Quantification of Land Acquisition for MRTS using GIS

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***Abstract*— Land acquisition is a major hindrance in any MRTS project. Usually the land acquisition required for MRTS projects are determined by conducting extensive field surveys. Adjacent land available is broadly classified into vacant space, agricultural land and built up area. In this study, a method was developed to determine the land acquisition required for the proper widening of monorail corridor using GIS. This method is found to be effective in quantifying the land acquisition.**

Keywords—GIS, Land acquisition, Monorail, MRTS (key words)

I. INTRODUCTION

Monorail is the safest and most viable Mass Rapid Transit system (MRTS) for a state like Kerala. Kerala Monorail Corporation Ltd. (KMCL) was planned to implement monorail project in Thiruvananthapuram. The second phase of the monorail extends from Karamana to Neyyatinkara which is aligned through the National Highway.

Monorail is constructed along the median of the existing road. Corridor width of 22m is required for the construction of monorail including 2m median, 7.5m wide carriage way in both sides and 2m for foot paths [4]. Monorail cannot be aligned outside road median since it evolves construction difficulties and obstruction from other sources such as buildings, trees etc. First step taken by the planners of monorail is to widen the existing road to the required width and align the monorail through the median.

The existing roads in the corridor were not satisfying the corridor width condition. So there is a necessity to acquire the available adjacent land. The land required has to be quantified to determine the cost involved in land acquisition. Land acquisitions needed for the project were usually determined by conducting extensive field surveys. These surveys require large amount of man power and involves large quantity of data.

In this study, a method is developed to determine the land acquisition required for the widening of monorail corridor using Geographic Information System (GIS). The objectives of the study are:

i. To find the shortest path alignment for monorail corridor.
ii. To quantify the land acquisition required in the proposed route.a

The study is limited to the second phase of monorail project in Thiruvananthapuram

II. LITERATURE REVIEW

Liu et.al [3] proposed solution algorithms for the multi-criteria multi-modal shortest path problem.

Alignment options for the MRTS based on travel demand pattern, major activity centres, and the residential neighbourhoods were developed [1]. In this method whole data is maintained in three layers as road network layer, traffic analysis zone layer and public transport layer. Due to the use of powerful graphical display and analysis tools, GIS can serve as an integral component of future studies.

Verma et.al [7] proposed to identify a rail transit corridor in a city which has a potential demand for a new rail based mass transit system. The proposed rail corridor identification model consists of three stages: public transport demand forecasting, creation of corridor link set, and optimization of rail corridor using GIS.

Peter and Liza [5] studied the feasibility of using GIS in transportation planning studies. This study identified transportation needs and evaluate a full range of transportation improvement strategies. The strength of using GIS in a large scale transportation planning study lies in the versatility and ease of use for both the GIS and non-GIS users.

Gilbert et.al [2] examined some modeling issues associated with the design of rapid transit networks, algorithms for alignment and station location and also address the global issue of network assessment. Operational research methods helped in determination of alignments and stations.

III. METHODOLOGY

This section describes the overall methods, techniques and process used to attain the study objectives. This mainly includes the data sources and data preparation methods. The methodology adopted for the study is shown in Fig. 1.

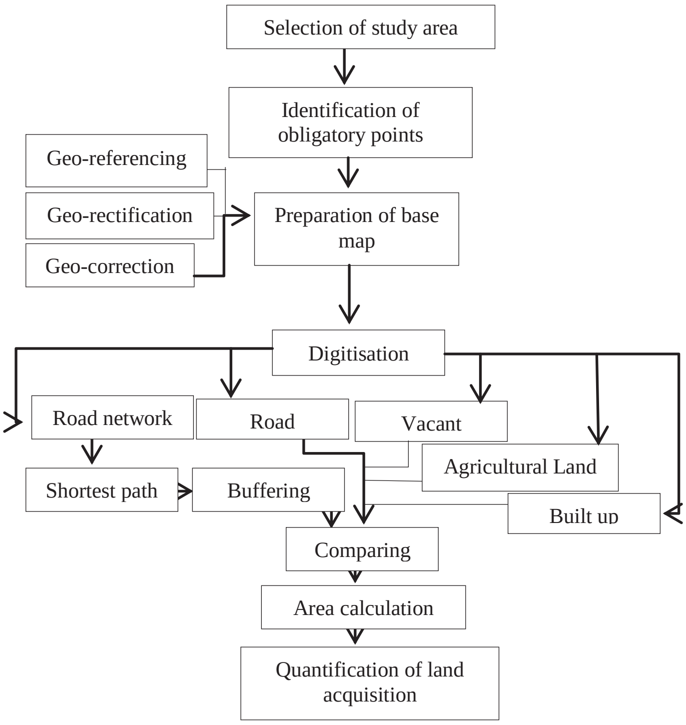

Fig. 1. Flow chart showing the methodology

A. *Selection of study area*

The study area consists of Thiruvananthapuram Corporation, Neyyattinkara Municipality, Venganoor, Kalliyoor, Pallichal and Balaramapuram Panchayaths as shown in Fig. 2.

