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Social and Institutional Infrastructural Sufficiency Model Development using GIS

Arun Pillai
Pillai HOC College of Engineering & Technology
Rasayani, Maharashtra, India.

Dr. Shrikant Charhate
Pillai HOC College of Engineering & Technology
Rasayani, Maharashtra, India.

***Abstract*- This paper depicts how simple analytical tools of Geographic Information System (GIS) can be utilized to fortify the planning of social and institutional infrastructure. The study area selected was Nerul and Vashi nodes of Navi Mumbai, Maharashtra, India. The purpose of the study was to assess the current status of social and institutional infrastructure in terms of spatial distribution and to propose improvements to enhance the current status of social and institutional infrastructure by using GIS tools. The spatial distribution of the social and institutional facility was assessed to figure out the social level of the facilities. The improvement of the plan was proposed by recommending appropriate location for new social and institutional facilities. Analysis of facility provision (social and institutional infrastructure) is greatly useful for long term planning as they fortify the distribution and reservation of land for different uses including open space and facilities inside a planning region. This study is helpful in deciding the planning aspects and urban policy. In doing so it illustrates how GIS-based analytical tools can be effectively utilized in preparing more strategic spatial development planning of social and institutional infrastructure in the study area.**

Keywords- Geographic Information System (GIS), Institutional Infrastructure, Location Allocation model, Social Infrastructure, Urban Planning.

I. INTRODUCTION

The social infrastructures are administrations which are given a goal to enhance the social welfare of the general population. The social infrastructures generally incorporate education, health, police and fire protection and an assortment of cultural and recreational services. The performance of social and institutional infrastructure thoroughly relies upon the availability of spaces, the quantity of population it serves and the location distribution of administrations. Lack of availability of spatial distribution leads to low accessibility level for the general population to get to the social and institutional facilities. Sometimes inundating quantity of individuals to be served by one social and institutional facility prompts low service level of one specific social and institutional facility. This low performance may impact the richness of inhabitant's life. By taking health care and education facility as a case of social infrastructure, this study endeavour to build-up a strategy to plan social and institutional infrastructure by utilizing geographic information system (GIS) as a tool of analysis.

Pacione (1989) explains how physical access to urban services and facilities is a major component of quality of life and a key ingredient of people's real income. It is concluded that to promote an equitable distribution of urban services must also consider the socio- political processes which constrain the quantity and quality of resources available. M Truelove (1993) explains how the spatial equity of a facility system can be measured and the problems associated with the measurement of spatial equity. Talen E. and Anselin L. (1998) carried out a spatial analytical perspective to evaluate the importance of methodology in assessing the distribution of urban public services by means of an empirical case study of the spatial distribution of playgrounds in Tulsa, Oklahoma, on the basis of the targeted constituencies (children) and other socioeconomic indicators. Ilhamdaniah, Talat Munshi and Sherif Amer (2004) describe how simple analytical GIS techniques can be used to support the planning of social infrastructure in Ahmadabad city, India. 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. The study was carried out in commuter accessibility indicators by A Juan Carlos Martin and Bert Van Wee (2011) focusing on the travel cost and spatial interactions. Similar Study was carried out by Steve Abley and Derek Halden (2013) how accessibility could be measured and quantified in New Zealand considering the experiences of other countries which was important to setting up the policy and the success of those approaches. Sama'ila Saleh (2013) used GIS-base urban traffic network analysis of Abuja, the federal capital city of Nigeria. the GIS was used to handling data and working for the network, modeling the connectivity. It also helps in finding the best route, finding the closest facility, finding the service area and creating the o-d cost matrix.

Navi Mumbai is one of the urban communities in Maharashtra, India serves as a study region for the proposed approach of this paper. Two nodes of Navi Mumbai namely Vashi and Nerul have been selected as study area, where Vashi is the oldest developed node and after that Nerul was developed. So this paper is an endeavour to enhance the performance of existing social and institutional infrastructure i.e. health care and educational facility, for advancement in serving the developing demand of the general population in the future by appropriate planning. The target of this study is to enhance individual's access to social and institutional infrastructures in the planned nodes of Navi Mumbai.

