



Research on the Information Construction Technology and Model of Smart City in China

Haiyun Cui^{1a}, *, Yajiao Liu^{1b}

¹Business school, Beijing Wuzi University, China Beijing

*Corresponding author

^ahaiyuncui@126.com, ^bliuyajiao_bwu@163.com

Abstract

City information construction is the core of smart city. With the development of the fourth generation of information technology, the process of smart city construction is emerging. City development and city information construction have always been worth in-depth discussion and attention. Based on this basis, the city information model (CIM) concept is generated. On the basis of analyzing the key technologies of CIM, this paper proposes to improve the D-S evidence theory for data fusion, develop GIS + BIM + IOT technology integration, and apply blockchain to ensure data security. CIM can enable urban information management and promote urban planning and development. At the same time, this paper combines the concept of innovation ecosystem to give CIM the concept of renewal. The "center-periphery" mode of city information construction innovation ecosystem is constructed. The core layer is composed of "innovative industry population" and "scientific and technological population", the middle layer is composed of city information construction resources, and the peripheral layer is composed of environment and innovative city information construction. With CIM as the platform, technology enables us to build a smart city.

Keywords: Smart City, CIM, Technology, Center-peripheral Model, Innovation Ecosystem

1 INTRODUCTION

"The opinions on promoting the green development of city and rural construction" proposes to promote the intelligent construction of cities and provide convenient services for the masses. The "14th Five-Year Plan for National Economic and Social Development and the Outline of Long-term goals for 2035" defines China's construction into a strong socialist cultural country by 2035 to promote the comprehensive development of city economy and culture. With the rapid development of modern information technology based on the Internet of Things, building a digital city and driving urban planning and governance with data have become a new trend of smart city development. By April 2020, the total number of pilot smart cities in China had reached 749. However, in the process of smart city construction, there will be problems such as lack of information and non-sharing, which will lead to the incoordination of all links of urban construction. Thus it follows as City Information Modeling (CIM). At present, CIM is in its infancy at home and abroad, involving the convergence and fusion of multiple models. It still has technical pain points in data processing, integration, security and other

links. This paper briefly analyzes the technical means of CIM construction to promote the CIM-enabled city construction. At the same time, the "center-periphery" mode of city information construction and innovation ecosystem is constructed to promote city development in an all-round way.

2 LITERATURE REVIEW

2.1 CIM intension

CIM was proposed for the first time in the Ministry of Housing and city-Rural Development, promulgated in the Technology Standard for Business Collaborative Platform for Engineering Construction Projects (CJJ / T296-2019), In September 2019, the City Information Model (CIM) Basic Platform Technical Guidelines, detailed CIM is a building information model (building information model, BIM), Geographic Information System (geographic information system, GIS), the Internet of Things (internet of things, IOT) and other technologies are based on, Formed as a three-dimensional digital space of the city information organic complex. In June 2021, the Technical

Guidelines for city Information Model CIM Basic Platform (revised version) was released in China. CIM classification criteria. Constantly improve the CIM related concepts. In February 2022, the first CIM Industry Standard was issued in the announcement of CJJ / T315-2022).

"C" in CIM, which refers to city, can not only represent a city, but also for a project, park, community, etc. It is corresponding to the city-level modeling object. "I" refers to information, which is a multi-source information that covers both temporal and spatial dimensions. "M" is the process method of modeling information construction. In essence, there are two kinds of connotation interpretation of CIM: the first is the digital twin city information model, [4] and the second is the city full life cycle management platform. CIM relies on advanced technology, faces specific needs, integrates dynamic information, describes physical units, and supports various applications. Ji Jue et al. (2021) identify CIM models from three perspectives of temporal dimension, spatial dimension and perceptual dimension. In view of the difficulties of multi-source data fusion. [3] Lin Yu et al. (2020) proposed the practical engineering big data analysis architecture of massive log processing, combing OWA operator, SVM-based fusion model, SVM parallel load prediction fusion algorithm, D-S evidence theory and other fusion technologies, as well as using Euclidean distance, Pearson correlation coefficient, to build a multi-source data processing platform.

