EVALUATING THE PLANNING OF

SOCIAL INFRASTRUCTURES IN AHMEDABAD, INDIA

ILHAMDANIAH
Lecturer
Department of Architecture
Universitas Komputer Indonesia (UNIKOM)
Jalan Dipati Ukur 112-114, Bandung West Java, 40132, Indonesia
E-mail: ilhamdaniah@yahoo.com

Talat MUNSHI
Lecturer
PGM Department
International Institute for Geo-information Science and Earth Observation (ITC)
Hengelosestraat 99 PO Box 6, 7500 AA Enschede, The Netherlands
E-mail: munshi@itc.nl

Sherif AMER
Assistant. Professor
PGM Department
International Institute for Geo-information Science and Earth Observation (ITC)
Hengelosestraat 99 PO Box 6,7500 AA Enschede,The Netherlands
E-mail: amers@itc.nl

Abstract:

This paper describes how simple analytical GIS techniques can be used to support the planning of social infrastructure in Ahmedabad city, India. The planning context in Ahmedabad consists of a micro and a macro level. The social infrastructure is planned for in the context of Town Planning Schemes (TPS) which are micro level land use/land allocation plans for relatively small, mostly peri-urban, areas. At the macro level, the urban development of Ahmedabad is guided by a Development Plan. The problem addressed in this paper arises from the fact that each TPS is planned for on an individual, one by one, basis even if different TPS areas are spatially adjoining. The potential outcome of this way of working is that the spatial distribution of social infrastructure may not be efficient or equitable. The approach developed in this paper evaluates the performance of existing social infrastructure in terms of spatial equity and efficiency and provides suggestions for improvement for a cluster of three adjoining TPS. In doing so it illustrates how GIS-based analytical techniques can be usefully applied in support of more strategic spatial planning of social infrastructure.

Keywords:

Social Infrastructure, Town Planning Scheme, Accessibility, Allocation,

1 INTRODUCTION

1.1 Overview

Cities are considered as engines of growth, within cities infrastructure provision, more specifically social infrastructure provision are important to people.. The low quality or absence of these kinds of infrastructure has a direct impact on living conditions, health and potential for economic development for large parts of the population in rapidly growing cities in developing countries. Creating good quality basic infrastructure therefore is the first and foremost step to achieve sustainability and create healthy living conditions in our cities. Cities in developing countries also have to plan for urban amenities, like physical infrastructures (road, drainage, water supply, electricity, etc) and social infrastructures (school, health care facility, etc) with specific circumstances, like lack of financial support and rapid informal development in urban periphery often leading to deficient poor planning of urban land use and infrastructure.

This paper evaluates the process and provision of infrastructure, especially the planning for social infrastructures in the city of Ahmedabad using GIS-based accessibility analysis and the allocation analysis

1.2 Context

Ahmedabad City is one of the many rapidly developing cities in India. The city is located in the western part of India in Gujarat State. Its population growth rate between 1981 and 1991 was 33. %, from1991 to 2001 it was 28. % and the projected population growth for the years 2001 to 2011 is 25% (AUDA, 1997).

The spatial development of the city is controlled by two authorities. The Ahmedabad Municipal Corporation (AMC) is responsible for the planning in the city core, and the Ahmedabad Urban Development Authority (AUDA) plans for the newly developing peri – urban areas. Urban development is regulated in a hierarchical manner: at the macro scale by a strategic Development Plan which is revised every twenty years; at the micro scale by means of Town Planning Schemes (TPS). A TPS is a method of land development which pools non-urban land, rearranges the irregular plots of land into a regular pattern, reserves part of the land for public space and redistributes the remaining land to the original owners, and provides for physical and social infrastructure (Gurumukhi, 2003).

Social infrastructure provided within the TPS are usually lower order services, such as health care facilities, schools, neighbourhood centres, parks, and open space. Individual planners decide upon the quantity and quality of social in a particular TPS area. Their decision is generally based upon issues such as, for example, the population projection, and the situation in the surrounding area. Therefore, the decision is subjective to the planner who plans the land allocation for each TPS. Furthermore, multiple agencies (staff of AMC, AUDA or private consultant) are involved in developing TPS. Because different agencies work on separate TPS, this results in TPS being prepared in isolation with each other, with none or little coordination with the surrounding TPS areas. This approach can easily lead to a non-optimal distribution of social infrastructure within a TPS area and among adjacent TPS areas. Therefore, there is a need to evaluate whether planned social infrastructure in TPS area is sufficient in quantity and if it is adequately distributed in geographic space.