II. METHODOLOGY AND STUDY AREA

The paper assesses the subsisting provision of social and institutional infrastructures and further proposes improvement for its ideal social and institutional infrastructure provision in Vashi and Nerul node of Navi Mumbai, Maharashtra, India. The provision of social and institutional infrastructure is related with how well they can serve the general population furthermore related with what number of individuals can get to these social and institutional infrastructures. The assessment of existing social and institutional infrastructure provision is

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directed by checking accessibility level of individuals to reach the existing social and institutional facility and in addition checking the quantity of individuals which could be served by existing facility. This paper likewise surveys the social and institutional infrastructure as showed in current nodal plan and helps to overcome the issues regarding social and institutional infrastructure provision. The educational and health care facility provision is done by few strategies like accessibility analysis and location-allocation model.

The paper recommends the plan adjustment to serve population in terms of proposing new location setup to enhance the geographical accessibility. Endeavor to proposing new ideal locations of social and institutional facilities in integration to existing facilities is done using location-allocation model. It minimizes the aggregate travel distance to the facility and boosts the quantity of population served within the service distance. The Fig. 1 elaborates the study outline of the paper.

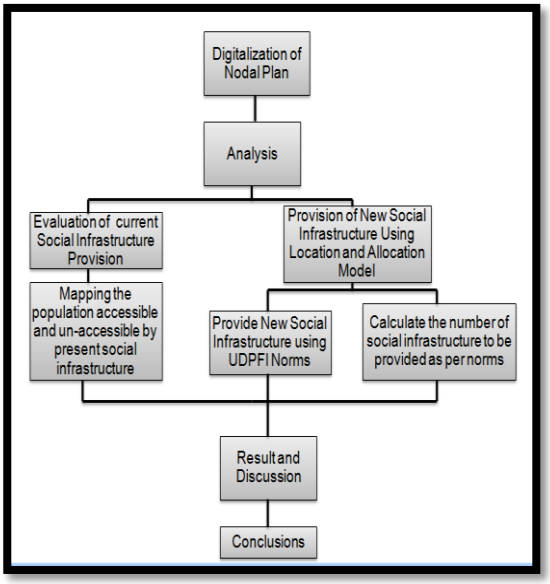

Fig 1: Study outline

Study Area:

Navi Mumbai is a planned township of Mumbai off the west coast of the India in the state of Maharashtra. Navi Mumbai has a population of 11,19,477 as per the 2011 provisional census. It was mooted in 1971 to be a new urban township of Mumbai by the Government of Maharashtra. For this purpose a new public sector undertaking was established that is CIDCO. CIDCO carved out 14 small nodes with a view towards facilitating comprehensive development. These nodes are named Airoli, Ghansoli, Kopar Khairane, Vashi, Sanpada, Nerul, CBD Belapur, Kharghar, Kamothe, New Panvel, Kalamboli, Ulwe, Dronagiri, Taloja, Karanjade. Navi Mumbai is situated across two districts namely Thane and Raigad.

The Vashi and Nerul nodes have been selected as the study area because they are the oldest and already developed node of Navi Mumbai, so to enhance the performance of existing social and institutional infrastructure without disturbing the current development plan, for serving the developing demand of the growing population by appropriate planning.

Nerul node is a residential and commercial node of the city of Mumbai. It consists of more than 50 sectors. It is one of the biggest, and most populated residential nodes of the city. Nerul along with Seawoods are the second most developed zone of New Mumbai after Vashi. Nerul along with Seawoods-Dharave is one of the most expensive, promising and developing realty locales in the satellite city. Nerul has a huge floating and residential population moving in from South Mumbai and the western suburbs, making it more up market by the day. The nodal plan of Nerul is as shown in Fig. 2.

Vashi node is divided into sectors 1 through 30. Sectors 1 to 8 consist of residential buildings, sectors 9 to 29 have combined residential and commercial, educational institutions; Sector 17 is a prominent residential, commercial as well as shopping area. Sector 30 is home to many malls, information technology parks, 5-star hotels and an exhibition centre and the railway station. The APMC (Agricultural Produce Market Committee) market, one of the largest markets in India is in and around Sector 19. The nodal plan of Vashi is as shown in Fig.3.

