadhar nagar,Tr [redacted]	(Vdn,triton)	(Mansarover,vivek [redacted]	(mansarover,rajmandir)	(GT,MGF)	(Jhotwra,Triton) [redacted]	(pink square,rajmandir)	(WTP,rjmandir)	(Mansarover,pink square)	(Pink square,MGF)	(GT,Rajmandir)
	Malviya nagar,rajmandir)	(Mansarover,Malviya nagar)	(Pink square,Triton)	(Jhotwara,GT)	(MGF, Rajmandir)	(Triton, GT)	(Vdn,GT)	(Vdn, WTP)	(Pink square,Jhotwara)	(Vdn, Malvi [redacted] nagar)	(Triton, Rajman [redacted]
	(Jhotwara,WTP)	(Triton, WTP)	(Vdn,Rajmandir) [redacted]	(Vivek vihar,Rajmandir)	(Vdn,Vivek vihar)	(Malviya nagar,Jhotwara)	(Malviya nagar,Triton)	(Pink square, Vivek vihar)	(Jhotwara,Vivek vihar)	(Triton,Vivek vihar)	(Pink square, WTP)
	(Vdn,Mansarover)	(Mansarover,Triton)	(Vidyadhar nagar,Mansarover)	(Mansarover,Triton)	(Vdn,MGF)	(MGF,Vivek vihar)	(Mansarover,Jhotwara)	(Jhotwara,MGF)	(GT,Vivek vihar)		

Sequence customers within routes

- The next step is sequencing customers assigned to the same vehicle. A question is in what sequence will the first vehicle visit customers 1,2, 5 and 7 and return to the warehouse?
- This problem is popularly called the traveling salesman problem.
- We shall use the nearest neighbor rule which states that always visit the customer that is nearest.

Sequence Customers

	Vaishali Nagar	VDN	Mansarover	Mal.nagar	P.square	Jhotwara	Triton	Wtp	GT	mgf	Vivek vihar	Rajmandir
Vaishali nagar	0											
VDN	10	0										
Mansarover	13.6	21.8	0									
Mal.nagar	16.1	18.8	24.1	0								
P.square	14.3	13.6	14.2	6	0							
Jhotwara	8.1	2	20	19.5	14.8	0						
Triton	7.8	1.7	19.01	19..4	12.7	1.7	0					
Wtp	15.2	17.4	10.2	1.4	26.1	16.4	16.1	0				
GT	14.7	16.6	10.06	2.2	4.1	13.1	15.2	1	0			
MGF	12.3	20.2	1.4	5	14.2	20.1	18.1	10.4	11.1	0		
Vivek vihar	5	5	1.79	22.6	15.3	9.4	9.4	20.2	19.7	15.2	0	
Rajmandir	6.8	11	5	10	8	11.1	9.05	8.5	8.05	9.4	6.3	0

Among 1, 2, 5 and 7 is 1 is the nearest to Warehouse. So, the vehicle will first travel from Vaishali nagar to customer 1. The row (=from) corresponding to Vaishali nagar and the column (=to) corresponding to customer 1 are crossed out.

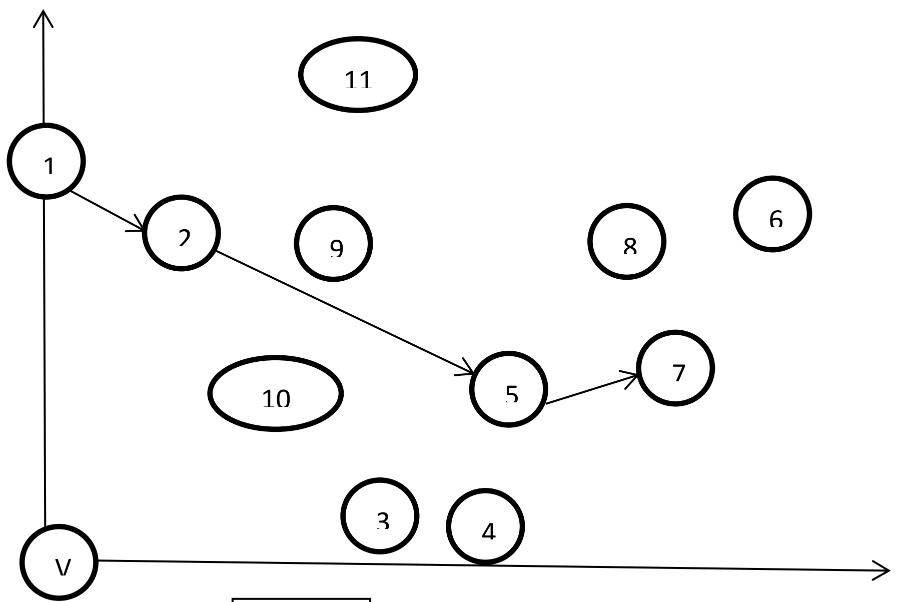


Figure2.

