

# **Enrichment of Land Information Database for Smart City Development**

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## **SUMMARY**

A reliable and well-kept land information database is crucial for implementing an effective and efficient land administration and management system in supporting proper functioning of land markets. The Survey and Mapping Office (SMO) of the Lands Department (LandsD) of the Hong Kong Special Administrative Region Government has been maintaining a Land Information System (LIS) comprising a departmental-wide land information database to support the daily operations of land administration and management in Hong Kong. However, some fundamental information of the land parcels including type of grant, lease term, usage and development conditions is often incomplete in the LIS, causing inefficiency in searching for the land parcel information and making difficulty in providing timely and accurate analysis to support the day-to-day land administration. As the Hong Kong Government is striving to develop the Common Spatial Data Infrastructure (CSDI) in support of the smart city initiatives, a comprehensive land information database becomes indispensable. In view of this, LandsD has initiated a data enhancement project to enrich the existing LIS since 2018. This paper outlines the key activities, progress, and achievements of this project.

## **1. INTRODUCTION**

### **1.1. Land administration and management in Hong Kong**

The LandsD is the land administrative agency of the Hong Kong Special Administrative Region responsible for the land matters in Hong Kong, such as land disposal, land allocation, valuation, acquisition, clearance, land enforcement, to name a few. According to the World Bank collection of development indicators (World Bank Group, 2019), the quality index of land administration in Hong Kong rose from 23 in 2016 to 27.5 (out of 30) in 2019, indicating that the land administration and management in Hong Kong has been improved continuously. LandsD, which operates through three offices, i.e. the Lands Administration Office (LAO), the SMO and the Legal Advisory and Conveyancing Office (LACO), will continue to commit to optimising the use of land resources and maintaining an effective land administration system for meeting the needs of the community.

Since a reliable and well-kept land information database with transparent and accessible land-related information is vital for a well-functioning land management, the LIS managed by the SMO of LandsD becomes indispensable for LandsD to maintain a comprehensive land information database in supporting the daily operations of land administration and management in Hong Kong.

### **1.2. Business needs on the Land Information System**

The LIS is an enterprise geographic information system (GIS), mainly comprising a large-scale topographic map database and a land parcel database. It not only allows SMO to update and maintain the territory-wide land status information for land administration and management in a more efficient manner, but it also supports SMO to provide land-related geospatial analytical services in supporting land enquiries for the Department, other Government Bureaux/Departments (B/Ds), Legislative Council, as well as the public.

## **2. THE LAND INFORMATION SYSTEM**

### **2.1. Overview**

In 2011, SMO launched the LIS to replace the legacy Computerized Land Information System (CLIS) which had served as the first computerized land information database in the Department for nearly 20 years. The CLIS was a file-based digital mapping system with limited GIS functionalities. It was designed to convert the paper copies of survey map sheet and land records plans into two major digital mapping systems: i) Basic Mapping System for the

topographic mapping; and ii) Cadastral Information System for the land parcel mapping. The digital map features were separately coded thereby enabling selective retrieval and display.

During the implementation of the CLIS replacement project, SMO took the opportunity to review the data model and inject new land-related elements to the data model in supporting potential applications of the use of LIS. The spatial data models of LIS were re-classified into three main groups, namely i) land parcel group, ii) topographic group and iii) survey and mapping reference group.

Among which, the land parcel group comprises of land parcel data including private lots, tenancies and Government Land Allocations (i.e. the land parcels allocated for the use by the Government departments) as well as other land information related to land parcels that affects the land status such as government land licences, drainage reserves and waterworks reserves. The re-classification aims at facilitating the searching, retrieval and analysis of the land parcel information to support day-to-day land administration, land resource management and land use planning for the Government.

## **2.2. Current environment of land parcel group dataset in LIS**

Since the LIS was migrated from the CLIS, of which fundamentally it was a digital mapping system, only primitive information about the land parcels was stored in the LIS. Although the data model for land parcel group was re-designed in LIS to facilitate spatial data analysis and support GIS applications, some fundamental information about the land parcels including type of land grant, lease term, usage and development conditions is often incomplete in the LIS. The lack of needed land related information in LIS results in an inefficiency in searching for the land parcel information. And more, it is difficult for the Department to provide timely and accurate spatial data analysis to support Government's day-to-day land administration and the development of the Common Spatial Data Infrastructure (CSDI) in Hong Kong.

