Review of Data Policy and Common Spatial Data Infrastructure (CSDI) in developing Hong Kong as a Smart City

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Key words: Data Policy, Spatial Data Infrastructure, CSDI, Smart City, Hong Kong

SUMMARY

In the era of big data, our life has been surging with numerous information and data nearly every minutes every day. However, most of them is stuck, without being structurally utilized, analyzed and implemented into valuable applications. Indeed, around 80% of the data is spatial data, which is usually stored in separated parties and systems without networking with each other, not to say integrating them for further innovations.

Seeing the potentiality of utilizing spatial data and technology in developing Hong Kong into a smart and sustainable city, since 2017, open data policy and Common Spatial Data Infrastructure (CSDI) have been addressed in the Hong Kong Smart City Blueprint.

Data used to be kept internally is encouraged to be sharing among governmental organizations and private sectors. A geospatial data infrastructure, namely Common Spatial Data Infrastructure (CSDI) and its portal has also been established with common guidelines and standards in the vision of supporting innovative applications.

In this paper, the open data policy and framework of CSDI would be reviewed, followed by latest application of the datasets from the portal in the construction projects. Their limitations would also discussed in terms of availability of data and standards, with the way forward.

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1. INTRODUCTION

The idea behind smart cities is to use contemporary information and communication technology to improve urban services and citizens' quality of life. A comprehensive digital system for real-world city infrastructure monitoring, planning, and maintenance is necessary to accomplish this goal.

To expedite the development of a smart city, geospatial data is crucial, being processed, analyzed and managed through technologies such as BIM (Building Information Modeling), GIS (Geographic Information System), and their integration.

In an era of information overload, spatial data seems readily accessible, but it is imperative to verify its accuracy, up-to-datedness, and to handle the issues of privacy and security with care.

Since 2017, the Hong Kong government has been actively establishing the open data policy, as well as developing the Common Spatial Data Infrastructure (CSDI) with the vision of transforming Hong Kong into a smart and sustainable city.

The development of CSDI may be one way to serve a variety of applications across the city and consolidate a large amount of spatial data in standardized forms. In the next chapters, we will go over the CSDI framework and data policy, look at construction project procedures, and use the available datasets in a case study to find any constraints.

2. OPEN DATA POLICY AND FEAMEWORK OF COMMON SPATIAL DATA INFRASTRUCTURE (CSDI)

Spatial data, which makes up around 80% of all data worldwide, has long been managed by many systems and parties without established standards. As part of its Smart City Blueprint, the Hong Kong government has developed the Common geographical Data Infrastructure (CSDI) and an open data policy in recognizing the importance of geographical data in policymaking and innovation. Using tools like the CSDI portal and 3D digital maps, these programs promote data exchange across public and commercial sectors.

The CSDI framework's development seeks to accomplish three objectives: 1) the establishment of data and technical standards, 2) the creation of a platform to support applications, and 3) the enhancement of capacity and outreach. To achieve these goals, modern technologies such as BIM and GIS are advocated for the storage, analysis, and management of spatial data, facilitating the development of creative smart applications.

Data is typically gathered from diverse sources and categorized according to its characteristics. By employing modern technology, all the data and information is ultimately interconnected and exploited (see Figure 1).

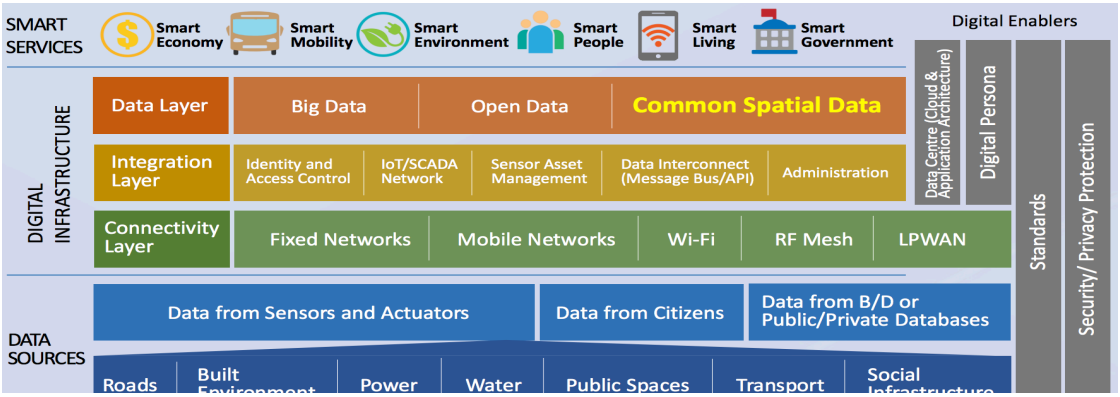

Figure 1 Framework of Data Policy and CSDI (Lands Depsrtment of HKSAR, 2019)