B. *Identification of obligatory points*

Obligatory points are the approximate station locations identified for the project based on the studies conducted by National Transportation Planning And Research Centre, Thiruvananthapuram(NATPAC). The proposed corridor and obligatory points are shown in Fig. 3.

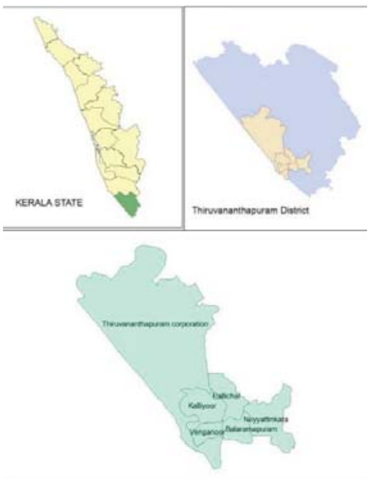

Fig. 2. Study Area

Fig. 3. Proposed corridor and obligatory point

NATPAC have conducted surveys including volume of vehicles at screen line locations, volume of divertable passengers, inventory details of roads and peak hour volume of vehicles at screenline locations in the study area and passengers handled at major bus stops etc. From these studies, 13 obligatory points through which the monorail corridor should pass were identified. They are listed below:

Karamana – Pappanamkode – Karakkamandapam - Vellayani – Pravachambalam - Pallichal – Vedivachamkoil - Balaramapuram - Vazhimikku - Aralumoodu - Pathamkalu - Moonukalumukku - Neyyattinkara[4]

C. *Preparation of base map*

The Google map images used for the study were taken on 19th January 2014. The image taken for a region on a particular date have same spatial, spectral and temporal resolution since it is taken on same date, by same sensor at same height. Necessary corrections for the common errors were done by the image providers. These images of the study area extracted from Google maps were taken as the base map for the study. The images were geo-referenced, geo-rectified and geo-corrected using control points which were taken using GPS to maximum possible accuracy to prepare the base map. Extracted images from Google map were geo-referenced to the geographic coordinate system WGS 84. These geo-referenced images were mosaicked and projected to UTM WGS 84 Zone 43 N. This was then geo-rectified using 125 ground control points. Later the base map was geo-corrected by comparing the actual measurements taken from the ground with the corresponding measurements on the map. Thus the base map which is representative of the actual ground was prepared. The final map prepared had a resolution of 85000 x 70000 pixels having 96dpi.

D. *Digitisation*

Data required for this study includes the digitised features of road network and road as a polygon. These were in vector format which are saved as separate feature classes.

The centre line of the road was digitised to polyline feature class. Road network which comes in a 1km buffer of the proposed corridor was digitized. Combined length of the digitized road network was 23.78 km.

Roads were digitized as a polygon feature for the entire length of road network. This was done to identify the exact width of road according to the base map. Digitised road polygon inclusive of the carriage way, shoulders and drainage which were identified visibly from the base map. Since the base map was geo-corrected the road polygon and road network will represent the measurements in the ground.

Vacant spaces digitised include the barren lands without any vegetation, open spaces etc. Agricultural land includes the vegetated area, cultivable lands etc. Built up area includes all the buildings in the study area. The important buildings like religious places, monuments, cultural sites etc. were excluded from the digitised features. Digitised features in the study area is shown in Fig. 4.

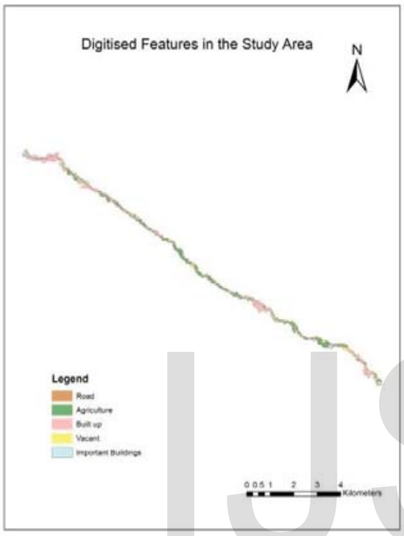

Fig. 4. Digitised features in the study area

E. Identification of shortest path

The alignment having the shortest length is the most economical corridor for an MRTS project. The corridor which passes through all obligatory points was used to identify the shortest path. Shortest path in the existing road network can be found out by the Network Analyst tool in the ArcGIS software. But the output will be shown as only a layer in the ArcMap window, whereas, for further analysis of the identified shortest path it should be saved as a feature class. For this purpose, the shortest path was found out by modifying the standalone Python script provided by the ESRI resource centre. The python script was modified such that it gives the shortest path inclusive of the obligatory points and to save it as a feature class. The shortest path identified using developed script is shown in Fig. 5.

