# The Role of Geospatial Information in Planning and Management of Smart Cities

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**Abstract** - This paper deals with the concept of the smart city from the standpoint of geospatial information enablement. The analyze emerging research on smart cities, particularly those addressing the potential role of geospatial information in the development, implementation, and management of the concept of smart cities have been presented. The involvement of geospatial information in many aspects of the smart city model is illustrated. While geomatics-driven solutions should foster new opportunities to meet smart city objectives, they could also imply new issues and challenges which should be addressed.

**Index Terms** - Geomatics, Smart City, Planning, Management, City 3D Model

## 1 INTRODUCTION

Recently, in Vietnam, smart city has attracted attention from both scientists and managers. In the world, this concept has existed for a long time, however, there is no consistent definition for smart urbanization. Its definition varies between countries and the perspective of the experts. The concept of "intelligence" is understood in different ways. For example, in many countries the "Intelligent City" is used, but in others it is called "Smart City". There have been heated debates on these two concepts. The majority favor "Smart City" and understand the concept of intelligence in a broader and wiser sense.

In the world, the ISO 37120 standard has been using to assess and rank sustainable cities on the basis of urban service quality and quality. However, each country, each city has its own objectives, approach, and assessment based on the different Core and Supporting Standards [1,3].

Although there is no single definition, on the basis of the objective of sustainable development, smart urban development must be based on the requirements of socio-economic components and is mainly outlined in six main factors:

- Smart economy: a city with high economic efficiency and competitiveness;

- Smart mobility: modern and optimal transportation network;

- Smart environment: energy saving, maximum consumption of renewable energy; substainable management of natural resources;

- Smart people: urban residents are well educated and able to employ and manage high-tech urban infrastructure;

- Smart living: in smart urban areas people are give the high quality of life in terms of material conditions, public transport services, culture, entertainment, education, security and clean environment;

- Smart governance: effective management is based on the Information and Communication Technology- ICT system which ensures a seamless connection and optimal service to the urban living.

Geospatial data plays an important role in the process of planning and managing smart urban. In recent years, modern geospatial technologies such as global satellite navigation systems (GNSS), geographic information systems (GIS), satellite remote sensing (RS), unmanned aerial vehicles (UAVs) LIDAR, and TLS have been constantly developing to collect, store, analyze, and display information about entities and phenomena on the surface of the Earth. Data quality has been at increasingly high level with lower prices, which opens the possibility of employing geospatial data in all sectors of economy, security and defense of Vietnam.

In order to plan and manage smart cities, it is necessary to use a wide range of modern technologies in which geospatial data is an important factor. It is estimated that nearly 80% of decisions in urban planning and management are based on data analysis and geospatial information. Smart city also refers to an electronic service system based on the Information and Communication Technologies (ICT) system. Meanwhile, geospatial data plays an important role and is the basis for developing various types of ICT systems.

To assist the planning and management of smart cities, geospatial information are required for a database including many layers:

- Layer of street address,

- Terrain information layers, including digital elevation models (DEMs), digital terrain models (DTMs) and digital surface models (DSMs),

- Layer of geological conditions including hydrogeology,

- Layer with information on current status of land use,

- Layer of environmental conditions,

- Layer of administrative boundaries in the city,

- Layer of infrastructure including the road system, water supply and drainage system, as well as power supply network,

- Layer of health services, education, sports and tourism.

## 2 3D URBAN SPACE INFORMATION MODEL

The geospatial data of real city can be represented by different models such as the Image Model from aerial or satellite imagery, the LCM (Digital Landscap Model), digital map LCM (Digital Cartographic Model) and 3D model. Each type of model has its own advantages and disadvantages. In the planning and management of smart cities, urban 3D models play an important role.

The main data for establishing 3D models are topological data in vector, aerial photographs, satellite imagery, LiDAR data, UAV or ground laser scaning data. Orthophoto and digital terrain model (DTM) are a visual information platform, where building models, vegetation cover, roads, etc. can be built. Modeling and facilitating the exchange of information, the Open Geospatial Consortium (OGC) has issued the international CityGML Standard. According to CityGML, the urban 3D model is divided into five levels of detail (LoD). This classification is based on the geometric complexity of the object and the accuracy requirements of the model.