## **2.3. Improvement opportunity of land parcel information in LIS**

As announced in the Chief Executive's 2017 Policy Address, the Government is striving to develop Hong Kong into a smarter city to strengthen the city management and improve the livelihood of Hong Kong citizens. The enhancement of the land information database in LIS is of paramount importance for better management of land resources in LandsD. With a view to improve the comprehensiveness and accuracy of the land information database, LandsD kick-

started a data enhancement project in 2018, aiming at enriching the information contents of LIS for better land administration thereby supporting the development of CSDI and keeping pace with the city growth.

### **3. ENHANCEMENT OF LAND INFORMATION DATABASE OF LIS**

#### **3.1. Enrichment of information contents of land information database**

Since 2018, LandsD has initiated the phase I data enhancement project to enrich the information contents of the existing LIS, targeting at providing a comprehensive and accurate land parcel dataset relating to private lots in Hong Kong. The phase I project involves i) the acquisition of registered land documents from the Land Registry (LR) which is operated under a trading fund mode, and ii) the extraction of core lease attributes from the acquired land documents for all the Private Treaty Grant (PTG) lots in the territory and all the New Grant (NG) lots in the New Territories. Along with the data enrichment project, LandsD also set up the workflows to maintain the continuous updates on the land information in LIS and provided tools for making the searching on the land information easier.

##### **3.1.1. Acquisition of registered land document from the Land Registry**

In Hong Kong, the LR maintains a computerised land register for each property of Hong Kong including particulars of deeds, land documents, or other documents affecting a property lodged for registration. Under the scope of phase 1 data enhancement project, LandsD has conducted a large-scale acquisition exercise to purchase over 91,000 numbers of land documents, including the land grant documents in respect of all active private lots in Hong Kong from the LR including Government Lease, New Grant and Conditions documents, and relevant registered land documents. The acquisition exercise aimed at maintaining a comprehensive land document repository for the LIS to facilitate day-to-day land administration and also to support the subsequent extraction of lease related attributes from the land documents for enriching the information content of LIS.

To maintain the land documents in a ubiquitous format for easy viewing and searching, LandsD engaged a service contract in 2019 to convert the registered land documents from the digital scanned images into PDF files. The service contract also includes additional services of optical character recognition (OCR) enablement for converting the scanned land document images into searchable documents for further data processing and documents management. All the registered land documents were managed in the land document repository of LIS.

### 3.1.2 Establishment of LIS Portal

To facilitate the retrieval and sharing of land documents within the Department, SMO developed a portal website named Land Information System Portal (LIS Portal), which is a centralized document retrieval platform for searching the digital content of the registered land documents and download copies of the registered land documents from the land document repository of LIS. The LIS Portal also provides capabilities for users to search for a private lot by its location or by its lot number, and retrieve copies of the registered land documents lodged for the lot. Figure 1 shows the application interface of LIS Portal.

