

BUS ROUTE OPTIMIZATION IN JYOTHI ENGINEERING COLLEGE USING Arc- GIS

Noble Jose¹, Dr. Anitha Jacob²

¹PG Scholar, Dept. of Civil Engineering, Jyothi Engineering College, Kerala, India

²Associate Professor, Dept. of Civil Engineering, Jyothi Engineering College, Kerala, India

Abstract - Transit should be planned to optimize its performance for the benefit of users and the city. With the growth of cities, the need for people for transport increases, and not all of these journeys may be in private transport due to congestion that is generated. Therefore, the government must provide a transit system well distributed and organized to meet the demand efficiently. All this must be planned with a holistic view of the problem in order to get the best use of economic resources, the best functionality for commuters, preserve the environment and make energy savings. Optimization has importance in different aspects, it may be in cost, distance, time, aspects. The objective of the mini project is to check bus routes (within Thrissur district) of Jyothi Engineering College are efficient in all aspects with the help of Arc-GIS. Network analysis is the basic operation involved in this work. Creating a georeferenced base map of Thrissur, and digitized bus routes are the basic requirements. Attribute data includes the demand from each stop (impedance), speed, distance etc. For network analysis, "network analyst" tool in Arc tool box is used. After Geo referencing and Digitization attribute values assigned to the each routes with the help of proximity tools and then run the analysis will give the shortest path. If the shortest path obtained is same as current route then the route is efficient..

Key Words: Optimization, Arc-GIS, Network analyst tool

1. INTRODUCTION

Transportation is the movement of humans, animals and goods from one location to another. In the 21st century there is huge importance given to management, logistics and networking and this is mainly done so that the overall efficiency of each sector gets improved. In this particular project, the importance is mainly given onto the transit networking problem, i.e. bus route problem where busses will carry people from one location to another along different routes with intermediate stops. Problem is considered to be complex in nature due to the multiple variables and parameters. Considering the two depots (end points) there will be many route combinations possible. Those alternate routes may have different characteristics like distance, cost, time etc.

The advancement in route optimization where a solution loads and distributes routes and stops based on achieving the minimum miles driven can drastically reduce fuel use, vehicle wear and tear and exposure risk, which has an impact on violations, accidents, and insurance premiums. Another importance of this problem is the shortest path finding out, which is very important in the 21st century world is because at present time is money and we humans are trying to cut short on everything. So as the networking and linking sector among all other sectors and hence it is important that we find ways and methods to improve the efficiency of the same.

2. LITERATURE REVIEW

Abousaeid [1] determined the fastest delivery route by Geographic Information System (GIS) modelling. The study involves the adoption of GIS modelling approach to determine the quickest routes for fresh vegetable delivery in Kuala Lumpur. Amria [2], analyzed hot spot occurrence classification in Riau Province Indonesia using Geographic Information System. They developed a classification module for hotspot occurrences in a GIS using Open GeoSuite3.0. Visualization of hotspots classification results in the form of a map allows users to see the location of hotspots based on the characteristics of the location of the distance to nearest main cities, roads, and rivers. Hannan [3] explained about capacitated vehicle routing problem by using pso algorithm. Vehicle routing problem (VRP) which aims to determine the minimum total cost pathways for a fleet of heterogeneous vehicles to deliver a set of customers' orders. The inability of optimization algorithms alone to fully satisfy the needs of logistic managers become obvious in transportation field due to the spatial nature of such problems.

Sandeep Gupta [4] explains Route Optimization of Municipal Solid Waste Collection in Jabalpur city using Arc-GIS. Solid waste collection routes optimization using Geographical Information System (GIS Arc View) was investigated. The present route were optimized to reduce the length of the routes and consequently the time taken to complete the collection. Slesha D [5] explains Route optimization for Solid Waste Management using ArcGIS Network Analyst. ArcGIS Network Analyst is presented for

the best identification of routing applied in municipal waste collection. The proposed application takes into account all the necessary parameters for waste collection, so that we can model realistic network scenarios and conditions. Patil [6] discussed about the applications of GIS to smart cities. According to their study GIS is an integrated software that integrates hardware, software and data for capturing, managing, analyzing and displaying all forms of geographically referenced information for a city.

