CityLayers: Let's change the way we handle our cities

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Abstract

Development is all about people; who they are, where they live and how they live. To achieve this, we need to identify, understand and address people's needs, paving the way for a smart city, the next milestone. Smart decisions are based upon near real time handling of city's needs, optimizing resources to do the needful with proper planning and better finance in sectors like education, environment, water supply and waste management, property tax and public health. For this, there is a need for a new generation DSS (Decision Support System) enabled Municipal GIS for better Municipal e-Governance. Municipalities especially in developing countries do not have proper integrated tool to analyze broad spectrum of information which varies from public utilities and network data to precise location of a property in order to enable holistic planning and functionality of a city by understanding local needs with high visual impact. To address this, Nascent Info Technologies Pvt. Ltd has developed a software called CityLayers which has integration with e-Governance applications. It is OGC compliance-based tool which is cross platform and cross device in nature providing quick access to spatial data, visualization and analytical capabilities over a web browser. It serves multiple departments in a corporation as well as accommodates multiple corporations' data. Currently it has been implemented successfully at Vadodara and Bhavnagar Municipal Corporations in Gujarat, India.

Keywords: CityLayers, Decision Support System(DSS), Geographic Information System (GIS), Municipal e-Governance, OGC, FOSS

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1. Introduction

Development is all about people, who they are, where they live and how they live. In the last two decades, metropolitan areas around the globe have been engaged in initiatives to improve urban infrastructure and services thus leading the way for smart cities. Govt. of India has started Smart Cities Mission, an initiative to develop 99 smart cities across the country in collaboration with state governments and urban local bodies. [1] Smart cities arise due to intelligent use of digital information in the area such as education, environment, water supply, energy use, waste management, property tax and public health etc.

Municipalities primarily governing the cities for which most of the activities are geographically based such as utility networks, streets, disaster management, waste management, land and estate management, building permissions, tax assessment, collection and enhancement etc. Most of these data available with them is not in digital format. Due to which, many municipalities are facing the challenges in maintaining data quality and integrity.

Most of the municipal corporations have recognized the importance and benefits of Geographic Information System (GIS). A comprehensive and integrated municipal Information system integrated with GIS, in short Municipal GIS has become essential and thus municipal corporations have planned to implement it in order to enhance governance. Municipal GIS thus helps municipal officials in various planning such as infrastructure planning, land use planning, water distribution and planning, town development and planning etc as well as community development, administration, licenses and approvals for the city. It also provides city information system to citizens. Citizen can also get authorize plot map information and building permission which saves their time and money.

Today e-governance has become the buzzword which uses information technology to improve government work. We are witnessing the increased use of geospatial technology in the many government sectors. Thus governance processes are evolving from e-governance to g-governance helping decision makers to take smart decisions which are spatially enabled in turn to deliver better services. [4]

Municipalities especially in developing countries do not have proper integrated tool to analyse broad spectrum of information that varies from public utilities and network data to precise location of a property in order to enable holistic planning and functionality of a city by understanding local needs with high visual impact. [3]

For this, there is a need for a new generation DSS (Decision Support System) enabled Municipal GIS for better Municipal g-governance.

"CityLayers, just about what you need to make a city smart"

Nascent Info. Technologies has developed a GIS-based product named 'Citylayers' that meets the entire requirement for municipal g-governance and a holistic visualisation with insights for efficient decision making. The vision behind building Citylayers is better g-governance for a sustainable development. Citylayers by the virtue GIS not only provides a bird – eye view of the city as a whole of each municipal sector but also brings ease of decision making process through its highly powerful data analytics capabilities. This product will cater to the viewing, analysing and utilising the geographic information needs of various departments.

CityLayers consists of following components:

Departmental geoportal is an Intranet based solution for municipal officials for decision making, data visualization, data analytics etc.

Citizen portal is a web based application whose main objective is to bring the citizen closer to digital maps for understanding their location, nearby facilities, and surrounding areas, so that they are better placed to make location-specific decisions.

Data update using QGIS, a desktop environment that offers viewing, editing and validation of spatial data which is centrally located in the database.

The property tax is the main source of income for any corporation. The Municipal Corporation until now are maintaining the

property information on papers, and revise the information every five years. The **Property Survey application** has been developed for property tagging, it's assessment, updating property details, measurement features etc. The application is android-based and runs on mobile and tablet devices.

