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A Brief Analysis of the Construction and Application of City Information Modeling in Urban Business Districts

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Abstract: City information modeling (CIM) is a database, in which its intelligent and real-time collection functions allow the database to grow or update continuously. There are many types of data so a computing model capable of processing and analyzing large amounts of data is needed. At this time, the application of breaking down the whole into small scenarios and cities has become a necessary stage in the early development of CIM. This article focuses on the core development driving force of the urban economy in commercial districts. In response to the issues that need to be urgently solved in commercial districts, the study analyzes the use of CIM technology to build a "cloud city" for commercial districts and analyzes feasible commercial district scenario applications.

Keywords: City business circle; City information modeling; Construction and application

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1. The significance of commercial districts to cities

Convenient transportation continues to develop and grow, as the outline of the city is growing. As society develops to a certain stage, new industries are constantly being created while existing industries are expanding. More and larger enterprises are settling in, and residential areas are gradually becoming more densely populated. With the need for social work and activities, the population will also undergo some migration, and urban centers will either expand or become primary, secondary, or even multiple centers Many supporting commercial clusters have emerged around work-intensive areas, residential gathering areas, some social and cultural activities, as well as landmarks, landscapes, and other areas. The long-term existence of commercial clusters has cultivated some consumption habits, formed consumption patterns, attractiveness, and stickiness that are suitable for the current location, naturally generated levels, and even started to have spillover effects from this area, forming commercial districts. According to the prosperous form of commercial consumption activities, they are divided into core commercial districts, secondary commercial districts, boundary zones, and so on. Due to the diverse characteristics of the commercial district, different consumer circles can be formed.

Each business district layer plays its role in meeting similar consumer demands.

Within the urban commercial district, there are often numerous groups of businesses such as salespeople, suppliers, material suppliers, construction and logistics, and operation management, which also attract a large number of consumer groups such as workers, learners, local residents, and recreational workers who are stranded. They gather in a certain spatial range to carry out economic activities, generate economies of scale, promote the upgrading and transformation of surrounding infrastructure, facilitate and optimize transportation, greatly increase the demand for information sharing, exchange, and circulation, and even continuously improve the standardized management of social activities, civilized rule of law, etiquette norms, safety management, and so on.

From this, it can be seen that urban commercial districts play a role in promoting the economic vitality of urban development, especially for the development of large and mega cities. They are like engines, providing power for the development of different areas in the city.

2. Current situation of urban commercial districts

Currently, there is a significant regional development imbalance in cities, especially in large and mega cities.

Some areas used to be densely populated and bustling, but with the extension of the urban area, the original commercial district was temporarily unable to match, and the value of the plot was under pressure or even decreased. The personnel structure and enterprise composition within the original site have changed, and the economic structure within the original circle urgently needs to be re-evaluated. The corresponding urban environment needs to be renovated, commercial districts need to be transformed, and urban supporting facilities need to be updated.

How should the commercial district be developed for some newly developed lands? Is it a trendy urban brand? Or is it a characteristic consumption category with regional characteristics? Or is it community service? Or is it a business office category or part of the industrial services? If there is no unified planning and management but “free growth”, it will lead to excessive frequent turnover of merchants, diverse types, and disorderly types; If there is unified planning and management, but incorrect predictions occur, it may result in narrow entrances to commercial buildings, unbearable road congestion, and businesses having to withdraw, which may lead to the inability of the commercial district to form a climate for many years, making people’s lives inconvenient. At the same time, the original beautiful and grand plan cannot be realized, which also drags down the value of the land and even causes a sharp decline in the reputation of the area, causing more businesses and consumers to hesitate.

In summary, a good match between the commercial district and the land area requires accurate and timely database feedback and analysis to assist the construction within the commercial district in keeping up with the development and changes of the land area. The operation and management of commercial districts require refined big data models, simulations, and analytical calculations to provide more realistic and diverse solutions for planning managers, helping them make the most suitable decisions at present. It is also very important to have refined data management models to support different states such as the commercial district being unformed, taking shape, and gradually improving.

All these expectations now fall on city information modeling (CIM).

3. Building a CIM platform

3.1. Background and preparation

City information modeling (CIM) uses building information modeling (BIM), geographic information system

(GIS), Internet of things (IoT), and other technologies, takes spatial coordinate system and urban geographic information as the underlying foundation, combines the BIM information between the underground and overhead dimensions of the city to build the urban spatial model, makes the urban information of the physical world enter the Internet through information sensing, intelligent devices, and so on, and updates it as time goes on. Simultaneously, digital twin technology is used to integrate the spatial scene and urban perception into an information complex that can accurately reflect the history, status quo, and expected future of the city in multiple dimensions, that is, the mapping of the physical world city in the virtual space. By adjusting the granularity of CIM data in different application scenarios, data support and precise dynamic simulation can be provided for refined and agile management of cities while maintaining real-time updates through interaction with the physical world, that is, "one city on the ground, one city in the cloud."

The CIM platform intelligently perceives the dense and frequent sensor data streams in urban commercial districts, making the virtual mapping of the commercial district contain a huge database. The denser and more frequent the sensor data streams, the higher the replication accuracy of the mapping and the closer it is to the physical world. However, the resulting cost will also become more expensive. Therefore, creating a CIM platform for a commercial district in a certain city requires starting from the fundamental needs of the district, considering long-term efficiency and cost, appropriately reducing the granularity of data, optimizing and extending the layout of sensors and the frequency of data updates to ensure that the platform is more agile and smooth to use, and the cost is within an acceptable range.