3. 0 DATA COLLECTION AND METHODOLOGY

Study Area

Efficient transportation and transportation scheduling is a huge challenge due to the various constraints of time distance and cost. Therefore it is very important to find out ways of optimizing and if possible suggesting a more suitable route which is optimized in both cost and time which can be used for a variety of cases which thus shall make it very flexible in nature. So project will be focusing on the bus network of the Jyothi Engineering College. There are 18 college buses running to different directions in Thrissur district. The prime objective of the work is to identify the shortest path from the college to various destinations.

Specific objectives of the projects are,

- i. Studying the basics of Arc-GIS software and the route optimization techniques used in Arc-GIS
- ii. Checking the efficiency of the current routes with the help of Arc-GIS network analyst.

Methodology Adopted

- i. Collection of base map and bus data
- ii. Importing Base map to Arc-GIS
- III. Geo referencing of base map
- iv. Digitization of road network
- iv. Database creation
- v. Analysis using network analyst tool

Data required for the present study are base map of study area that includes the different places in Thrissur district. A base map of Thrissur district is needed or we can use the online Arc map for that purpose. Bus data includes the cost, distance, time as additional attributes. Georeferencing is the process of assigning spatial coordinates to data. When co-ordinates of spatial dates are referenced to their corresponding positions on the surface of earth then it is called Georeferencing of spatial data. Digitizing is a process of encoding geographic features in digital form as x, y coordinates. It is carried out in order to create spatial data from existing hardcopy maps and documents. There are three types of features used for digitization purpose, point, line and polygon features. Bus stations, railway stations, hospitals, places of tourist interest, offices, educational institutions and stadiums and various facilities in the study area are digitized as point features, lakes and

rivers are digitized as polygon features, . Roads, streets and railway lines are digitized as line features.

Steps for Georeferencing

The base map is dead without adding the real earth coordinates into it. For the analysis the map without real features wont work. Scanned maps don't usually contain information as to where the area represented on the map fits on the surface of the earth. The location information delivered with aerial photos and satellite imagery is often inadequate to perform analysis or display in proper alignment with other data. Very essential information may be contained in data or images that were produced at a different point of time. It may be desired either to combine or compare this data with that currently available. The latter can be used to analyze the changes in the features under study over a period of time. Georeferencing is crucial to making aerial and satellite imagery, usually raster images, useful for mapping as it explains how other data, such as the above GPS points, relate to the imagery. Different maps may use different projection systems. Georeferencing tools contain methods to combine and overlay these maps with minimum distortion. Steps for the georeferencing is given below.

1. Start ArcMap.
2. Add base map click "add data".
3. Add the geographical map that is to be aligned with the base map.
4. Select four control points, in such a way that that four points should be uniformly distributed throughout the base map.
5. The latitude and longitude of corresponding control points were added.
6. Click "Go to XY" With that of the geographical map.
7. Save the geo-referencing information.

The following dialogue box will appear while entering the latitude and longitude of each control points.

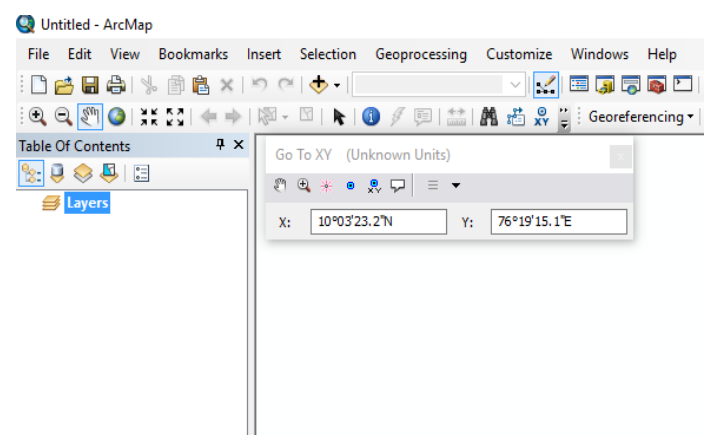


Fig.1 Entering coordinates of control points

Steps for digitization

Digitization can be done by two methods, Manual digitization and heads up digitization. In this method, the digitizer uses a digitizing tablet (also known as a digitizer, graphics tablet, or touch tablet) to trace the points, lines and polygons of a hard-copy map. This is done using a special magnetic pen, or stylus, that feeds information into a computer to create an identical, digital map. Manual Digitizing is still a useful technique because of its ability to accurately copy maps in poor condition. Computers have a higher risk of error when interpreting information contained on a faded, stained, or poor quality map or image. Heads up digitization involves scanning a map or image into a computer. The digitizer then traces the points, lines and polygons using digitizing software. This method of digitizing has been named "heads-up" digitizing because the focus of the user is up on the screen, rather than down on a digitizing tablet. It has largely replaced manual digitizing because of its speed and accuracy. It is, however, limited to using scans of high quality maps and images.

