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To Determine the Shortest and Fastest route using GIS based Open-Source Tool

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ABSTRACT: Finding of shortest path is studied in computer science especially under graph theory. It is used for planning road network, traffic control system, transportation system and many network based objectives.
There are many GIS software (licensed or open- source) used for analyzing road network and give best output. In this paper we are proposing use of QNEAT plugin of QGIS software for Network Analysis, an open source, cross platform Desktop Application.
Geographical data of road network is analyzed using this plugin for finding shortest path from point A to point B in minimal time. It helps in minimizing the cost of travelling between two points.

KEYWORDS: QGIS, QNEAT, SHORTEST PATH, DIJKASTRA'S ALGORITHM

I. INTRODUCTION

Now a days we are facing different problem in travelling called traffic. When we go from one place to other, face lots of traffic on roads, this makes our journey slower. We have many ways to go somewhere. But we choose that way which takes less time and less distance.

Everyone wants to reach from one place to other in less time also travel short distance called minimal optimum path. A path having less distance or take less time from reaching one place to other.

In this paper, we are proposing the use of QNEAT plugin of QGIS in finding shortest path between two points (source - destination). Using this plugin we can easily find shortest path between two points or also find shortest path between multiple points, and also calculate Isochrone Area.

This plugin is implemented on Dijkstra's Algorithm of shortest path. This famous algorithm is proposed by Edsger W. Dijkstra in 1956.

In this, we are using the data of road network of Lucknow City. Our objective is to finding optimal path for employees reaching to their office or their near by places like hospitals, restaurants, petrol pumps, and others. Shortest path is most required in emergency situation to save someone's life. The sets of source and destination points are houses of employees to the office, petrol pumps, schools, restaurants and other places people used to go in their daily life.

In graph theory, there are two types of graph: Directed graph and Undirected graph. We create a directed and weighted graph of road network data consisting of edge and vertices. This graph having the information about the road length, road id and direction.

II. METHODOLOGY

We are using Geospatial data of Lucknow city road Network (line data) and some point data which have location of some important places like hospital, school, office, resturants and specially location of home and office. We are finding shortest path between home and the office.

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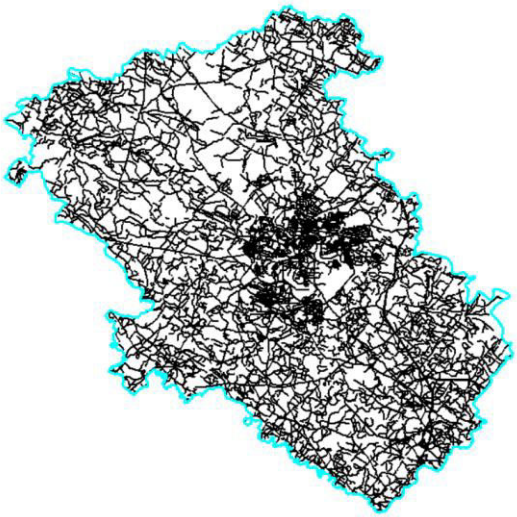

Fig: 1(a)

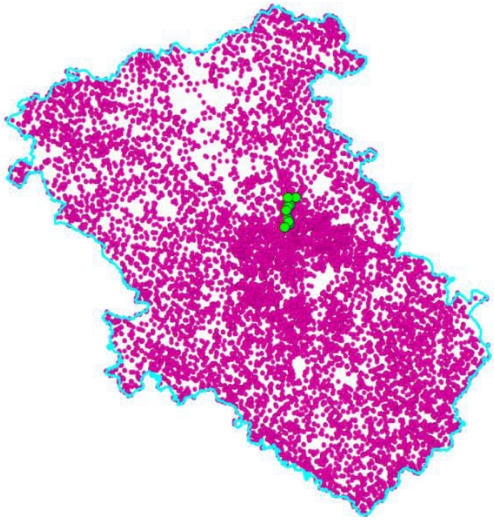

Fig: 1(b)