3D models with modern visualization techniques enable ones to view objects from multiple perspectives and enable the implementation of a variety of computational methods, and simulating with multiple solutions. 3D modeling also allows for estimating the correlations of surface and altitude between buildings, visibility from a given point and to simulate the direction of winds, and then noise pollution in the city. 3D models show the status and simulate urban space structures in future; is a visual model that helps the analysis, evaluation, planning and management of urban areas to be fast and accurate not only in the horizontal plane but also in the vertical plane. 3D models, as the tool to manage the ownership of urban real estate tool, are the basis for determining ownership of AR (Air Right) space both above and below ground. 3D modeling is an effective tool for smart urban planning and management.

## 3 APPLICATION OF GEOSPATIAL INFORMATION IN SMART URBAN PLANNING AND MANAGEMENT

### 3.1 Optimal location for planning and investment

In general, investment projects in urban areas include the expansion of the road network, the construction of commercial centers, resorts, waste disposal sites, etc. The selection of suitable locations for these projects often depends on many criteria. Geospatial information such as terrain, administrative boundaries, transport network, water supply and drainage, vegetation cover, water surface, electricity network, etc. are the database for the process of multi-criteria (MCA) or multi-objective analysis (MOA) to select optimal spatial locations that meet all criteria. Geospatial data integration and hierarchical analysis (AHP) methods are a prime example of the process of selecting the optimal option in intelligent urban planning and management.

Geospatial data is the background data for the planning and investment of street transport systems, the timing estimation of urban transport activities. Thanks to the layers of geospatial information, the development of education and training infrastructure, healthcare facilities, culture, urban tourism, etc. is also analyzed and selected optimally.

### 3.2 Assistance in the coordination of construction and infrastructure management

Infrastructure in the city is dense and complex. All systems such as transport, energy, water supply and drainage are often managed by several single administrative units. The process of investment, construction, expansion and management should be coordinated by these units. The spatial information system provides data and maps of the current state of the infrastructure networks. The more detailed the spatial information, the more effective the development and control of urban operation would be.

### 3.3 Provision of information for urban real estate management

Spatial information systems are essential to the management of real estate, including land and buildings. In addition to traditional documents such as land excerpts, cadastral maps showing the location of land and houses, 3D map systems with varying levels of detail (LoD) provide more detailed and technical visualization of urban real estate objects. For example, a 3D map with the detail level of LoD3 would offer the overview of entire floor of a building; LoD4 shows the architectural and interior modalities of each house or apartment. The BIM (Building Information Modeling) real estate model which describes in detail the real estate building and combines with spatial information about terrain and infrastructure in the vicinity is an effective tool in smart urban management.

### 3.4 Provision of information for handling incidents, emergency and urgent handling

In crowded urban areas, several problems such as traffic incidents, emergency patients, fires and crime frequently occur and require prompt and timely handling. Thanks to spatial information about street networks, addresses, houses, roads, industrial and civil works, experts could quickly identify and access the location of incidents. Moreover, by analyzing spatial data, it is possible to determine the shortest or most reasonable path to reach the target in the most beneficial way. The spatial information about the density of buildings, the infrastructure system, and the location of the crime scene is the basis for the municipal government to take measures to remedy fires and traffic accidents, and crime.

### 3.5 Provision of information for support tourism activities

Tourism is one of important factors for the economic development and cultural promotion of smart cities. Maps are one of important means to support tourism activities. Electronic maps make tourism become easier and more efficient. A smart metropolis needs to build a comprehensive, detailed tourism map system with timely and user-friendly mapping capabilities. In addition to the basic background information, the city's tourist map including a 3D map should display urban transport topics, landmarks, cultural heritage and history in the city and surrounding area. The electronic map system in GIS combined with GNSS would create an urban tourism gate system which in turn facilitates visitors to explore the socio-cultural and artistic values of the city [2].

### 3.6 Provision of information for support urban transport

In many countries around the world, there are still many problems in urban transport. A smart city is required to have a smart transportation system. Traffic systems are always considered as a criteria for assessing the level of smartness of a city and the quickest, most sensitive feeling for city residents and visitors. Modern technologies used for providing traffic information are first applied in smart cities. It can be seen at the bus stations and train stations; In the public transport, there is an electronic guide to the road traffic system, the means of transport, the way to choose he optimal route. In order to successfully build these systems, geospatial data and technology must be used, and GNSS and geospatial databases play an important role. Spatial information would help ones to know where they are, what transportation options they are going through, which areas of the city are on the road, what are the buildings of the city, etc. The more complete and detailed space information system, the simpler, easier, and more convenient, the operation and management of urban traffic, and the quality of life for urban residents would be.

