International J. of Math. Sci. & Engg. Appls. (IJMSEA)
ISSN 0973-9424, Vol. 10 No. I (April, 2016), pp. 87-102

APPLICATION OF DYNAMIC PROGRAMMING TECHNIQUE FOR SHORTEST PATH ANALYSIS IN HEALTH CARE SERVICES

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Abstract

This paper studies the application of dynamic programming approach to solve the multi-stage transportation problem. Today, transportation facility is acting vital role for economic and social development of the country. Mobility of the people and transportation are directly related to over all development of the people, society and country for which complex and advanced transportation infrastructures are required. To connect the urban and rural area of India, we need a compact interconnectivity of roads to commute public transport. Mathematical model for complex transportation infrastructure in many folds is derived and solved by applying multi-stage decision technique to minimize the distance to be travelled in multi stages. This paper explores the application of dynamic programming approach to solve the multi-stage transportation decision problem to develop roads for complexes connectivity between villages. The concept of PURA VISION 2020 has been considered to develop the complex road infrastructure to connect the villages.

Key Words : *Dynamic Programming, PERT/CPM Network, Shortest Path Analysis, PURA-VISION 2020.*

2000 AMS Subject Classification : .

1. Introduction

The 21st century is built upon the word "Transportation". The transportation problem has a direct impact on social and economic development of people and nation. Mobility has made life faster and life in speed changes trends is impossible in the traditional way. Internet connectivity and information technology have changed the life of general people. At present, transportation acting vital role for financial and social development of the country. The combination of transportation and mobility are directly involved with development of economic and social system of the country and for that the complex infrastructure is required. The efficient use of OR techniques and transformation of the real life problems into OR models would drive the managerial choices and their decision policies for the development of the society and living standard (Quality Adjusted Life) of rural Indian. To translate the problems related to life of rural people, we have to translate the goal of the development as an objective function and recognize the restrictions or limitations based on economic and other social conditions and then, formulate them into mathematical equations as constraints of the objective function. This type of OR models would play important role in decision making in the context of competitive environment. Minimization of total distance to be travelled is possible only when villages have interconnectivity.

For the social and economic development of village people we have to make sure about the successful implementation of several rural development programs launched by the state or central government of India. According to concept of PURA, firstly given by Dr. A.P.J. Abdul Kalam and then remodeled by Mr. Jairam Ramesh (Wikipedia) given emphasis on sustainable development of India and they have recommended that the physical connectivity of villages among themselves and with main towns and metros through roads and railway lines are necessary. They also suggested for the preservation of native knowledge and its enhancement with latest tools of technology. The villages must have access to good education from best teachers, good medical facilities and must be provided with latest information on villagers pursuits like agriculture, fisheries, horticulture and food processing. They must also have electronic connectivity. The former President also called for knowledge connectivity that could increase the productivity, the utilization of spare time, awareness of healthcare, ensuring a market for products, increasing quality consciences, and transparency in partnership. These three types of connectivity would ensure and increase earning capacity that would lead to economic development of rural people. Therefore, the upliftment of rural areas would be possible through PURA project and about 600,000 Indian villages where 700 million people were living could have get the essential facilities by connected them with PURA annular roads structure. A number of PURA projects were being implemented by many educational, healthcare institutions, industries and other institutions. The government of India had already moved ahead with the implementation of PURA on a national scale across several districts of India.

With a view to improve quality of health services and quality adjusted life of rural people, government should enhance public spending on health sector in the vicinity of 3% of GDP. These problems contribute to the unreliability of official estimates, and may explain official failures to increase allocations of facilities where they are needed most. Many reasons have been documented for why health workers, educationist etc. are not having willingness to choose to work in rural areas. Salary emerges as an important factor of a job and strongly affects the willingness to work in rural areas (Chomitz 1997; Serneels, Lindelow et al. 2007). Factors other than salary also play an important role in the preference of urban positions. For example, access to training, health care and education for children, promotion opportunities, the availability of electricity, water, market and housing are all reasons that urban jobs are usually favored (Dussault and Franceschini 2006; Lindelow and Serneels 2006; Serneels, Lindelow et al. 2007). A two-stage transportation problem is solved by using genetic algorithm (Mitasu Gen, etal. 2006). Baboli, et al. (2006) have obtain the EOQ supply chain model to minimize the total transportation cost. Sancho (1992) have applied dynamic programming technique to solve the shortest route problem under time constraints on movement and parking of vehicle.