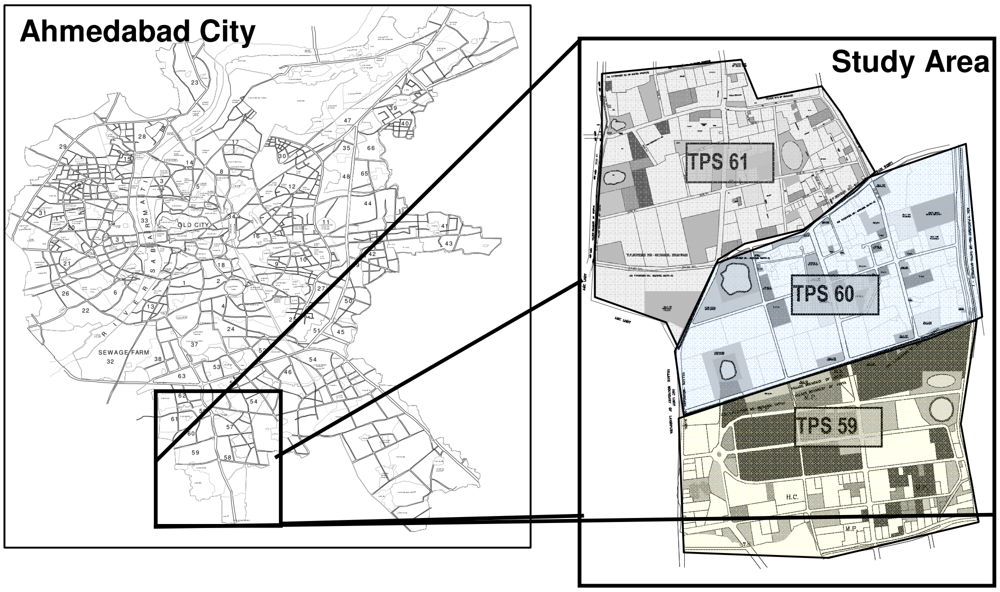

Figure 1: TPS Number 59, 60 and 61 as study area

The data used in the remainder of this article cover only a part of Ahmedabad and consists of the villages Narol and Vatva, which are located in the southern part of the city (See Figure 1). This area used to be an agriculture area and has recently been developed as an extension of a nearby industrial area. Currently, the area is developing rapidly.

1.3 Concepts

Spatial planning of social infrastructure facilities at the intra-urban level concerns the identification of suitable locations for a given number of social facilities in a defined territory, in such a way that the needs of a spatially dispersed population are served in an optimal way. Basic to this type of location planning is the concept of accessibility. Stated in general terms, accessibility relates to the ability of people to overcome the friction of distance to avail themselves of services at fixed points in space.

A very useful framework that introduces the notion of accessibility in the context of service provision is provided by (Moseley 1979). Moseley systematizes accessibility as consisting of three components: (1) people, (2) the activities or opportunities that they require, and (3) the transport or communication link between the two. The strength of this framework is that it makes explicit that accessibility varies according to the characteristics of people, of the activity or opportunity, and of the transportation infrastructure. Accessibility is the outcome of the combined characteristics of the three components mentioned above. Moseley's framework explicitly positions accessibility as a concept consisting of a socio-economic as well as a spatial dimension between which important relationships exist.

In a GIS environment the spatial arrangement of opportunities is normally represented by point locations; attractiveness is mostly measured in terms of variations in size and functional make up. Another important consideration concerns the representation of the spatial variation in demand or need. This requires some form of spatial dis-aggregation: the breaking down of a bounded region into smaller zones, thus grouping people by proximity. For analysis at the intra-urban scale, the definition of spatial units for which demand or need is estimated, can be based upon the boundaries of administrative units (e.g. census tracts, wards). An important motive for using such units is the link to descriptive data (e.g. census data) that can be used to approximate demand or need. A disadvantage is that these units may be arbitrary in size and shape and internally heterogeneous (problem of the ecological fallacy). In the more recent literature, a trend can be observed towards using smaller geographic units, the use of postcode areas in particular. Another approach is to subdivide a study area into a regular tessellation of some kind (squares, hexagons). The advantage of such an approach is the near elimination of the ecological fallacy (Spiekerman and Wegener 2000). A disadvantage is the weaker link to secondary data sources. Friction of movement is normally described in terms of travel mode, time, costs or effort. It can be estimated in GIS environment by Euclidian distance, some modification of it such as, for example, the Manhattan metric, or actual distance/time calculation along a street network (Hanson and Schwab, 1986). The latter is generally considered to give the best approximation (Geertman and Ritsema van Eck 1995).