2.2 Innovation ecosystem

The term "innovation" was originally proposed by Joseph Schumpeter. He published the "Theory of Economic Development" in 1921. Since then, the research on innovation has been enriched. In 2004, the Chinese President's Science and Technology Advisory Committee issued a report that clearly proposed the concept of an "innovation ecosystem," indicating that the establishment of an innovation ecosystem can greatly drive the US economy. ADNER. (2006) proposes that the innovation ecosystem is a paradigm of integration and collaboration. When the core enterprises in the system face their own project management risks, they also need to deal with the risks caused by the interdependence between the subjects and the risks brought by the integrated value chain. [1]

Zeng Guoping (2013) proposed that the innovative ecosystem is dynamic, habitat and growing. In the system construction, we should pay attention to talent introduction, continuous evolution and self-transcendence, support a good ecology, mutual cooperation, build and improve the innovation ecosystem, and implement the innovation-driven development strategy. [8] Zhao Fang (2014), based on the level and diversity of the innovation ecosystem

proposed by Zeng Guoping, incorporated the central perspective into the "central-periphery" innovation framework. [7] Zhang Sheng (2018) believes that innovation subjects have commonality, added value, stability, complementarity and diversity. It is an organizational consortium formed by the innovation subject based on certain innovation resources. [9]

Through the research, analysis and summary of existing scholars, we can think that the innovation ecosystem is a dynamic open system composed of the deep integration of resources and environment by innovative disciplines. Each innovation subject in the system has its own heterogeneity, which leads to the difference in the share of innovation resources and makes each innovation subject compete with each other. However, we must make collaborative innovation with other disciplines in the system to achieve value creation, mutual benefit and win-win results, and finally form a complex system of interdependence, competition and collaborative evolution.

2.3 Information management and city information construction

Information management plays an important role in the organization, enterprise and urban construction. From the information industry construction, the information market construction to the information city construction. VonKrogh (1998) proposed that information management refers to giving full play to the collective information in the organization to help the organization obtain competitive advantage. Zhang Xi (2021) proposed digital information management to lay a theoretical foundation for digital development in China. [6] Yin Fei (2022) believes that implicit information has obvious value compared with explicit information and becomes its competitive advantage after internalization. At the same time, we should pay attention to the transformation between implicit information management and explicit information management. [5]

Information is a useful knowledge that reflects the characteristics and changes of various things in the objective world and can be transmitted by a certain carrier. Information is processed data, which can have an influence on the receiver's behavior and has value for the receiver's decision. Dong zhaofeng (2020) believes that city information construction combines various information technologies on the basis of cities to provide support for city construction, planning and economic development and promote the construction of smart cities.

3 KEY TECHNOLOGY OF CITY INFORMATION MODEL

3.1 Massive multi-source data fusion

CIM involves all aspects of city development. Facing the collection and fusion of its massive data, CIM must improve its data fusion technology and improve its efficiency and performance. The complex system data of CIM comes from the data acquisition sources in different fields. Therefore, the data preprocessing is first conducted to integrate the multi-source heterogeneous data of the same type. At present, the more accurate fusion analysis method is correlation analysis, using European distance and Pearson correlation coefficient. Secondly, for data fusion, the data formats of different channels are inconsistent, and no unified standard has been formed, resulting in the difficulty of multi-source heterogeneous data fusion. Compared with the commonly used data fusion method D-S evidence theory, Fang Yanqiong et al. proposed to improve the D-S evidence theory, taking a local GIS data source as an example, studying and proving that the larger the data volume, the more accurate the results are. In city information construction, improved D-S evidence theory can be used to solve the problem of massive data fusion. Suppose there is a complete set U, set m_1, m_2, \dots, m_n is independent basic probability assignment functions, focal elements are A_1, A_2, \dots, A_n . Bel (A) meets $2^U \rightarrow [0, 1]$.

$$Bel(A) = \sum_{B \subseteq A} m(B) \tag{1}$$

$$Pl(A) = 1 - Bel(\bar{A}) = \sum_{B \cap A \neq \emptyset} m(B) \tag{2}$$

Pl (A) indicates the degree of trust in the data source, with the trust interval of [Bel(A), Pl(A)]

Normalization coefficients.

$$K = \sum_{\cap A_i = \emptyset} \prod m_j(A_i) * \max(m_j(A_i, w_j)) / K \quad j = 1, 2, \dots, n \tag{3}$$

$$m(A_i) = \sum_{\cap A_i \subseteq \emptyset} \prod m_j(A_i) * \max(m_j(A_i, w_j)) / K \tag{4}$$

Let w_j be the number of weights that each data source appears. When $\max(m_j(A_i, w_j))$ indicates that $m_j(A_i)$ is the largest, take its corresponding weight w_j .

3.2 CIM Core technology integration

GIS+BIM technology integration, with GIS massive terrain data + BIM fine modeling technology, to achieve the smooth and orderly city information management platform, in the city rail transit building planning modeling. At present, GIS and BIM are as follows: first, G I M data into BIM data into GIS database, expressed

in a three-dimensional data model, which can be used in city-level data refinement management; second, GIS data into BIM scenarios directly read new BIM data, suitable for fine management of single projects; third, data conversion through intermediate formats, such as Industry Foundation Classes (IFC), OBJ, FBX and other formats. Use the intermediate format to ensure that the format standard is unified. Take IFC as an example, although there are unified international standards, there may still be missing data conversion problems in the conversion process. At the same time, there are massive multi-source heterogeneous data of city information construction and design industries, which requires spatial coordinate conversion and connection.