In this paper, firstly the shortest route problem has been formulated as multi-stage transportation problem and for this a network diagram of village connectivity has been obtained by using the PERT/CPM network analysis. To find out the optimal path to reach the destination by keeping in mind that the total distance travelled is minimum a Geographical Map collected from Land utilization department has been used to calculate the actual distance between the villages to obtain the path. To obtain the optimale paths which may not be shortest, this problem is formulated as dynamic programming problem. Dynamic programming technique is used for multi-stage decision problem where decisions must be made not just at one point in time but sequentially at many points in time. Since a person has to take decision at different level of points (villages), this problem is formulated as multi-stage transportation problem. To provide the complex connectivity between villages, the all possible routes are shown by constructing Critical Path network diagram. Then, forward and backward pass methods of dynamic programming technique have been applied to solve this transportation problem which minimizes the total distance to be travelled by using different alternative paths. Now, to improve the available inter connectivity facilities between villages and to obtain the alternative paths to reach any one of the facility center within village complex, circular path method of construction of roads (PURA structure) have been suggested from different points of circle for actual map obtained from Chhattisgarh government. The villages which are coming on the perimeter of the circle have been taken as starting nodes to reach any other node inside the ring-road structure and there are several alternative paths available to reach the destination. The concept of PURA VISION 2020 has been used to develop the circular path for complex road connectivity between villages and a village has been taken as center of the concentric circular roads.

This empirical study identifies the specific complexes of factors at the individual level which act in favor of retention of service providers in rural areas. Planners and health authorities can address critical issues of workforce retention by professional education and recruitment policies that attract candidates more likely to serve in rural areas, by enabling and emphasizing the positive phenomena and factors which underlie practitioners decisions to remain, and by addressing their emerging needs through varied policy actions including improvements in specific aspects of social and economic development of the society.

2. Mathematical Formulation of the Problem

2.2.1 Dynamic programming Technique under Certainty to Minimize Travelling Time, Distance and Cost

To show the application of the Dynamic programming technique to solve the real life problem, we have chosen a particular cluster of villages from the Geographical map available in the department of rural development of Chhattisgarh state. The distances between villages are shown in the map in kilometers or in some standard unit of distance. This cluster of villages is showing all the primal information related to all villages and from that map we have found that the village Bilaigarh (node A) has almost all essential facilities such as markets, clinics, post office, schools, etc., therefore, this village have been taken as center place and then we have tried to choose the villages which are in almost equal distance from Bilaigarh. In this way, villages which are around 4 Miles to 6 Miles away from Bilaigarh have taken into first stage of dynamic programming problem and then the villages which are approximately 6 Miles to 8 Miles away from the villages of first stage are taken as second stage of the problem and so on. At last, the outer circle is nearer to cities or town from where people can move from city to village and vice - versa.

Dynamic programming under certainty involves problems where the problem conditions at each stage, that is, state variables are known with certainty. In deterministic dynamic programming there is neither uncertainty nor probability distribution associated with the state in various stages of the decision process. To solve this problem, we have to define problem stages, decision variables, state variables, return function and transition function. For this particular type of problem, the following definitions will be used to denote various stages, state variables and decision variables.

d_n = decision variables that define the immediate destinations when there are n $(n = 1, 2, 3, 4)$ stages to go.

s_n = state variables describe a specific city at any stage.

D_{S_n}, d_n = distance associated with the state variable, s_n, and the decision variable, d_n for the current n^{th} stage.

$f_n^*(s_n, d_n)$ = minimum total distance for the last n stages, if we are in state s_n and selects d_n as immediate destination.

$f_n^*(s_n)$ = optimal path (minimum distance) when we are in state s_n with n more stages to go for reaching the final stage (destination).

We start calculating distances between a pair of cities from destination city (j, i) and work backward to **source** *city* (i, j) to find the optimal path. The recursion relationship for this problem can be stated as follows:

$$f_n^*(s_n) = \min_{d_n}\{D_{s_n} = f_{n-1}^*(d_n)\}; \quad n = 1, 2, 3, 4, \cdots$$

Where $f^*_{n-1}(d_n)$ is the optimal distance for the previous stages.