CityLayers has been developed as per the guidelines provided for digital india policy for using open source software. [2] CityLayers is OGC compliant and developed on open source software like Postgresql along-with PostGIS, GeoServer, OpenLayers etc. It is a cross browser, cross platform and cross device product serving multiple departments in corporation which has integration with e-Governance applications. This paper mainly focussed on departmental geoportal.

CityLayers - departmental geoportal is equipped with dedicated municipal departmental modules which has basic GIS tools, attributes and spatial query modules along with bookmarks, dashboard, fuzzy searching, map print facility and advanced tools like routing, network tracing

2. Literature review

Although several attempts have been made to assess web-GIS applications, there is no consensus to evaluate the standard framework. Most studies are area-specific or usability. The 'pitfalls' of GIS-based web applications like non-intuitive design, lack of metadata information, overlay of intensive mapping functionalities as done by review studies did not entirely address potential concerns of implementation and promoting Web-GIS for municipalities. Hence, generalizing and expanding the criteria from previous studies provide detailed understanding to evaluate web GIS applications.

Samadzadegan F., et al, (2008) demonstrated how a service oriented architecture (SOA) can provide useful tool in enterprise municipal information management for distributed municipal organization and citizens. They gave importance of use of a centralized enterprise-wide shared GIS to significantly improve the availability and consistency of spatial and non-spatial data across different software systems, integrate data across various disciplines, and facilitate the flow and exchange of municipal information. In conclusion, SOA serve as an enterprise base for sharing and integrating data across all municipal departments and software systems which will reduce or eliminate inefficiencies of information access and exchange, and thus lead to cost-effective and more efficient operational and strategic decisions. [1]

Waleed A.A. (2009) has attempted to provide a framework for enterprise GIS for Saudi municipalities. The suggested GIS framework includes three main factors: business functions, tasks and data requirements which will help Saudi municipalities to develop their IT solutions in general and GIS applications in particular, because the majority of municipal decisions are spatially oriented. He further identified municipal data issues and felt a need for establishing a unified municipal data model. [2]

Li Zonghua, et al, (2016), from Wuhan, China proposed the use of service oriented architecture (SOA) based Geographic Information Systems (GIS). The main aim of the study was to provide departments access to the spatial data with-in the government intranet and integrated in different type of applications. The system is based on OGC standard web services for sharing the spatial data. Hence, the implementation of web-GIS based platform has been developed, the result of which is that GIS data and information is distributed via XML web services to other applications. Departments can share data on a single application irrespective of data sources and format. [3]

Victor Neene, et al, (2017), demonstrated the development of the mobile GIS property survey application using open-source software tools and mobile mapping services for the real time capture of property data. The efforts were made specially to help local authorities in developing countries in overcoming the challenges in property tagging and assessment. [4]

P.K. Garg (2015) did study of Dehradun city in Uttarakhand, India with a primary objective proper mapping of all properties using GIS as

a tool, computed the property tax and provided computer-coded unique number to properties. He showcased the importance of digitization along with importance of GIS technology to support decisions which can be of a great value in municipal planning process. He also observed that municipal authorities have to improve the data handling capabilities, set-up appropriate technical infrastructure and interface with a wide variety of other agencies, such as government departments, local authorities, NGOs and many others. [5]

Rajeshkumar J. Ajwaliya, et al, (2017), designed and developed a GIS-based utility management system to perform spatial analysis for enhanced administration and management. The Web-GIS based Utility Management System enables efficient network management by providing instant access to information. The system contains electrical lines, drinking water supply, waste water lines, sewer line, gardens, Low Tension (LT) Panel and Sewage Treatment Plant (STP), along with offices, residential buildings and many more. The outcome of the study is a developed Web-GIS based utility management system for spatial planning in the field of utility mapping. [6]

Anuj Tiwari, et al, (2014), insights the power of GIS in Smart Cities. GIS can prove to be one of the most efficient tools in terms of smart city planning and a sustainable development. A smart city is the integration of technology with the strategic approach to sustainability. The case-study of Lavasa smart city and GIFT city, India has been taken in order to corporate the use of GIS in smart city planning, decision-making frameworks and many other criterias. As a result, the study gives an overview on how GIS is currently converging with other technologies to provide new level of accessibility and functionality. [7]

