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"OPTIMIZATION OF DISTRIBUTION ROUTE USING DIJKSTRA'S BASED GREEDY ALGORITHM: CASE OF RETAIL CHAIN"

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***Abstract*- In cities, the efficiency of resolving pickup and delivery routes is dependent on calculating the shortest routes among shops in a complicated road network directly. Selecting the best path is a practical problem with a high frequency of application in everyday life, and it has practical implications for the research. One of the most well-known optimal path selection methods is the Dijkstra's based greedy Algorithm. In actuality, there exist numerous models for route selection; however, the main focus of this study is on the implementation of one of them, shortest path algorithms for distribution routing optimization. When solving the optimal path problem, it also serves as the theoretical foundation for many empirical models. Many factors will affect your decision on the best path to choose. In practise, the selection conditions will frequently contain many precedence conditions and will entirely pick the influence path. The optimization algorithm is implemented and confirmed in this paper through analysis and actual application.**

***Keywords*-Optimal route, Greedy algorithm, Distribution network, Retail chain.**

I. INTRODUCTION

The difficulty of determining the shortest path or route from a starting point to a final destination is known as the shortest path problem. Graphs are commonly used to represent the shortest path issue. According to (Ivan Beker at all,2012) a graph is a mathematical abstraction that consists of a set of vertices and edges. Edges join two vertices together. It is possible to walk around the edges of a graph by going from one vertex to the next. The graph is either a directed graph or an undirected graph depending on whether one can walk along both sides or only One side of the edges.

In addition, edge lengths are sometimes referred to as weights, and the weights are typically utilised to calculate the shortest path between two points. In the actual world, the graph theory can be used to solve a variety of problems. For example, we can use a graph to depict a map, with vertices representing cities and edges representing routes connecting the cities (Elise and Hani 2000) studied the optimal path problem for a combination of two conditions with randomly varying road length and time independence.

The graph will be directed if the path is one way; otherwise, it will be undirected. The shortest path problem can be solved using a variety of approaches. Only a few of the most popular traditional shortest path methods, as well as one that uses a greedy approach, will be described in this work, and they are as follows:

1. Dijkstra's based Greedy Algorithm
2. Bellman-Ford Algorithm
3. Floyd-Warshall Algorithm
4. Johnson's Algorithm

II. PROPOSED ALGORITHM

Dijkstra's based Greedy Algorithm

The ability of Dijkstra's Algorithm to discover the shortest path from one node to every other node inside the same graph data structure sets it apart from the others. This means that instead of only finding the shortest path from the

starting node to another specific node, the algorithm searches for the shortest way to every single reachable node- as long as the network remains unchanged. The procedure continues until all of the nodes that are reachable have been visited. As a result, you would only need to run Dijkstra's method once and preserve the results to be utilised again and over without having to rerun the process — unless the network data structure changed in any manner. Dijkstra algorithm (discovered by E.W. Dijkstra at 1956).
If the graph changes, you must restart the graph to guarantee that you have the most up-to-date shortest pathways for your data structure. Take our above routing example: if you want to get point A to point B as quickly as possible, but you know that some roads are severely crowded, obstructed, or under construction, Dijkstra's will discover the shortest path while avoiding any edges with bigger weights, resulting in the shortest route.

III. LITERATURE REVIEW

After reviewing research papers focused on the route optimization and similar strategy from journals. The result of the review is summarised as below in table.

Table:1 Summary of reviewed literature

No	Authors	Descriptions	Year of publication
1	Andre Maia Pereira, Hossam anany,Ondrej pribyl,and Jan Prikryl	The authors in this paper reviewed route selection with the objection of automated vehicle in smart urban environment	2017
2	Raja kumar kedia ,B Krishna Naick	The authors analysed vehicle routing problem and linked it to the environment pollution problems. The discussion on GHGs and climate change along with algorithm development for route optimization was done by the authors	2017
3	Ojekudo, Nathaniel Akpofure and Akpan Nsikan poul	The used Dijkstra's algorithm with the objective of finding best shortest path thus minimizing time and saving cost of fuel for the vehicles	2017
4	Michel Gendreau, Gianpaolo Ghiani, Emanuela Guerriero	The authors in their paper reviewed time dependent routing methods to design best riute in a graph. The criteria included in this paper are (i) node, arc or general routing; (ii) the possibility to choose the vehicle speed.	2014
5	Ivan Beker, Vesna Jevtic, Dalibor Dobrilović	This paper focus on to reduce total operating logistic cost and approx. 5%to 7.5% cost are reduces. Using Dijkstra algorithm.	2012
6	Sachin Kumar, Avninder Singh	This paper suggested implementing a new optimal shortest route and reduce distance using Genetic algorithm perfume on metlab language.	2016
7	Minhang Zhou a, Nina Gao	Hear in this paper they have used Dijkstra algorithm to optimize the network route having multiple term and conditions followed dangerous good, safety parameter, crowded area and distance using multiple weight matrix.	2003
8	Arjun RK, Pooja Reddy, Shama, M. Yamuna	This paper focus on making a software to the find shortest route using c++ language.	2015
9	Sathyapriya .S, Kavin.M.K, Mythre Rakshana.S	This paper focus on implementation of Dijkstra's algorithm to find the shortest path in google maps. But in this study give negligible efficiency.	2020
10	Nor Amalina Mohd Sabri, Abd Samad	According to this paper the select the optimal route in emergency situation. The result we can see ambulance/fire	2002

