



ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 8.4
IJAR 2021; 7(12): 19-21
www.allresearchjournal.com
Received: 16-10-2021
Accepted: 18-11-2021

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Role of GIS in urban planning in context of Indian smart cities

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Abstract

The pace of urbanization is speeding up in India with an expectation of better facilities and living conditions. Ministry of Urban Development (MoUD) initiated the much laudable national programme for urban India – ‘Smart Cities’, to match the pace of urbanization and further drive economic development. Smart planning, transparency in governance, smart energy, smart infrastructure, smart buildings, smart security, public safety, smart traffic management, smart waste disposal and smart service delivery mechanisms are some of the key components of any smart city. GIS integrates all aspects of city planning and management providing a common operating picture to all. The geographic information system (GIS) offers advanced and user-friendly capabilities for urban planning. This paper is an attempt to explore and illustrates the role and capacity that geo-information and GISs have in the processes of the planning and management of urban regions.

Keywords: geographical information system (GIS), geo informatics, remote sensing, urban planning, smart city, spatial planning

Introduction

Urban planning and management is the technical, social and political process concerned with the design, development and maintenance of land use in an urban environment, which includes attention to air and water quality and the infrastructure into and out of urban areas (e.g. transportation, communication and distribution networks). Urban planning encompasses activities such as strategic thinking, research and analysis, public consultation, urban design and policy implementation whereas urban management mostly consists of tactical and operational issues related to the performance and maintenance of an urban system. The reality of urbanization generates some challenges, among them low-density suburbanization—largely steered by private rather than public interest, and partly facilitated by dependence on car ownership. Urbanization is also energy intensive, contributing dangerously to climate change. Moreover, it generates multiple forms of inequalities, exclusion and deprivation. Often, such urban challenges are exacerbated by urbanization that has been poorly planned and managed. The key objective of adequate urban planning and management is, therefore, to overcome and eradicate the dysfunctions and discontinuities of development. Information, particularly spatial information, plays a fundamental role in the practice of urban planning and management. Most information used by planners is geographic in the sense that it makes use of topographic maps or is linked to a geographic location through a coordinate reference, a street address or an administrative area. A Geographic Information System (GIS) is an information system that integrates, stores, edits, analyses, shares and displays spatial or geographic information. Over the past few decades, these systems have become an increasingly familiar aspect of urban design and planning practice (Maliene *et al.*, 2011) [4]. The increasing use of GISs in urban planning and design holds the promise of enabling a higher quality of quantitative and qualitative data analysis, thereby improving the evidence base of decision-making as well as the knowledge base of the decision-making process. Current progress in GIS technology has created favourable conditions for the development of solution-supporting systems at all stages in the planning and design process – although there is still much work to be done if its promised utility is to be realised (Maliene *et al.*, 2011) [4]. With respect to planning support systems, this has been dubbed the implementation gap (Geertman, 2017) [3].

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GIS – A platform for Smart Cities

As urban areas are getting more crowded and falling increasingly short on future development potential, development of new self-sustaining cities are emerging as an alternate solution to these problems. Technology is at the heart of these new self-sustaining cities enabling automation and real-time integrated city monitoring and management through a network of sensors, cameras, wireless devices and data centers. Also referred to as smart cities, these new self-sustaining cities are a developed urban area that creates sustainable economic development and high quality of life by excelling in multiple key areas like economy, environment, energy efficiency, mobility, governance, people and living conditions. Smart cities, on one hand present a substantial growth opportunity in the coming years while on the other offers various challenges as well. Smart city projects are rather complex with residential and commercial spaces supported by an infrastructure backbone for power, roads, water, drainage and sewage i.e. a virtual living and breathing city. A critical success factor is a need for a common technology platform to enable integration, coordination and synergistic functioning of different participants of the smart city ecosystem.

A centralized information system based on GIS provides an IT framework for maintaining and deploying data and applications throughout every aspect of the city development life cycle.

- **Acquire:** Find the right sites for city development, view legal boundaries, arrive at right valuation of your existing / new sites
- **Planning & Design:** Identify deficiencies and determine optimal solutions. Integrate GIS with most design tools, including Computer Aided Design (CAD), Building Information Modeling (BIM) bringing greater analytics and cost-estimation capabilities to your infrastructure design process
- **Construct:** Integrate project and financial management software with GIS to better manage projects. GIS can provide a single point of entry for all construction-related documents and files
- **Sell:** Understand where and how to market city developments, attract buyers and tenants, and improve retention rates. Analyze demographics and market conditions to provide a more accurate picture of a property's suitability to needs
- **Maintain:** Easily manage disparate assets. Integrate your asset inventory with inspection history and work order management to maintain your critical investments in a cost-effective manner.

GIS Applications for Smart Cities

Site Selection & Land Acquisition: GIS can combine and integrate different types of information to help making better decisions and also provides high quality visualization tools that can improve the understanding and enhance decision making capability w.r.t to site identification, valuation and finally selection. By analyzing location data – proximity to road network, fertility of soil, land use, soil bearing capacity, ground water depth, and vulnerability to disasters such as floods, earthquakes - the real estate organizations can arrive at the right property valuation. By analyzing, mapping, and modeling the merits of one site or location over another can be evaluated. In addition, this can also be used for arriving at appropriate market linked

compensation to owners based on valuation parameters and in rehabilitation and resettlement planning.