Surat Municipal Corporation (SMC), Gujarat, India has designed, developed and implemented a Web based GIS application along with GIS database for better governance, improving operational efficiency and ease of interaction with citizens. It has been developed using indigenous technology I-GIS (Integrated GIS and Image Processing Software) by ISRO, GOI jointly with Scanpoint Geomatics Ltd. (SGL). This integrated solution contains citizen interface and SMC Departmental Interface with central repository for all departments. [8]

Mario Miler, et al (2010) mentioned the use and importance of Free/Libre/Open Source Software (FLOSS) tools and carried out the case-study for City of Zagreb, Croatia to develop a fast web mapping solution for urban planning and management. They have demonstrated an original and efficient solution for visualization of a very large amount of spatial data on the web using Open Source technologies which combine tiled raster maps and vector WFS data. They have confirmed that FLOSS can result in the same usability and efficiency as a commercial package and it is increasing the capacity of small and medium enterprises to develop similar spatially-aware applications without high starting investment. [9]

Debasish Chakraborty, et al, (2015), enlightens on the use of Free and Open source software GIS (FOSSGIS) as a cheap yet feature-rich alternative to commercial softwares. Through this study, they present an approach of developing a web-based GIS application using FOSS for sharing of map and non-spatial data along the web and to provide a customized interface for data visualization, analyse and share it. Hence through integrated system, a web-based portal help users with limited GIS knowledge to access the information customized for specific applications. [10]

Mustafa A. Kamal, (2008), through his study, explains the importance of using GIS integrated system for city planning and development and worked on a system with city government and incorporated it into many sectors of public sector development, offering web-based services to its communities. It added a new dimension to city planning and development with traffic control, drainage system and various other applications. Hence, improving the efficiency of city government and their administration. [11]

After studying available literature, the importance of integrated GIS with decision support system needed for municipal corporations has been understood. Further study revealed the lacuna in the available

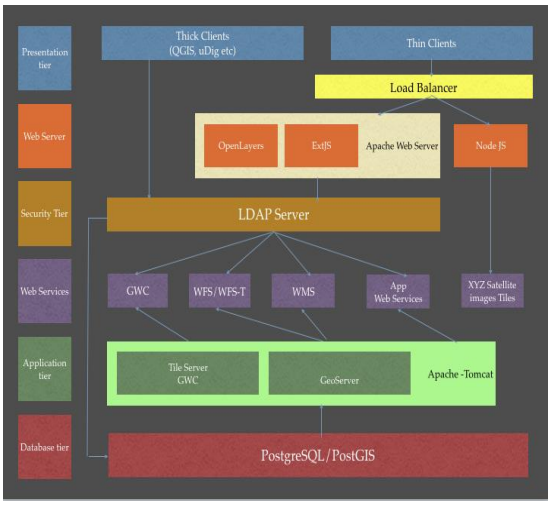
solutions which plots the idea of developing 'CityLayers'.

3. Method and Materials

A. Methodology

CityLayers is based upon client-server architecture which has four tiers such as presentation tier, authentication tier, application logic tier and database tier. CityLayers is service oriented designed application based on OGC standards such as WMS, WFS/WFS-T and TMS.

The methodology followed for development of CityLayers is given in figure ().



1. Presentation tier

The first tier is the user interface where the input and output of the data along with display get managed. The intuitive user interface of CityLayers has been developed using JavaScript libraries such as ExtJS and OpenLayers. The rich components such as attribute grid, dashboard and the forms in the various modules has been developed using ExtJS while map components are developed using OpenLayers.

2. Application Logic tier

The application logic tier which a bridge the between the user interface and the underlying database, containing interoperable web services. In general, it generates on the fly content in various formats upon user's request. It also performs the business logic as well as maintains the state of data for a user's session.

It consists of GeoServer and business logic that handle the requests from the client. GeoServer handles the map related requests, which are mainly in form of WMS, WFS/WFS-T. The non-spatial data requests are handled through REST services that has been developed in Java using Grails framework.

3. Authentication tier

The authentication tier is the very important layer between application tier and database tier, which ensure the privileged access to the data. LDAP (Lightweight Directory Access Protocol) has been used against which users are validated. The components of CityLayers such as departmental geoportal, data update and mobile survey application whose users get authenticated through central LDAP.

In GeoServer, Key authentication module has been used which provides WMS access to authorised users from LDAP. The data through web services API is also secured using token and session based authentication written in Java. Thus any unauthorised access is denied over the service which ensures the leak-proof data interoperability without any fear.

4. Database tier

The data that is needed by the application logic tier are retrieved from the underlying database, Thus the database tier is responsible for providing optimized data access through modelled and stored information needed for the system.