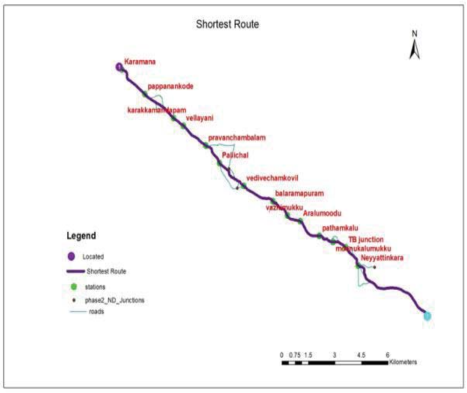

Fig. 5. Identified shortest path including all obligatory points

F. Quantification of land aquisition

Following steps were adopted for quantifying the land acquisition required for MRTS corridor in GIS platform:

- The shortest path saved as a feature class was given as input.
- The shortest path were buffered to 11 m distance on both sides so that the width of the corridor will be 22 m as per the specifications.
- The digitized roads was input as polygon feature.
- The polygon road feature was then overlaid with the buffered shortest path being the input feature using Erase feature tool in ArcGIS.
- Erase Feature tool creates a feature class by overlaying the Input Features with the polygons of the Erase Features. Only those portions of the input features falling outside the erase features outside boundaries are copied to the output feature class.
- The area of the output feature class from Erase feature tool gives the total area of land acquisition needed.
- Buffered shortest path is again overlaid with the merged feature class of road polygon and vacant spaces.
- The area of the feature class obtained is deducted from the total area required for land acquisition which gives the area of vacant space available for the corridor widening.
- Similarly the area of agricultural land and built up area required for corridor widening is computed

Standalone python script was coded to do the above mentioned steps. Standalone python script performed the functions in one step and computed the area of land required for corridor widening with vacant space, agricultural land and built up area. Partial view of the land acquisition required for widening the corridor is given in Fig. 6.

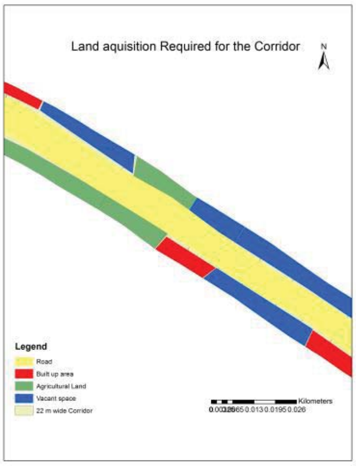

Fig. 6. Partial view of the required land for widening of the corridor

IV. Results and Discussion

A. Land acquisition required

The land acquisition required computed using GIS showed that, for the widening of the monorail corridor, 55787.40 m^2 of built-up area, 37291.86 m^2 of agricultural land and 39871.77 m^2 of vacant space is needed. Land required for the widening of the monorail corridor is given in Fig. 7.

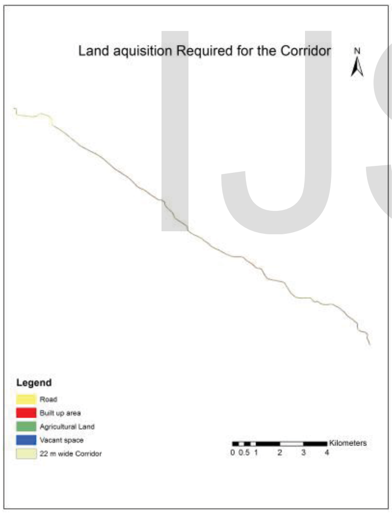

Fig. 7. Map showing acquired land for corridor widening

V. Conclusions

Base map prepared having an accuracy of more than 98% was geo-corrected with field measurements. Shortest route alignment in proposed corridor was found out by using python script considering the obligatory points. For the widening of the monorail corridor, 55787.40 m^2 of built-up area, 37291.86 m^2 of agricultural land and 39871.77 m^2 of vacant space is needed. Accuracy of the results depends on the accuracy of base map and digitization. Developed GIS method was found to be efficient than conventional methods.

Acknowledgment

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