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Development of educational Infrastructure assessment framework: Case Study of Ahmedabad sub-urban Region

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***Abstract*—Education is one of the most commanding instruments for plummeting poverty and inequality and lays a foundation for nonstop economic growth of the country. Planning of an infrastructure system is an iterative process in which engineers try to achieve an optimal solution to achieve design criteria. With the help of powerful and advance tool of GIS, an attempt has been made for mapping and assessment of existing educational infrastructure in context of planning scheme of Ahmedabad Sub-urban region. To locate it at appropriate place to achieve maximum efficiency and coverage all over the area is still a complex problem. It requires large number of factors and assessment to locate it. Therefore, aim of this research was to create a framework to identify the location of educational infrastructure considering in which(facilitate) order to provide infrastructure, location of infrastructure and capacity of infrastructure required for the region including all the factors like population growth in upcoming years, budget, existing infrastructure, Pupil to Class Ratio etc. So, Withthe help of this framework that comprises Geographical information System, location allocation tool, logical condition of the region and probabilistic approach which indicatethat how goal can be achieved is discussed in this paper with a case study of a sub-urban region of Ahmedabad city.**

***Keywords*— write around 5 key words**

I. Introduction

Schools are the most important assets of any educational Infrastructure, which contribute in continuous economic and social growth of the country.Planning and Managing this educational infrastructure projects in the new era of globalization and cost-effective liberalization is a demanding task calling for new abilities and approach [1]. According to Gujarat Education Statistic Report, Primary educational infrastructure in Gujarat is having 1.36 primary to upper primary ratio against the country's average of 2.07. According to educational statistic report, Gujarat state is having the number of primary schools per 1000 child population is 8 compare to India which is having 10. Ensuring the best practices are applied to our national infrastructure. Reasons behind this study is to provide Infrastructure networks that provide the stage for economic and social development. Also, Good quality infrastructure adds towards continuous improvement in asset management practices and the execution of cost-effective lifecycle management strategies.[2] so, Objective of this research paper is to create a decision making tool that helps to take decision where to locate educational infrastructure considering population growth. Geographical Information System (GIS) can be applied use in urban planning as an analytical and modeling tool. It can be applied to a wide range of addressing problems related to data basestructures, decision making and complex analytical models.

II. Background

On the primeval site of Ashaval and Karnavati, Ahmedabad was originated on 1411. Recently, in 2017 World Heritage Committee of UNESCO has declared Ahmedabad as heritage city. Being the heritage city and not planned, its growth is found in a circular manner, getting bigger in all directions. The growth of Ahmedabad city is managed by Ahmedabad Municipal Corporation (AMC) within the municipal corporation area. Ahmedabad Urban Development Authority (AUDA) was established on 1st February. 1978, by the State Government of Gujarat with the leading objective to carry out the persistent planned growth of the area dropping outside the boundary of Ahmedabad Municipal Corporation [3]. The location of infrastructure educational infrastructures are identified by AUDA in their development plan as per the population of relevant area. On the identified sites the educational infrastructure is constructed by Sarva Shiksha Abhiyan (SSA), a project launched by government of India in partnership with state government with objectives to enroll of all children in age group of 6 – 14 years, accessibility (to education), equity (in allocation and consuming the resources for all), their retention and improvement in quality education [4].

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III. Literature review

Lots of studies and research paper are published to elaborate a proper infrastructure assessment framework. This literature review is divided into two parts. 1.) What is the existing assessment framework for the region? 2.) Is there any other framework or assessment methodology adopted world wise for assessment of any infrastructure?[5] There are ample number of papers available which assess the different infrastructure with the different framework and in different region. The assessment of school infrastructure in PaschimMedinipur, West Bengal, India. In which, their objective is to analyze existing educational infrastructure in context of planning scheme [6] The Spatial Data Infrastructure (SDI) framework, which aims to assess many different aspect in a comprehensive and unbiased way. And the results shows that it can be applied to 21 National SDIs and evaluation of application process revels the completeness of data and time needed to measure indicators. With the help of Geographical Information System (GIS) feature of data integration and analysis complex problem can be deciphered with realistic solution. Using GIS in land use planning is a new approach to words the continuous improvement in planning of the infrastructure facility [7]. But, implementation of the analyzed results into the study area is still a constraint for the authority of urban development in India.