In CityLayers, the database tier stores the Spatial and non-spatial data in normalised state. The spatial inheritance has been implemented at the database end which allows homogeneous and heterogeneous spatial data accessibility. The database design has been developed to accommodate any municipal corporation. The flexibility of the DB design allows to accommodate any kind of spatial and non-spatial data. To load the spatial data which is in normalised form in the database is a challenge. It has achieved through ETL mechanism using GeoKettle software.

Software and libraries / extensions used in development of CityLayers

1. **PostgreSQL** - PostgreSQL is a powerful, open source object-relational database system.
2. **Extensions for PostgreSQL**:
   - **PostGIS** - It is a spatial extension which adds support for geographic objects allowing spatial queries to be run in SQL using spatial functions.
   - **PgRouting** - This extension provides geospatial routing functionality having routing algorithms like pgr_dijkstra, a star etc.
   - **pg_trgm** - It is an extension providing simple fuzzy string matching based upon three consecutive characters from the string.
   - **tablefunc**: This extension provides the crosstab function for creating pivot tables output.
3. **GeoServer** - It is OGC complaint, Java-based software server that allows users to view and edit geospatial data, map creation and data sharing.
4. **Modules for GeoServer:**
   - **Mapfish Print**: This module provides an HTTP API for printing maps in formats such as jpeg, png, bmp, gif, tiff, PDF etc.
   - **Key authentication:** This module allows for a authentication protocol designed for OGC clients that cannot handle any kind of security protocol. It allows a minimal form of authentication by appending a unique key in the URL that is used as the sole authentication token
   - **YSLD:** It is a YAML based language for styling which closely matches the structure of SLD.
   - **JAI and ImageIO:** JAI is an advanced image processing library which helps in increasing the image handling performance significantly.

     ImageIO for raster reading and writing affecting both WMS and WCS.
5. **Java (Grails):** Grails is a nice, well documented MVC web framework which is a combination of Groovy, Spring Boot and Hibernate.
6. **ExtJS:** Ext JS is a pure JavaScript application framework for building interactive cross platform web applications using techniques such as Ajax, DHTML and DOM scripting.
7. **OpenLayers:** OpenLayers is an open source JavaScript library for displaying map data in web browsers as slippy maps. It provides an API for building rich web-based geographic applications.
8. **GeoKettle:** It is a tool used for Spatial ETL which also known as Geospatial Transformation and Load (GTL), provides the data processing functionality of traditional Extract, Transform, Load (ETL) software, but with a primary focus on the ability to manage spatial data.
9. **Apache Tomcat** (or any J2EE Server)**:** It is an open source web server that is developed by Apache software foundation which hosts basically Java web applications to run.
10. **Apache Web Server** (or any Web Server)**:** It is free and open-source cross-platform web server that delivers content over HTTP. It is fast and secure server that have the ability to host one or more HTTP-based websites and runs over half of all web servers around the globe.
11. **GDAL**: The Geospatial Data Abstraction Library (GDAL) is a computer software library for reading and writing raster and vector geospatial data formats, data translation and processing.
12. **ogr2ogr**: It is part of the GDAL which provides a similar ability for simple features vector data. It provides functionalities like converting file formats, reprojecting the features, processing operations etc.
13. **LDAP** (ApacheDS / OpenLDAP): LDAP, (Lightweight Directory Access Protocol) is a directory service protocol that often used for authentication and storing information about users, groups, and applications. It is a fairly general-purpose data store and can be used in a wide variety of applications.

4. Results and Findings

In this section, the mainly out of box features of CityLayers - Departmental geoportal are discussed.

In the geoportal, system administrator can handle the metadata creation and update. In

metadata section, administrator can manage master data for departments, layers and its metadata, user roles and privileges, etc.

Following is the login screen of geoportal

Figure 1: (a) Web-login ; (b) Mobile-login

Login: A login page allows the authenticated users to the Geoportal and authentication is done against LDAP. User rights and their roles are defined at LDAP level which are at feature and AOI level.

Once logged in, welcome screen appears which contains basic GIS tools panel, map section and various menu items to access the functionalities.

A) **Map Section** - In this section, user can view and interact with basemap along with overlays.

BaseMap: Basemap is background reference information such as highways, state highway, district roads, railway network, landmarks, waterbodies, canal network, gardens, airport, building footprints, etc. with labels onto which other thematic layers are overlaid. A basemap is also used for locational reference.