2.2.2 Shortest Route Analysis by Dynamic Programming under Certainty by Forward Pass and Backward Pass Recursion Method And PURA- VISION 2020

At first, PERT/CPM Network analysis has been used to develop network diagram for a map of cluster of villages of Raipur district of Chhattisgarh state to show the possible road connectivity and then divided the villages into different stages to translate the actual transportation problem in the form of Dynamic programming problem. To solve this transportation problem by dynamic programming we have to make different stages so that we can take decision into each and every stage and state to find the alternative and optimal path to reach the next stage. By using dynamic programming we have shown both optimal path and alternative paths to move from one place to another. The optimal distance from stage I to stage V has been computed out by dynamic programming technique for secondary data collected from the government office.

By using dynamic programming technique several alternative paths have been marked but the total distances to travel by general people are very long. Also, it is not possible to construct all possible connectivity paths under limited budget. To overcome this problem, we have suggested for developing concentric annular roads in multiple layers where each layers are about 10 Kilometers apart and then divide the whole circular road in sectors of circular path. This type of division of circular path will connect many villages by one sector path and will certainly minimize the total length of path to be travelled by people to reach a inside or outside of the ring road. For this, we have used the concept of PURA VISION 2020, firstly documented by Dr. A. P. J. Abdul Kalam. The PURA is suggested to provide connectivity between villages.

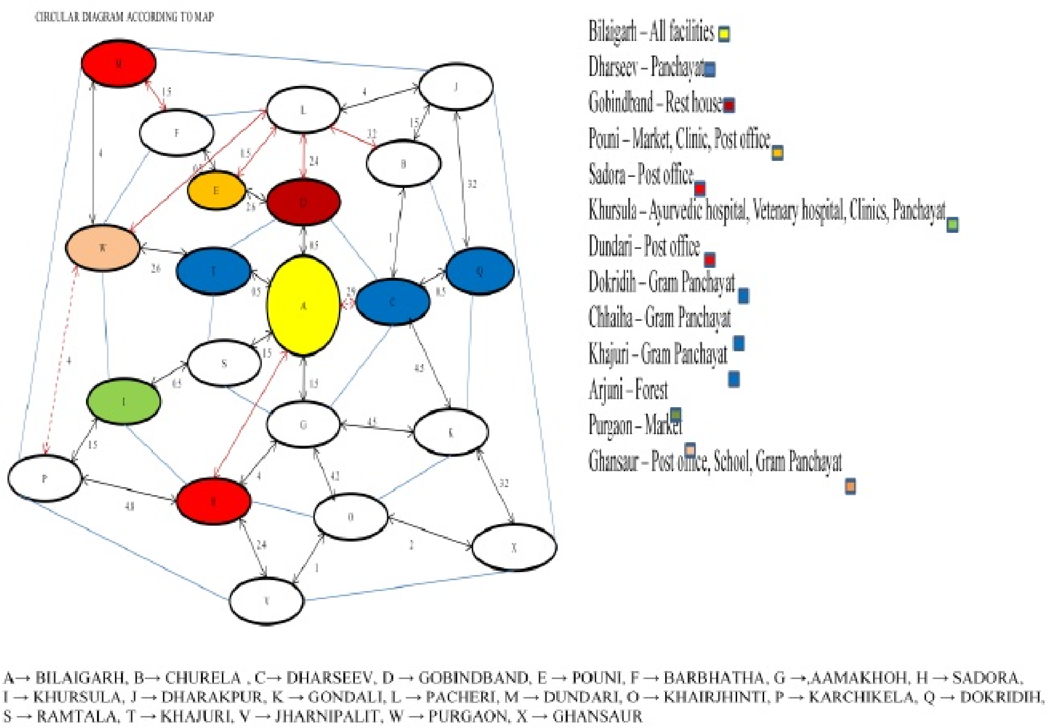

Figure 2.1 : Network Diagram of a cluster of villages

Colour Indicator for the above figures

Yellow colour(A) indicates that this village is having all the essential facilities such as schools, markets, hospitals, post office, etc. Villages (C), (T), and (Q) indicated by Blue colour is having Gram Panchayat, village (D) indicated by Maroon colour have rest house facility, village (E) indicated by Orange colour have facilities such as markets, clinics, post office, etc, villages (H) and (M) indicated by Red colour has post office, (W) is a village in which there is a market and village (I) indicated by light Green colour have facilities such as Ayurvedic hospital, Vetenary hospital, primary health care center, Panchayat, etc.