DIJKASTRA'S ALGORITHM: This algorithm is used for finding Shortest path between two points (origin, destination) and it is also called minimization algorithm. It approaches Greedy Method and gives optimum results. This algorithm is used in following:

Google Map
Social Networking
DNA Mapping
Telephone Network

The heart of this algorithm is Relaxation. It approaches to get least cost node in finding shortest path. The sum of distance of first vertex and the cost of reaching from first vertex to next vertex is less the distance of next vertex then the sum become the distance of next vertex. Following is the

If $d(u) + c(u,v) < d(v)$,
$d(v) = d(u) + c(u,v)$

Using above mention data of road and point (place) we create a weightedgraph of 34 nodes and 33 edges, nodes are encircled number and the weight is aside the edges as shown in Fig 2 in our study. Node 1 is source and node 10 is destination, shortest path is calculated for these two points. The distance (in metre) between 2 nodes taken as weight.

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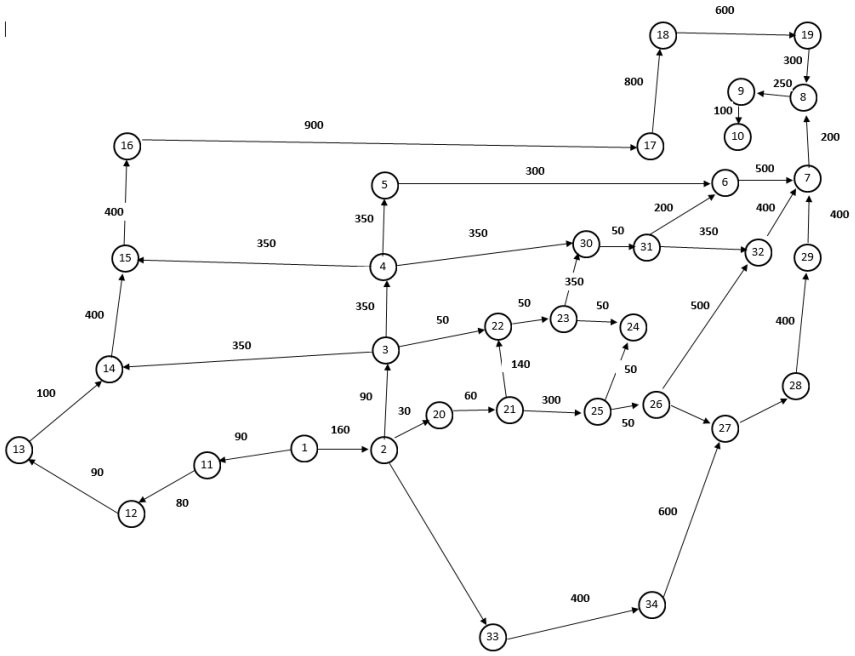

Fig 2

On the basis of above graph, first find the shortest distance with minimum cost between nodes. For that initially infinite is assigned as cost for every node and then calculate cost for every node as shown in Fig **3.**

Source	Destination																																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
	160	∞	∞	∞	∞	∞	∞	∞	∞	**90**	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
1,11	**160**	∞	∞	∞	∞	∞	∞	∞	∞	**90**	170	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
1,11,2	**160**	250	∞	∞	∞	∞	∞	∞	∞	**90**	**170**	∞	∞	∞	∞	∞	∞	∞	190	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	860	∞
1,11,2,12	**160**	250	600	∞	∞	∞	∞	∞	∞	**90**	**170**	260	600	∞	∞	∞	∞	∞	**190**	∞	300	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	860	∞
1,11,2,12, 20	**160**	**250**	600	∞	∞	∞	∞	∞	∞	**90**	**170**	260	600	∞	∞	∞	∞	∞	**190**	**250**	300	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	860	∞
1,11,2,12, 20,3,21	**160**	**250**	600	900	∞	∞	∞	∞	∞	**90**	**170**	260	600	950	∞	∞	∞	∞	**190**	**250**	300	∞	∞	**250**	∞	∞	∞	∞	650	∞	∞	860	∞
1,11,2,12, 20,3,21,25	**160**	**250**	600	900	∞	∞	∞	∞	∞	**90**	**170**	**260**	600	950	∞	∞	∞	∞	**190**	**250**	300	∞	∞	**250**	350	∞	∞	∞	650	∞	∞	860	∞
1,11,2,12, 20,3,21,25,13	**160**	**250**	600	900	∞	∞	∞	∞	∞	**90**	**170**	**260**	360	950	∞	∞	∞	∞	**190**	**250**	**300**	∞	∞	**250**	350	∞	∞	∞	650	∞	∞	860	∞