The Lands Department of the Hong Kong Government is tasked with creating a unified data platform with established standards and fostering collaborative tactics across government departments and the public. The CSDI Portal was publicly introduced in December 2022 (see Figure 2). The Development Bureau (2019) states that this portal functions as a comprehensive data "supermarket," enabling users to access, download, and employ a diverse array of open data for innovative and value-added applications. In 2023, over 298,000 datasets were downloaded, and more than 7.8 billion API service requests were recorded.

Figure 2 Interface of Common Spatial Data Infrastructure Portal

2.1 Data Sources and Standards

Nearly four years since the official launch of the CSDI Portal in 2021, more than 900 datasets were obtained from various government departments for download, which have been categorized as Common Sharable Spatial Data (CSSD) and Framework Spatial Data Theme (FSDT).

CSSD includes datasets such as planning and census information, infrastructure facilities, maps, pedestrian networks, and more resources, maintained by their respective departmental custodians. In contrast, FSDT provides a specific geographic framework for geo-coding or referencing other datasets.

More specifically, the datasets available in the CSDI Portal fulfill five standards as follows:

- Geo-tagging of non-spatial data
- Documentation of data specifications
- Documentation of metadata
- Establishment of Application Programming Interfaces (APIs)
- Conversion of spatial data to an open and machine-readable format

Thematic datasets are classified and labeled with geographic locations, enabling users to display them on a map and retrieve comprehensive information in tabular formats for diverse applications. Figure 3 displays the "Schools participating in the "Waste Separation and Recycling Scheme in Schools" dataset provided by Environmental Protection Department, where standardized information for a selected location, such as the universal coordinates, address and even GML ID is listed.

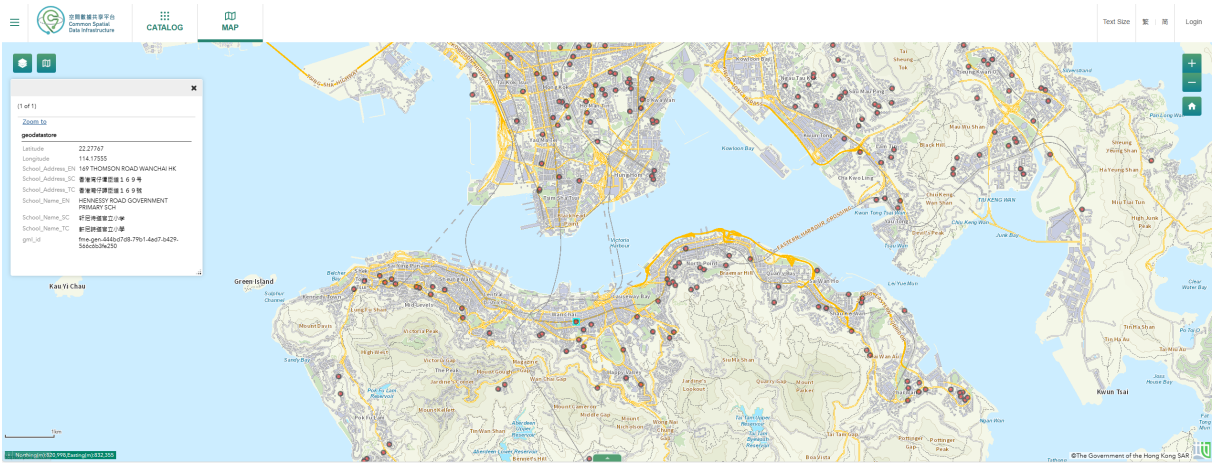

Figure 3 Preview of thematic data on map available on CSDI Portal

Spatial data is widely utilized in the development of 3D digital maps, which are served as the foundation for territory-wide city modeling and the establishment of Application Programming Interfaces for innovation.