BIM + IOT data integration, BIM technology is virtual, BIM and IOT combined to realize the connection between reality and virtual, to ensure the interaction and consistency of the stage results of each architectural design, Integrate city planning with city numbers. TOL technology is the foundation of the CIM platform and the main channel for it to obtain information and data.

The data integration of GIS and IOT is supported by a powerful database and combined with the geographic information system to accurately find the target positioning.

3.3 Information security issues

In the future, CIM will integrate the massive data information of cities, and the development of information technology makes various information security risks in urban information construction in data acquisition, data transmission, intelligent analysis and processing. If there are problems in urban information security, it may cause the chaos of urban data and information, citizens' personal information leakage, government decision-making mistakes, urban planning errors, etc. Therefore, it is very important to prevent information security risks.

Blockchain technology can be used to ensure urban information security. We will accelerate the development of advanced technology and information application scenarios such as big data, the Internet and blockchain, and accelerate the construction of smart cities. Blockchain is a database with distributed ledgers, sharing, encryption, and smart contracts. It conducts multi-chain transactions according to its decentralized, non-tampering and traceability characteristics. Chen Li and Zhu Bingli (2020) have built a blockchain-based intelligent city system based on the physical layer, communication layer, platform layer and application layer. [2]

The architecture model of blockchain first collects complete data in time through chain structure, time stamp, asymmetric encryption and so on.

Secondly, the obtained data and information are transmitted to the decentralized communication network, and the verification center and audit center in the distributed ledger in the blockchain are used for the platform processing to build intelligent contracts.

Finally, it is applied to finance, medical care, transportation and other aspects of city information construction. The application scenarios of blockchain technology in the city information construction innovation ecosystem include protecting user privacy and information security, and including the use of distributed ledgers to protect personal privacy information, avoiding information disclosure and data traceability based on its decentralized characteristics, and linking data storage structures to ensure data traceability.

4 INNOVATION ECOSYSTEM MODEL OF CITY INFORMATION CONSTRUCTION

Firstly, we need to determine the dynamic mechanism of the system. The three elements of production are land, capital, and labor. As the economy develops, economists have found it difficult to explain some real economic phenomena with these external variables alone. Later, they proposed the endogenous variables. The theory of endogenous economic growth divides information, technology and human resources

into the endogenous drivers of economic growth. This paper combines the theory of endogenous economic growth and the particularity of urban information construction, and summarizes the dynamic mechanism of technology innovation, talent innovation, resource innovation and market innovation of urban information construction. To build an urban information innovation ecosystem, the most important thing is to give full play to the dynamic role of innovation, Strengthen the innovation of information resources, promote the sharing of information resources, develop smart scene applications, and improve the utilization of information resources. While realizing the sharing of information resources, we should also ensure the security of information. Improve the collection, storage and analysis of information and realize the construction of urban informatization.

Secondly, build the urban information construction innovation ecosystem model. Extending CIM to higher levels, "I" in CIM is not just "Information" and more likely "Intelligent". Let the CIM realize the city's civilization and natural digital connection. The help of CIM can make the process of city information management more humanized. This paper applies the "center-periphery" model of the innovation ecosystem of Zhao Fang (2014) to unify all the elements in the innovation ecosystem of city information construction into the "center-periphery" hierarchy structure as shown in Figure 1.

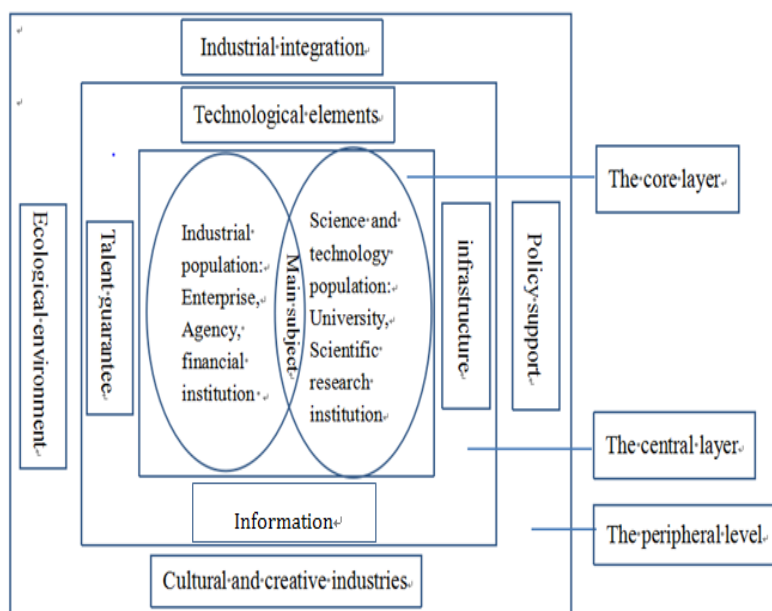


Figure 1. Model of city information construction innovation ecosystem

4.1 The core layer

The core layer analyzes the behavior of the core subject in the system. Leading enterprises split with small and medium-sized enterprises to form the backbone of city information construction, and support

information construction through technological innovation or enterprise business model innovation. Relying on the application of big data and Internet, they cultivate a large number of Unicorn enterprises and lead the new direction of information construction. Intermediaries and financial institutions provide

professional financial service support for innovative subjects, and universities and scientific research institutions provide them with technical resources, information resources and talent resources.