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	Hasan Basari, Burairah Husin .	brigade used shortest route for going to accidental zone	

IV. METHODOLOGY

In this study the method used is Dijkstra's based greedy algorithm. In this algorithm find out the location of the destination and distance in between.

Create the network diagram using GPS and made a matrix then calculate the shortest path of the source to destination. Below are the steps to calculate the shortest path.

Step:1 In the first step minimum actual distance between each available location and each destination is calculated as per google maps data. For this we have used google spreadsheet and a function is build which takes three input variables namely coordinate of start and end location and the type of distance between these two locations such as kilometre, meter etc.

AD_{ij} = Actual distance between location i and location j.
i= first location
j= second location

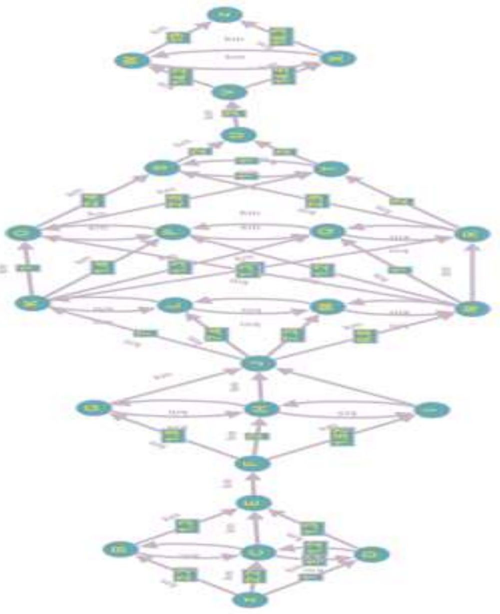
Step:2 In the second step each location is give weightage based on google maps distance.

W_i = Weightage of two location.

Step:3 In third step the minimum distance is calculated in between two location and that step follows other location.

$$w\_j=\min \{ w\_j, w\_a+d\_aj \}$$

Figure:1 Shows the network diagram of source and destination



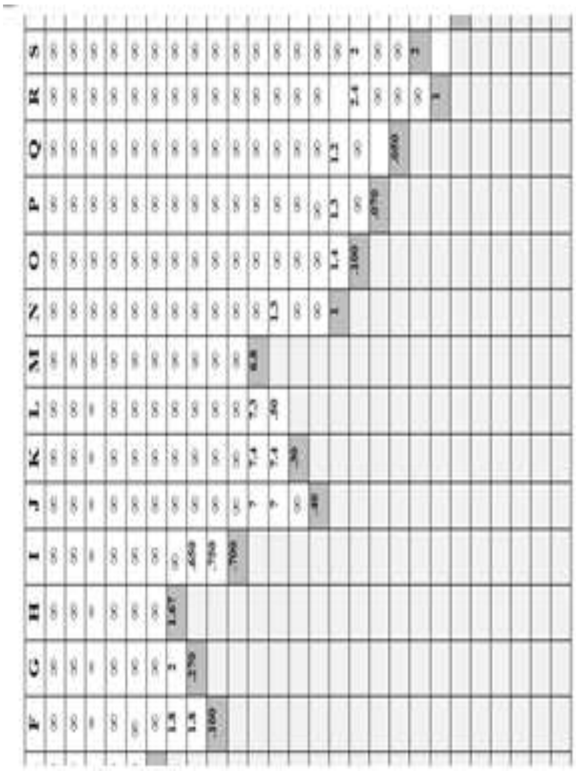


Table2: -Path weight and connectivity matrix

Current route follow by ABC company
Z→A→B→C→D→E→F→G→H→I→J→K→L→M→N →O→P→Q→R→S→T→U→X→Y→Z

Total distribution distance: 61.44 km.
Optimum route:
Z→C→B→A→G→E→H→G→F→I→M→L→K→J→N →O→P→Q→S→R→T→U→V→X→Y→Z

