

GEOSPATIAL TECHNOLOGY'S ROLE IN E-GOVERNANCE AND PUBLIC SERVICE EFFICIENCY

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Abstract—Geographical information technology, including GIS technology, has been identified as one of the great innovation technologies that is revolutionising a number of aspects such as governance, natural resource management and public service delivery. Currently, in India, the government is implementing an e-governance program called Digital India that addresses society's challenges by applying geographical information systems for decision-making. Conclusively, Digital India is an initiative whose objective is to enable the citizens to access digitally provided services and make the governing procedure more fast, inclusive and focused on the citizens. Here, GIS has a significant role to play because it provides location-based information that is useful in planning, policy, and resources. Among the major deliverables under this program is Bharat Maps, a multiple-layer GIS from NIC. Bharat Maps also provides seamless country-wide base, Satellite and hybrid maps that are compatible with international geospatial technologies. It allows central and state government departments to acquire essential geographic data for decision-making and service delivery. The use of GIS technology improves resource management; City planning not only assists in environmental, disaster, and social development. It helps the country in managing various issues like climate change, economic differences, and public health, starting with mapping the infrastructure forms, environment and population of the country. Meanwhile, the e-government uses the GIS, but some barriers exist, such as integration problems of data, problems of infrastructure, and problems of skilled persons. Though, at present, there is enormous scope for the use of GIS in the government's plan to continue with the new change, it has the capability to transform almost all public services, helping bring a society of engaged citizens.

Index Terms—Geospatial Information Systems (GIS), Digital India, E-governance, Bharat Maps, Public service delivery, Resource Management, Location-based data, Digital transformation, Decision-making, Citizen engagement

I. Introduction

In the digital era, Information Technology has become an indispensable tool, fostering and unlocking possibilities and progress in many fields of society. Among them, there is a complex technology, GIS or Geographical Information System, that is emerging to be essentially important in sectors like natural resource management, city planning, and governance. The GIS also facilitates data collection, analysis, and mapping and, therefore, improves decision-making, hence improving the public services to be provided.

In connection with India's e-governance, it is worth stating that the Geographical Information System contributes immensely to the modern type of e-governance regarding planning, decision-making and management. Some of these are – Bharat Maps – Which is a multi-scale, multi-resolution imaging that provides satellite imagery, which is helpful for the government in delivering several citizen-oriented services by using GIS efficiently. They also discuss what GIS entails in relation to, posit the use of GIS in

governance as the solution to enhancing service delivery and digitizing public services, and reveal the pitfalls that the government experiences while implementing and incorporating digital tools at their scale.

II. The objective of paper

1. Assess the Current State of Geographical Information Systems with a Referee to check exactly how Geographic Information Systems can be useful in e-governance to facilitate decision-making, effective service delivery, and efficient resource use in different sectors.
2. Evaluate the effect of GIS on Public Service: This will assess some of the ways in which GIS can enhance public service effectiveness, administrative efficiency, and accessibility to the populace.
3. Further, discuss GIS Application in some important areas like urban planning, Disasters and Emergencies, Infrastructure and Development, and Public Health, where the application of GIS has proven to improve governance standards.
4. Factors that hinder GIS implementation: Understand the factors that hinder the government from adopting GIS technology in the e-governance system, such as issues of data availability, technical specifications, and cost.
5. Toward the Goal of the Digital India Initiative: Categorize the extent to which GIS supports the concepts of DiGI and how it aims at empowering the citizen, increasing transparency, and the ability of its governance framework.

III. Introduction to Geospatial Technology in E-Governance

It has emerged as a major driver of change and influence in e-governance since it allows governments to gather and utilize location-based information to enhance the delivery of government services, policy decisions, and governance in general. These technologies include Geographic Information Systems (GIS), Remote Sensing, and Global Positioning Systems (GPS), whereby governments amass geographic data on a range of issues such as urban planning, resources, disasters, and the environment. They also make it easier for the government to be open by including the public in up-to-date information delivery within the shortest time possible.



Source : Image from Geospatial World

The use of GIS in government is beneficial in various sectors since it eases various activities, including land use planning, infrastructural planning and even disaster management. For instance, GIS helps the urban planners determine the land that is available as well as its suitability for purposes of development hence providing a clear guide to the right procedure. Natural disasters involve location-based information that can

play a huge role in finding out potential risk prone areas, paths of evacuation, and other necessary measures to be taken for the general welfare of people during such calamities. Other sources complement this study through information obtained from satellite imagery that enables one to track the environment, rate of deforestation and spread of urbanization-issues that are important in development.