- i. Check on "Editor" tool bar, click Start Editing
- ii. Select Layers that should be digitized
- iii. On the editor tool bar, click „Create Features“
- iv. From the dialogue box, select the layers and click on „Construction tools“ drop down menu Click on Line Feature-to digitize roads, Point Feature- to digitize land marks
- v. Click on Editor icon, Click save edits, then Stop the Editor Given below figures shows the dialogue box for create feature.

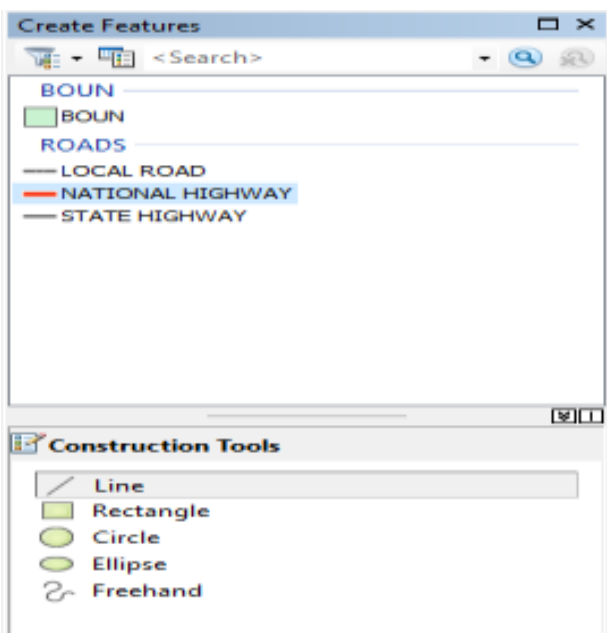


Fig.2 Create feature dialogue box

Digitized map of the bus routes are given blow in Fig. 3

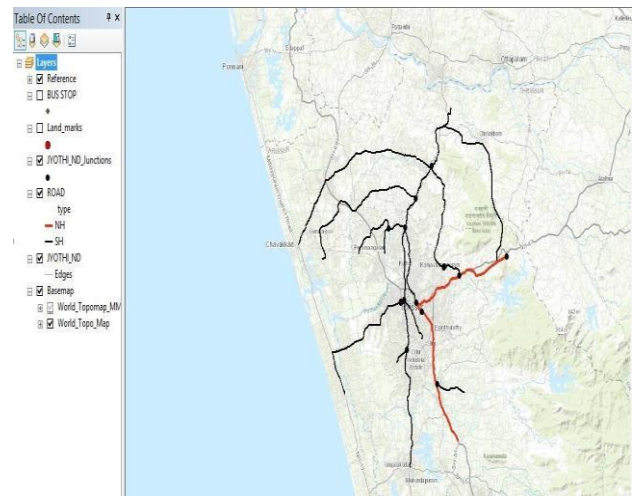


Fig.3 Digitized map of the bus routes

Database creation

Database creation is one of the most important part in the analysis. Marked the major junctions,distance to reach each junction from the origin, etc. This is done by adding required number of fields and entering the data for all the features in their corresponding records.Recently there are 18 college buses within the Thrissur district and 3 of them are towards the Palakkad direction.Created 4 layers, such as landmark, road, road junctions, bus stops for the easiness in the database creation. Input data includes the speed in different roads (for National Highway it is given 80Kmph and for State Highway it is given 60Kmph), demand of students from each stops for the whole route. For adding attribute data to these 4 layers created new feature class. The feature class window is given below in Fig.4 and Fig.5