Hybrid Map: CityLayers hybrid map is composition of satellite image and some layers like road network and landmarks.

Both basemap and hybrid maps are made available through Tile Map Service (TMS) specification of OGC which are served in XYZ tile format.

The functionalities such as scale bar, mouse position, north arrow, fullscreen map are also available for map details.

B) **Basic GIS tools:**

Basic GIS tools are the tools for navigation within the map area. Tools include Zoom IN, Zoom Out, Zoom to Box, Zoom to scale, Pan, Map Overview, Navigation history, Selection by feature, Information tool are available.

C) Functionality menu-bar

Analytical Capabilities: Analytics is the crucial part of the geoportal. The geoportal provides mainly two kinds of analytical capabilities. (A) MIS analytics (B) Spatial analytics.

(A) **MIS analytics** is traditional analysis method which is performed on attribute data of the feature. In CityLayers, it can be performed in two ways viz. Basic Query, and Advanced Query. Basic query allows users to perform the query on single attribute whereas advanced query allows users to perform the queries on multiple attributes with AND, OR, NOT option which filters the data upon provision of the attribute criterion.

(B) **Spatial analytics** is the core of geoportal that allows spatial operations to derive the decisions enabling the spatial relationships between the layers. In this module, user can run a query on a source layer (single layer) and the mask layer (can be multiple layers) in combination with spatial operation and user's area of interest. The query can be performed using spatial operations like Disjoint, Intersects, within, Overlaps, Contains, Covers, Covered by, Within a distance, Equals.

Bookmarks: This tool facilitates users to save their queries and bookmark it. It also facilitates user to view the query and edit it as and when required and modify it.

Attribute Grid: Attribute grid shows user the attribute information of the features available in the map view (extent). The user can make use of zoom to feature to visualise specific feature or can select the feature in the attribute grid which gets highlighted on the map. It provides the facility to set column wise filters, sorting of the data and summary information for the attribute. It also allows users to export current extent and all the data in xlsx format.

Layer Management: Layer manager provides listing of layers along with legend as per category. It enables user to turn on/off individual layer or group of layers.

Layer manager provides the list of the layers for the department categorized into 1) Operational Layers, 2) Supported Layers and 3) Administrative Layers. The operational layers are the layers owned by the department and appear as the overlays. The supported layers are the layers owned by other departments but added for reference and viewing purpose as the per the need. The administrative layers are the admin boundaries respective to the departments.

It also allows users to dynamically change the label of layer. There is the facility of highlighting the selected layer and changing the opacity of layer.

Fuzzy Search: Search tool helps user to search any location on the map or with just a keyword can search through the layers available. The search tool is based upon the db driven fuzzy logic derived using fuzzystrmatch and pg_trgm extensions of the PostgreSQL database.

Selection Tool: This tool helps users to select either single feature or multiple features using select by point, or select by polygon on the map which gets highlighted in the attribute grid respectively.

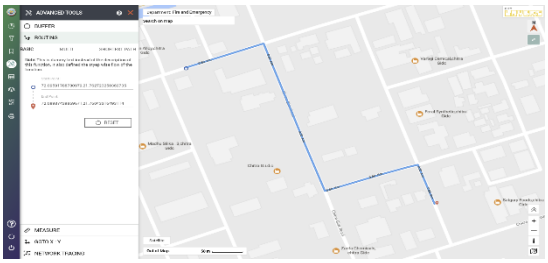
Dashboard: Dashboard provides at a glance view in the form of graphical/tabular summarization. In this module, there is three-way connection between spatial data, attribute data and graphs so that user can interact between graph, attribute data and map The user has choice of multiple graphs (Bar, pie or line graphs) and can compare the graphs zone or ward wise.

Following advanced tools are available in the geoportal.

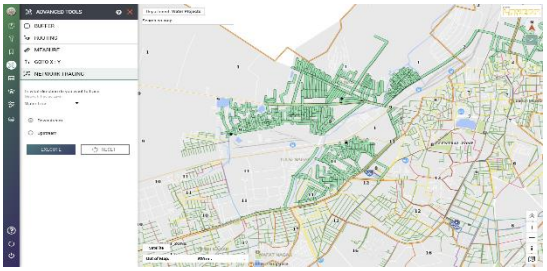
Buffer Operation: Creating buffers around features is useful for proximity analysis, and finding out the surrounding features of feature in/within the specified distance. In geoportal users can create buffer around drawn Point, Line, Polygon, and Box.