IV. Study area

For the study area, Bopal-Ghuma region of Ahmedabad city has been selected, which is a part of Ahmedabad Urban Development Authority, not part of Ahmedabad Municipal Corporation. The region consist of total area of 12.9 km2. Bopal-Ghuma is located at the north-west region of Ahmedabad city, having co-ordinate 23.0337° N & 72.4634° E.

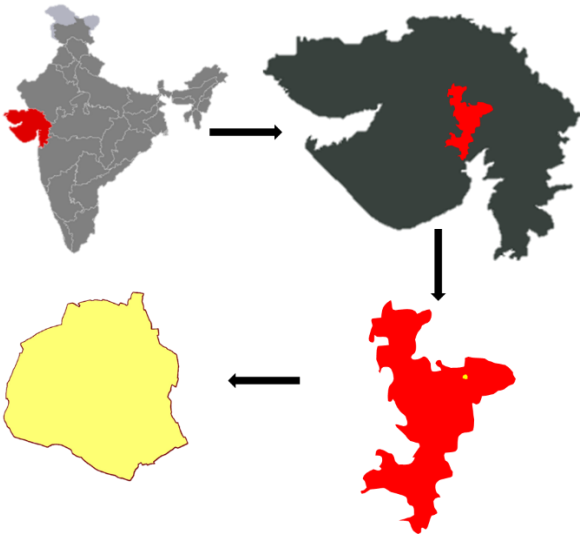


Fig. 1: Study Area

V. Methodology

The analysis is made from the data collected from District Information system for Education and School report card collected from website. The methodology is divided into following tasks.

A. Area Selection

In order to arrive for the city growth, map from the Google Earth Pro of different years is observed. It also provides timeline tool, which indicates the map of different years as per timeline. The map of different years shows that the growth of Bopal-Ghuma area in AUDA region is maximum as per the visual inspection of google map of year 2003, 2008, 2013 & 2018. So Bopal-ghuma area is selected for pilot project study area.

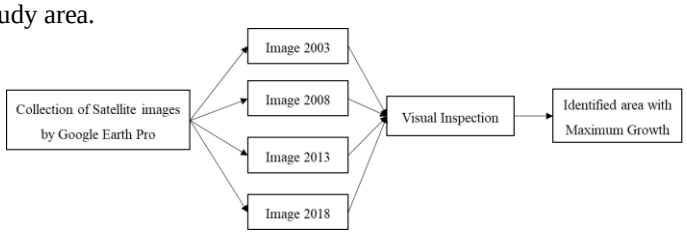


Fig. 2: Area Selection Procedure

B. Data Base Generation

The requirement of educational infrastructure depends on the growth of population within the particular area. It is observed the educational infrastructure is inadequate compare to the population growth of the area [8]. The town-planning scheme of Bopal-Ghuma area is collected and studied. It is also observed from the study carried out of town-planning scheme that the educational infrastructure is mostly not located at the spaces identified by AUDA as per their planning. Latitude and longitude of each schools are derived from the Google Earth Pro. The other requirement for the assessment are School code, enroll students, number of classrooms and other facilities like toilets, drinking water, play area, library, campus development and boundary wall. This data is generated from schoolreportcard.in. An excel file is prepared from the data, which consist following data.

- Latitude
- Longitude
- School Code
- School Name
- Enrolled Students
- No. of Classrooms
- Student to class Ratio

C. Base Layer Creation

For the base layer creation, Google Earth Pro and ArcGIS 10.3 is used, in which 2 layers are prepared.