Source of Data : To solve the problem of Transportation as multi-stage decision problem, Geographical Map of Actual Village Cluster is obtained from **Govt. Land utilization Department of Chhattisgarh State**, we have subdivided the problem of finding out routes between the villages. For this, the villages have divided into different stages so that we can pick up the near about villages in one stage and then construct the second stage, in which, villages are in the similar distances from the nodes of first stage and so on. Villages of the last stage are connected with sub-urban area of that district.

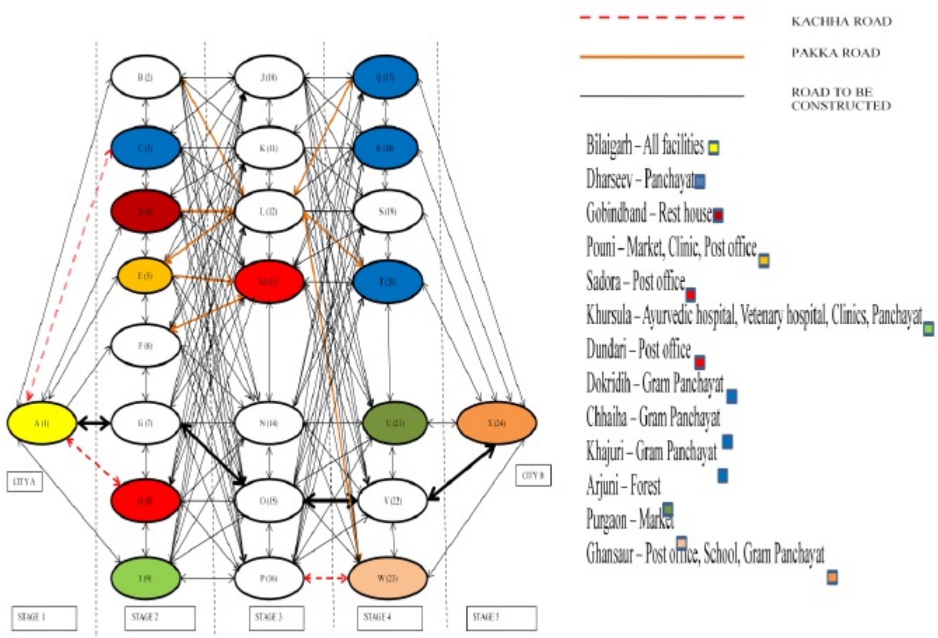

Figure 2.2 : Network Diagram of Villages according to Dynamic Program Technique

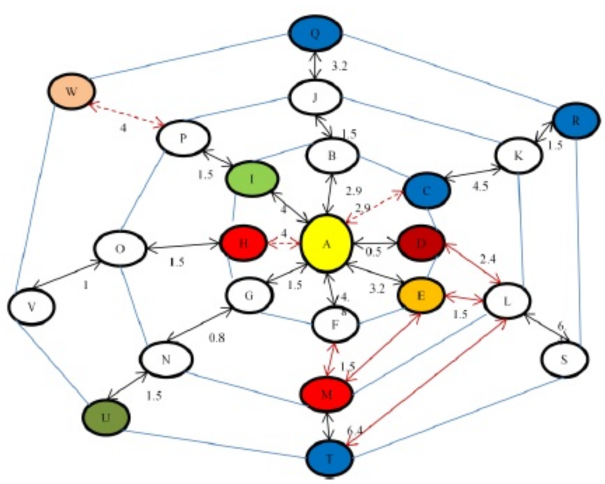

Figure 2.3 : PURA Network Diagram for Geographical and Economical Development of India

3. Result and Discussion

The map obtained for the cluster of villages from Land utilization department of Chhattisgarh government has been shown in the **figure 2.1** by using PERT/CPM network analysis method. This network diagram is showing the available pakka road between very few villages and some kuccha roads available. Many villages are not having any type of road to travel. Hence people are unable to move from their village to some another village to get facilities like, school, primary health care center or market etc. This shows, we are in need of transportation facilities among these villages. For this, we have to construct atleast kuchha road to connect interior villages, so that people can visit to any other place to avail proper basic facility. To solve this transportation problem within limited budget, we have used dynamic programming technique.

