Applications of GIS to Smart Cities

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Abstract— GIS integrates hardware, software and data for capturing, managing, analyzing and displaying all forms of geographically referenced information for a city. GIS technology allows a city to view, query and understand data in many ways. It is very easy to see relationships, patterns and trends in the form of GIS-based maps, reports and charts. Apart from enabling cities to be more efficient, GIS can play a critical role in enabling government interface where citizens can share grievances, comment on the status of city infrastructure and understand the corrective measure taken by the city authorities. Citizens can also access the city master plans and share their views on the proposed development activities. This paper describes application of GIS for enhancing the functions of cities to make them smart cities.

Index Terms—GIS Geographical Information system, Global Positioning System, Remote Sensing, Smart City.

I. INTRODUCTION

Smart cities are broadly defined as a SMART city as one wherein investments in human, social capital, traditional transport and modern (ICT) communication, infrastructure, sustainable economic development provides a high quality of life by engaging management of natural resources, through participatory action. The concept is still under development and evolution as a new approach to urban development and management. SMART city is one which provides for the well being of the people through integration of urban planning systems, efficient service delivery, smart governance, energy management and conservation of resources with underlying use of technology and instrumentation leading to socio – economic and sustainable development. The vision of the Ministry of Urban development is to facilitate creation of economically vibrant, inclusive, efficient and sustainable urban habitats. Consistent with the vision, the Mission is to promote cities as engines of economic growth through improvement in the quality of urban life by facilitating creation of quality urban infrastructure, with assured service levels and efficient governance. Smart city is a "booming" international phenomenon. There are smart cities projects across the globe. The statistics show that over 2000 Smart City projects have been started or going on in Asia, Europe, the Americas and Africa: there have been more than 1500 by 2015, with an annual compounded growth rate of 20%. Among the stakeholders, there are Governments, Municipalities, Property Developers, Utilities, IT Companies, Engineering Companies, Architectural Firms, Telecommunications Companies, Infrastructure Providers, Grid Providers, Building Systems Suppliers, and even Automakers.

II. GIS AND ITS CONTRIBUTION TO SMART CITIES

One consequence of the transformation towards a digital society that is largely dependent on information has been the increasing political and economic significance of GIS – especially over the last decade. While GIS are (in principle) as old as human culture, the opportunities provided by recent developments in information and communication technologies provide a wealth of new possibilities and opportunities. Throughout the years, with the significant contribution from various technologies like computer science, information technology, remote sensing, advance multimedia world etc, GIS evolved from traditional geographer's or cartographer's tool for surveying and planning to a rapidly expanding primary technology for understanding our planet and related geospatial opportunities to foster a sustainable world. GIS technology bridges the gap between different sectors and acts as an integrated cross sectored platform to collect, manage, compile, analyze and visualize geospatial, temporal information for sustainable urban planning, development and management. Nowadays, immense value and broad applicability of GIS is obviously a major driving force of some significant changes happening around us. GIS was basically developed as a system for capturing, storing, querying, analyzing and displaying geographically referenced data but with the advancement in web, mobile technology, GIS emerged as a broad term and a complete package, which can refer to a number of modern technologies and advance processes and become more mainstream that expands knowledge of the urbanization and connections among people. As an indispensable decision making tool GIS is now finding its place among decision makers for assessing and creating sustainable urban policies and smart place to live, learn, experience, socialize and grow. GIS are being used to provide solutions in numerous branches of government service as well as in businesses and industry. Geoinformation technology is being used in surveying, engineering, planning and

logistics for the collection, processing, management and presentation of spatial information. The main reason organizations are investing in GIS is their potential to increase efficiency. These systems can be used to help develop and deliver new types of services such as better transportation and service information for citizens.

