



## Integrated Property Deviation Solution: A Smart Geospatial Information Framework for Urban bodies

### I. Introduction

People from the villages and rural areas migrate to urban areas for the search of better job, lifestyle and standards. This phenomenon is global. The urban planners are working hard to meet the ever growing demand and needs of the inhabitants to provide better infrastructures. Updated master plans and improvement of the various buildings, utilities, amenities and their maintenance is a perennial challenge for the city administrators. As per the Assessment of the World Bank, globally, over 50% of the population lives in urban areas today. By 2045, the world's urban population will increase by 1.5 times to 6 billion. City leaders must move quickly to plan for growth and provide the basic services, infrastructure, and affordable housing their expanding population need. Cities generate over 80% of gross domestic product (GDP) in many countries in Asia and the Pacific and are engines of economic growth that have lifted millions from poverty as per the Asian Development Bank (ADB).

But as these cities swell in size and number, they are under increasing strain. The recent report by UN on global population forecast predicted that an extra 2.5 billion people will be living in the continually expanding cities in the coming 30 years, of this 90% of the urban growth is centered in Asia and Africa. This unprecedented growth of cities to mega cities would make it imperative for planners and city managers to work towards building sustainable urban habitations. Majority of the cities are struggling with inadequate urban infrastructure, traffic congestion, air pollution, lack of basic services such as round the clock water and power supply, sanitation, and waste management. In order to manage the activities of the city infrastructure it is essential to have a detailed map of the city that needs to be periodically updated. These maps need to be disseminated in the web based system so that it can be accessed by the concerned officials and citizens through their desktop computers and smartphones. Geospatial technologies therefore need to be at the core of any city development and management program.

## II. Problem Statement

The funds required meeting the expenditure towards development of new infrastructure and their maintenance in a city comes from the Central Government under various development schemes and also allocated by the state government. At the same time, the urban bodies are also responsible for generating their own revenues to provide better facilities to its citizens. The collection of these revenues from the owners of the residential, commercial and industrial properties are done by the officials based on the self-assessment of the building owners or through a systematic study of the city buildings through door to door property surveys executed by the surveyors. Other source of revenue generation is through the fees collected through the advertisements in hoardings etc. The results are mixed. While there are residents who proactively deposit the annual property taxes while many others who neglect this activity. There is a direct behavior relationship of the taxpayers with respect to their geo-location within the cities. There are structured colonies and apartments wherein the payments are regular while there may be unauthorized constructions in a city wherein the residents do not abide by the law of the land. It is important to have a detailed map of the city which can be regularly updated and these MIS records of taxation of the municipalities can be linked and quickly accessed. With the advent of the modern tools and technologies mapping of the city infrastructure at a large scale is now possible at a faster pace more accurately.



## III. Problem Analysis

It is essential to have a detailed mapping of the city infrastructure with high resolution satellite datasets. The front façade of the buildings and the height of the builds also need to be captured for easy identification and correlation with the departmental datasets. In order to enable this component, it is important to use mobile mapping systems equipped with the LiDAR sensors (to generate heights of the various buildings and assets) and also the 360 degree views of the roads to have a seamless coverage. While satellite data provides the synoptic view of the area of interest, the vehicle driven LiDAR based data capture provides 360 degree immersive 3D point cloud imagery with reality “As-Is”. Once these datasets are acquired then a web based geospatial software application needs to be deployed which can render the datasets in the client browsers and smart mobile phones.

## IV. Approach towards Solution

In order to identify the tax defaulters it is important to locate them and plan to recover the taxes. To achieve this objective an Integrated Property Validation Solution is required to be developed and deployed in the City which can provide data, system, analysis & reports, installation support and training on a turnkey basis to support Property Tax assessments.

The Integrated Property Validation Solution is intended to provide authentic ground data and web enabled applications as a technical support for property tax assessment and reconciliation processes to meet the goal of enhancing tax collection through transparent approach. A project to develop IPVS aims to ensure capture of accurate information related to properties as they exist on the ground. The solution is based on reliable ground information captured 'as is' at street level using state-of-the-art mapping and surveying technologies.