Taking a certain old city renovation area as an example, the plot was originally an industrial area, and the plot was originally a general manufacturing and warehousing base. With the development and expansion of the city, the plot is located in the central urban area of the city, where traffic is often congested and the living experience of nearby residents is poor. After the government's re-examination and analysis, the industrial enterprises and bases within the block have been relocated to the new area. After measures such as land consolidation, transportation reconstruction (above and below ground), and municipal facility supplementation, the plot has also completed a digital spatial model simultaneously. Next, developers will build a CIM platform and use digital twin technology to assist regional managers in achieving the goal of construction management. This allows a better understanding and grasping of the operational status of subsequent commercial districts. Dynamic optimization of spatial planning was performed. Real-time traffic flow and pedestrian flow data were obtained to improve traffic congestion. Consumers were provided with rich consumption information and interactive experiences.

3.2. Construction and implementation

Based on the above requirements, the implementation goal of this CIM platform construction is established. Based on existing digital models, 3D modeling, and data global identification, combined with actual management business, to build a virtual display platform for the above-ground and underground space forms of this commercial district, achieve accurate mapping of the commercial district within the physical jurisdiction in the digital twin space, and construct a dynamic, interactive, and full lifecycle digital twin system.

Firstly, build a multi-dimensional data system called digital twin to solidify the data foundation of the commercial district. The digital model of the commercial district should cover coordinates, topography, road network, vegetation, buildings, municipal facilities, and so on, within the physical jurisdiction. The urban design plan to be constructed or renovated within the commercial district, including terrain, road network, vegetation, buildings, municipal facilities, and so on, utilizes a simulation of the urban landscape within a range of 30–80 square kilometers outside the commercial district (the distance of the area can be set based on the

convenience and radiation level of existing transportation).

Secondly, realistic simulation of 24-hour lighting and flood effects, including buildings, parks, roads, and so on. For key areas of concern (with landmark attributes or special lighting schemes), various lighting schemes should be covered.

During implementation, different granularity can be applied to different modules according to different needs to achieve an economically reasonable, agile, and smooth user experience. For example, the key focus areas within the commercial district can use slightly smaller scales, and denser and more frequent data streams for real-time feedback. Other areas within the commercial district can obtain perception data with a certain degree of accuracy. The areas within the external setting range of the commercial district can use general accuracy or relatively rough data. In addition to adjusting the layout and accuracy of data collection, urban aerial photography also needs to be differentiated and adjusted. Aerial photography collects basic data and processes it. The city model within the commercial district can be formed into a standard model using different CIM accuracies based on the core area, a certain area within square kilometers outside the core area, the entire commercial district, and the entire city scenario (CIM accuracy classification can be found in the "Technical Guidelines for Urban Information Model (CIM) Basic Platform" issued by the Ministry of Housing and Urban-Rural Development in 2020). Similarly, urban landscape and terrain models can also be implemented with reference.

In summary, based on the specific needs of the commercial district, set the construction goals of the CIM platform to determine the construction plan and budget. Implement regional and key data collection methods with different accuracies and frequencies, and construct models with different accuracies. In addition to having a dynamic data model, it can also integrate or interface with numerous management applications such as 3D visualization from any angle, site selection analysis, planning display, traffic analysis, project progress analysis, and more.

4. Scenario application

After the "cloud city" was built, it entered the target stage for applications in different scenarios.

4.1. Planning and management scenarios

The renovation of old cities and the reshaping of commercial districts were taken as examples. The inadequate spatial planning of the old city area leads to uneven resource allocation, with some streets lined with shops and traffic congested, while others are deserted and ignored. The experience of merchants and consumers is poor, and the overall operational efficiency of the business district is low.

The CIM platform allows for global roaming, allowing for viewing of urban scenes from any angle and location, including high-altitude and human height perspectives. It can truly showcase the daytime and nighttime scenes of the urban area, and check the overall coordination of the exterior facade and floodlighting effects. It can analyze the exterior facade, landscape, environment, traffic, and pedestrian flow of the area that requires special attention. It can simulate switching between different lighting schemes and generate related videos and images. It allows real-time display of demolition projects and visualization of relevant information and progress. In the business district, one map can display all plans, all demolitions, and all construction progress. By utilizing these functions, regional managers can gain a deeper understanding of the current situation in the area and achieve the goal of optimizing and adjusting urban spatial planning.

4.2. Investment promotion scenarios

The CIM platform can be used to display basic information about the commercial district through animation or

video, including geographic location, urban policies, district planning, and development status, business layout and data, existing facilities and ecology, existing businesses and industries, and so on. Site selection reports within the area can be provided, including store, takeaway, and customer group data analysis, first-person perspective indoor and outdoor, and simulation of site selection with obstructed views.

5. Summary

With the construction of CIM platform digital bases in many large and mega cities in China, some cities have integrated some scenario applications, making the management of commercial districts and urban governance more intelligent. Through precise big data model simulation, repeated verification, and deduction, the most suitable development strategy for the current situation is obtained. After application and practice, it is supplemented by appropriate manual adjustment and correction. The interaction between "above-ground city" and "cloud city" effectively avoids much resource waste, ineffective labor, and so on. Some people believe that although this approach is good, it is limited by the carrying capacity of the CIM platform, which needs to be able to carry a wide variety of data and operate effectively to develop various application scenarios on top of it. In the author's opinion, in response to such a situation, it is feasible to first target the main issues and difficulties of the city and apply them in different scenarios. By distinguishing between coarse and fine precision, the CIM platform construction required for the scenario application can be completed first, which can effectively assist in solving problems. In the process of platform construction, consider reserving interfaces for further future updates or extensions. Continuously drawing experience and lessons from the application in local areas, summarizing, and realizing the entire smart city and smart China is a promising future.

Disclosure statement

The author declares no conflict of interest.

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