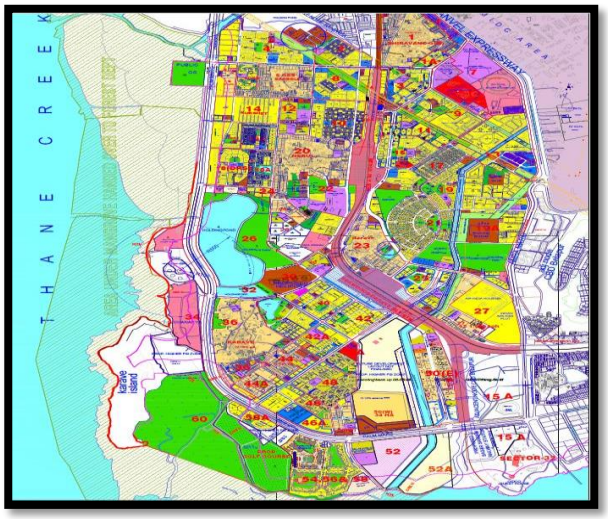

Fig 2: Nodal Plan of Nerul [Source: www.cidco.maharashtra.gov.in]

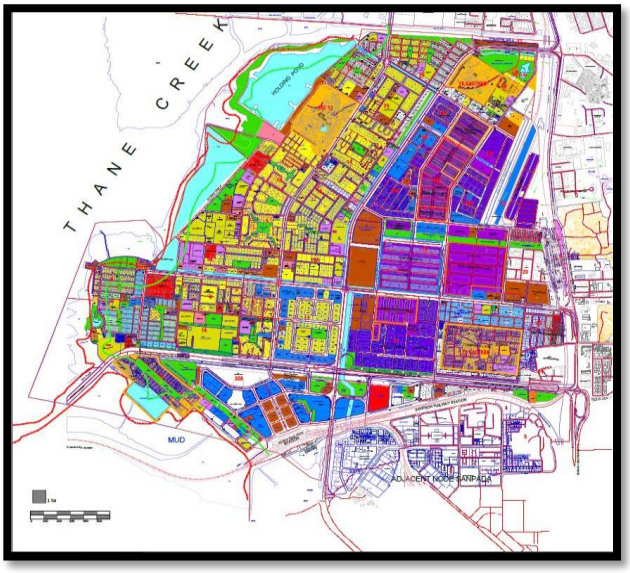

Fig 3: Nodal Plan of Vashi [Source: www.cidco.maharashtra.gov.in]

III. ANALYSIS AND RESULTS

Current Provision:

The current study area already had a land use and social and institutional infrastructure plan. By using QGIS Lyon

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2.12.3 software these plan where checked for current provision of social and institutional infrastructure against the population residing in the area. The accessible population to social and institutional facility at a walk able distance was found out by buffering the area of 500m radius around the facility. The population residing within the 500m radius is accessible to social and institutional facility and the remaining population is un-accessible at a walk able distance. The Fig. 4, Fig. 5 shows the accessibility of the current school. Same procedure is carried out for hospital facilities in Nerul and Vashi Node.