Any project which aims to have a comprehensive mapping of the area with an objective to recover the property taxation and also support other municipal functionalities needs to have the following:

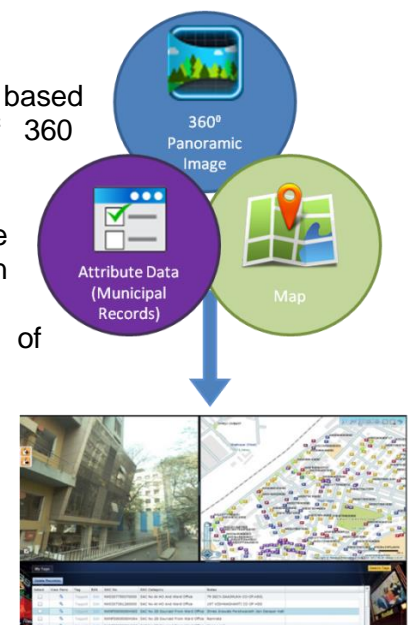
- To survey and indicate properties existing on ground with deviations in comparison with MIS tax records available at Urban body/ Municipality applying reliable visual support, updated base map, and field survey inputs to enable reconciliation and accurate property tax assessment.
- To provide support with common data for interpreting information relevant to Municipality functions other than property tax including Hoardings, Hawkers, Street Furniture, Municipal Assets, Tree Census, and other municipal functions where accurate and reliable ground data is desired.

To provide a centralized online solution to various stakeholders for viewing and sharing information gathered from different sources in this project for improved decision support.

## V. Components of the Solution

Composite approach and technologies includes

- High resolution satellite imagery to update base map data
- Vehicle mounted LiDAR (Light Detection And Ranging) based equipment system that enable combined acquisition of 360 panoramic imagery and point cloud data
- Physical field survey of the buildings and data collection
- Collation of overall data to validate against attribute information available in MIS tax records at Municipality/ Urban body
- Identify deviations to support upstream processes of reconciliation and assessment at Municipality.
- Integrate Municipality MIS data, base map (CAD) data, Field survey data and 360 degree immersive visual image data.
- Design and develop a web based property validation system with intelligent visualization tool to display integrated data.
- Design web based system to provide Tagging facility for property numbers in Visual and map data
- Perform analysis of integrated data to generate various reports to support property tax



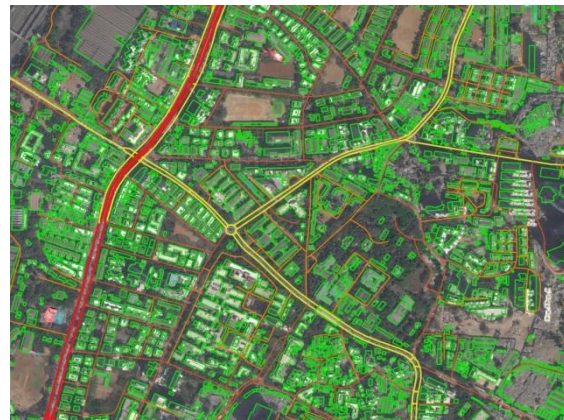
## Data Components

LiDAR and 360° Panoramic Imagery of entire urban area: Photo-realistic street level imagery of real-world captured in 360 degree immersive media. This can also be integrated with LiDAR datasets.

- ◎ **Geo-referenced Map:** Geo-referenced street-level map of the area. Solution has provision to include user provided project specific maps, which may, for example, include:
  - Large scale topographic sheets and geospatial information
  - Development / Master Plans
  - Land Use/Land cover maps
  - Digitized cadastral maps
  - Other geo-referenced maps
  
- ◎ **Attribute data:** Project specific attributes information (user provided) on features and objects viewable on the map and panoramic imagery.