In addition to existing 2D mapping resources, the Lands Department of the Hong Kong Government has collecting extensive city-wide spatial data using advanced technologies like large-scale aerial imaging and mobile mapping systems equipped with various sensors. These mapping data from different acquiring sources was then integrated to become basis of the 3D maps and modelling data for further applications.

By the first quarter of 2025, digital maps including the majority of Hong Kong's area are anticipated to be accessible using a three-phase methodology. The initial phase, which involves the provision of visualization maps, has been successfully completed and is available via the portal. The second step entails supplying maps for unit-specific indoor applications, such as Building Information Modeling (BIM), while the third stage concentrates on maps for urban modeling in OGC CityGML and IndoorGML (see Figure 4). An online platform named “Open3Dhk” has been established to facilitate the visualization and interaction with mapping data, including the presentation of profile graphs featuring bathroom and transport sites along hiking trails (see Figure 5). The dataset is concurrently accessible for download from the CSDI Portal.

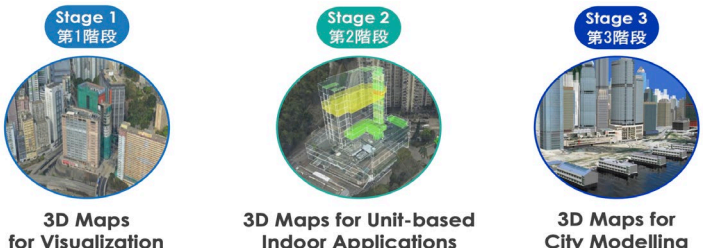

Figure 4 Generating 3D Digital Maps in 3-stage strategy

Figure 5 Hiking information visualized on Open3Dhk

2.2 Utilization of Geo-spatial Data

Since 2021, multiple Application Programming Interfaces (APIs) have been developed to enhance public access to spatial data and to advance the digital infrastructure, utilizing data sourced from the CSDI portal.

These APIs facilitate development of novel applications without the necessity of pre-collecting spatial data, particularly in a large urban context. Various APIs are concurrently accessible via the CSDI portal. For instance, Map APIs and Dataset APIs facilitate the retrieval of diverse mapping data in accordance with open standards such as WFS, WMS, and ArcGIS established by the Open Geospatial Consortium (OGC) for geospatial data and services.

In addition to providing APIs for developers, geo-spatial applications and tools have been developed to enable general users to see and analyze substantial data, as well as create their own datasets. The Geo-tagging Tool allows the users to create and alter their own geo-spatial data, while the District-based Spatial Information Dashboard provides a user-friendly and interactive representation of thematic data online, along with analytical tools in terms of district aspects.

Figure 6 presents an overview of childcare services in Hong Kong, featuring multiple filtering options for comprehensive data analysis. Utilizing consistent, current, and aggregated district-level data, alongside essential analytical tools, these Dashboards function as an interactive platform for municipal administration, gauging public sentiment, and tracking trends in relation to digital infrastructure and smart city advancement.