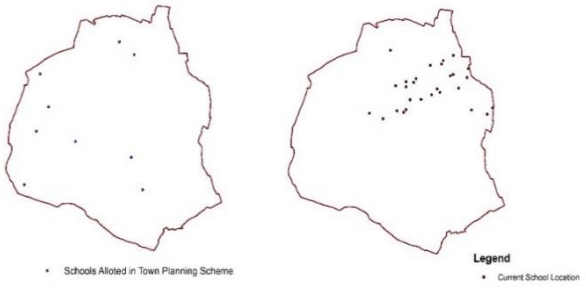


Fig. 3: Base layer creation

First, existing educational infrastructure layer has been prepared. In which, latitude and longitude of existing educational infrastructure is marked on the map and excel file is prepared. After preparation of excel file, it is imported to ArcGIS 10.3 for locating existing educational infrastructure.
Secondly, as the area is increasing in circular manner, a discrete spaces are identified and kept by AUDA to provide educational infrastructure in future. Development plan collected from the AUDA is overlapped over the high resolution image and places are identified and digitized using Google Earth Pro and exported to ArcGIS 10.3.

VI. Assessment and Results

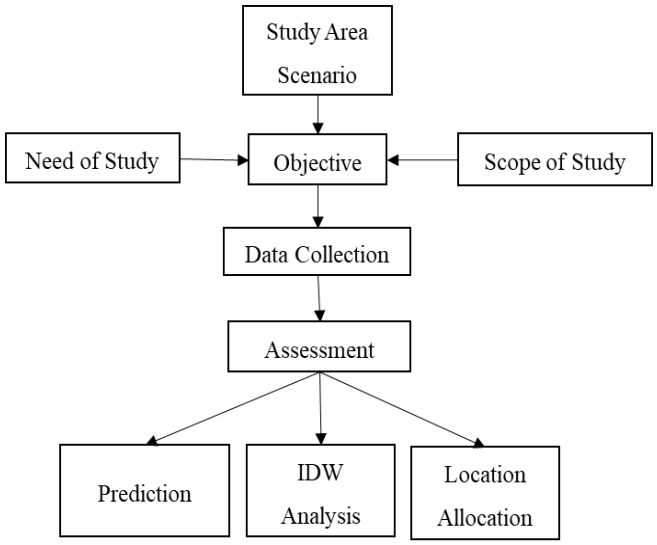


Fig. 4: Flowchart of

A. Prediction of Requirement of Classrooms:

For expected population growth extrapolation is performed for predicting upcoming amount population. With the help of land use usage, logical condition of study area and probability of occurrence expected population can be determined. In population 6 – 14 year age group is responsible for elementary education, which is 10% of total population. From the past year maps area in which city is growing is identified and digitized in google earth pro and imported to ArcGIS 10.3. From that following map is prepared with yearly area growth of the city.

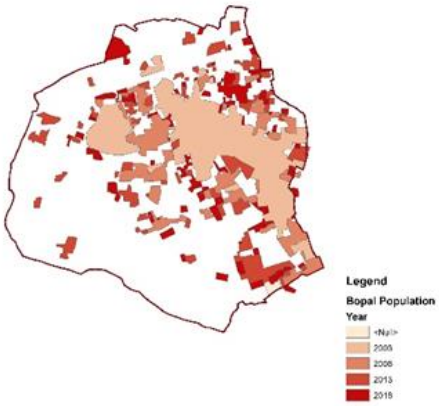


Fig. 5: Digitization of Population

Area growth shown in the above figure is calculated from the ArcGIS 10.3 and table is being prepared with year wise area growth. By extrapolating with 2nd order polynomial we get area growth in year 2023 is 1.22×10^6 m^2. From which 50% area is residential zone and other is for industrial zone, recreational purposes etc. In residential zone 40% area is excluded for margins for roads connections and parking. So, only remaining 60% area is used for construction of residential buildings.