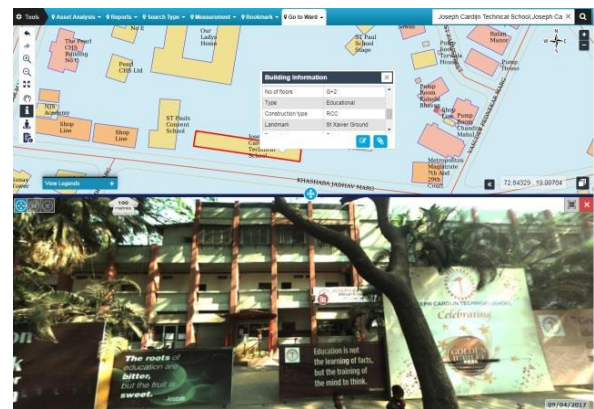
## Application Components

The Integrated Property Validation Solution is a common system for information related to properties. The system acts as a decision support system. The IPVS system has a web interface and tools to view street level 360° panoramic images that are geo-referenced with base map, view and edit tags of attribute information created from existing MIS records, and information on identified properties with deviations and represented on the street level panoramic imagery and map; store, view and edit observation information; search and display options with selection criteria; generate reports and option to export attribute information. This system is user friendly to Municipality users to validate the survey outcomes, observations and extract the necessary information to engage in the process of follow up activities to be carried out by officials from Tax function to rectify and subsequently update the property records accurately in their existing MIS.



The Integrated Property Validation Solution has following functionalities.

- It is web-based, accessible to authorized users only and facilitate municipality functions
- A seamless walkthrough/navigation over the 360° panoramic imagery with pan/zoom functionality and interactivity with map corresponding to panoramic imagery
- Tagging of attribute information against the identified properties (Building, Telecom Towers and Hoardings) on panoramic images with icons.
- Search/Select options with specific Point of Interest based on criteria including modifications of tags based on user authorization/authentication with log details on the changes against the users and create a certificate of the log details with the print option.
- Identification and display of properties on geo-referenced panoramic images with attribute information displayed on the grid.
- Export of attribute information displayed on the grid based on search criteria into MS Excel file.
- Selection of an object on the map and interactively display the corresponding panoramic image with related attributes.
- Selection of multiple objects on the map and interactively displays corresponding attribute information in the grid with panoramic view options.
- A software interface to panoramic image database and corresponding laser scan point cloud data to facilitate viewing and measurements of dimensions of visible façade of the property.
- Query builder to search on Road details and parameters of the road.
- Multiple User Access - Allows multiple users to access the system with their unique user ids and passwords
- Provision to define access rights by administrator to different users / groups.
- Modifications of tags- (Create/Edit/Delete) of tags based on user authorization/authentication
- Audit Trail - Creates the log of the user after every modification
- Print - User should be able to print reports
- Data security and access - Ensures data is secure and not accessible by unauthorized personnel





## VI. Benefits to the Stakeholders

### Property Taxation through Deviation analysis

Holding wise infrastructural information can be made readily available. At pre-GIS age (before the advent of GIS), it was impossible to find out the proper location of a holding instantly and due to non-availability of database the information of a holding was not collective and organized. But presently, identification of tax defaulter is much easier & appropriate by using GIS as a monitoring tool. The detailed information of a holding like – owner's income, tax status, building status, building structure, power supply status, drinking water source, family members etc. are instantly available along with its proper location on the base map. Access to any types of queries regarding Tax, such as Annual/Quarterly Demand, Valuation, Current Collection, Arrear dues & collection, Remission amount etc. are possible. While considering the valuation as well as tax remission of a holding, it can easily be cross checked with the data of the concerned holding.

### Support to other Line departments

#### 1. Roads and Traffic

- To assess present road dimensions, pavement areas, road conditions, inventory of road assets, traffic zone delineations, inventory of traffic signal assets at street level. Realistic road data with segmentation (chainages) and bits to budget and track historical expenses (capital/maintenance/cleaning etc.) effectively.
- Pot hole Tracking solution
- Reference system to review surroundings before releasing road digging permissions.
- Road furniture maintenance and contract management.
- Availability of road data like – road length, width, variable width, road status (material), repairing cost, repairing agency etc.
- Deformed or un-metalled roads are easily identified and as a result repairing process becomes less hazardous.