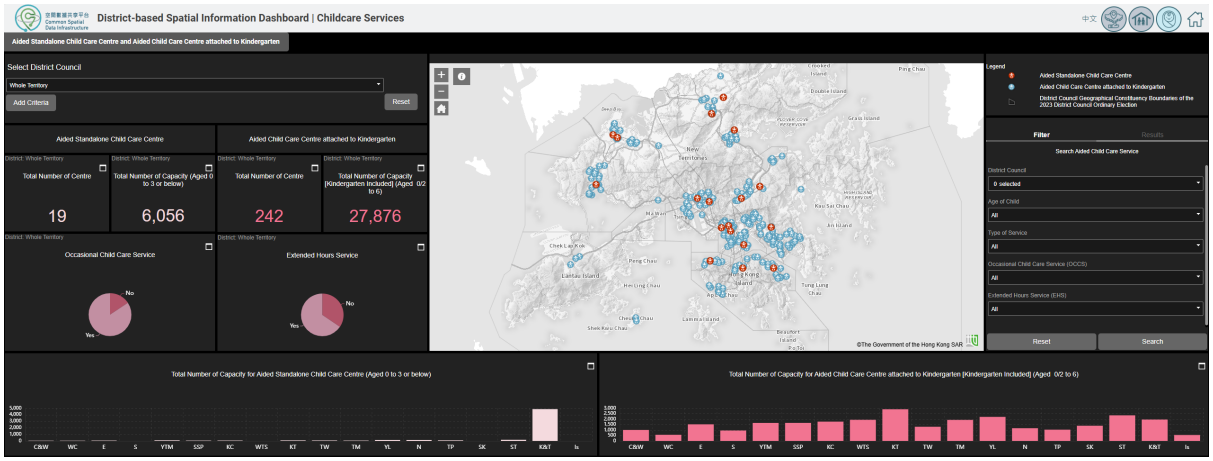

Figure 6 Details of childcare services in Hong Kong shown on the Dashbroad with analytical tools

3. APPLICATION OF DATA AVAILABLE IN CSDI PORTAL IN CITY MODELLING

The integration of spatial data is essential for combining various environmental and city service datasets and creating comprehensive 3D models for effective city governance. In this chapter, we will review the datasets accessible in the CSDI Portal and explore the process of downloading BIM and GIS data for assessment within a commonly used GIS platform.

3.1 Data from CSDI Portal

A primary purpose of this review is to gather high-quality and current spatial data. The CSDI Portal is intended to deliver data in open, machine-accessible formats, including a diverse array of spatial and non-spatial datasets in widely utilized formats. The Annual Spatial Data Plans delineate the regularity with which each data supplier plans to update and upload their data in formats like XLSX and JSON.

Under the "Land Information" sub-group in the "Data Categories" section of the Portal, users can access various major spatial datasets. These include digital topographic maps in both 2D and 3D, as well as thematic datasets such as community and social services facility locations, historical maps, and land sales records.

According to the report of Construction Industry Council in 2021, local construction projects have begun integrating vairous data sources for various planning and assessment purposes. Alongside conventional on-site field surveys to collect geographical information, data from the surrounding environment is being downloaded from the CSDI Portal to support broader urban studies. Table 3.1 below provides details on commonly downloaded datasets from the Portal, including information on accuracy, update frequency and usage.

Table 1 Overview of commonly used datasets from the CSDI Portal

Dataset Name	Data Format	File Extension	Provider Name	Update Frequency	Accuracy	Cases Applied
3D Spatial Data 3D-BIT00	3D	GeoPackage, GeoJSON, GML, SHP, KML	Lands Department	Every 2 months	Unspecified	General use
Digital Land Boundary Map iC1000	2D			Every 2 weeks	N/A	
Digital Orthophoto DOP5000	2D			On as-needed basis	0.2m	
Digital Topographic Map iB1000	2D			Every 2 weeks	5m	
Digital Surface Model from 2010 / 2020 LiDAR Survey	3D		Civil Engineering and Development Department	As and when there is update	0.3m	
3D Visualization Map	3D	GeoPackage, GeoJSON, GML, KML	Lands Department	As and when there is update	1m	
Digital Planning Data	2D	GML, GeoJSON, SHP	Planning Department	As and when there is update	N/A	
Ambient environmental data: - temperature - humidity - solar radiation - wind speed - Wind direction	2D	GeoPackage, GeoJSON, FGDB, SHP, KML, CSV	Hong Kong Observatory	Hourly / monthly / when there is update	N/A	Geotechnical Study, Traffic and Environmental Impact Assessment
Country Park boundary	2D	GeoPackage, GeoJSON, SHP, GML, KML, CSV	Agriculture, Fisheries and Conservation Department	As and when there is update	N/A	
Road network	2D	GeoPackage, GeoJSON, GML, SHP, KML	Transport Department	Monthly	Unspecified	Traffic Impact Assessment
Traffic flow	2D	GeoPackage, GeoJSON, GML, SHP, KML	Transport Department	Yearly	N/A	
Digitized Traffic Aids Drawings	2D	GeoPackage, GML, SHP, KML	Transport Department	Monthly	N/A	
Short Term Tenancy	2D	GeoPackage, GeoJSON, GML, KML	Lands Department	Quarterly	Unspecified	Premium Assessment and Property Valuation

3.2 Case Study with current datasets

This chapter aims to integrate BIM and GIS datasets from the CSDI Portal into data management, analysis, and decision-making platforms. Expanding on the three-stage methodology for constructing 3D city models outlined in the preceding chapter, the datasets within the CSDI Portal will ultimately facilitate the development of a digital twin, providing intelligent solutions that improve quality of life.