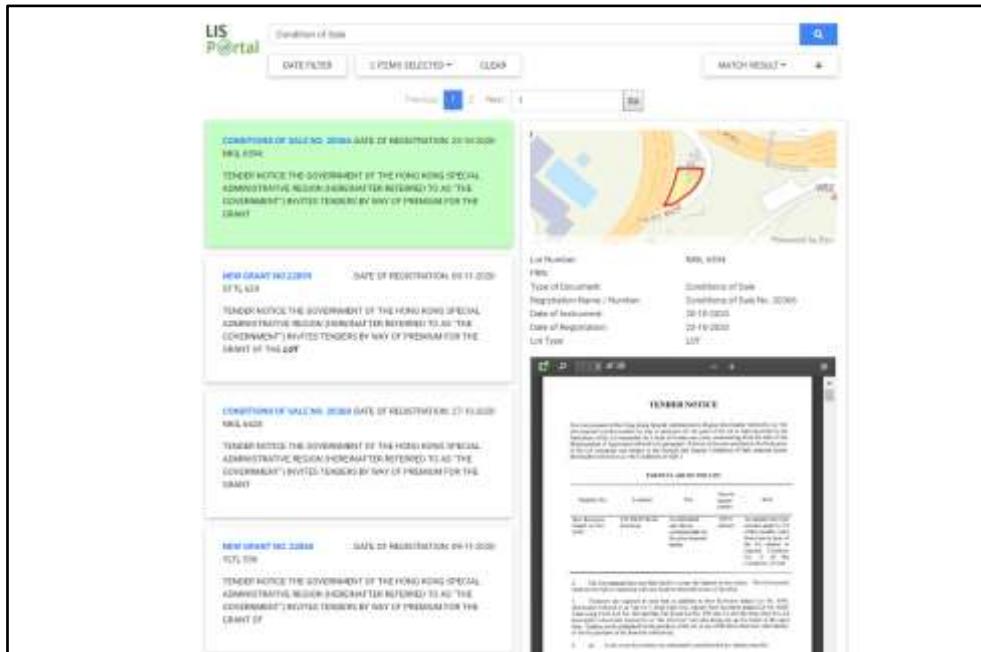


Figure 1. Application interface of LIS Portal

### 3.1.3. Extraction and compilation of lease attributes of private lots in Hong Kong

Before the implementation of data enhancement project, land parcel information stored in the LIS are primarily for the users in LandsD to review primitive land status information including lot number, lot type or lot area. For additional information about a private lot such as its lease information and development conditions, users usually need to refer to the relevant land documents that might be found in the paper file records or might need to be acquired from the LR. Obviously, it was an inefficient way for the day-to-day operations in the offices.

Because of this, LandsD engaged general practice surveyors and relevant specialists through the professional services contracts, to perform land records study and to extract the essential

lease attributes of the land parcels from the relevant registered land documents. Since 2019, four phases of lease attributes extraction exercises have been conducted for about 66,000 NG lots in Hong Kong. The core lease attributes identified in the study include: i) general lease information such as name of grantee, lease term and lease expiry date; ii) development conditions such as type of building, building height restriction and gross floor area; and iii) other special conditions such as restriction on alienation and resumption.

Whilst the data extraction exercise was conducted, the LIS data model was also reviewed for merging the lease attribute data into LIS. However, it was noted that the data model of the land parcel group dataset was inadequate to accommodate the lease attribute data from this data extraction exercise. Therefore, the data model structure of LIS was also enhanced to address the business needs in this exercise. For example, the lease attributes were stored in a separate lease condition table that had a single cardinality relationship with the private lot feature table. However, this one-to-one relationship would not be able to describe the situation where multiple sites within a single private lot may have their own lease conditions. Therefore, multiple cardinality relationship in the data model would be required for re-structuring the lease attribute data for the private lots. After two years of the data enhancement project, the data extraction exercise was completed and the lease attribute data of about 66,000 NG lots were integrated into an existing LIS.

### **3.1.4 On-line dissemination platform of lease attribute information**

To make the extracted lease attribute data available to the users in the Department, SMO also enhanced the existing LIS web map applications, called Geographic Information Retrieval System 2 (GIRS2), in facilitating users to search and review the lease attributes of a PTG or NG lot on the web browser. The core lease attributes of about 66,000 NG lots in Hong Kong will be progressively disseminated on the GIRS2 platform in 2021. Figure 2 shows the application interface of GIRS2.



Figure 2 . Application interface of GIRS2 v3

### 3.1.5 New workflow for maintaining registered land documents

Since the phase 1 data enhancement project was to extract the lease attributes for the land documents registered at the LR before 2018, it is required to keep up with the lease attribute updates in LIS with reference to the land documents that were lodged for registration after 2018. Therefore, LandsD has implemented a new workflow to maintain the scanned copies of registered land documents in the land document repository as well as to update the lease attributes of the concerned lots in the LIS. Figure 3 shows the new workflow of maintaining registered land documents and lease attributes in LIS. The workflow is a collaborated effort from the three offices in LandsD including LAO, LACO and SMO to upkeep the land documents and the associated information in LIS.

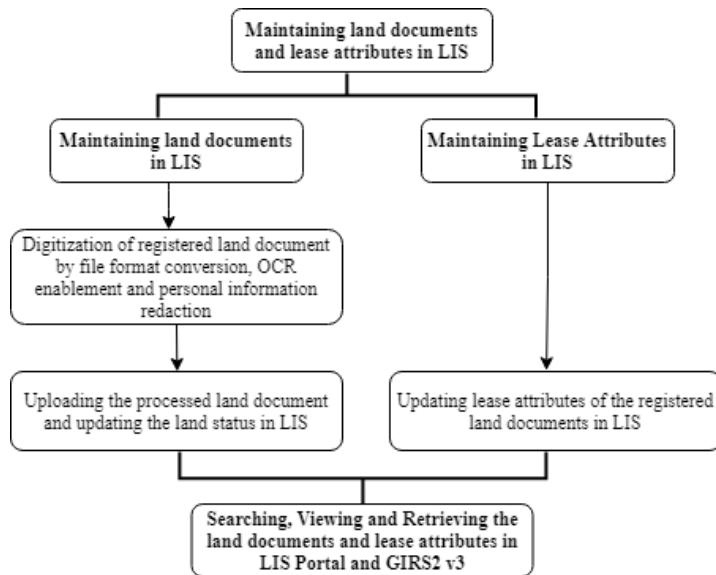


Figure 3. New workflow of maintaining registered land documents and lot attributes in LIS

### 3.2. Data integration of other land-related systems in the LandsD

Over the years, LAO, LACO and SMO have developed their own silo information systems to support their own business functions. Thereby, the land information in LandsD were fragmented and kept in the isolated database systems which results in inefficiency in retrieving and analyzing the land information from the land administration viewpoint.