4.2 *The central layer*

The central layer is composed of innovation resources, which is a platform for the development of innovation activities, mainly for a series of related technological innovation integration and application integration. First of all, consider that city information development is the human development that promotes city development. We can attract creative talents from a global perspective, for BIM, GIS, IOT, city management, city planning, computer information and other professional graduates and employees. And we can carry out the city information model integration and application cultivation work, and to cultivate more in line with the industry development planning, has an international vision, has a high level of city information model integration and application of technical personnel.

In the model, we should give full play to the leading role of technological elements, and introduce virtual reality technology in city spatial planning. We can build city three-dimensional spatial information system by using computers and fully combined with virtual reality technology to carry out three-dimensional information space scene design; Artificial intelligence is widely used in city production and life. Intelligent robots are used to complete some repetitive, boring and simple basic work, improve residents' sense of satisfaction and happiness, and further promote the construction of city information system; Relying on the city intelligent transportation of Internet and big data, reduce residents' transportation costs and create a good transportation environment; Application of satellite remote sensing technology, Liang Si (2021) pointed out that satellite remote sensing can analyze the thermal infrared remote sensing image data during the epidemic, divide the temperature level and count the situation of returning to work and production; The application of new energy can reduce carbon emissions, improve residents' living environment, build a livable city and shape city green space.

4.3 *The peripheral layer*

At the peripheral layer, the city innovation ecosystem is a complex system involving policy, industry, environment and organization. It mainly refers to providing environmental protection for innovative ecosystems.

4.3.1 *Strengthen the Top-level Design*

Firstly, strengthen the top-level design and give play to the leading role of the government. In the top-level design, we need to coordinate and integrate, always

design the planning from the overall perspective, play a leading role, improve the government governance system, improve the system and integrity of the government organizational structure, and give play to the guiding and synergistic role of the policy framework. We will improve and strengthen the functions of service-oriented governments, and give full play to their organizational functions in planning, macro-control and policy implementation. City information construction will be included in the medium-and long-term planning of city construction. At the same time, it is important to establish information construction evaluation mechanism, strengthen the implementation and effect of information construction, strengthen the management of construction process, and promote city information construction. [10]

In terms of funds, it is suggested that the government should establish a special development fund to promote city information construction and provide corresponding financial policy support for information enterprises.

In terms of institutional construction, we should strengthen the reform of the systems and mechanisms of government departments, and improve the government laws and regulations.

4.3.2 *Industry Integration*

Secondly, to promote cross-border industrial integration and development, city information construction should pay more attention to information management, transform information into economic value, and capitalize information, data and other factors through technology application, to realize the sustainable development of the city information innovation ecosystem. City information construction needs to rely on big data, Internet, artificial intelligence and other technologies to facilitate the exchange, sharing and integration, so as to promote the liquidity of information elements in the market. We can use the information generation in the information management system, promote the innovation and development of city big data, artificial intelligence and other technologies, and further promote the construction of city information.

4.3.3 *Optimize the City Spatial Layout*

Thirdly, when optimizing city spatial layout, it is necessary to rationally layout and plan city development space, gradually expand the space for production, living and ecological development, and expand city capacity. By implementing the ecological transformation of the old city area, the spatial structure of production, living and ecology should be optimized. In terms of green infrastructure construction, from the construction of community green space to the construction of city green space, gradually strengthen and improve the

construction of green infrastructure, build a modern city environment in which man and nature coexist harmoniously, and improve biodiversity and diversified ecological services. As far as the livable environment is concerned, it is a high summary of the beautiful environment, social security, civilization and progress, comfortable life, rich information and pleasant landscape. It is an important link in improving the living environment, ensuring people's livelihood and promoting scientific development.

5 CONCLUSIONS

This paper presents CIM's data fusion method: D-S evidence theory in detail, and the current difficulties and future development trends of CIM. We expand the CIM to a higher level, combined with the innovation theory of ecosystem system, and establish the city information construction model concept and the smart city information construction is realized based on the "center-periphery" model. At last, build a beautiful city with the CIM enabled by science and technology. The paper aims to provide some theoretical help for the construction of smart city in China.

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