To achieve the previously mentioned purpose, consider a scenario in which a family of three—father, mother, and child—plans to relocate to To Kwa Wan. Datasets relevant to the area of concern are retrieved from the CSDI Portal and integrated into a GIS platform. The supplied reference map includes the latest building models from Urban Renewal Authority, which are equipped with detailed information, while other 3D polygonal models are added with no textures (see Figure 7 and Table 2). The software integrates data from the Digital Topographic Map and GeoCommunity Database, including train station accessibility, street furniture, libraries, schools, and grocery stores. A variety of functions are employed to assess if the area of interest satisfies the family's requirements.

Figure 7 Mapping data extracted from standardized tiles from the Portal

Table 2 Datasets used in the case study

Dataset Name	Data Format	File Extension	Provider Name	Sheet no.
3D Spatial Data 3D-BIT00	3D	SHP	Lands Department	11-NW-20D
				11-NE-16C
				11-NW-25B
				11-NE-21A
3D Intelligent of an area in To Kwa Wan	3D	OBJ, OSGB	Urban Renewal Authority	N/A
Digital Topographic Map iB1000	2D	SHP	Lands Department	11-NW-20D
				11-NE-16C
				11-NW-25B
				11-NE-21A
GeoCommunity Database	2D	CSV	Lands Department	N/A

Upon importing the 3D models into the GIS platform, the area of interest can be seen in both 2D and 3D perspectives (refer to Figure 8), facilitating diverse studies. For example, one can perform basic distance analysis between two locations and viewshed analysis to ascertain observable locations from a particular vantage point (see to Figure 9).

Figure 8 3D building model visualized on the GIS Platform (left: top view; right: side view)

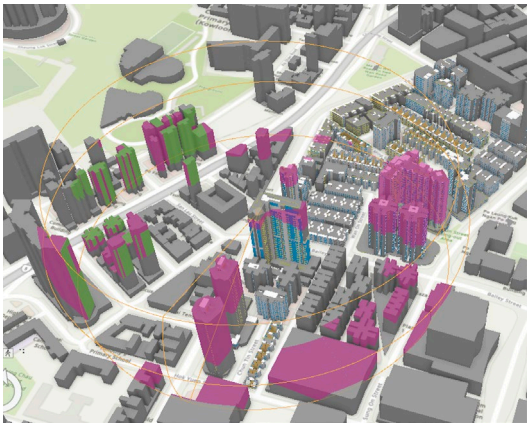

Figure 9 Viewshed analysis tool being utilized

Specific services within the community, such as schools, can be identified, sorted, and summarized in charts or tables (see Figure 10).

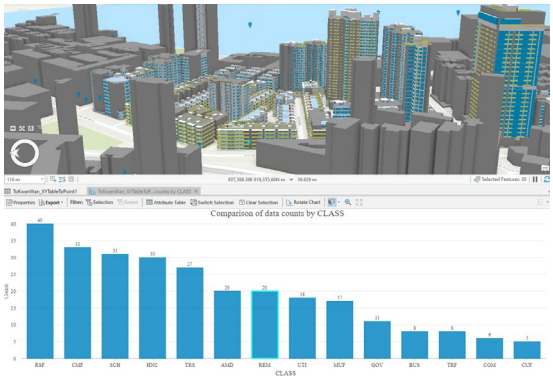

Figure 10 Identify educational institutions within the area of interest

Upon further magnification of the 3D indoor maps, the building floors and units are apparent, allowing for the extraction of pertinent information, including location, unit type, area, and height, for examination (see Figure 11).