- Pre-assessment of cost & planning are possible for road repairing due to instant access of road data.
- It has been possible through GIS to get the information as well as choose the appropriate route regarding immediate access to Pool Car to holding and the details of the roads adjacent to that holding.

## 2. Solid Waste Management

- To assess existing solid waste collection points, collection units, parking place for the solid waste collection vehicles for loading and unloading, reassessment of collection locations with respect to place, space, present cleanliness and sanitation aspects etc.

## 3. Development Planning

- To aid decision support for assessment of ground reality for development planning and control.
- Validation of existing or reported data with visual information
- Validation of the various rules (with road facing visible data)

## 4. Healthcare

- To assess present locations of healthcare centers, accessibility, location suitability analysis for extensions and new constructions.
- Health project budget management as per the topography of the area.
- Decision support system for various healthcare related project and activities.

## 5. Sewage

- To assess open storm water drainage system conditions, open sewage conditions, present construction quality, requirement assessment for repairs and upgrading, sanitation conditions of open systems, debris removal; and asset management.
- Validation of recorded data with visual data
- Situation analysis with as is information of the project point and its surroundings

## 6. Water

- To make a first level engineering assessment and reconciliation with work/material management for new connections, extensions etc. with availability of accurate ground reality with surface features.

## 7. City Engineering-Municipal Architect

- To cross verify the ground information for applications seeking permissions for construction of new structures, alterations, extensions, renovations, and dismantling etc. The data to aid analysis of aspects like offsets, building heights, zoning, FSI etc.

## 8. Vigilance

- To identify and analyze encroachments, bye-law violations, construction of unsafe structures, non-compliances, municipal asset management, illegal building usages etc.

## 9. Disaster Management Planning

- To assess low lying areas, dilapidated structures, inaccessible zones, sites vulnerable for flood inundations, fire, poor sanitation, disease prone areas, accident prone areas etc.

**10. Tree Authority**

- In correlation of tree census data for reconciliation and aiding decision support for specific measures to upkeep

**11. Fire Services**

- To identify and map the dilapidated structures, fire hydrant networks/assets, marking buildings with/without fire control compliances, maneuverability of fire tenders, fire station location suitability analysis.

**12. Estate and Land Management**

- To identify municipal assets at street level and correlation with asset inventory for improved asset management

**13. Education**

- To map the locations and perform suitability analysis of educational centers.

**14. Ward Management (Advertising and Hoarding management)**

- To validate the hoarding licenses against location, size, type etc. and identification of illegal hoardings, defaulters, structurally unsafe hoardings etc.

**15. Garden Department (Open spaces including gardens, parks)**

- To identify gardens, parks, open spaces. Assessment of present condition and planning for development and improvement.

**16. General Administration Department**

- To identify and monitor status of street poles.
- Hoarding management solution
- Display building approval records (against the buildings) to help citizens buying properties and flats.

**17. Health Department**

- Monitoring the work of Health programme more effectively.
- Availability of health data including BPL families.
- Identification of the deficient area.
- Comparisons of health status in respect to their surrounding environment are possible due to availability of both the Health & Holding data.

**18. Power GIS (Electricity)**

- Locations of Electric Post & Transformer can be identified
- Instant information can be provided about the light/lamp status of any Electric Post
- Identification of power connection from Transformer to Electric Post & from Electric Post to the holdings enables instant access to the entire Power Network System.
- Power problems created due to Transformer Disorder are easily being solved, due to instant identification of the concerned disordered Transformer as well as the Electric Post.



## VII. Summary

The urban bodies need to adopt innovative methods which can help them to quickly assess property tax of the properties within its jurisdiction. The methods to be adopted should be unbiased and transparent in nature from governance point of view. Any disputes arising out of the survey should have proper time stamped documentary evidence which can stand the court of the law. Usage of satellite data for creating a large scale accurate city level base map and integrating 360 degree panoramic imagery with LiDAR datasets and departmental MIS taxation record provides a powerful system. This integrated datasets when rendered through a secured web based, easy to use decision support system to the stakeholders it helps the government to provide better governance and citizen centric services efficiently.