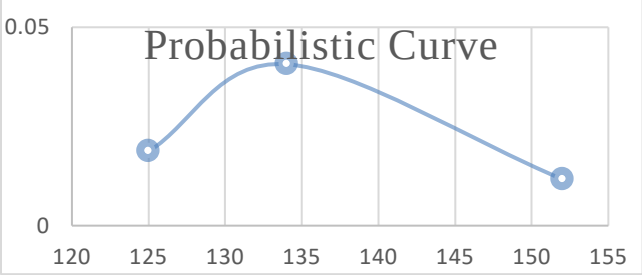
Table 1: Year wise area growth

Year	Area Growth ($\times 10^6$ m^2)
2003	2.066
2008	1.055
2013	0.961
2018	0.760

After extrapolation following probabilistic model is prepared to calculate the amount of classroom required in year 2023 from the area growth. In this section 1.22×10^6 m^2 is horizontal area which is going to develop in upcoming years. But development is not always horizontal, it's vertical also. To include vertical growth Floor Space Index (FSI) factor is introduced and for it's probability of occurrence is derived by land use planning of the study area in this calculation. And theirs values are considered with the help of AUDA regulation, which is collected from development plan of Ahmedabad city prepared by AUDA.

		Probability of Occurrence			Area		
	FSI	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
366000	2.5	0.6	0.35	0.3	549000	320250	274500
366000	4	0.15	0.15	0.4	219600	219600	585600
366000	1.8	0.25	0.5	0.3	164700	329400	197640
				Total Area	933300	869250	1057740
				Flat Area	70	71	72
				No of Flat	13332.86	12242.96	14690.83
				Population	39998.57	36728.87	44072.5
				Children	3999.857	3672.887	4407.25
				No of Classroom	133	122	147

Now, plotting chart of number of classroom to z-curve (Probability Distribution Curve), which elaborate the probability of occurrence of requirement of number of classrooms.



B. IDW Interpolation

After digitizing all the data, Inverse Distance Weighted (IDW) interpolation over the region. In this analysis layer two layer created in ArcGIS 10.3 work as an input for analysis. Following results are obtained after the analysis. Two IDW interpolation analysis are carried out base on pupil to class ratio and number of enroll students in particular educational infrastructure. Following figures show are the results of analysis.

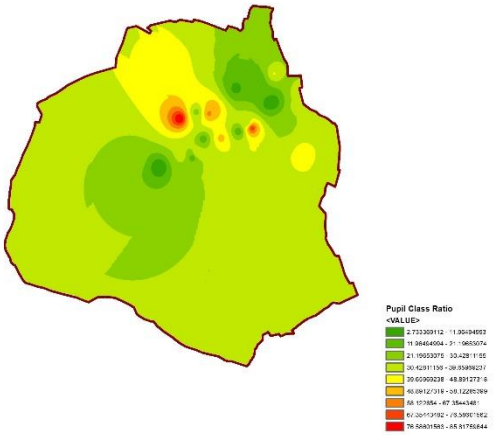


Fig. 6(a): IDW Analysis of Pupil to Class

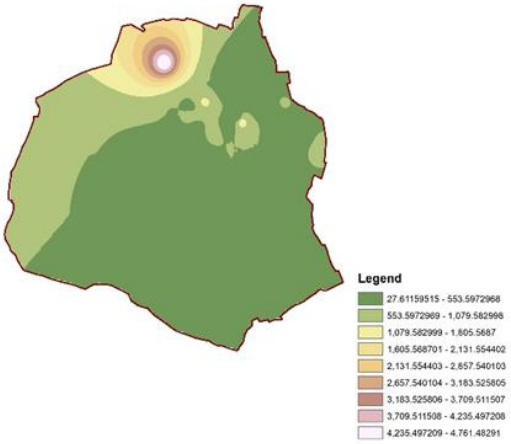


Fig. 6(b): IDW Analysis of no. of Enroll Students

Above figure 6(a) shows that region consist of very unequal distribution of pupil to class ratio. For better quality and efficiency of education, this unevenly distribution should be minimize. Because high pupil to class ratio leads to the high amount of students in class, which will compromise the quality of education.

Above figure 6(b) represent the distribution and direction of number of students enroll in schools, which helps in where to put infrastructure that maximum number of students can enroll to increase literacy rate of the region.