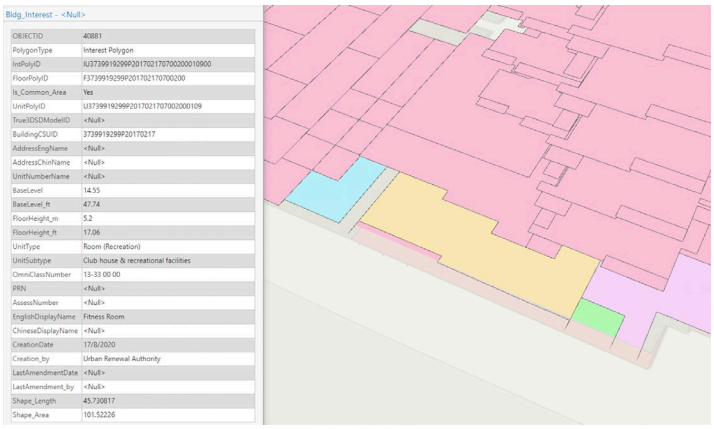

Figure 11 Extraction of detailed information from imported datsets for overview

3.3 Findings from the Case Study

The CSDI portal functions as a centralized platform for diverse geo-coded and standardized datasets, enabling society to investigate relevant information. At present, solely government departments have contributed their datasets to the CSDI Portal. Nonetheless, certain datasets are accessible exclusively upon request and are supplied without indicating their accuracy.

In building projects, the available datasets may be outdated, necessitating minor on-site surveys to acquire latest site conditions for design and evaluations. Project-specific information is retained by the data holders and limited to internal use mainly, unless when regulations exist, such as for development paperwork asking for governmental permits.

The current community information may be inadequate and lacking for the general public interested in community services in a particular location. The case study of To Kwa Wan reveals that just 275 service items are now accessible, which inadequately represents the community's needs.

Moreover, the 3D models can be augmented with additional textures, therefore raising privacy issues. Furthermore, the models can solely be seen through specialized platforms for functional purposes, hence restricting accessible to data specialists. District-based geographical information dashboards have been launched to facilitate data analysis for societal benefit. Currently, these dashboards are restricted to three specific subjects: temporary vacant government properties, elderly services, and childcare services.

4. Current Operation and Future Development of CSDI

This chapter presents surveys performed by email with individuals associated with CSDI, concentrating on current operational challenges, including data policy and the forthcoming trajectory of CSDI in advancing Hong Kong as a smart city. The conclusions of the CSDI policy and its enhancement for advancing Hong Kong as a smart city will be presented in conjunction with the findings from the preceding chapter.

4.1 Evaluation of the existing Data Policy and CSDI Portal

4.1.2 Frequency of Dataset updates

The CSDI Portal will furnish Annual Spatial Data Plans containing details regarding forthcoming upgrading projects. Various departments maintain distinct timetables for updating data types and frequencies. Certain datasets, such 3D photorealistic and visualization maps, are singular initiatives, whereas others are updated solely when required.

The interviewee indicated that the timeliness of the datasets is not always essential, particularly with the exteriors of 3D structures, which remain quite stable. The update frequency must balance demand with financial constraints. The Lands Department coordinates updating cycles with other departments according to actual demands, practical methods, and necessary resources. Furthermore, community service data is perpetually updated and classified into eight prominent categories of interest.

4.2 Quality of Dataset

Each dataset in the Portal is accompanied by a distinct information page that delineates its requirements and characteristics, enabling users to acquire suitable datasets for their applications. The mapping tools offered by the Lands Department can achieve an accuracy of up to 0.2 meters. Nonetheless, not all datasets from other departments delineate the precision of the gathered data.

The Lands Department, which specializes in mapping and spatial data management, should not only develop formatting standards but also give consultation guidelines for determining accuracy requirements for various widely used data in the long term.

4.3 Public Privacy

During the post-processing phase, when nearby street data is acquired by cameras affixed to the Mobile Mapping vehicle, specific safeguards are implemented. Warning labels are attached to the mobile vehicle to inform the public. Human faces and car numbers are hidden via a semi-automated technique augmented by AI technology to mitigate privacy issues.

Moreover, data collection and security are executed in compliance with applicable

legislation and under the supervision of the Office of the Privacy Commissioner for Personal Data and the Innovation Technology Bureau Office. The interviewee stated that publicly available datasets undergo independent Security Risk Assessment and Audit.