To determine the best locations of these facilities the concepts of accessibility and reach can applied using greedy model, which is based on the greedy algorithm and can calculate most optimum location from which the largest area can be covered. (Van Der Zwan et al, 2003).

In the context of this study the demand for use of social infrastructure was assumed to originate from individual residing in residential land uses. Because the formation of TPS is based on reallocation of plots; the area of reformulated plots is also dependent upon and vary based the original ownership. The mean value of all the plots was used to determine the unit for analysis which was found to be around 2,500 m^2. The TPS land use map was converted to grid map of equal hexagons having the area of 2, 500 m^2. Assuming that the population of each TPS is equally distributed among the hexagons the population in each TPS in study area was distributed equally and stored as attributes of residential hexagons. The serving capacities of social infrastructure were stored as attributes of hexagon where these were located. To calculate the friction of movement the network distance from centre points of residential hexagon to the social infrastructure facility was considered.

2 ANALYSIS

The framework followed for analyzing the present situation and location of additional social infrastructure services for the present and the future requirements is shown in figure 3.

2.1 Present Provision.

Since the TPS in the case study area already had a land use and infrastructure plan, these plans were checked for the present provision of social infrastructure against the requirement of the present population residing the area. The population figures for year 2001 were available at the ward level in the census book. A population ward has a population of around 100 thousand and can have an area of about 10 TPS. To calculate the population for TPS area, the net residential density in the ward areas was calculate and multiplied by the total residential area in the town planning scheme. Likewise population values school going children and total female population were also determined. Table 1 shows the derived population figures for the three TPS.

Table 1: Population data of study area

TPS No.	Total Population (No.).	Population Density (People/ha)	Total House Holds (No.)	Child Primary School	Child Sec. School	Child 0-6 yrs	Female Population
59	4033	34.94	846	1361	714	469	1668
60	10333	88.27	2261	2759	1350	1484	4060
61	8559	88.27	1873	2286	1188	1229	3363
Total	22925	69.58	4980	6406	3252	3182	9092

Source: Census of India, 2001, Study Estimates.

The Urban Development Plans Formulation and Implementation (UDPFI), Government of India (GOI, 1996) define the standards for infrastructure provision in India. These standards are shown in Table 2 Based on these standards the requirement for social infrastructure in the study area was determined. It was found that the education facilities and nursing home facilities are less in supply whereas neighbourhood centres were in over supply.