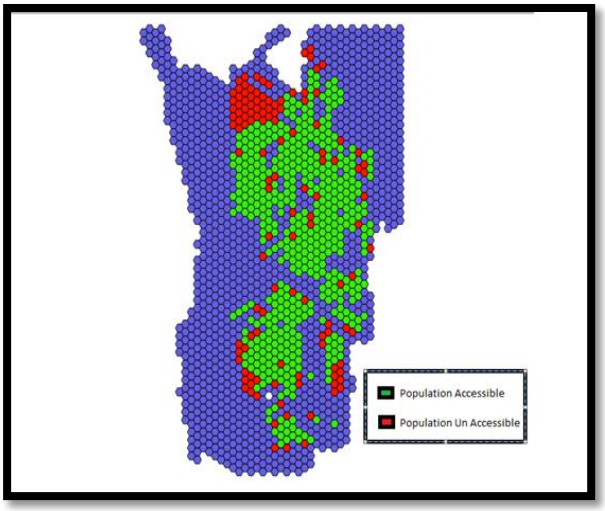

Fig 4: Accessibility of population in schools of Nerul

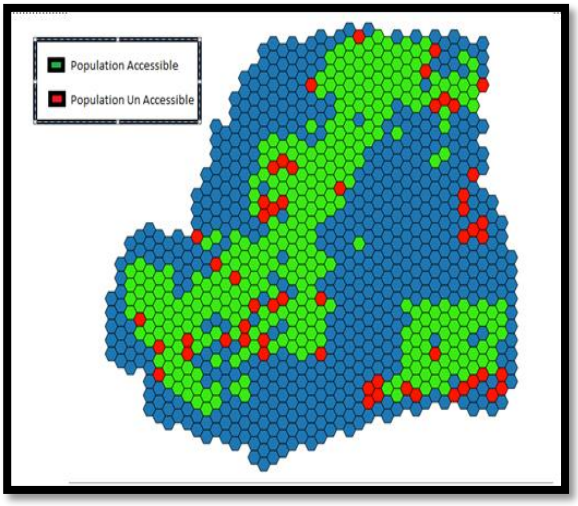

Fig 5: Accessibility of population in schools of Vashi

The result of population accessible to the schools and hospitals facilities of Nerul and Vashi node are as shown in Table 1, Table 2.

Table 1: Population accessible to the School

Sr. No.	Node Name	Total School Population	Population Accessible	Population Un-Accessible	% Accessible
1.	Nerul	37,489	35,866	1,623	96%
2.	Vashi	27,932	26,168	1,764	94%

Table 2: Population accessible to the Hospital

Sr. No.	Node Name	Total Population	Population Accessible	Population Un-Accessible	% Accessible
1.	Nerul	2,33,222	1,88,319	44,903	81%
2.	Vashi	1,73,774	1,06,417	67,357	61%

Summary:

QGIS Lyon 2.12.3 was used to locate various infrastructure facilities available and the result shows the current status of the social and institutional infrastructure of Nerul and Vashi node of Navi Mumbai. In the near future, the uncovered population in these nodes will experience vast population growth. The current educational and healthcare facility in these nodes needs consideration, since they are serving individuals beyond their ability and can't serve the developing population satisfactorily. For improving this current service condition of social and institutional infrastructure, more facilities to be provided at the location where the subsisting facility no longer serve the entire population in its coverage radius.

IV. FUTURE PROVISION

Population forecasting: Mean incremental increase method:

Design of social and institutional infrastructure depends on the anticipated population of the study area, assessed for the design time frame. The underestimated value will make system insufficient for the reason planned and overestimated value will make it expensive. By using the mean incremental increase method, the present 2016 and future 2031 population record is obtained from the 2011 census population records. The graphical result of the projected population is as shown in Fig 6.

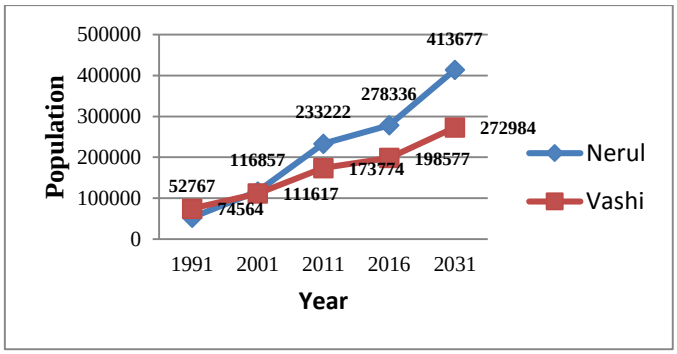

Fig 6: Population growth in Nerul and Vashi node

Urban Development Plans Formulation and Implementation:

The Urban Development Plans Formulation and Implementation (UDPFI), Government of India (GOI, 1996) defines the standards for infrastructure provision in India. These standards are shown in Table 3 based on these standards, the requirement for social infrastructure in the study area was determined.

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Table 3: UDPFI Guidelines (Source: http://moud.gov.in/urdpfi)

Type of Social Infrastructure	Population served by one service (people)	Area Needed per service (m^2)
Educational Facility		
Nursery School/Child care	2500	800
Primary school	5000	4000
Secondary school	7500	18000
Integrated School	100000	35000
School for physically challenged	45000	7000
Healthcare facility		
Polyclinic	100000	3000
Nursing home/Maternity centre	100000	3000
Dispensary	15000	1200
Intermediate Hospital	100000	37000
Veterinary Hospitals for pets and animals	500000	2000
Socio-cultural facility		
Community hall	5000	750
Meditation/Spiritual centre	100000	5000
Recreational club	100000	10000

The balancing of the social and institutional infrastructure is done using UDPFI guidelines as shown in Table 4.