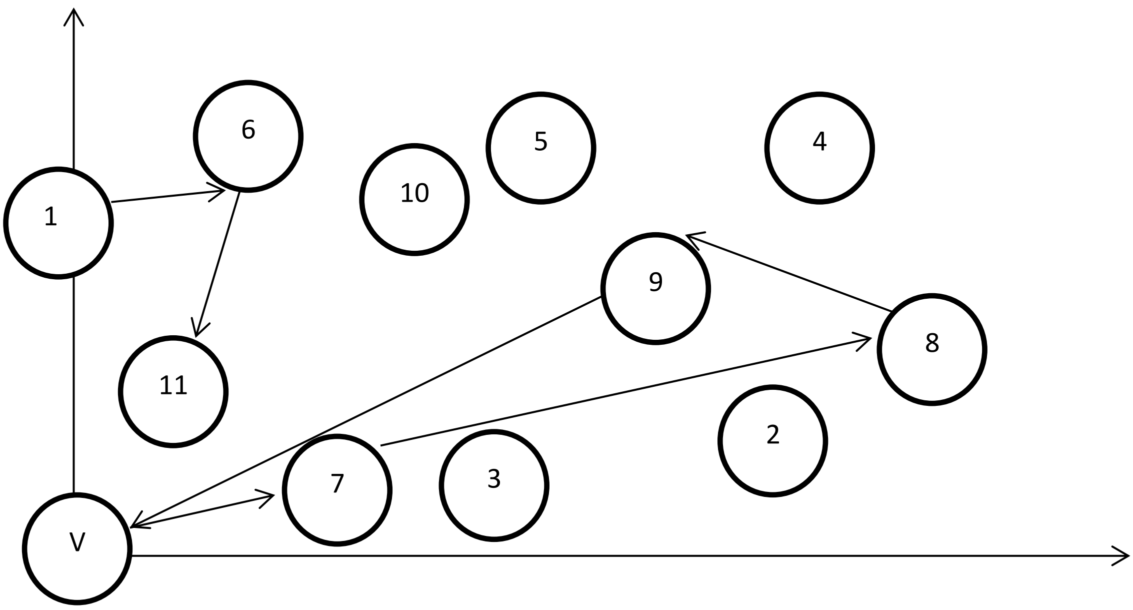
First, consider the problem of sequencing customers 1,2,5 and 7 who are assigned to the same vehicle. The relevant distances are copied from the distance matrix and shown below. Between 3 and 4 is 3 is the nearest to 1. So, the vehicle will travel from 1 to 3. The row (=from) corresponding to customer 1 and the column (=to) corresponding to customer 3 are crossed out. The only possible tour is then Vaishali nagar-10-2--Vaishali nagar. Next, consider the problem of sequencing customers 1,3,4,5,6,7,8,9,11, who are assigned to the same vehicle. The relevant distances are copied from the distance matrix and shown below.

	VDN	Mal.N.	Pink.sq.	Jhot.	Trit.	WTP	GT	MGF	Viv.vi.	Raj.m.
Vaish										
VDN	0									
Mans.	21.8									
Mal.N.	18.8	0								
Pink.sq.	13.6	6	0							
Jhot.	2	19.5	14.8	0						
Trit.	1.7	19.4	12.7	1.7	0					
WTP	17.4	1.4	26.1	16.4	16.1	0				
GT	16.6	2.2	4.1	13.1	15.2	1	0			
MGF	20.2	5	14.2	20.1	18.1	10.4	11.1	0		
Raj.m.	11	10	8	11.1	9	8	8	9	6.3	0

Between 1 and 6 is 1 is the nearest to the Warehouse. So, the vehicle will travel from the Warehouse to customer 1. The only tour is then W-1-6-11-W. Note: due to symmetry both W-1-6-11-W and W-11-6-1-W have the same distance traveled.