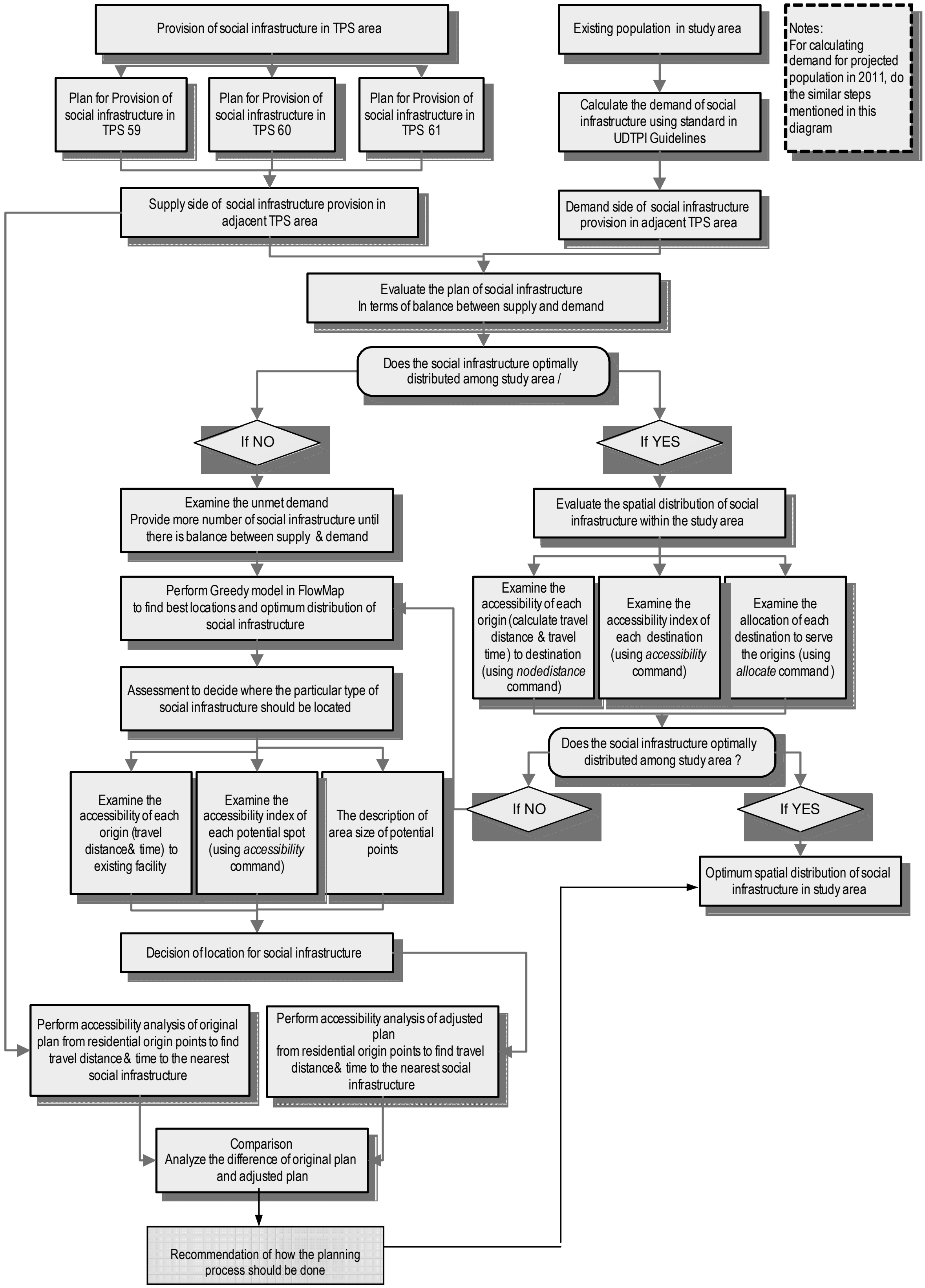

Figure 3: Concept framework

Table 2: Standard of Social Infrastructure Provision in Ahmedabad

Type of Social Infrastructure	Population served by one service (people)	Area Needed per service (m2)
Educational Facility		
Nursery School/Child care	2,500	800
Primary school	5,000	4,000
Secondary school	7,500	16,000
Healthcare facility		
Polyclinic	100,000	3,000
Nursing home/Maternity centre	50,000	3,000
Dispensary	15,000	1,200
Socio-cultural facility		
Neighbourhood room	5,000	660
Neighbourhood hall	15,000	2,000
Meditation/Spiritual centre	100,000	5,000

Source: Rewritten from UDPFI Guidelines

Table 3: Balancing supply and demand for social infrastructure

Type of Social Infrastructure	Demand (m^2)	Supply (m^2)	No of Add. Facilities Required	Supply – Demand (m^2)	Remarks
Educational Facility	20,000	9,321	5	-10,678	lack of supply
Healthcare facility	7,200	1,955	3	-5,244	lack of supply
Socio-cultural facility	12,300	123,827	Nil	111,527	over supply
	39,500	**125,093**		**95,605**	

The location of these facilities with the respect to the minimum distance individuals residing in different residential location have to travel to access the nearest social infrastructure facilities was also checked. The results are shown in Figure 4. Parallel to the statement on less supply of social infrastructure facilities of schools and health services it was observed that these services were also not optimally located. The darker shades in the map show the residential location where individuals residing have to travel longer distance to access social infrastructure facilities. The spatial distribution of planned school was also found to be unequal because TPS 60 has a larger concentration of schools. Mostly all residential areas have high accessibility to neighbourhood centres, since their supply was much higher therefore travel distance and travel time is considerably low and their than their demand.