In dynamic programming technique, we have selected those villages which are nearby to each other in first stage of this multi-stage decision problem. Also, these villages are nearest to the facility center. In the second stage, villages which are having some connectivity with the few villages of first stage but not having direct connectivity with the facility centers and so on. In this way all villages of this cluster have been chosen into different stages and the villages in the last stage are quite nearer to the urban area of that district. Now, by using dynamic programming technique under limited resources we have obtained all possible connectivity from one node to another. Since all routes cannot be constructed under fixed resources, we have to decide in each stage that which route should be constructed so that maximum people will get connectivity with another stage's village. In resultant, by using this technique we can obtain few optimal route to be constructed to provide maximum facilities. All the stages of DPP and all possible connectivity are shown in **figure 2.2**, very few of them are to be chosen for possible construction under so many geographical and financial constraints.

In stage I, the villages Gondali , Churela(B), Barbhata(F), Aamakhoh(G), Dharakpur(J), Gondali(K), Pacheri(L), Diwanpur(N), Khairjhinti(O), Karchikela(P), Ramtala(S), Jharnipalit(V) are considered on the basis of their distances from center point.

In stage II, Churela(B), Dharseev(C), Gobindband(D), Pouni(E), Barbhatha(F), Aamakhoh(G), Sadora(H), Khursula(I) villages are considered because these can be connected with villages of stage I.

In stage III, villages Dharakpur(J), Gondali(K), Pacheri(L), Dundari(M), Diwanpur(N),

Khairjhinti(O), Karchikela(P) are taken because few of them have connectivity with villages of stage II and few which do not have road can be constructed.
In stage IV, villages Dokridih(Q), Chhaiha(R), Ramtala(S), Khajuri(T), Aarjuni(U), Jharnipalit(V), Purgaon(W) are considered as some of these villages have road connectivity with the villages of stage III but villages which do not have road connectivity could have been suggested to construct roads so that people can travel from one place to other in minimum time. Also the villages of Stage IV can be connected with outer ring roads which are having connectivity with cities or sub-urban area.
In Table 1 and Table 2 all possible alternative paths have been shown with the length of road which can constructed for each stage by using forward and backward pass method of Dynamic programming technique. The resultant optimal paths obtained by Forward and Backward pass method of Dynamic Programming techniques are

$$1 \rightarrow 7 \rightarrow 14 \rightarrow 18 \rightarrow 24 \quad \text{and} \quad 1 \rightarrow 7 \rightarrow 14 \rightarrow 21 \rightarrow 24$$

with the minimum distance 700 Kilometers approximately.
Hence, we conclude the principle of optimality embodied in dynamic programming is that an optimal path has the property that, for any intermediate point along that path, the remaining path is an optimum path from that starting point. By using dynamic programming technique we have computed the distances of all possible roads for each and every possible alternative path in different stages which could be constructed for providing essential facilities for rural development according to PURA, by using EXCEL template.
Now, to obtain the optimal path and some alternative paths from stage I to stage V, we can remodel this transportation problem by using PURA VISION 2020 model given by Dr. A.P.J. Abdul Kalam in the form of concentric circular ring road (A.P.J. Abdul Kalam, 2010). If we follow this method, all villages of a particular cluster can be rearranged in the form of circular paths with common center point. In this case, people need not have to travel all connecting road to reach the destination. Instead, people will start from their origin and by using radial path of concentric circle which are connected by sectorial in minimum time and there is no need of constructing so many paths as shown by dynamic programming method. For example
In the **figure 2.3**, Village A indicated by yellow color is having all essential facilities

such as schools, markets, hospitals, post office, etc. The available **pakka** roads $B \to L$, $D \to L$, $E \to L$, $E \to M$, $F \to M$, $L \to Q$, $L \to T$ and $L \to W$ are represented by continuous line in red colour. The available kachha roads are $A \to C$, $A \to H$ and $P \to W$ represented by dotted lines in red colour and the roads to be constructed are shown in black colour lines to interconnect the villages with each other to provide proper transportation facilities to the village people for their economic and social development which is required as overall development of each people. For example, people those who belongs to the villages which are in the first layer of the circle B, C, D, E, F, G, H and I can directly go to village A to avail the basic facilities but the people belonging to the second layer of the circle in which the villages J, K, L, M, N, O and P which are not having school or health care center has to visit the villages such as H, I or A. If he visits village H or I they may not get all facilities. In that case they must have to visit village A. in this situation they have to travel a long if there is no direct connectivity. Otherwise, they can visit directly from $P \to I \to A$ or $N \to G \to A$ whichever is minimum in length.

Now suppose that there is a village between $O \to P$ or $P \to I$ etc and they have to travel to village A, in that situation they can choose the route from that village $P \to I \to A$ or $O \to H \to A$ whichever is minimum. Similarly, we can provide routes for all the villages which are far away from A but can be connected by using network diagram as given in figure 2.3.