	Mal.N.	Pink.sq.	Jhot.	WTP	GT	MGF	Viv.VI.	Raj.M.
Vaish.								
VDN								
Mans.								
Mal.N.	0							
Pink.sq.	6	0						
Jhot.	19.5	14.8	0					
WTP	1.4	26.1	16.4	0				
GT	2.2	4.1	13.1	1	0			
MGF	5	14.2	20.1	10.4	11.1	0		

Between 7 and 8 is 7 is the nearest to the Warehouse. So, the vehicle will travel from the Warehouse to customer 7. The only tour is then W-7-8-9-W.



Construction and Improvement Procedures

The nearest neighbor rule just discussed is a tour construction procedure which can construct a tour when there is no tour.The nearest neighbor rule is only a heuristic and does not guarantee optimality. The tour obtained by the heuristic may provide improvement opportunities. If a tour intersects its own path, the tour can be improved. An improvement procedure will be discussed now.For example, consider the locations and the tour shown on the right.From the Warehouse, 10 is the nearest. From 1, 11 is the nearest, etc. So, the nearest neighbor rule produces the tour W-1-2-3-4-6-7-8-9-10-11-W.However, the tour intersects itself. The arc (8,9) intersects arc (12,W) For example, consider the locations and the tour shown on the right.

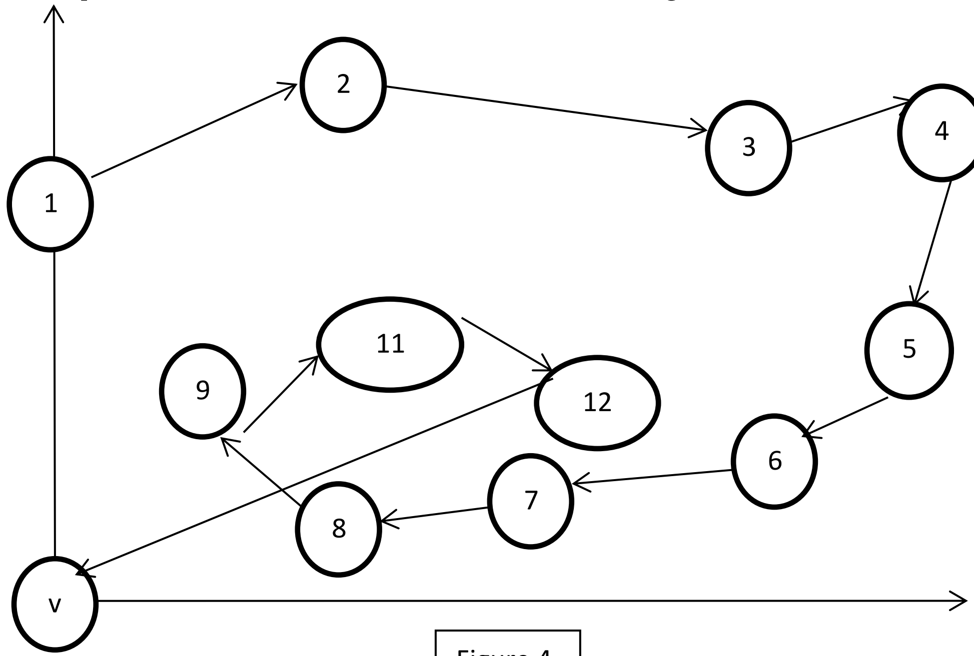


Figure 4.

Construction and Improvement Procedure

The improvement procedure has three steps.

Step 1: Remove the intersecting arcs. The result is two disjointed paths
Step 2: Arbitrarily choose one of the two disjointed paths and reverse the path..
Step 3: There is only one way to get a tour from the two resulting paths. Construct the tour.
Note: The resulting tour may include a new intersection. In such a case, apply the procedure again!.

Result:

There are four optimum routes to cover all the centres for the distribution/supply of the products, therefore requires four vehicle to optimum time or cost. In this paper we have used the nearest neighbor rule which states that always visit the customer that is nearest.

a.	V-1-6-11-V	27.55 km.
b.	V-7-8-9-V	39.6 km.
c.	V-3-2-V	53.8 km.
d.	V-10-5-4-V	33.5 km.

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