Environmental / Legal Compliance: GIS makes meeting regulatory requirements less time consuming and easier to accomplish by providing a common platform for communication with regulators and public. The existing data can be directly connected to a compliance workflow ensuring adherence. Also, GIS-based graphical outputs can help in quickly generate reports that clearly demonstrate how compliance requirements and building bye-laws are being met.

Planning, Design & Visualization: Geo design will be the key framework for conceptualizing and planning for smart cities; it will assist at every stage from project conceptualising to site-analysis, design specifications, stakeholder participation and collaboration, design creation, simulation and evaluation. GIS enables planners to integrate a variety of data from multiple sources like road, sewerage and drinking water and to perform spatial analyses and planning. Utilities can manage and map the location of millions of miles of overhead and underground circuits. By integrating imagery, elevation, and environmental information with the CAD / BIM environment, engineers can continue working with familiar software while gaining access to important GIS data. Design files can be brought into a GIS and linked to financial software for better labor and materials and total project cost estimation. With these types of capabilities, GIS is an essential component of the engineering information systems of the future. A 3D geographic information system can be used to create a realistic simulation of a project, environment, or critical situation. GIS can help increase a facility's sustainability by reducing energy and water use, finding better waste disposal, and decreasing a building's carbon footprint. By managing information both inside and outside buildings down to the asset level, GIS can help in for example differentiating the environmental impact of development, planning and evaluating neighborhood patterns and design, estimate the "walkability" for LEED-ND projects based data on streets, pedestrian routes, bicycle routes, transit accessibility, building entrances, and a variety of other factors.

Construction & Project Management: GIS, integrated with project management and financial software provides a comprehensive view of projects and their current status and helps in tracking performance. GIS helps organize all relevant project information, from soil data, and geotechnical studies to planning, environmental studies, engineering drawings, project maps, inventory and asset control.

Sales & Marketing: With GIS, city developers can win over prospective businesses by creating informative sales tools and marketing reports that highlight the economic potential of a new location or future development. For residents, GIS helps in presenting a visual representation of all the information affecting the desirability and value of a property giving them a far more accurate picture of a property's suitability to their needs.

Facility Management (FM): A GIS-based information system provides a powerful foundation for better facility management by generating integrated information that helps make better allocation decisions. GIS can integrate with and extend the current facilities management system. By importing and aggregating into a GIS the geometries and tabular data of the multiple BIM and/or CAD files required to accurately represent the built environment, the efficiencies and power of BIM can be leveraged, extended, and connected in geographic space to other relevant site, neighborhood, municipal, and regional data.

Operations & Reporting: GIS can track and analyze assets over space and time and provide insight through visualization of information via maps and easy-to-understand reports. It supports creating an operations view that include maps, lists, charts, gauges, and more based on live geographic data defined in a web map or web service. Multiple operation views can be defined to meet the needs of stakeholders focusing on different aspects of the operation. With this ability to integrate disparate information sources into a common operational picture of all facilities, GIS provides greater power to control township operations and positively impact bottom line.

Smart Cities in India

Lavasa in Maharashtra is India's first e-city., My City Technology -- a joint venture setup by Lavasa Corporation and Wipro would help in city management services, e-governance, ICT infrastructure and value-added services, including proposing and implementing intelligent home solutions and digital lifestyles for the Lavasa citizens. Lavasa homes will offer touch-point automation, occupancy-based lighting, door and motion sensors, beam detectors and on-call transport services.

GIFT City in Gujarat GIFT city coming up in Gandhi Nagar, Gujarat, will have a central command centre to monitor the city-wide IT network and respond quickly during emergencies, energy efficient cooling systems instead of air conditioning, and high-tech waste collection systems. Cars will remain outside, and there will be moving walkways to get to the city centre. Greater Hyderabad is using GPS and GPRS technologies to cover solid waste management, and maintain parks and street lights through cell phone images, subsequently put in the public domain. Surat has an on-line water quality monitoring system; Coimbatore's computerized building-plan approval scheme; Bangalore opting for geographic information systems (GIS) to standardize property tax administration; Jamshedpur Utilities Company providing an IT-enabled 24/7 single-window call centre and customer database.

Conclusion

GIS is an emerging technique that can be effectively used as an essential tool for transforming cities to Smart cities. GIS can be used throughout the life cycle of a smart city – from site selection, design and construction to use and maintenance. GIS is an ideal technology that has the ability to scale across any expanse, from the individual asset within a building to a virtually global context tying all aspects of a Smart City planning and development. Remote Sensing and GIS is capable of extracting urban land cover information with robust results. On the other hand, moving further, interfacing of urban planning models with GIS should now

receive due attention. Incorporation of land use transportation models, network analysis, and simulation of urban activities to evaluate different urban development alternatives in the GIS framework needs to be explored for added advantage. Land use planning, community facilities planning, transport planning, and environmental planning all can benefit from this information. Rapid development in city poses several challenges including problems associated with urbanization for urban managers and policy makers.

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