Measurement tools: This tool facilitates user in measuring distance and area on the map in different units of measurement. Using this tool, user can know the distance between two points or an area covered between set of points as per the defined units.

Routing: This tool provides the facility to trace the route between any two points or landmarks upon selection by user. It also helps user in finding the shortest route to a nearest facility. The routing tool has been developed using pgRouting extension. The shortest path is calculated using Shortest Path Dijkstra (pgr_dijkstra) algorithm.



Network Tracing: This is very important tool for utility departments such as sewerage, storm and water which helps in tracking the health of a network, and identify deteriorating areas. In this module, user can trace the network either upstream or downstream side from a given point in a utility department. It has been developed using PostgreSQL's "WITH RECURSIVE" clause.



Print: Print module allows user to print their AOI map. It is based on current view extent. Users have flexibility to select paper size and DPI to print map. This is the geo pdf which enables user to on/off layer in pdf viewer.

Reset Map: This tool facilitates user to reset map. If a user wants to get back to the default view (after login) and the default properties, reset map tool will be useful in getting the default settings.

Plan, Dig and Monitoring module (PDM): Maintenance, upgradation of utility network, infrastructure like road, footpath etc. is a continuous activity carried out by corporation

in the interest of the citizens. The utility authorities of the corporation viz. water, sewage, storm, streetlight etc. along with agencies like Electricity Board, Telecom, Gas agency also keep upgrading/maintaining their network after seeking the requisite approval from the corporation. These activities being carried out at different part of the city, the visibility of work being carried out and its status is not readily available to Decision authorities of the corporation. PDM module in CityLayers to manage, control this important functionality of corporation.

PDM will help the road cutting agencies and the road owning agencies to streamline their area of work by eliminating all manual work and gaining online access to all data and information related to the work, right from sending a new request till the completion of work. This module would be utilized for many purposes like submitting new request, giving consent to other's request, editing already submitted request etc.

5. Discussion & Conclusions

The CityLayers - departmental geoportal has been successfully implemented at Vadodara and Bhavnagar municipal corporations (VMC and BMC) in Gujarat, India. Currently its implementation going at Gandhinagar Municipal Corporation (GMC), Gujarat, India. At VMC, CityLayers is in use for 22 departments while at BMC for 17 departments. A centralized GIS repository hosts the data needed for all departments in a municipal corporation. All the departments of municipal corporations can now easily access the centralized GIS database using CityLayers.

Data collection and digitization from the various departments was a challenging job especially with utility, engineering and property tax departments etc. The property survey was an extensive process as each house had to be tagged, assessed and verified. Following benefits has been observed after implementation of CityLayers.

The property tax department could monitor the property surveying activities such as property tagging or assessment through on the fly generation of thematic map. Even the system provides the daily survey audit to municipal official for surveyors and their activities carried out. The basic queries like property search, building age, construction type etc provides property related information. Integration of CityLayers with property tax module of E-governance for real time analysis would helped in identifying tax defaulters, locate dangerous properties, locate disputed properties etc which is going on.

To utility departments, the thematic view of water pipe, storm line or sewer line based upon various attributes like diameter, width etc. would give the fair visualisation of beneath utilities and assets. Future integration with SCADA system will provides the real time data like flow-pressure etc. The network tracing tool is of great help to trace the network.

At time of emergency, incident and disaster there is a need to locate the nearest available facilities like fire stations, hospitals, PHC, etc., the CityLayers provides the shortest route from incident point to available facility.

The PDM module of CityLayers provides two level (Manager) Approval workflow to streamline the dig requests and tracking in case of any physical damage cost to other buried assets along with road relaying activity.

Education department, can monitor the infrastructure facility, boys'/girls toilet availability, gender ratio, teacher's information etc.

In town planning department, the efforts have been made to facilitate citizens to get the part plan and Form-F in digital format as well as the information on TP schemes which has increased the transparency in governance.

The problems like finding illegal hoardings, management of approved hoardings, identifying fresh slots for establishing new hoardings, verifying the dimensions on approved hoardings were attended through CityLayers for hoarding department by providing hoarding information like its location, dimension and type, vendor details etc.

In engineering department, problem statements like availability of speed breakers, traffic

signals near schools to regulate speed of vehicles and traffic, the information like Right of Way and Road width will help officials to take decisions related to future expansion, maintenance of roads and other engineering related issues.