4.2 Data Sharing Mechanism in the Future

Recently, the data providers in the CSDI Portal are predominantly governmental departments or quasi-governmental institutions. To enhance geographical information and facilitate smart city development, data sharing from the business sector is essential. The Spatial Data Office has been actively collaborating with several sectors, including the Hong Kong Science and Technology Parks and professional institutes in Architecture, Engineering, and Construction, to advocate for the advantages and commercial prospects of spatial data sharing.

The creation of the Geospatial Lab can enhance the development of geospatial collectives consisting of entrepreneurs, technological experts, startups, professional groups, academic institutions, and youth, resulting in various prospective smart city applications. The 3D pedestrian network API facilitates uninterrupted interior and outdoor navigation for visually impaired users, while real-time availability of parking data supports driving and transportation tools.

The preliminary comments regarding government-private sector partnership was favorable and promising. The government may contemplate offering incentives to the private sector, such as easing rules or diminishing fees, to foster the advanced growth of the local geospatial industry.

4.4 Online 3D City Models

An online platform can be developed to integrate diverse theme data information with fundamental functional and analytical tools, utilizing the datasets housed on the CSDI portal. The Dashboard for childcare services in Hong Kong is publicly accessible, and several topical datasets are compiled online for straightforward analysis.

Additionally, numerous APIs have been created to enable users to integrate them into their applications. The 3D maps serve the general public with integrated features such as shortest path projection and a services search engine, allowing users to view the maps and utilize the intelligent digital resolutions offered by the official channel.

Given the sophisticated data analysis of 3D city models, their utility in making choices, and privacy issues, access control on the web platform must be established for various user groups. Premium customers should have the authority to modify sensitive data, but the general populace may only access less sensitive information or seek access to community

services. Protocols for the data sharing policy must be created to guarantee systematic data management.

5. Conclusion

In era of massive data and information, it is essential for professionals and stakeholders, especially land surveyors, to embrace geospatial technologies for further evolving data management and development.

Seeing the necessity and opportunity of developing Hong Kong into a smart city, the CSDI Portal was established to gathering various types of data and information from scattered sources, with unified formatting standards.

Taking an sample of using datasets provided by the CSDI Portal, it was potential to allow general public to have the data they concerend at one end and to make daily life decisions based on the analysis and findings. Indeed, the geo-spatial datasets allow diversified users to explore countless applications on innovative ideas, making life easier and the city more lively.

Nevertheless, data security and privacy shall always be of a top concern. Data quality and updating periods should also be refined to make the datasets more reliable and anaylsis more valuable in long term.

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BIOGRAPHICAL NOTES

Sr Hau Wing Shuen, Miki is a land surveyor with specialized experience in the field of cadastral and engineering surveying. She currently serves as a Surveyor at the Airport Authority Hong Kong. Her major duties are to assist the manager in overseeing the survey team and managing all surveying activities related to the airport area. She also monitors contractors' surveying work progress to ensure compliance with quality standards and maintains a high standard of survey control network for Airport Island. Additionally, Ms. Hau maintains and updates land allocation records for the airport platform and explores new surveying technologies.

Prior to her current role, Ms. Hau worked for a private surveying consultancy since 2013. During this period, she managed various projects for government agencies, real estate developers, architecture firms, and main contractors. She provided professional advice and optimal solutions on vsrious cadastral, topographic and engineering projects to clients. Ms. Hau also supervised field surveys with colleagues and conducted training for junior colleagues.

Ms. Hau holds several professional qualifications and memberships. She became a member of The Hong Kong Institution of Engineering Surveyors in December 2023, a Registered Professional Surveyor (Land Surveying) with the Surveyors Registration Board in April 2022, a Corporate Member of The Hong Kong Institute of Surveyors in January 2021, and a Chartered Land Surveyor with the Royal Institution of Chartered Surveyors in January 2020. She has just pursued a Master of Science in Integrated Project Delivery at The University of Hong Kong and holds a Bachelor of Science in Geomatics (Land Surveying) from The Hong Kong Polytechnic University.

Outside of her professional endeavors, Ms. Hau is actively involved in activities related to her surveying field. She serves as the Vice-Chairman of the Young Surveyors Group at The Hong Kong Institute of Surveyors since November 2023 and is a member of the Land Surveying Division at the same institution since December 2021.

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