

Optimization of Bus stop locations using GIS as a tool for Chennai city- A case study

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Introduction

The Cities in India are growing considerably at a faster rate with the suburbs thriving at a rapid rate. Chennai is also no exception for such development. The problems of congestion and overcrowding are common predicament in urban life. This situation force the planners to evolve with new strategies and ideas for meeting the requirements of the population which is steadily increasing quantitatively and also having a rapid shift in the cultural pattern which influence much on the living style of the people.

Transportation network can be rightly stated as the lifelines of the people that connect both urban and rural areas. In Metropolitan cities, public transport especially the corporation buses caters to the need of all the sections of the society irrespective of their economic status. On considering all the above mentioned factors it is apparent that the use of GIS would ensure optimum utilization of available resources for development of transport network.

Defining the problem:

The problem presented here is the location of bus stops. Are the bus stop location conducive for everyone? Any facility could not meet the need of each and every individual, here comes the optimization principle where maximum comfort and convenience could be given to the public by proper planning, which can be effectively done using GIS by considering the apposite parameters. The location of bus stops and the walking distance to those stops are of great concern.

The following defects were observed in the present locations of the bus stops:

- i) In certain areas, the bus stops are closely located resulting in waste of time and space.
- ii) In many areas the bus stops are sparsely sited forcing the people to walk long distances or to take other modes of transport.
- iii) Some bus stop locations are found to be hazardous posing danger to other vehicles and may also cause traffic congestion.

Description of City:

The Chennai City, the capital of Tamil Nadu State is the fourth largest city in India. Chennai is situated in the 13th north parallel and 80° longitude, along the Coromandel Coast in the southern part of the Indian peninsula .

The present area of this Metropolitan city is 170 sq.km. with a population of about 6 million. As per the 2001 Census density of population is roughly about 24,000 persons per square kilometer .

Public Transport

Chennai's MTC (Metropolitan Transport Corporation) Bus service provides a network that covers the entire city. This service, operating from 4.00 am to roundabout midnight, is affordable and frequent. Apart from the regular buses, there is Limited Stop services, Express services and Point-to-point services, circular route services. It is necessary to guarantee that all these services serve the people.

Advantages of the present study:

Some studies carried out in this area are based on conventional methods of data collection and analysis. So the proposed study has the advantage of using advanced methods of data collection such as the use of GPS for the collection of co-ordinates and the use of GIS for the spatial analysis which offers the following advantages.

- Graphical and attribute data input and editing
- Use of spatially referenced data
- Selective spatial and attribute query

Influencing factors:

There are certain parameters which need to be considered for performing the analysis. Weightages are assigned to each of the parameters based on the existing situation and the requirement of the public. They are arranged according to their degree of importance as

1. Maximum & minimum distance between two successive point locations:
2. Importance of location
3. Density of population
4. Time
5. Availability of infrastructure and finance
6. Willingness to walk
7. Monetary status of the people
8. Site details such as junction points etc.

The maximum distance between two stops is taken to be not more than 2 kilometers, this distance is assigned based on the type of settlement, the study of the landuse pattern gives an understanding about the population, population density and the monetary status. The present study is based mostly on ground data with some amount of sampling and then the data is extended through interpolation technique. The minimum distance is taken as 500 meters.

The above mentioned norms are adhered to as long there are no other forceful factors such as the presence of any imperative location such as hospitals which cannot be ignored. These are vital locations for locating bus stops irrespective of the separable distance between them as they serve the needy who cannot afford other modes of transport. The other important locational data considered are the schools, temples, colleges and other important tourist location.

Willingness to walk is another important criteria which is the underlying factor for making the decision on the distance. In certain cases there may be willingness to walk little extra distance in return for pollution free environment. In these conditions the bus stops are not located in the interior regions.

Density of population is one criterion that is directly proportional to the number of bus stops. There is mutual benefit for both transport corporation and the commuters by increasing the

stops in terms of pecuniary benefit for the former and comforts for the latter covering large population.

The unnecessary loss in time due to extra stops is issue to contemplate upon and make analysis.