Optimum distance:
1+1.2+0.05+1.3+0.9+1.67+0.27+.100+.700+6.8+0.50+.30+. 40+1+0.070+0.050+2+1+2+.750+3+14.2+.300+18.3

Total optimum distance: 56.88km

V. RESULTS AND DISCUSSION

Table 3: - Result of the shortest route of given data of ABC company

Route	Actual travelling distance	Optimization route distance	efficiency
Route 1	61.44km	56.88km	7.4%
Route 2	89.43km	81.3km	9.09%
Route 3	108.34km	96.43km	10.9%
Route 4	42km	38.42km	8.5

Table 3 shows the comparisons between actual travelling distance to optimization route distance. It is clear from table that efficiency of this method is approx. 7-10% of given data of ABC company.

Optimization route graph

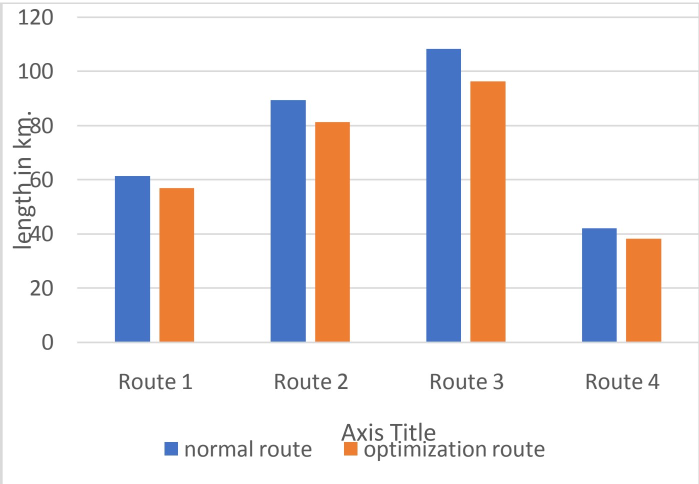


Figure 2: - "Graph between normal route and optimize route".

Figure 2 shows relation between normal route and optimizing route (shortest route).

- Based on the result that study by Dijkstra algorithm method is able to produce the shortest distribution route which is more efficient and easier to be understood by researchers, so that further use these algorithms to delivery distribution route for retail chain.
- After applying the Dijkstra algorithm, we concluded that there are some opportunities for improvements in the routing part too. The route obtained was tested on a number of other parameters such as distance covered and cost of transmission The route obtained using the algorithm when compared with the existing route of the van shows that the distance covered by the van if the van follows the route obtained using the algorithm is less. A total of 7to10% of distance is reduced if the van follows the route obtained by applying the algorithm.

VI. CONCLUSION

This study has been carried out distribution route to selected ABC company the selection with the help of Dijkstra's based greedy Algorithm. By the application of the method, we were able to get at least 7.4 % reduction in the distance travelled & on an average 8.97 % reduction is reaching each node.

The algorithm can hence provide following benefits to the ABC company if the results of this research paper are adopted.

- Direct savings on cost of transportation
- Direct saving its distribution time which could be utilised to add more serviceable nodes in the existing map or the map itself could be increased keeping in view the maximum available time, thus increasing business to the organization.
- Since the algorithm is able to avoid crowded, obstructed, diverted and/or under constructed route, high precision delivery/service time estimates could be provided, hence increasing customer confidence is the organization's business.

VII. LIMITATIONS

This study has few limitations such as,

1. The real data used for calculations is of one day duration only, so the results may show a different trend if the duration of data is increased or decreased.
2. The study has shown the destination of the shops based on the real data accumulated. If you want to obtain the destination of the shops without having the real data, then the efficiency of these methods will largely rely on the data generation methods used.
3. That method consuming a lot of time for calculation of finding the shortest path method.
4. It cannot handle negative edges. This leads to acyclic graphs and most often cannot obtain the right shortest path.

VIII. FUTURE SCOPE

The results of this study are limited with respect to an ABC company. The result can be made more generalized if we consider more institutions or companies of India/world. Below we mention some future research scope related to these fields.

1. Here we have used the distance optimization criteria, so other research can concentrate on multi criteria optimization methods.
2. Here in this study, we have managed to get the data for only one day so other studies may focus on more days of data accumulation.
3. Here we have used delivery data of Ujjain for alternate available destination, for more detailed alternate available source and destinations genetic algorithms can be used.
4. Routing can be made more precise with the help of real time data accumulation devices and real time decision making.
5. In future Dijkstra algorithm can be used in GPS system to find out the shortest route and mapping the route.
6. Dijkstra algorithm can perform in so many languages and software like metlab and python etc.

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