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1,11,2,12,20,3,21,25,13,22	160	250	600	900	∞	∞	∞	∞	∞	90	170	260	360	950	∞	∞	∞	∞	190	250	300	350	∞	250	350	∞	∞	∞	650	∞	∞	860	∞
1,11,2,12,20,3,21,25,13,22,23,26	160	250	600	900	∞	∞	∞	∞	∞	90	170	260	360	950	∞	∞	∞	∞	190	250	300	350	400	250	350	750	∞	∞	650	∞	850	860	∞
1,11,2,12,20,3,21,25,13,22,23,26,14	160	250	600	900	∞	∞	∞	∞	∞	90	170	260	360	760	∞	∞	∞	∞	190	250	300	350	400	250	350	750	∞	∞	650	∞	850	860	∞
1,11,2,12,20,3,21,25,13,22,23,26,14,24	160	250	600	900	∞	∞	∞	∞	∞	90	170	260	360	760	∞	∞	∞	∞	190	250	300	350	400	250	350	750	∞	∞	650	∞	850	860	∞
1,11,2,12,20,3,21,25,13,22,23,26,14,24,4	160	250	600	900	∞	∞	∞	∞	∞	90	170	260	360	760	∞	∞	∞	∞	190	250	300	350	400	250	350	750	∞	∞	650	∞	850	860	∞
1,11,2,12,20,3,21,25,13,22,23,26,14,24,4,30	160	250	600	900	∞	∞	∞	∞	∞	90	170	260	360	760	∞	∞	∞	∞	190	250	300	350	400	250	350	750	∞	∞	650	700	850	860	∞
1,11,2,12,20,3,21,25,13,22,23,26,14,24,4,30,31	160	250	600	900	900	∞	∞	∞	∞	90	170	260	360	760	∞	∞	∞	∞	190	250	300	350	400	250	350	750	∞	∞	650	700	850	860	∞
1,11,2,12,20,3,21,25,13,22,23,26,14,24,4,30,31,27	160	250	600	900	900	∞	∞	∞	∞	90	170	260	360	760	∞	∞	∞	∞	190	250	300	350	400	250	350	750	850	∞	650	700	850	860	∞
1,11,2,12,20,3,21,25,13,22,23,26,14,24,4,30,31,27,15	160	250	600	900	900	∞	∞	∞	∞	90	170	260	360	760	1160	∞	∞	∞	190	250	300	350	400	250	350	750	850	∞	650	700	850	860	∞
1,11,2,12,20,3,21,25,13,22,23,26,14,24,4,30,31,27,15,28,32	160	250	600	900	900	1250	∞	∞	∞	90	170	260	360	760	1160	∞	∞	∞	190	250	300	350	400	250	350	750	850	1050	650	700	850	860	∞
1,11,2,12,20,3,21,25,13,22,23,26,14,24,4,30,31,	160	250	600	900	900	1250	∞	∞	∞	90	170	260	360	760	1160	∞	∞	∞	190	250	300	350	400	250	350	750	850	1050	650	700	850	860	1250