III. THE STRUCTURE AND ELEMENTS OF A GIS

An information system consists of a collection of procedures applied to sets of raw data to generate information that supports decision-making processes. Decision-making is the common goal of all GIS. The monitoring of land use, of natural resources, transportation capabilities, economic trade and other issues with spatial components is a secondary goal, since the spatial component is the connecting element of the information. A GIS must therefore provide an array of functions that support the decision-making process. The system should be able to store data, to describe and manipulate data, to carry out analytical and explanatory procedures and to run predictions and simulations. The four main elements of a GIS are hardware, software, data and applications, Along with their components. It is important to note that software is divided into the geo-database, basic and specialist software shells as well as geodata. The geodata component is itself divided into both specialized and basic formats.

Hardware: The hardware aspect of a GIS consists of the following:

• Data input – digitalize, scanner, network elements, and keyboard.

• Data storage – disc drives, magnetic drives, optical storage.

• Data output and presentation – screen, printer, plotter, VDU (visual display unit).

• CPU (central processing unit)

• User interaction – order input.

Software: The software elements of a GIS consist of components for:

• Data input and verification processes;

• Data storage and database management;

• Data output and presentation;

• Data transformation and manipulation;

• User interaction components; and an

• Operating system.

Data: A significant part of GIS is the data it manipulates, analyses and presents; the collection, modeling and structuring of data is key to the successful design of GIS. The collection of spatial data is both labor- and cost-intensive, as the level of completeness and accuracy and the quality of the database structure must be very high. Spatial information usually comprises geometric data and thematic data. Geodata includes topological information while thematic data is purely descriptive in nature. Geodata comprises information about the surface of the earth. It describes the location on earth of individual objects, including topology and infrastructure. Geodata can be correlated with each other through these spatial references, forming the basis of further analysis and evaluation. Geodata is divided into two main sub-classes: basic geodata and application-specific geodata. They are simply referred to as subject data.

IV. GEOINFORMATION SYSTEM REQUIREMENTS

A geoinformation system's strength lies in how it is able to analyse spatial data. This is the major difference between GIS and mapping and CAD-based systems. GIS allow users to access and even manage administrative data (e.g. resource data, taxation data and geographic location, etc.). The procedures and processes listed below are characteristic of GIS.

• Spatially guided data retrieval from a database so that users can search for data according to specific characteristics.

• Regionalization (classification of spatial phenomena, generalization).

• Survey of spatial objects (areas, distances in absolute and relative space etc.).

• Geographic superposition of different topics from congruent and non-congruent models (layer concept) i.e. combined data analysis.

• Neighbor-analysis (e.g. catchment areas, location finding problems).

• Connection and network analysis (including spatial statistics). GIS can access and manage large amounts of spatial data. Effective data access should make it possible to perform a broad spectrum of interactive queries on the location and associated characteristics of spatial data. The system ought to be designed in such a way as to exhibit a large degree of flexibility in order to suit the individual needs of a wide variety of users.

V. SMART CITIES IN INDIA

Lavasa in Maharashtra It is India's first e-city., My City Technology -- a joint venture set-up 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-calltransportservices.

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, energyefficient 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 It 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 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.

VI. GIS SMART CITY SERVICES GIS

Solutions for smart city are capable to help policy makers to manage and deliver spatial data by geographic location, and integrate this data with existing applications. This can help to visualize scenarios, extend intelligence, make more informed decisions and address complex issues such as: Asset management—gather and summarize data across

- Geographic locations, track movement of assets over time, and identify trends and predict future events with greater accuracy by analyzing and visualizing asset use patterns. Water management—use sophisticated sensor networks,

- And apply advanced computing and analytics to support better-informed water policy and management decisions. Crime prevention—integrate data collected through

- GPS into a new repository of consistent, accurate information, which is then presented in multiple business views, including offenses or incidents, dispatch history and arrests.

VII. CONCLUSION

This paper describes how the GIS could find its applications in various aspect of civil engineering along with few examples of smart cities in India. GIS has emerged from the scientific laboratories, conventional cartographer table into the heart of urban and regional planners, policy makers. GIS is an emerging technique which can be effectively used for making optimum use of resources in day to day life; as such it is an essential tool for transforming the cities to Smart cities. Smart city have various overwhelming benefits for both, government & the citizens. The awareness and technical know- how about the GIS is important for its invariable use.

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