In a developing country like India every advancement depends upon the funds available. This influencing factor is considered as there is huge need of finance for the development of infrastructure such as laying of good, strong roads. The road grade is essential for having bus routes in a particular area. It is not possible to have bus stops in the interior where the grade is poorer. The density of population and the infrastructure go hand in hand, this is the reason for having many bus stops in close proximity in the main roads.

While considering the financial status of the government it is also necessary to consider the status of the public. In a higher middle income, higher income groups the dependency on the public transit system is less making it less imperative to have more bus stops. Conversely the lower income group and the economically weaker section entirely depend upon the corporation buses for their transit.

Finally the locations are graded based on the risk factors. The sites selected should not be near the junctions. Dangerous turnings are avoided. Any positioning that will hinder the normal flow of traffic be avoided.

The factors listed above are not the final list; there are still many more conditions that could be considered, depending upon which the study will be near perfection

Methodology:**Data Collection:**

The case study is based on the data collected on ground using GPS and the map of the road network. Exhaustive work has been done in the field collecting the co-ordinates for each bus stop locations. There are about 41 bus - stops between Vadapalani and Besent nagar, which is the study area. There are about 21 roads in the selected route. The data collection is done taking into consideration the accessibility of the road in both ways. Most of the collateral data are collected manually, which is the scope of development in the future study in the same area.

The network map is digitized. Digitization is done manually using On-screen method. The errors in the original maps will be transferred and they are likely magnified when digitized using GIS. Here arcs and nodes are defined by the user. The advantage here is the ease in the ability to spot

the digitizing errors. Post digitizing process generally includes building topology and cleaning the coverage. Finally the errors are corrected for each of the GIS layers.

Tic points are to be digitized for calculating the accuracy and for performing projection. The control points are collected using the GPS from well-identified, prominent locations such as road junctions, which are distinctly visible on the map. Co-ordinates for control points are collected in more than 4 points, which is the minimum requisite to increase the validity of the data. The tics can also be used for transforming the coverage to the required projection so that real world co-ordinates are obtained for our analysis. The projection used here is polyconic which is considered the best suited for India. Arc View and Arc Info are the softwares used for digitization, transformation/projection and analysis.



Analysis:

After the data collection, the next step is the analysis. The co-ordinates of the bus stops are known using which their positions are determined on to the transformed map to the geographical co-ordinates. These are taken to as point data, which give the bus stop locations. Buffer analysis is made to determine the area of influence. The minimum and maximum distances are given

which are given as buffer distances. If there is overlap in the buffers then a common point can be considered for the location of the stop such that there is no overlap. This point is selected considering other criteria also. Confluence of all parameters is essential before arriving into any decision. The similar way if the distance between two buffers are more this indicate that the area in the in between region is not properly served by any of the bus stops. In this case new bus stops can be created. Thus it is necessary to calculate based on all the parameters that none of the areas are under served or over served.

The route analysis is made; the impedance value and the speed are given based on the vehicular volume on each road. The bus stops can be minimized in roads where there the existing traffic is high, additional positioning of these stops would add up to the traffic congestion. The locations of important centers such as hospitals, schools etc are also estimated for their proximity to the stops using the route analysis module. The time gained due to the reduction of the stops vice versa is also projected by having each location as a node and by giving a positive or negative value for the calculation of impedance. The demographic characteristics are also computed.

Conclusion:

A multi criterion analysis is thus performed taking into consideration all the parameters explained above in detail. It was found that the bus stop location could be changed in some places. In few sites the bus stops were too closely located which results in unnecessary loss in time in space. The area satisfies all the conditions set forth and it is optimal approach to take out that bus stop which was found on our analysis it would reduce the precious travel time of the commuters and also the even more valuable commodity in urban area i.e. the land. Another solution obtained is the optimal location for the creation of new bus stop, that would serve the population that earlier suffered. This way GIS can be used in all the ways to carefully analyze all the criteria and successfully give good solution that is acceptable to everyone.

The study presented above has been made only for a single bus route. This can be extended to the whole of Chennai. The increase in use of high spatial and spectral resolution satellite data for analysis can make the whole job much simpler.

References :

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