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27,15,28, 32,33																														
1,11,2,12, 20,3,21,2 5,13,22,2 3,26,14,2 4,4,30,31, 27,15,28, 32,33,5,6	160	250	6000	9000	900	1250	∞	∞	∞	90	170	260	360	760	1160	∞	∞	∞	190	250	300	350	400	250	350	750	850	1050	650	700	850	860	1250
1,11,2,12, 20,3,21,2 5,13,22,2 3,26,14,2 4,4,30,31, 27,15,28, 32,33,5,6, 29	160	250	6000	9000	900	1250	∞	∞	∞	90	170	260	360	760	1160	∞	∞	∞	190	250	300	350	400	250	350	750	850	1050	650	700	850	860	1250
1,11,2,12, 20,3,21,2 5,13,22,2 3,26,14,2 4,4,30,31, 27,15,28, 32,33,5,6, 29,16	160	250	6000	9000	900	1250	∞	∞	∞	90	170	260	360	760	1160	2060	∞	∞	190	250	300	350	400	250	350	750	850	1050	650	700	850	860	1250
1,11,2,12, 20,3,21,2 5,13,22,2 3,26,14,2 4,4,30,31, 27,15,28, 32,33,5,6, 29,16,7,3 4	160	250	6000	9000	900	1250	1700	∞	∞	90	170	260	360	760	1160	2060	∞	∞	190	250	300	350	400	250	350	750	850	1050	650	700	850	860	1250
1,11,2,12, 20,3,21,2 5,13,22,2 3,26,14,2 4,4,30,31, 27,15,28, 32,33,5,6, 29,16,7,3 4,8	160	250	6000	9000	900	1250	1700	1950	∞	90	170	260	360	760	1160	2060	∞	∞	190	250	300	350	400	250	350	750	850	1050	650	700	850	860	1250
1,11,2,12, 20,3,21,2 5,13,22,2 3,26,14,2 4,4,30,31, 27,15,28, 32,33,5,6, 29,16,7,3 4,8,9	160	250	6000	9000	900	1250	1700	1950	2050	90	170	260	360	760	1160	2060	∞	∞	190	250	300	350	400	250	350	750	850	1050	650	700	850	860	1250
1,11,2,12, 20,3,21,2 5,13,22,2	160	250	6000	9000	900	1250	1700	1950	2050	90	170	260	360	760	1160	2060	∞	∞	190	250	300	350	400	250	350	750	850	1050	650	700	850	860	1250

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3,26,14,24,4,30,31,27,15,28,32,33,5,6,29,16,7,34,8,9,10						0	0	0	0						0	0											0					0
1,11,2,12,20,3,21,25,13,22,23,26,14,24,4,30,31,27,15,28,32,33,5,6,29,16,7,34,8,9,10,17	160	250	600	900	900	1250	1700	1950	2050	90	170	260	360	760	1160	2060	2860	∞	190	250	300	350	400	250	350	750	850	1050	650	700	850	860	1250
1,11,2,12,20,3,21,25,13,22,23,26,14,24,4,30,31,27,15,28,32,33,5,6,29,16,7,34,8,9,10,17,18	160	250	600	900	900	1250	1700	1950	2050	90	170	260	360	760	1160	2060	2860	3460	190	250	300	350	400	250	350	750	850	1050	650	700	850	860	1250

Fig 3
Dijkstra Algorithm

Create a Function of Dijkstra algorrthm D(G,S)
create vertex set Q
for each vertex v in graph
assign infinite to each vertex
Then add vertex v to vertex set Q
Cost of Source is zero.
while vertex set Q is not empty
u = Extract of minimum cost vertex from vertex set Q
for each neighbour vertex v of u
Relax(u,v)

Using Relation method
If d(u) + c(u,v) < d(v),
d(v) = d(u) + c(u,v) , where d is distance and c is cost, u is initial vertex and v is next vertex.

Time Complexity: Dijkstra algorithm create Heap data Structure. The execution time of first for loop is O(V). In each iteration of the while loop, Extract_Minimum cost vertexfrom the heap and execution time is logV.In the next iterates each adjacent node of the current node, the total run time is O(E). Therefore, the time complexityof: Dijkstra algorithm is O((V + E)*log(V) = O(E* log(V)).
We get shortest path between vertex 1 to vertex 10 is: v(1) --> v(2) → v(3) --> v(4) --> v(5) --> v(6) --> v(7) --> v(8) --> v(9) --> v(10). Total distance of this path is 2300 meters. in graph Fig 3 Highlighted node and edge is showing shortest path.