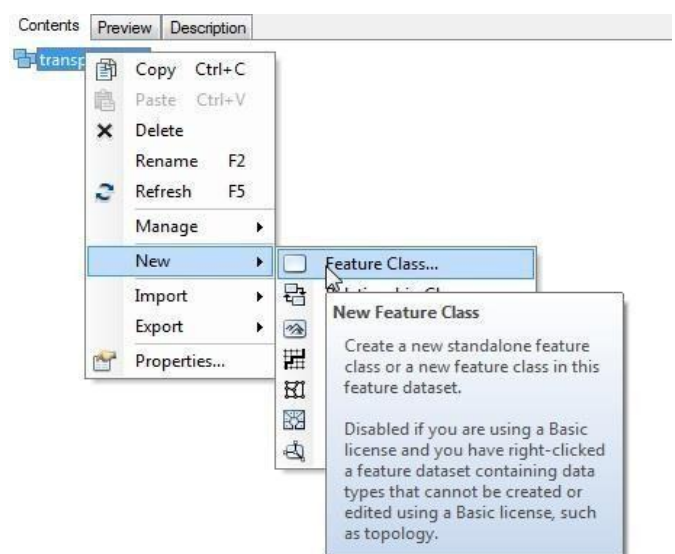


Fig. 4 Creation of new feature class

From the feature class select the appropriate one to create the landmark layer. Then each of the point features were named as stops. By selecting the each point layer it's possible to add the attributes that need to be considered in the analysis. Here the attributes considered are cost, distance and time. The attribute table made for the analysis is given below in the figure 5. While digitization the software itself will calculate the shape length between the features that created for the analysis. There is a possibility of putting impedance / barriers / or the real earth feature in between the stops. But for wide range of survey and observations are needed.

OBJECTID	SHAPE_L	name	type	SHAPE_Length	SPEED	LENGTH	TRAVEL_TIME
19	181	Payyole	chub	6162.071719	60	6.100358	6.100358
20	181	Payyole	chub	5063.542445	60	5.053664	5.053664
21	181	Payyole	chub	5471.652217	60	5.471652	5.471652
22	181	Payyole	chub	2945.740562	60	2.945741	2.945741
23	181	Payyole	chub	14871.208995	60	14.871217	0.248217
24	181	Payyole	chub	5068.493711	60	5.068493	5.068493
25	181	Payyole	chub	6113.58860	60	6.113588	6.113588
26	181	Payyole	chub	5113.58860	60	5.113588	5.113588
27	181	Payyole	chub	19992.074714	60	19.992074	0.260359
28	181	Payyole	chub	5113.58860	60	5.113588	5.113588
29	181	Payyole	chub	723.52355	60	0.723523	0.723523
30	181	Payyole	chub	6089.794189	60	6.089794	6.089794
31	181	Payyole	chub	6089.794189	60	6.089794	6.089794
32	181	Payyole	chub	6089.794189	60	6.089794	6.089794
33	181	Payyole	chub	5400.208484	60	5.400209	0.065213
34	181	Payyole	chub	5476.807018	60	5.476807	0.043467
35	181	Payyole	chub	5979.6111	60	5.979777	0.007113
36	181	Payyole	chub	2089.277232	60	2.089272	0.009464
37	181	Payyole	chub	3528.27548	60	3.528275	0.007717
38	181	Payyole	chub	1079.495311	60	1.079454	0.009216
39	181	Payyole	chub	2876.177817	60	2.876178	0.044021
40	181	Payyole	chub	2876.177817	60	2.876178	0.044021
41	181	Payyole	chub	4182.277231	60	4.182277	0.009389
42	181	Payyole	chub	2479.198892	60	2.479198	0.009491
43	181	Payyole	chub	2847.856471	60	2.847857	0.048967
44	181	Payyole	chub	4817.104544	60	4.817044	0.005201
45	181	Payyole	chub	266.807163	60	0.266807	0.004447
46	181	Payyole	chub	14624.120189	60	14.624121	0.248983
47	181	Payyole	chub	3584.187189	60	3.584189	0.475989
48	181	Payyole	chub	9681.191688	60	9.681192	0.161102
49	181	Payyole	chub	1252.742036	60	1.252742	0.006969
50	181	Payyole	chub	3084.702589	60	3.084725	0.013364

Fig. 5 Attribute Table

4. ROUTE OPTIMIZATION USING NETWORK ANALYST

Route optimization is done by the Arc-GIS tool named network analyst. The Network Analyst toolbox contains tools that perform network analysis and network dataset maintenance. This toolbox, can maintain network datasets that model transportation networks and perform route, closest facility, service area, origin-destination cost matrix, vehicle routing problem, and location-allocation network analyses on transportation networks. The tool box is shown below in Fig.6