By using all above operation research techniques we have tried to show the application of operation research techniques for solving real life problems which is also a part of rural development program of government of India.

3. Numerical Computation

Table 1 : Alternative Paths obtained by Forward Pass Method (100Km = 1 unit)

S.No.	Alternative Path					
	Sequence	Distance				Total
1	$1 \to 2 \to 10 \to 8 \to 24$	2.9	1.5	11	1.5	16.9
2	$1 \to 2 \to 11 \to 18 \to 24$	2.9	6.4	1.5	1.5	12.3
3	$1 \to 2 \to 12 \to 18 \to 24$	2.9	3.2	9.6	1.5	17.2
4	$1 \to 2 \to 13 \to 19 \to 24$	2.9	9.6	7	6.4	25.9
5	$1 \to 2 \to 14 \to 18 \to 24$	2.9	6.4	3.2	1.5	14
6	$1 \to 2 \to 14 \to 21 \to 24$	2.9	6.4	1.5	3.2	14
7	$1 \to 2 \to 15 \to 22 \to 24$	2.9	9.6	1	1.5	15
8	$1 \to 2 \to 16 \to 22 \to 24$	2.9	13.2	6.4	1.5	24
9	$1 \to 3 \to 10 \to 18 \to 24$	2.9	4.8	11	1.5	20.2
10	$1 \to 3 \to 11 \to 18 \to 24$	2.9	4.5	1.5	1.5	10.4
11	$1 \to 3 \to 12 \to 18 \to 24$	2.9	4.8	9.6	1.5	18.8
12	$1 \to 3 \to 13 \to 19 \to 24$	2.9	10.3	7	6.4	26.6
13	$1 \to 3 \to 14 \to 18 \to 24$	2.9	3.5	3.2	1.5	11.1
14	$1 \to 3 \to 14 \to 21 \to 24$	2.9	3.5	1.5	3.2	11.1
15	$1 \to 3 \to 15 \to 22 \to 24$	2.9	8	1	1.5	13.4
16	$1 \to 3 \to 16 \to 22 \to 24$	2.9	11	6.4	1.5	21.8
17	$1 \to 4 \to 10 \to 18 \to 24$	0.5	6.4	11	1.5	19.4
18	$1 \to 4 \to 11 \to 18 \to 24$	0.5	7	1.5	1.5	10.5
19	$1 \to 4 \to 12 \to 18 \to 24$	0.5	2.4	9.6	1.5	14
20	$1 \to 4 \to 13 \to 19 \to 24$	0.5	6.4	7	6.4	20.3
21	$1 \to 4 \to 14 \to 18 \to 24$	0.5	4.8	3.2	1.5	10
22	$1 \to 4 \to 14 \to 21 \to 24$	0.5	4.8	1.5	3.2	10
23	$1 \to 4 \to 15 \to 22 \to 24$	0.5	8	1	1.5	11
24	$1 \to 4 \to 16 \to 22 \to 24$	0.5	8	6.4	1.5	1.4
25	$1 \to 5 \to 10 \to 18 \to 24$	3.2	8	11	1.5	23.7
26	$1 \to 5 \to 11 \to 18 \to 24$	3.2	9.6	1.5	1.5	15.8
27	$1 \to 5 \to 12 \to 18 \to 24$	3.2	1.5	9.6	1.5	15.8
28	$1 \to 5 \to 13 \to 19 \to 24$	3.2	2.4	7	6.4	19
29	$1 \to 5 \to 14 \to 18 \to 24$	3.2	8	3.2	1.5	15.9
30	$1 \to 5 \to 14 \to 21 \to 24$	3.2	8	1.5	3.2	15.9
31	$1 \to 5 \to 15 \to 22 \to 24$	3.2	9.6	1	1.5	15.3
32	$1 \to 5 \to 16 \to 22 \to 24$	3.2	8.7	6.4	1.5	19.8