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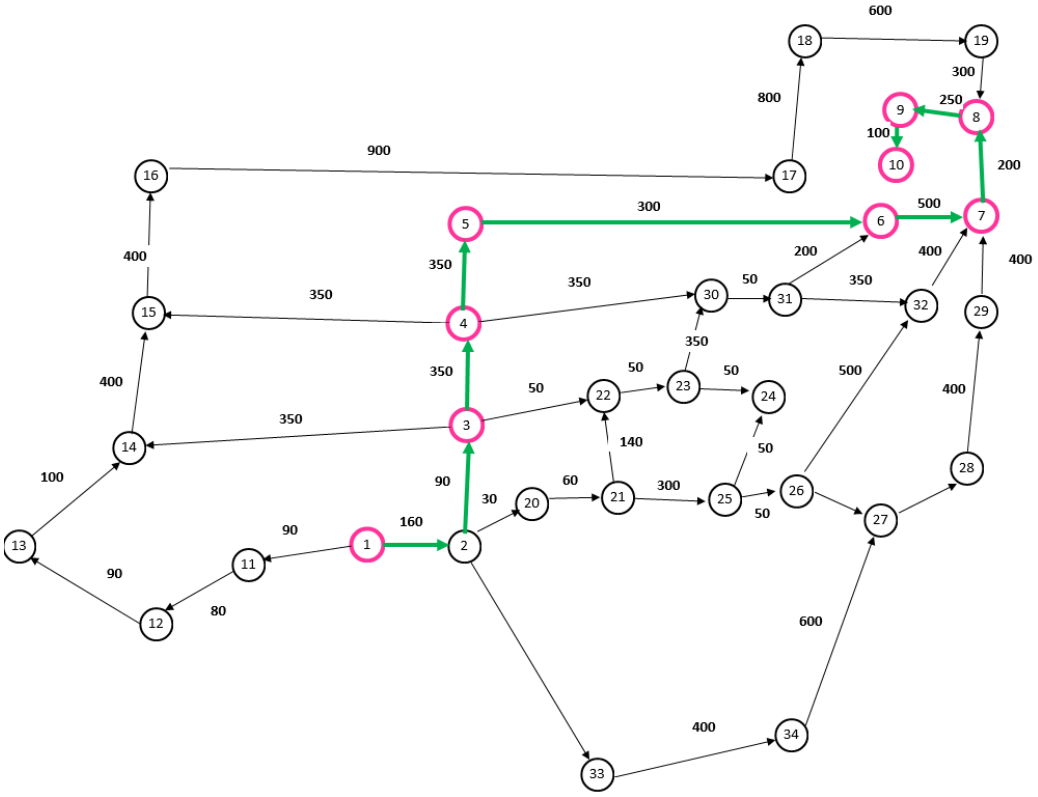

Fig 3

QGIS: Qgis is an open-source GIS software. It is used for creating map, creation, modification, preparation and analyzing GIS data.

QNEAT: It stands for Qgis Network Analysis Tool. It is a downloadable extension provided for Processing-Toolbox algorithms. It is used for Network analysis like Fastest first, shortest first between origin – destination points. The range of this plugin from finding shortest path to the computation of more complex OD matrix and Isochrone Area. This algorithm is also using Dijkstra algorithm for calculating shortest path.

Available Algorithms under QNEAT plugins are as following:

A. **Distance Matrix:**This algorithm is used to get distance matrix between all pair nodes (source- destination). We use lucknow city road data and point data for input and the output of this plugin origin destination matrix is shown in In fig: 4(a)