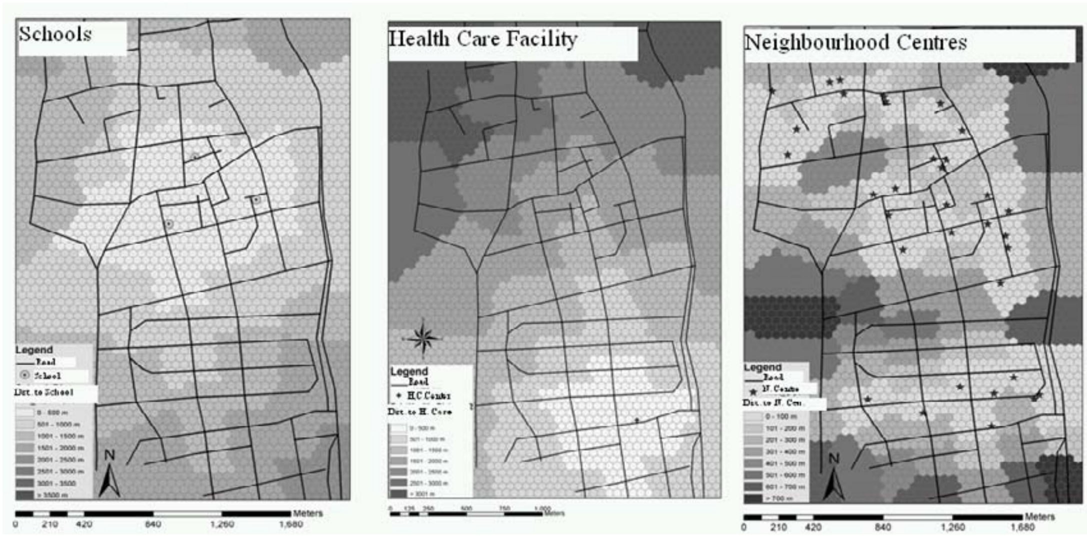

Figure 4 : Travel distance to school, health care facility and community centre

2.2 Planning the Adjusted Allocation of Social Infrastructure

The analysis of the present provision led to the conclusion that the provision of school and health facilities in the existing TPS plans is lower than norms suggested by UDPFI and these were also not optimally located. From the demand calculation, the study area still needed 2 additions of primary schools, 3 new secondary schools, 2 new nursery schools and 1 maternity centre. On the contrary, there were more neighbourhood centres than required. Because the case TPS areas already had a land use plan it was decided to suggest location of new facilities in areas where neighbourhood centres are planned in the existing TPS plans so that the other land use allocation is not disturbed.

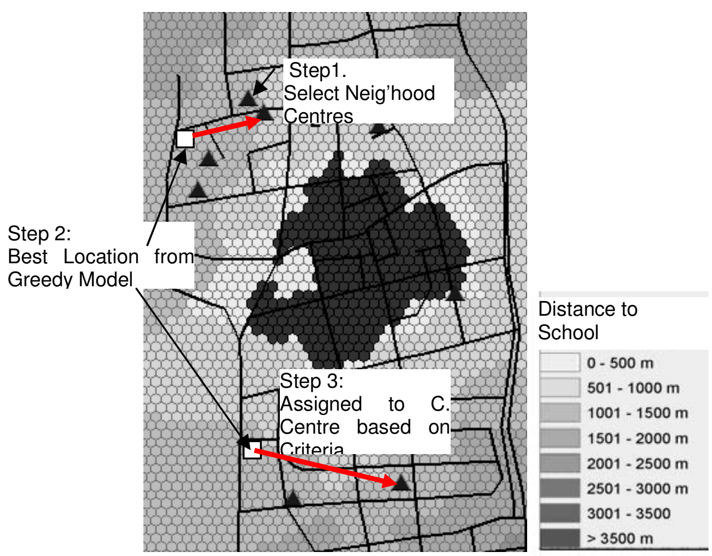

Figure 5: The allocated area to school and potential locations for locating new primary school

Greedy model was used to find best locations to locate primary school, within the reach of 1,500 meter (Figure 5). These were allocated to land by using the criteria that its existing allocated should be for neighbourhood centre; located in the area which is not allocated to school (by allocate analysis using 1500 mt. threshold distance), with a minimum plot size is 4,000 sq. m.(refer to the UDPFI guidelines in table 3). Likewise analysis using Greedy model was performed to find best for secondary school, within the reach of 3,000 meters from each residential origin which are not allocated to school before. Based on the result of *greedy model*, the three best locations are located to the nearest neighbourhood centre were selected which had area larger than 16000 sq. m. The same steps were followed for determining the location for health care facility, but using different parameters, that is, threshold travel distance of 3000 m. and minimum plot size as shown in table 3.

Because the existing plans were adjusted to incorporate new facilities in place of neighbourhood centres the new plans were also checked using accessibility and allocation analysis to find out how much improvement could be achieved in terms of travel distance to the nearest social infrastructure and to its service area. Improvements were observed for certain location in TPS, in terms of reduced travel distance and travel time. Table 4 sums up the improvement achieved in the improved plan.