Recommended by the Efficiency Office (2019) in its helicopter review of LandsD's IT functions in 2019, there has been a strategic imperative for LandsD to integrate the land-related systems maintained by different offices and establish a shared GIS-enabled platform for various business functions which would support the management in making informed decisions. In the past few years, SMO was working with LAO and LACO to revamp several LAO and LACO systems and integrate them into the LIS. Through integrating different databases into the LIS, the land-related data in separate systems maintained by LAO and LACO can be linked up with the land records and spatial information in the LIS. This way, LIS provides a centralized data management platform that would further improve the efficiency and effectiveness of internal operations, and facilitate the data sharing and land management within the Department. Further, with the integrated land information database, advanced statistical analysis can also be performed to better comprehend the land use pattern and land supply conditions that form the solid basis for the data-driven decision making for the Government.

#### **4. DEVELOPMENT OF INTERACTIVE GEOSPATIAL DASHBOARD PLATFORM**

SMO has been using geospatial technologies to provide land-related analytical services for the Department or other Government B/Ds to respond to the enquiries on the land matters in a timely manner. The types of enquiries ranged from the general enquiry on the number of Government Land Allocations records to the enquiry on the total area of unleased and unallocated Government Land that would require advanced spatial analysis using different land records in LIS. Currently, the land analysis results, spatial information statistics and business performance are usually provided using traditional report formats such as spreadsheet and location plans, which limits the availability of information for management review as well as for the decision making.

To align with today's data-driven business environment, SMO is developing an interactive web-based geospatial dashboard platform built on the integrated LIS platform to provide a real-time, or near real-time of the spatial data analytics results that include the operation performance review and geospatial data visualization. The dashboard would also leverage multiple land-related databases integrated with LIS for facilitating the handling of enquiries, progress monitoring and management review of land-related matters. It also aims at providing better quality services to the Government B/Ds and the public in the future.

The web-based geospatial information dashboard platform will provide both general enquiries on the publicly available data such as Government Land Allocations or tenancies and other specialized themes with specific restricted/confidential nature for the management review and decision support. The platform will serve the business needs of users from more than 30 functional offices/units within the Department. Figure 4 shows the application interface of the prototype of LIS dashboard application.

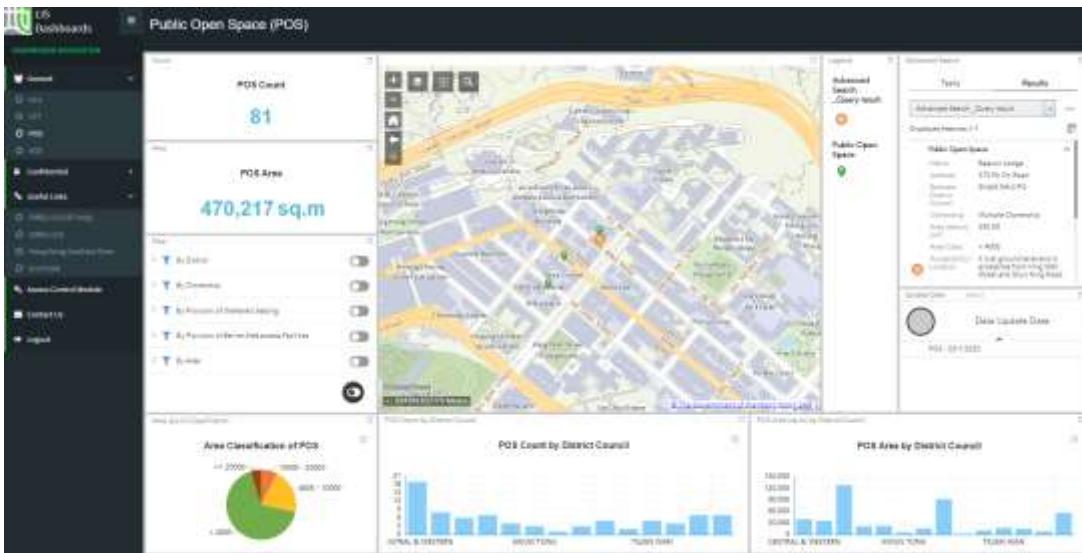


Figure 4. Application interface of LIS dashboard application

## 5. INTEGRATION OF 3D MAPPING INTO LIS

At the time, the land parcel datasets and topographic map datasets maintained in the LIS are 2D based. The 2D based LIS no longer meets the needs of capturing and storing the 3D related land information for the community. In 2011, SMO started maintaining a separate 3D mapping datasets comprising of three primary classes of 3D models namely building, infrastructure and terrain models. Figure 5 shows the 3D models visualized in 3D spatial data viewer application.