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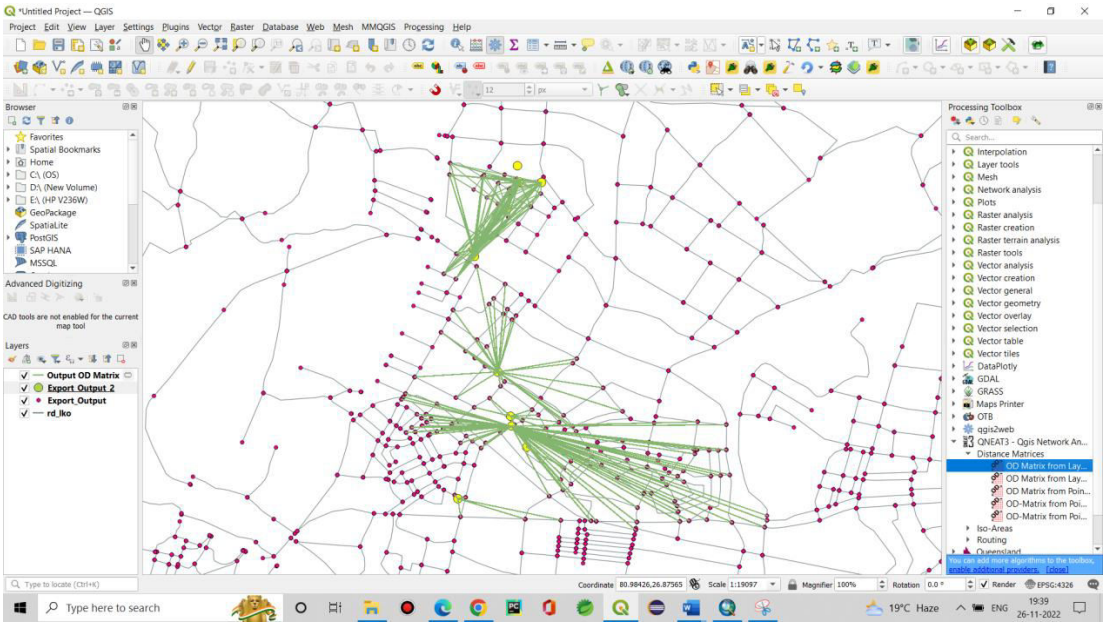

Fig 4(a)

B. **Routing:**It is used to finding of shortest path between source and destination. Output of this algorithm is a black line as shown in fig: 4(b).

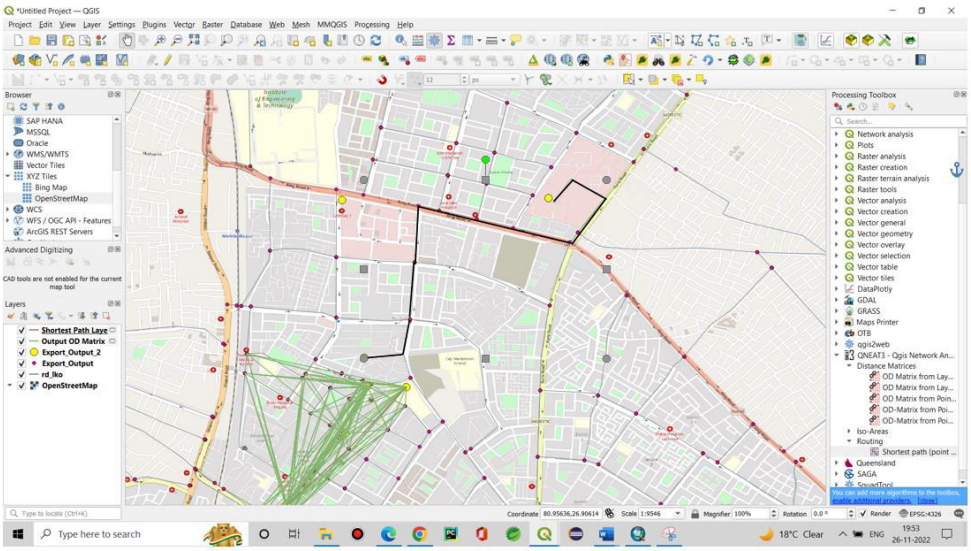

Fig 4(b)

III. CONCLUSION

Dijkstra the most appropriate algorithm for shortest path problem. This algorithm has the capability to repeat the search process by increasing the reduction factor. We get same result in our study, shortest path getting by QNEAT plugin in an open source application.

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