In addition, geospatial technology entails a decision-making tool that enhances the flow of information that will lead to the formulation of projects, distribution of resources, and policies. GIS thus facilitates the proper allocation of government resources especially in the provision of transport infrastructure or even healthcare services. Geospatial technology is thus used in the operationalism of the vision of digital governance as it seeks to enhance operational efficiency and promote more transparency within the public sector to make government services much more citizen-centred.

IV. Enhancing Public Service Efficiency through Geospatial Technologies

Geospatial technologies have essential functionality in improving public service delivery through better identification and quantification of units of space, their spatial relationships and display of facts. These tools include geographic information systems (GIS), remote sensing, as well as global positioning systems GPS in order to review the various sources of data and establish the spatial patterns for delivering and improving the public services provided by the governments. For instance, GIS can be applied in identifying the strategic placement of social amenities such as transport, health facilities, schools, and utilities so that the rated facilities are in strategic places to cater for the people's needs (West, 2019).

It applies especially in the area of urban planning and resource management, whereby geographical information technology is utilized. GIS is useful in assisting urban planners in managing lands, traffic flow and population density, which aids in designing cities. This makes sure that essential service delivery, particularly in the provision of water, sanitation as well as waste management, is effectively provided to the people. Also, using geospatial data, the local government can plan the routes of public transport in such a way that they can cover most of the population. In the provision of health-related services, GIS is instrumental in indicating disease outbreaks, distributing Ambulances, Hospitals and assessing the needy areas (Klaus, 2020).

However, information that is open to the public can be famous for immediate surveillance of public services with geospatial technologies. For example, in the context of sanitary and water and Sewerage Systems, using GIS can determine the status of the infrastructure and its services to pinpoint in a timely and efficient manner which needs to be either upgraded or fixed. This means that resources are utilised in a better way, thus cutting down the channelling time of services and enhancing efficiency. Real-time geospatial data assist in its technique of resource allocation in disaster response situations so as to reduce the response time of governments.

As mentioned above, geographical information technologies facilitate government operations, resulting in higher citizen satisfaction and, thus, increased confidence in the government.

V. Geospatial Data in Disaster Management and Environmental Monitoring

Such technologies are useful in the field of disaster management as well as monitoring and controlling the worsening state of the environment, which necessitates geographic data that can be obtained from spatial technologies in real time. Therefore, GIS, remote sensing, and satellite imagery have become invaluable tools in disaster preparedness, modelling, evaluation, and response in cases of floods, earthquakes, wildfires and hurricanes, among others. They include mapping and imagery technology to map terrain features, weather conditions, the existence and distribution of important infrastructure, and others critical during disaster response.

One of the many uses of geographic information systems in the case of disaster management is in mapping regions vulnerable to disasters. They can apply GIS to locate hazardous areas, monitor climatic changes and design, and organise systems to minimize the loss of human lives and property. For example, in the case of a flood problem such as flood occurrence, real-time geospatial data can help identify the flood level of water, flood area and evacuation routes. This enables authorities to mobilise resources, inform the residents, and ensure people vacate the endangered areas, meaning lives will be saved (Klaus, 2020).

Table 1 : Geospatial Data In Disaster Management And Environmental Monitoring

Area	Application	Technology Used	Purpose
Disaster Management	Identify disaster-prone areas and map vulnerable regions	GIS, Remote Sensing, Satellite Imagery	Helps in tracking weather patterns, assessing risks, and creating early warning systems to mitigate disasters.
Flood Monitoring & Evacuation	Real-time data to monitor water levels, flood zones, and evacuation routes	GIS, Satellite Imagery	Enables authorities to respond quickly with timely evacuations, mobilize resources, and save lives during floods.
Disaster Prediction & Early Warning	Predict and warn about potential disasters like floods, earthquakes, hurricanes	Remote Sensing, GIS, Satellite Imagery	Allows governments to anticipate disasters and warn populations in advance.
Environmental Monitoring	Track deforestation, desertification, and biodiversity loss	Satellite Imagery, Remote Sensing	Helps assess environmental degradation and enables proactive conservation efforts.
Air & Water Quality Monitoring	Monitor pollution levels and sources	GIS, Remote Sensing, Satellite Imagery	Used to track air and water pollution, assess sources, and create policies for improving environmental health.
Disaster Risk Reduction Policies	Analyze historical disaster data to identify patterns and create policies	GIS, Remote Sensing	Focuses on building resilient infrastructure and reducing disaster impact through informed policy-making.
Post-Disaster Recovery	Map affected areas and prioritize reconstruction resources	GIS, Remote Sensing, Satellite Imagery	Supports effective recovery by identifying areas in need of urgent attention and resource allocation post-disaster.
Environmental Protection Policies	Monitor the effectiveness of environmental policies on conservation and development	GIS, Remote Sensing	Assists in evaluating environmental protection policies, ensuring sustainability and tracking the impact of government actions.