S.No.	Alternative Path					
	Sequence	Distance				Total
33	1 → 6 → 10 → 18 → 24	4.8	7.7	11	1.5	25
34	1 → 6 → 11 → 18 → 24	4.8	10.3	1.5	1.5	18.1
35	1 → 6 → 12 → 18 → 24	4.8	3.2	9.6	1.5	19.1
36	1 → 6 → 13 → 19 → 24	4.8	1.5	7	6.4	19.7
37	1 → 6 → 14 → 18 → 24	4.8	8.7	3.2	1.5	18.2
38	1 → 6 → 14 → 21 → 24	4.8	8.7	1.5	3.2	18.2
39	1 → 6 → 15 → 22 → 24	4.8	10.3	1	1.5	17.6
40	1 → 6 → 16 → 2 → 24	4.8	9.3	6.4	1.5	22
41	1 → 7 → 10 → 18 → 24	1.5	8	11	1.5	22
42	1 → 7 → 11 → 18 → 24	1.5	4.5	1.5	1.5	9
43	1 → 7 → 12 → 18 → 24	1.5	5.8	9.6	1.5	18.4
44	1 → 7 → 13 → 19 → 24	1.5	8	7	6.4	22.9
45	**1 → 7 → 14 → 18 → 24**	**1.5**	**0.8**	**3.2**	**1.5**	**7**
46	**1 → 7 → 14 → 21 → 24**	**1.5**	**0.8**	**1.5**	**3.2**	**7**
47	1 → 7 → 15 → 22 → 24	1.5	4.2	1	1.5	8.2
48	1 → 7 → 16 → 22 → 24	1.5	7	6.4	1.5	16.4
50	1 → 8 → 10 → 18 → 24	4	12.5	11	1.5	29
51	1 → 8 → 11 → 18 → 24	4	6.4	1.5	1.5	13.4
52	1 → 8 → 12 → 18 → 24	4	9.6	9.6	1.5	24.7
53	1 → 8 → 13 → 19 → 24	4	9.6	7	6.4	27
54	1 → 8 → 14 → 18 → 24	4	4.8	3.2	1.5	13.5
55	1 → 8 → 14 → 21 → 24	4	4.8	1.5	3.2	13.5
56	1 → 8 → 15 → 22 → 24	4	1.5	1	1.5	8
57	1 → 8 → 16 → 22 → 24	4	4.8	6.4	1.5	16.7
58	1 → 9 → 10 → 18 → 24	4	12.5	11	1.5	29
59	1 → 9 → 11 → 18 → 24	4	8.7	1.5	1.5	15.7
60	1 → 9 → 12 → 18 → 24	4	9.6	9.6	1.5	24.7
61	1 → 9 → 13 → 19 → 24	4	8	7	6.4	25.4
62	1 → 9 → 14 → 18 → 24	4	8	3.2	1.5	16.7
63	1 → 9 → 14 → 21 → 24	4	8	1.5	3.2	16.7
64	1 → 9 → 15 → 22 → 24	4	5.5	1	1.5	12

Table 2 : Alternative Paths obtained by Backward Pass Method (100 Km = 1 unit)

S.No.	Alternative Path					
	Sequence	Distance				Total
1	1 → 24 → 18 → 10 → 2 → 1	15	11	15	29	16.9
2	24 → 18 → 11 → 2 → 1	1.5	1.5	6.4	2.9	12.3
3	24 → 18 → 12 → 2 → 1	1.5	9.6	3.2	2.9	17.2
4	24 → 19 → 13 → 2 → 1	6.4	7	9.6	2.9	25.9
5	24 → 18 → 14 → 2 → 1	1.5	3.2	6.4	2.9	14
6	24 → 21 → 14 → 2 → 1	3.2	1.5	6.4	2.9	14
7	24 → 22 → 15 → 2 → 1	1.5	1	9.6	2.9	15
8	24 → 22 → 16 → 2 → 1	1.5	6.4	13.2	2.9	24
9	24 → 18 → 10 → 3 → 1	1.5	11	4.8	2.9	20.2
10	24 → 18 → 11 → 3 → 1	1.5	1.5	4.5	2.9	10.4
11	24 → 18 → 12 → 3 → 1	1.5	9.6	4.8	2.9	18.8
12	24 → 19 → 13 → 3 → 1	6.4	7	10.3	2.9	26.6
13	24 → 18 → 14 → 3 → 1	1.5	3.2	3.5	2.9	11.1
14	24 → 21 → 14 → 3 → 1	3.2	1.5	3.5	2.9	11.1
15	24 → 22 → 15 → 3 → 1	1.5	1	m 8	2.9	13.4
16	24 → 22 → 16 → 3 → 1	1.5	6.4	11	2.9	21.8
17	24 → 18 → 10 → 4 → 1	1.5	11	6.4	0.5	19.4
18	24 → 18 → 11 → 4 → 1	1.5	1.5	7	0.5	10.5
19	24 → 18 → 12 → 4 → 1	1.5	9.6	2.4	0.5	14
20	24 → 19 → 13 → 4 → 1	6.4	7	6.4	0.5	20.3
21	24 → 18 → 14 → 4 → 1	1.5	3.2	4.8	0.5	10
22	24 → 21 → 14 → 4 → 1	3.2	1.5	4.8	0.5	10
23	24 → 22 → 15 → 4 → 1	1.5	1	8	0.5	11
24	24 → 22 → 16 → 4 → 1	1.5	6.4	8	0.5	16.4
25	24 → 18 → 10 → 5 → 1	1.5	11	8	3.2	23.7
26	24 → 18 → 11 → 5 → 1	1.5	1.5	9.6	3.2	15.8
27	24 → 18 → 12 → 5 → 1	1.5	9.6	1.5	3.2	15.8
28	24 → 19 → 13 → 5 → 1	6.4	7	2.4	3.2	19
29	24 → 18 → 14 → 5 → 1	1.5	3.2	8	3.2	15.9
30	24 → 21 → 14 → 5 → 1	3.2	1.5	8	3.2	15.9
31	24 → 22 → 15 → 5 → 1	1.5	1	9.6	3.2	15.3
32	24 → 22 → 16 → 5 → 1	1.5	6.4	8.7	3.2	19.8