In affordable housing department, one can get socio-economic household level information in the slums areas along with the mappings. It can help decision makers for rehabilitation of slums areas.

The park and garden department module helps in assessing the recreational amenities which in turn made available for citizens.

CityLayers is the part of broader vision of Layers which is pertaining to corporations. This is the first version of CityLayers which has targeted mainly towards streaming of municipal GIS data for making decisions by municipal officials by understanding the department wise data on map and making analysis for the same.

We are looking forward to integrate technologies such as IoT (Internet of Things), VTS (Vehicle Tracking System) and improvement on data visualisation. There is also need to develop the advanced admin portal which can handle the meta-data section of CityLayers and assigning roles and privileges to the users. There is also the need of thematic data visualization, clustering of the dasta, 3D visualisation, on the fly style changes by users through styling tools which has been planned as future development.

6. Conclusion

CityLayers is a product which satisfy almost all the municipal GIS requirements of a corporation by providing departmental geoportal for internal use, citizen portal for public use, mobile based application for property survey plus the data in the central repository needed for all applications can be edited and validated through QGIS against LDAP where all users are centrally located along with their respective privileges. It facilitates the flow and exchange of municipal information by significantly improving the data availability, interoperability and its consistency across various software systems and various departments.

CityLayers is an Enterprise scalable Web-GIS application which provides clustering at database and application level in turn provides load balancing and high availability.

The various forums, tutorials and mailing lists available through open source community made us to provide “out of the box” solutions in comparison with closed source software. We have a proud feeling that OGC compliance CityLayers is as per Digital India policy and a step towards contributing India’s smart cities mission.

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9. Author/s Biography

Maulik Bhagat, is Managing Director of Nascent Info Technologies Pvt. Ltd., Ahmedabad, Gujarat, India. He holds bachelors of engineering degree in Information and Communication Technology. His motto is "**Looking to create products and solutions using IT to enrich the quality of life for one and all**". He is a keen planner, strategist & implementer with abilities for conceptualizing, framing and implementing marketing activities. He is spearheading the development of "**CityLayers**" GeoDSS enabled product for municipal corporations. He is an effective leader & communicator with excellent relationship building & interpersonal skills.

Gaurav Gandhi, is Vice President Technology and Commercial os Nascent Info Technologies Pvt. Ltd., Ahmedabad, Gujarat, India. He holds a Master's degree in IT. He has a unique blend of Technical, Functional and Commercial knowhow. The principle Architect of the CityLayers, he was instrumental in defining the product vision, product roadmap, technology stack selection and functionality matrix. He has also been instrumental in defining the Goto market strategy and commercialisation of Citylayers. With close to 17 years of experience in Spatial and Enterprise Solutions he inspires leadership and technological innovation.

Santosh Gaikwad, is working as a Technical Lead at Nascent Info Technologies Pvt. Ltd., Gujarat, Ahmedabad, India. He holds master's degree in Agriculture and advanced diploma in Bioinformatics. His area of expertise is Spatial Informatics with more than 15 years of experience in it. His career has been focussed on geospatial aspects in various domains such as wetlands, biodiversity, agriculture, marine, education, insurance etc. His professional interests include software development, web mapping applications, spatial analysis and data visualisations. He has been awarded chevening scholarship in the area of biodiversity informatics at UNEP-WCMC, Cambridge, UK. He is a charter member of OSGeo foundation and closely associated with OSGeo-India chapter. He has worked with international organizations such as British Antarctic Survey, UK, Pacific Biodiversity Institute, USA and national organizations like Salim Ali Centre For Ornithology and Natural History (SACON), Professional Assistance for Development actions (PRADAN), India. Currently he is technically leading the development of "CityLayers" spatially enabled DSS product at Nascent.

Rahul Kanani is a senior software engineer at Nascent Infotechnologies Pvt. Ltd. He has been working with open source geospatial technologies and development of applications for over 4 years, has expertise in OpenLayers, GeoServer, PostgreSql/ PostGIS. He has past experience working with principal scientists and organisations like MPCST, MPRDC, MPGRP. He holds Masters in Computer Application.

Arjan Odedra, is a Senior Software engineer at Nascent Info Technology Pvt. Ltd., Ahmedabad, India. with 4+ years of experience in area of Open Source Web-GIS Software Development, Front end Development and Postgresql+PostGIS database development. He did Masters of Computer Applications(MCA) from Gujarat Technological University(GTU).