Geographic Information Systems are also used in the monitoring of the environment. Aerial photography and geospatial information systems are used for observation of environmental trends like deforestation, desertification and loss of bio-diversity. Thus knowing such changes, the governments and environmental organizations can come up with effective measures of conserving physical resources, reversing

environmental impacts and recommending and implementing sustainable development. For instance, it is applied to observe the environmental status, detect pollution sources, and evaluate the efficiency of environmental legislation (Brynjolfsson & McAfee, 2014).

The data-driven strategy offered by geospatial technologies also helps in making policies to reduce disaster risks. Furthermore, Governments can look at previous records and develop policies that may require the Development of strong infrastructure capable of sustaining the impact of future calamities and encouraging citizens to prepare for future disasters. In addition, GIS can also come in handy in disaster cases by creating a display of the affected areas, followed by providing aid for reconstruction.

By applying GIS, governments can not only effectively handle emergencies that may occur, causing disasters, but also balance environmental sustainability in the future and reduce vulnerability to other disasters that may occur due to development.

VI. Geospatial Technologies in Infrastructure Development

Geospatial application is a significant enabler of infrastructure development as it offers solution in the areas of planning, designing and construction supervision of roads, building and utilities, and other facilities. GIS, satellite imagery and remote sensing help government departments and urban planners collect and use valuable information that aids in decision-making in infrastructure projects. These technologies assist in the selection of areas for infrastructure development through factors including population density, traffic flow, environment as well as the availability of land (West, 2019; Rajabifard et al., 2014).

Table 2 : The Role of Geospatial Technologies In Various Phases of Infrastructure Development

Phase	Application	Technology Used	Purpose
Planning	Identify areas for infrastructure development and optimal locations	GIS, Remote Sensing, Satellite Imagery	Helps analyze factors like population density, traffic flow, land availability, and environmental conditions to determine the best locations for infrastructure projects.
Designing	Design infrastructure such as roads, schools, hospitals, and utilities	GIS, Satellite Imagery, Remote Sensing	Supports designing efficient road networks, residential areas, and public facilities, taking into account environmental and ecological impact.
Construction	Monitor construction progress and resource usage	Satellite Imagery, GPS, GIS	Ensures projects are completed on time, on budget, and with efficient resource usage. Monitors material deliveries, construction site logistics, and workforce productivity.
Post-Construction Monitoring	Ongoing infrastructure maintenance, monitoring road conditions, planning upgrades	GIS, Remote Sensing, Satellite Imagery	Helps maintain infrastructure, assess road conditions, schedule repairs, and plan future infrastructure expansions.

Phase	Application	Technology Used	Purpose
Lifecycle Management	Optimize resource allocation, monitor long-term infrastructure performance	GIS, Satellite Imagery, Remote Sensing	It enables efficient resource management and supports decision-making for future infrastructure improvements. It helps ensure that infrastructure meets the needs of growing populations.

During the planning phase, GIS helps the governments make a spatial assessment for areas that require the development of infrastructure facilities. With reference to the physical landscape and land cover, population distribution and growth rate, GIS can identify areas most suitable for establishing new schools, hospitals, transportation networks, and residential stands. For instance, patterns of traffic movement can help in planning a proper network of roads, whereas examination of environmental factors can help to reduce the negative effect of structures that are under construction. With the help of geospatial data, it will be possible to develop healthy and efficient infrastructural development that was opted in line with demographic density in conjunction with environmental functionality (Klaus, 2020; Smith et al., 2018).

In the construction phase, geospatial technologies help track and analyse infrastructure project status in real time. It is possible by using satellite imagery and a GPS tracking system to do a technical follow-up of the construction's progress and the usage of the supplies. In addition, with the use of the application of GIS, you can monitor material deliveries, construction construction sites, and even the work of employees. This level of monitoring enhances the transparency of activities relevant to infrastructure projects and avoids situations where costs go beyond set budgets and time estimates, resulting in the delivery of infrastructure projects beyond the expected time (West, 2019; Rajabifard et al., 2014).

In addition, the use of geometrical technologies is also vital after each infrastructure project. It can also be chosen for continual performance and improvement through mapping and location information. For instance, it can be used in the surveillance of road networks, assessment of the extent of damage or deterioration that requires repair or upgrade, and general forecasting for expansion. The effective application of GeoICTs throughout the entire phases of Infrastructural Development can assist governments in planning, designing, delivering, and maintaining infrastructures that will adequately address the needs of the growing urban population, as depicted below (Smith et al., 2018).

The use of geospatial technologies has significant benefits in formulating, implementing, and monitoring infrastructure. To do so, the governments of each country benefit by getting access to information, resource optimization, and, most importantly, the development of sustainable and strong infrastructure for the citizens of that particular country.