Table 4: Comparison between Original Plan and the Suggested Plan

Criteria	Original Plan	Suggested Plan
Balancing supply and demand	There was over supply in the provision in neighbourhood centres, lack of other type of social infrastructure.	2 primary schools, 3 secondary schools, 1 nursery, and 1 maternity centre. Total there are 5 primary schools, 3 secondary schools, 2 nursery school, 1 health care, 1 dispensary and 1 maternity care are proposed as suggestions for improvement.
Number of people deprived from the service and served by the service	4657(72%) pupils out of 6,405 have to travel more than 1.5 kilometres to access the nearest primary school. Improper allocation and spatial distribution of health care facilities..	5,140 (80%). pupils out of 6,405 in the suggested plan have to travel less than 1.5 kilometres to access the nearest primary school Better spatial distribution of health care facilities.
Accessibility level from each residential origin	Good Accessibility levels to Neighbourhood Centres,	Improvement in accessibility level to educational facility and health care facility.

3 CONCLUSION

The study demonstrates how simple GIS techniques like accessibility and allocation analysis combined with allocation models like Greedy Model can be used to better allocated and plan social infrastructure facilities. It also demonstrates that such measures can be applied to improve the existing land use and land allocation plans.

REFERENCES

a) Journal papers

Geertman, S. and J. R. Ritsema van Eck (1995). "GIS and models of accessibility potential: an application in planning." International Journal of Geographical Information Systems **9**: 67-80.

Handy, S. L., Niemeier, D.A., (1997). "Measuring Accessibility: An Exploration of Issues and Alternatives." Environment and Planning A 29: 1175 -1194.

Hanson, S. and M. Schwab (1987). Accessibility and intraurban travel. Environment and Planning A. **12:** 735- 748.

Hewko, Jared et al (2002).”Measuring Neighborhood Spatial Accessibility to Urban amenities: Does aggregation Error Matter?”. Environment and Planning A 34 1185-1206.

Ingram, D. R. (1971). "The Concept of Accessibility: A Search for an Operational Form." Regional Studies 5: 101-107.

Knox P.L., (1978).”The intraurban ecology of primary medical care: Patterns of accessibility and their implications”. Environment and Planning A 10: 415-435.

Knox P.L., (1980). “Measure of accessibiliy as social indicators: a note”. Social Indicator Research 7 367-377.

Ottensman J.R., (1994).” Evaluating equity in service delivery in library branches”. Journal of Urban Affairs 16 109-123.

Pacione, (1989). “ Access to urban services- the case of secondary school in Glasgow”. Scottish Geographical Magazine 105 109-123.

Pirie, G. H. (1979). "Measuring Accessibility: A Review and Proposal." Environment and Planning A 11: 299-31.

Ritsema van Eck, J.R., de Jong, T., (1996). “Location profile-based measures as an improvement on accessibility modelling in GIS”. Computers, Environment and Urban Systems 20: 181-190.

Ritsema van Eck, J.R., de Jong, T., (1999). "Accessibility Analysis and Spatial Competition Effects in the Context of GIS-Supported Service Location Planning". Computers, Environment and Urban Systems 23: 75-89.

Spiekerman, K. and M. Wegener (2000). Freedom from the tyrrany of zones: towards new GIS-based spatial models. Spatial models and GIS. A. S. Fotheringham and M. Wegener. London, Taylor and Francis**:** 45-60.

Talen E., Anselin L., (1998). “ Assessing Spatial Equity: An Evaluation of Measures of accessibility to Public Playgrounds”. Environment and Planning A 30 595-613.

Truelove, (1993). “Measurement of spatial equity”. Environment and Planning C: Government and Policy 11 19-34.

b) Papers presented to conferences

Gurumukhi K.T. (2003). Land Pooling Technique: A Tool for Plan Implementation – An Indian Experience. Map India Conference.

Munshi, T., Belal, W.E. and Dijst, M. (2004) Public transport provision in Ahmedabad, India : accessibility to work place. In: Proceedings of the 10th international conference on urban transport and the enviroment in the 21st century: Urban transport X., Dresden, 20 May 2004 / Southampton: Witpress, 2004. pp. 343-354

c) Other documents

Ahmedabad Urban Development Authority (1997) Revised Development Plan of AUDA 2011. Ahmedabad, India.

Geurs, K. T., Ritsema van Eck, J.R. (2001). Accessibility Measures: Review and Applications. Bilthoven, National Institute of Public Health and the Environment.

Moseley, M. J. (1979). Accessibility: the rural challenge. London, Methuen and Co.

Van Der Zwan. J et al (2003), FlowMap Manual, Faculty of Geographical Sciences, University of Utrecht, The Netherlands.