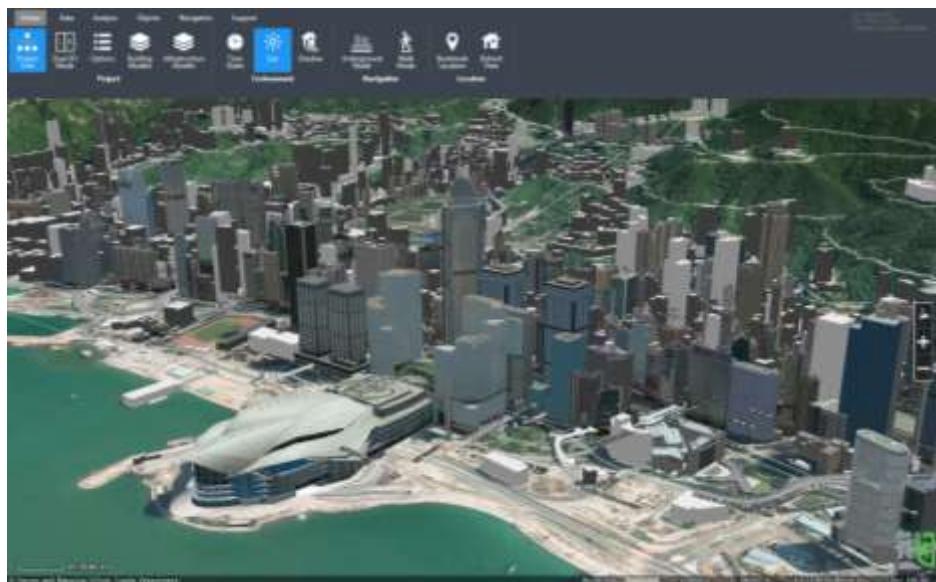


Figure 5: 3D models shown in the 3D spatial data viewer

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LandsD continues to build up the 3D digital map data infrastructure, moving from the enhancement of the 3D digital maps for visualisation to the development of 3D city models. By integrating the 3D city models into the LIS, additional information about the land ownership in 3D spaces can be captured in the land information database. With the consideration of the temporal element, a 3D spatio-temporal cadastre (Peter van Oosterom, 2018) would further enrich the information contents of LIS. It would not only provide a comprehensive spatial information of land rights understanding the complicated urban environment of Hong Kong, the CSDI that built on the 3D LIS would also unleash the potential for building the smart applications in supporting smart city initiatives for Hong Kong.

## 6. CONCLUSION

### 6.1. Achievements of the Data Enhancement project

Since the initiation in 2018, the project has been funded by the Government to enhance the land information contents of LIS for better land administration in support of smart city initiatives. Over the past 3 years, the project has contributed to the LandsD, by i) establishing the land document repository in LIS that manages more than 91,000 registered land documents acquired from the LR with the OCR-enabled documents for easier searching and retrieval; ii) enhancing the land information content of LIS by merging the lease attributes of more than 66,000 private lots extracted from the land documents to facilitate the retrieval and analysis of land parcel information; and iii) introducing an interactive web-based geospatial dashboard platform for effective dissemination of spatial data analytics results. Upon successful implementation of this project, more effective management of land-related information in LandsD could contribute to better land administration.

### 6.2. Way forward

To look forward, LandsD will progressively proceed to phase II data enhancement to incorporate the lease attributes of remaining private lots in the LIS (i.e. the private lots that are not PTG or NG lots). To leverage the values of the enhanced land information content and the integration of land-related databases into LIS, LandsD will also explore integrating the business processing workflows into the land-related data analysis for delivering actionable information that helps the Department to make informed decisions.

Besides, in line with the Smart Government Initiatives in the Hong Kong Smart City Blueprint (HKSAR, 2017), the enriched LIS can be viewed as the cornerstone in supporting the

Government-wide CSDI initiative for better land management and administration. Through the CSDI portal, improved accessibility to high-quality and up-to-date spatial data and services is expected to substantially increase the Government's capacity to perform sophisticated data analysis, understand social needs and trends, enhance the government intelligence to support better data-driven decision-making and deliver more responsive services to the public.

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