Geospatial information analysis techniques allow the identification of urban passenger traffic as a basis for planning the development of transportation infrastructure networks, adjusting the time and travel of vehicles public transport. Traffic systems are optimized during peak hours, including those in busy sports and cultural events. It not only computes and analyzes the distance and geo-spatial information but also estimates travelling time.

### 3.7 Identification of environmental issues and management of urban environment

Urban waste is one of the major problems in large cities. The results of geospatial information analysis allow to determine the location and volume of burial sites, determine optimal collection routes to save expenditure, and increase the efficiency of garbage collection. The location of the burial site depends on many criterion, for example, the distance to the city center, airport, residential area, well water collection, underground water, etc. The multi-criteria analysis would allow to determine the optimal location of landfills. In addition, the process of spatial information analysis allows to determine the optimum route for collecting and transporting solid waste in urban areas. Therefore, the optimal collection route would help save transportation costs, fuel and time.

In the context of climate in Vietnam, the analysis identifying areas of risk of urban flooding is important, not only allows appropriate spatial planning adjustments, but also can develop defensive plans for minimizing the impact of flooding. This analysis should be based on terrain database, DTM and DEM models, orthophotos etc ... and population distribution statistics of the city. The 3D data analysis allows for the identification of floodplain areas, and industrial and residential buildings with high risk of flooding.

### 3.8. Community consultation

The world is moving from smart urban to sustainable urban. A sustainable city must ensure that all three components of sustainable development namely economic development, social development and environmental protection are met. In the world, despite the standards of a smart metropolis, cities have their own solutions to be smart, but they all tend to develop ICT technology which is fully automate. There are many comments about the negative impact of smart urbanization, so that in an intelligent city, the communication between people is gradually decreasing, urban residents would live in a passive state, the lack of creative decisions and gradually losing traditional culture and customs. In addition, large scale traffic and security monitoring systems can upset people as they invade their privacy; a family surveillance camera system is vulnerable to hacker attacks and is easily compromised; The idea of car sharing may not be appropriate for some countries with low educational attainment and level of trust, etc. To take advantage of the opinions of city dwellers in the planning and management of urban communications under the "from the bottom" principle, there is a need for community consultation. City residents must have easy access to information, including maps, spatial and attribute data. Urban databases need to be established and transmitted on the Internet in the form of WebGIS, electronic gateways. With easy access to information, each urban resident has the ability to analyze, evaluate, comment, and minimize negative impacts during planning and management, moving from smart urban to more advanced urban - urban sustainable.

## 3 CONCLUSION

In most of planning stages and urban management activities such as optimum location for planning and investment, coordinating construction and management of infrastructure, provision of information on urban real estate management, provision of information on the handling of incidents and emergency, provision of information on supporting tourism activities, provision of information on supporting urban transport, environmental issues and environmental management, community consultation, etc., must be based on the analysis of geospatial information. Approximately 80% of decisions in intelligent urban planning and management must be based on geospatial information. The more complete, detailed and accurate the geospatial database is, the smarter the urban planning and management would be. It is necessary to study and exploit modern types of geospatial technologies in order to collect, manage, analyze, display and share information in appropriate models to meet the requirements of planning and management of smart and sustainable urban.



## REFERENCES

1. Ching T.Y., Ferreira J., (2015) Smart City: Concepts Perceptions and Lessons for Planners. Planning Surport System and Smart Cities, Springer.

2. Cosgrave E., Doody L., Walt N., (2014) Delivering the Smart City, Governing Cities in the Digital Age, Arap.

3. Dohler M. (2013), Smart Cities, Blog. http//community.comsoc.org/blogs.

4. Gotlib D. Olszewski R. (2016), Smart City: Geospatial Information in management of Smart Cities.PWN.

5. Navratil G., Fogliaroni P., (2014), Visibility Analysis in 3D Cadaster, International FIG 3D Cadastre Workshop, Dubai.