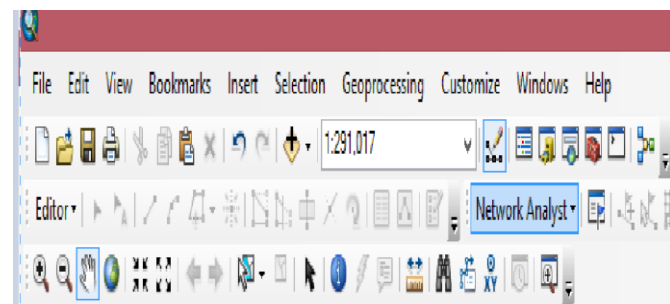


Fig.6 Network Analyst Tool

The above mentioned tool can also selected from the Arc-toolbox also. There are different college buses running to different directions of Thrissur. For finding out the optimized routes need to select two points in the digitized

map. For that the following steps should be followed. (Fig.7 and Fig.8)

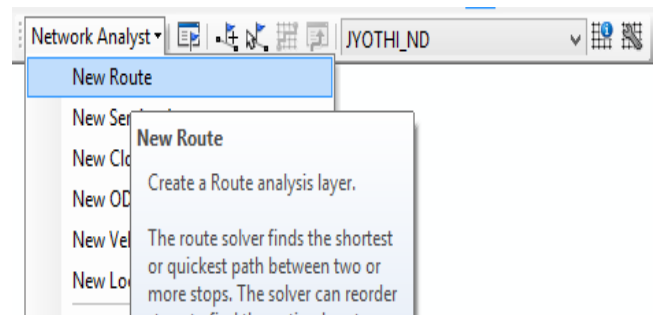


Fig.7 Selection Of New Route

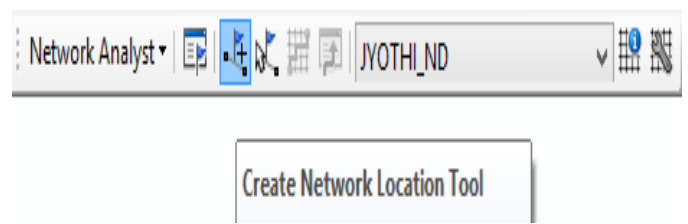


Fig.8 Create Network Location Tool

After selecting the create network location tool ,choose the two places (origin and destination) that is to be optimized(mostly the shortest path between the origin and destination.). The given below figure 9. shows the result when the origin is college and destination is kodakara. (Blue line indicates the shortest path).



Fig. 9 Shortest Path (Jyothi Engineering College ToKodakara)

5.0 RESULT AND CONCLUSIONS

All the bus routes were analyzed with the above given procedure by assigning the attributes distance, time, demand from each stops (considered as impedance) and with the help of network analyst, it's found that the existing bus routes are optimum based on the travel time and distance aspect. To achieve an optimized route in distance and time aspect, need to analyses the each bus routes separately with the help of "Vehicle routing problem "in the network analyst tool. Alternate routes can be suggested but the demand from those sides are less. So it will not be profitable decision, hence difficult to implement.

6.0 References

- i. Abousaeidi, M., Fauzi, R. and Muhamad, R. (2015), "Geographic Information System (GIS) modeling approach to determine the fastest delivery routes" Saudi Journal of Biological Sciences
- ii. Amria, K. and Sitanggang, I.S. (2015), "A Geographic Information System for hotspot occurrences classification in Riau Province Indonesia", *Procedia Environmental Sciences* 24, pp.127 – 131.
- iii. M.A. HannanMahmuda Akhtar b, R.A. Begum c, H. Basri b, A. Hussain d, Edgar Scavino-2018; "Capacitated vehicle-routing problem model for scheduled solid waste collection and route optimization using PSO algorithm"
- iv. Sandeep Kumar Gupta, Prof. R.K. Bhatia² – 2017-Volume3; "A Review on Route Optimization of Municipal Solid Waste Collection in Jabalpur city using ARC GIS"
- v. Slesha N. Desai, Mitali Shah, PayalZaveri - "Route Optimisation for Solid Waste Management using ArcGIS Network Analyst: A Review" Volume5- Issue 1-2018
- vi. Patil, N.B. and Nalawade, S.S (2016), "Applications of GIS to Smart Cities", ISSN, Vol.4, Issue3