S.No.	Alternative Path					
	Sequence	Distance				Total
33	24 → 18 → 10 → 6 → 1	1.5	11	7.7	4.8	25
34	24 → 18 → 11 → 6 → 1	1.5	1.5	10.3	4.8	18.1
35	24 → 18 → 12 → 6 → 1	1.5	9.6	3.2	4.8	19.1
36	24 → 19 → 13 → 6 → 1	6.4	7	1.5	4.8	19.7
37	24 → 18 → 14 → 6 → 1	1.5	3.2	8.7	4.8	18.2
38	24 → 21 → 14 → 6 → 1	3.2	1.5	8.7	4.8	18.2
39	24 → 22 → 15 → 6 → 1	1.5	1	10.3	4.8	17.6
40	24 → 22 → 16 → 6 → 1	1.5	6.4	9.3	4.8	22
41	24 → 18 → 10 → 7 → 1	1.5	11	8	1.5	22
42	24 → 18 → 11 → 7 → 1	1.5	1.5	4.5	1.5	9
43	24 → 18 → 12 → 7 → 1	1.5	9.6	5.8	1.5	18.4
44	24 → 19 → 13 → 7 → 1	6.4	7	8	1.5	22.9
45	**24 → 18 → 14 → 7 → 1**	**1.5**	**3.2**	**0.8**	**1.5**	**7**
46	**24 → 21 → 14 → 7 → 1**	**3.2**	**1.5**	**0.8**	**1.5**	**7**
47	24 → 22 → 15 → 7 → 1	1.5	1	4.2	1.5	8.2
48	24 → 22 → 16 → 7 → 1	1.5	6.4	7	1.5	16.4
50	24 → 18 → 10 → 8 → 1	1.5	11	12.5	4	29
51	24 → 18 → 11 → 8 → 1	1.5	1.5	6.4	4	13.4
52	24 → 18 → 12 → 8 → 1	1.5	9.6	9.6	4	24.7
53	24 → 19 → 13 → 8 → 1	6.4	7	9.6	4	27
54	24 → 18 → 14 → 8 → 1	1.5	3.2	4.8	4	13.5
55	24 → 21 → 14 → 8 → 1	3.2	1.5	4.8	4	13.5
56	24 → 22 → 15 → 8 → 1	1.5	1	1.5	4	8
57	24 → 22 → 16 → 8 → 1	1.5	6.4	4.8	4	16.7
58	24 → 18 → 10 → 9 → 1	1.5	11	12.5	4	29
59	24 → 18 → 11 → 9 → 1	1.5	1.5	8.7	4	15.7
60	24 → 18 → 12 → 9 → 1	1.5	9.6	9.6	4	24.7
61	24 → 19 → 13 → 9 → 1	6.4	7	8	4	25.4
62	24 → 18 → 14 → 9 → 1	1.5	3.2	8	4	16.7
63	24 → 21 → 14 → 9 → 1	3.2	1.5	8	4	16.7
64	24 → 22 → 15 → 9 → 1	1.5	1	5.5	4	12

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