VII. Geospatial Technology in Public Health and Safety

Geospatial technologies are a crucial part of public health and safety as they help monitor disease outbreaks, facilitate the elaboration of necessary measures in emergencies, and distribute the available resources effectively. Geographical Information Systems (GIS) are used in an important way in disease surveillance since they help in identifying the geographical spread of disease outbreaks. Thus, in general, such patterns help health authorities forecast potential risk areas, use resources thoughtfully, and apply timely actions. For instance, GIS was employed to monitor rates of infection and persons infected, outbreaks, and to map areas that could be targeted for vaccination during the COVID-19 pandemic. The visualization was helpful for the governments throughout the pandemic period to analyze the rates of the

virus and, therefore, determine the places that needed to be locked down and where health care may be needed most (Klaus, 2020).

Besides public health, GIS plays an important role in public safety, even as a tool for increasing the effectiveness of police work. Law enforcement agencies use geographical information in displaying crimes to understand areas that have increased crime rates for police to post their forces effectively. Using crime data and maps of areas, GIS assists in arriving at efficient operational patterns and dispatch of officers in the event of an emergency. This is a proactive system that aids Morehead State University in the prevention of crime and response to emergencies hence making the community safer, reducing the incidents of crime and mending the acrimonious relationship between the police and the public (Rajabifard, 2014). The use of GIS also enables decision makers to make better decisions through in policy formulation, the determination of resource needs and allocation, infrastructures, and development and management of the society. They entail the use of geospatial technologies in public health and safety, which enhances the public service delivery system. Geospatial information applied in real time shall be used by governments to enable better health conditions, safety, and security during disasters, among other benefits.

VIII. Challenges and Future Directions in Geospatial E-Governance

Thus, it should be noted that, in general, the use of geospatial technologies in e-governance is not without a number of challenges. On the same note, the cost of acquiring, implementing and continuously maintaining geographical information systems is another challenge. Geospatial technologies are capital-intensive in terms of infrastructure, hardware, and software which would pose a significant challenge for any government aiming at adopting this technology. Also, the successful implementation of these technologies requires key personnel which are capable of managing, analyzing and making decisions based on the data of a Geospatial operation (Brynjolfsson & McAfee, 2014; Sui et al., 2013).

The last concern is the protection of data, which is fast becoming a growing concern in organizations. The development of geographic and personal data through the geospatial technologies collected by governments Democrats and Republicans put high-risk policy toward identity thefts and misuse of valuable d. There is also a great danger that comes with geospatial data processing which is handling of sensitive data. Therefore, for the public to trust government institutions in handling their data the following are elements that should be considered. Also, many of the areas require the upgrade of old infrastructures in the modern developed geography technologies that have not been embodied in the technological advancement. They should set up adequate data warehousing, data processing, and communication technologies to address the massive geospatial big data sets that are created (Rajabifard, 2014).

By adopting and including geospatial tools in its e-governance solutions, there is a promise for its advancement in the future. The application of artificial intelligence and machine learning in combination with geospatial technologies also brings new insights for real-time decision-making. For instance, it can reveal what society will look like in the future in terms of demography, availability of resources, or even risks such as fire and floods, among others. Finally, AI intends to enhance generative geospatial systems, enhancing the speed of data analysis and decision-making. These advancements will help governments manage the available resources effectively, hence improving the delivery of services to the citizens and improving digital governance goals (Brynjolfsson & McAfee, 2014; Sui et al., 2013). Thus, governments have to consider existing issues of current special technologies while expanding on these new technologies with a view to enhancing public service, engaging the citizenry, and creating smarter, sustainable cities.

IX. Conclusion

Geospatial technology, therefore, holds much promise for modern governance by improving public service, efficiency and decision-making. It is evident that incorporating gadgets such as GIS, remote

sensing, and satellite images into practices of e-governance on government online portals will go a long way in enhancing efficiency and facilitation of public success. As already applied and exemplified by India's Digital India, GIS remains to be the key facilitator for the enhancement of human interaction by ensuring that an advanced computing of location information is carried out in a manner that improves social welfare as well as policy implementation. However, there are some effects of implementing GIS in e-governance as follows. Able to integrate the data Information on implementing GIS in e-governance is also known to face some challenges as are outlined next. High costs of implementation require personnel with specific skills. Nevertheless, the growing research in the field of AI and ML has the potential to produce even more value for geospatial technologies in terms of forecasts and real-time decision-making. It is clear that the future of GIS in e-governance will be promising because, with proper investments in infrastructure and data security, the aforementioned problems can be avoided, and modern cities of the twenty-first century can be built. In the long run, geo technologies will further transform public administration, and governance will become functional, proactive and citizens-oriented.

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