C. Location Allocation

Location Allocation tool is a very powerful tool provided by ArcGIS 10.3, in which location can be selected in such manner that are very close to demand points. So, in this case spaces which are allotted for educational infrastructure are inputted as the candidate facilities, current educational infrastructure is inputted as the required facilities and demand points are the population all over the region. As the population of the region is not available house-wise, with the help of visual inspection whole area is divided in scale of 1 to 20. If the area consist of multi-story buildings 20 value is assigned in the attribute, likewise for the bungalows 5 value is assigned. This scaling is done on the basis of how much population area consist. High population possesses high value vice versa low population possesses low value from the scale. This assessment includes the road network layer as assessment layer, in which constrains are like connectivity of road and infrastructure, one way road, U-turns are allowed etc. considering all of the above constraints following results is presented as an output file of the assessment.

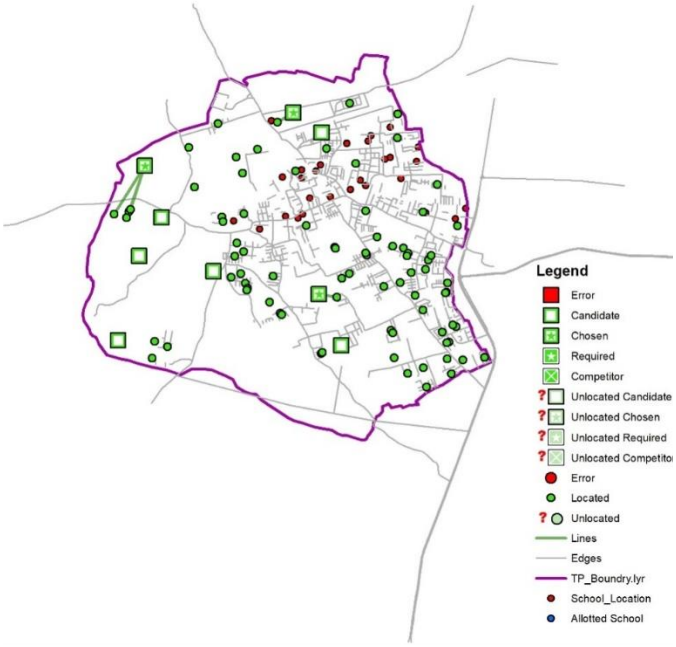


Fig. 7: Location allocation

Now, the question is how to determine the capacity of infrastructure?, as each area is having different population density. To solve this problem also location allocation tool can be used. After the analysis results are shown in figure 7. In this figure location is marked and which points are covered to that school is shown by green line. So, proportionate infrastructure should be implemented into the region. There are total 6 lines presented in the figure. Capacity of infrastructure or classrooms should be provided in weighted average of the classroom. Out of 134 classrooms, 3 schools should be constructed with 90, 22 and 22 classrooms.

VII. Conclusion

The use of GIS in planning of urban infrastructure is influenced by upon representing that current work can be done more efficiently and effectively using GIS than without it. If a GIS approach meets the different criteria set for answering the problems, a GIS can be designed to satisfy the required practices. In context to this paper, the availability of new tool may provide means of reappraising different approach to locate upcoming infrastructure. Figure 8 shows the chart of what are the output of each analysis and integrating all the output how it can be used as the decision making tool. The credibility of GIS lies in the value of the information output generated, their presentation and accuracy, and belief in their reliability. The assessment results showed above are quite realistic and can be implemented in the region. It answers all the question required for execution.

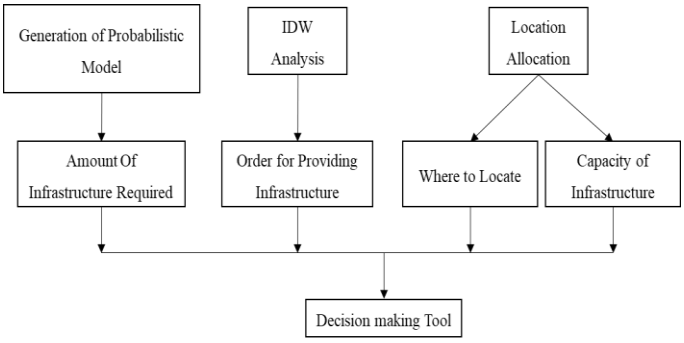


Fig. 8: Flowchart of Output

The applicability is multifarious and provides a very scientific and meaningful platform for participatory planning process.

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