Table 4: Balancing of the social and institutional infrastructure

Type of social facility	Node	Demand (m^2)	Provided (m^2)	Provided-Demand (m^2)	Remark	Facility added
School	Nerul	144786.95	121070.35	-23716.60	Lacking	5
	Vashi	95544.40	134045.51	38501.11	Over	NIl
Hospital	Nerul	153060.49	153060.49	-135874.79	Lacking	5
	Vashi	101004.08	123614.15	22610.07	Over	Nil

Location Allocation Model:

The analysis of the present provision led to the result that the provision of social and institutional facilities in the current Nerul nodal plans is lower than the standards recommended by UDPFI and these were also not optimally located. Since the study nodal plan as of now had a land use plan it was decided to suggest location of new social and institutional in the existing Nerul nodal plan so that the other land use allocation is not disturbed. Location allocation model was used to find the best locations to locate new social and institutional facility in Nerul node by using Arcmap 10.2.2. The social and institutional facilities in Nerul node were allocated in the areas where the land is not located to these facilities as shown in Fig.7 and Fig.8.

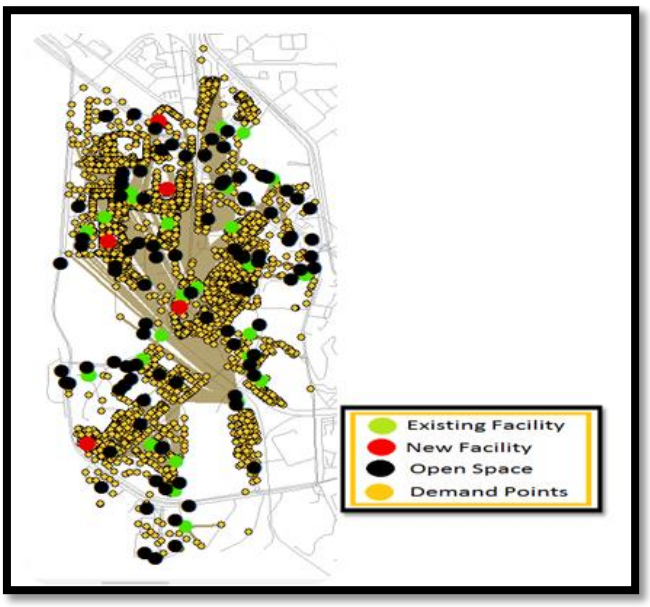

Fig 7: Location Allocation of new schools in Nerul node

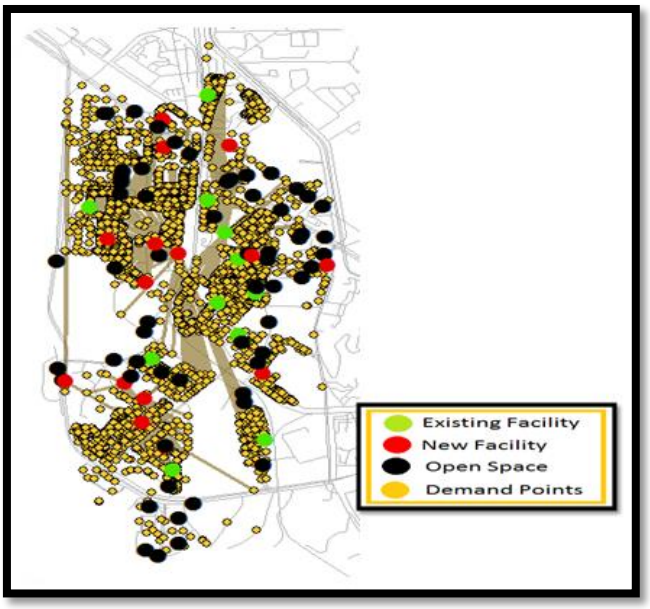

Fig 8: Location Allocation of new Hospitals in Nerul node

V. CONCLUSIONS

The study has been carried out on the two nodes of Navi Mumbai by using Arcmap 10.2.2. This study shows that how the method likes location allocation model can be used for identifying the optimal location for planning additional social and institutional facilities. This would enhance the geographical accessibility of the people residing at these nodes. Location allocation tool can be used as an instrument to assist location planning problem. In the end even though the final decision of social and institutional infrastructures is lying in the hands of decision makers, this input can be an important document for them to decide and to frame policies for urban planning. However the study has got some limitations, so the result will vary depending on the demand and population of various sectors and the facilities to be provided for specific infrastructure.

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