Project Title

Evolutionary Process of the Development of Spatial Data Infrastructure (SDI) in Hong Kong

2010 LSD Research Project

Submitted by

Investigators: Conrad Tang & Lesly Lam

Research Assistant: Patrick Kan

1 Introduction

Geospatial data is often used to assist decision-making in mapping and geographic analysis. Data records that are in paper form tend to have a shorter life expectancy than in digital form. Hence, the rising use of GIS to store digital geospatial information continues to increase its value in Hong Kong's government and private sectors. However, due to the lack of coordination, independent GIS systems have been developed only to meet individual needs. As a result, the duplicated efforts in collecting and managing these geospatial data are gradually increasing. Moreover, with no data standards, policies, and institutional framework to govern the properties of geospatial data in Hong Kong, the problem will remain unsolved.

Despite the rich technology, resources in collecting and maintaining such geospatial data will be wasted**,** and similar GIS systems will continue to accumulate in Hong Kong. Thus, under a structured spatial data governance, through developing and implementing a Spatial Data Infrastructure (SDI) in Hong Kong can promote data sharing and exchange of geospatial data, eventually enhancing Hong Kong into a spatially enabled society.

This report presents and summarizes the outcomes of a HKIS research initiative in understanding the current SDI status in Hong Kong. The Data Alignment Measures will be explained and a SDI model from the Singapore LandNet will be explored. Lastly, the paper identifies the challenges and future directions to the development of a Hong Kong SDI enabling platform.

2 Data Alignment Measures

In 2004, the Data Alignment Measures (DAM) initiative was launched to enable the exchanging and sharing of geospatial data among government departments in Hong Kong (HPLB, 2004). This project was led by the Lands Department (LandsD) as the central data provider and the data agent in carrying out this incentive. The participating government departments in the DAM included the Architectural Services Department, Building Department, Census and Statistics Department, Drainage Services Department, Electrical and Mechanical Services Department, Highways Department, Lands Department, Land Registry, Planning Department, Rating and Valuation Department, Registration and Electoral Office, Transport Department, and Water Supplies Department. The Metadata Catalogue System (MCS) was later developed to provide an online platform to view the metadata from the DAM project, which only consists of digital spatial data from 6 out of the 13 participating departments mentioned above.

The DAM project developed the 5 Common Spatial Unit (CSU) for solving data definition problems of the most commonly exchanged spatial data among participating departments in this project (HPLB, 2004), which include the:

- Slope CSU;
- Building CSU;

- Lot CSU;
- Road Centreline CSU;
- Tertiary Planning Units/Street Block CSU.

The spatial data are then disseminated via the Data Dissemination System (DDS), allowing participating departments to manipulate and utilize the Common Spatial Units for their daily activities (SMO, 2012).

The five Common Spatial Units are certainly a basis for a feasible integration towards a data infrastructure; however these does not represents the complete components of the required spatial data. The Lands Department took the lead in integrating a manageable GIS database. Much work has to be done for the development of a spatial data infrastructure in Hong Kong to utilize spatial data from all government department holdings. Therefore, a research initiative has been set out to understand the existing spatial data that are available in the Hong Kong government departments.

3 Investigation of the current SDI status in Hong Kong

A research initiative has been put forth to discover the current SDI situation in Hong Kong. In this project, the aim is to understand the properties and possession of geospatial data available in Hong Kong, and the main objective is to obtain information from the Hong Kong government sectors that have ownership of geospatial data. Thirteen departments from the government sectors were selected as the target group which include the Building Department, Civil Engineering and Development Department, Census and Statistics Department, Department of Health, Environmental Protection Department, Highways Department, Hong Kong Observatory, Leisure and Cultural Services Department, Planning Department, Rating and Valuation Department, Registration and Electoral Office, Transport Department, and Water Supplies Department.

First, the tailored letter, shown in Figure 1, was directly sent to the director of each government departments explaining the ongoing research project, “Hong Kong Spatial Data Infrastructure”, cooperated by the Hong Kong Institute of Surveyors (HKIS) and the Hong Kong Polytechnic University (HKPU). Then the letter requests assistance by attaching a questionnaire to collect basic technical information on any GIS systems employed in their department. Furthermore, the letter concludes by offering a report update on the progress of this research upon request to all of the participated departments.

Re: **Request for Information on Spatial Database**

In collaboration with the Land Surveying Division of the Hong Kong Institution of Surveyors (HKIS), the Department of Land Surveying and Geo-Informatics of the Hong Kong Polytechnic University (HKPU) runs a research on the policy, implementation and future development of a Spatial Data Infrastructure (SDI) in Hong Kong.

Hong Kong is a well developed society where government departments and utility companies hold key spatial data. This is an initial study to view the current status of the spatial data which are kept under various Geographic Information Systems (GIS) systems of different departments in Hong Kong. In this research, we have identified that several GIS have been developed in your department. We try to collect basic technical information of the GIS and thus send out the attached questionnaire.

We seek your kind permission and assistance to pass on the request to the department GIS Manager. One page of the information is requested from each GIS (sample template attached). The kind efforts will be greatly beneficial to the future development of the creation of SDI in Hong Kong. If you are interested in the progress of this research, we are most delighted to forward our research report for your reference.

Figure 1 The letter sent to solicit SDI information

An attached questionnaire was sent to each department along with the tailored letter to collect technical information on their daily GIS systems. The questionnaire included nine geospatial data elements to help the understanding of their GIS systems' components. These nine elements include the owner, geospatial data name, description, GIS manager/administrator, data sources, data software and format, users, availability, and data dictionary/specification. Each government department was requested to fill one questionnaire their available GIS systems. A sample questionnaire was also included to provide guidance.

Results gradually came back during the following weeks. The replies were received by both phone calls and emails. After a period of accumulation, it has been concluded that 12 departments from the government sectors took the effort to support the study in understanding the situation of existing spatial data in Hong Kong. Despite the presence of a non-participated department, the replies from the government sectors were greatly beneficial to the understanding of the majority existing spatial data in Hong Kong. Data were collected and analyzed from the replied questionnaires and the process of this research. Table 1 shows the list of government departments with their employed GIS systems to access, store and maintain spatial data in assisting their operation needs.

.

Table 1 List of government departments with spatial data systems

Building Department (BD)	Buildings Department Geographical Information System (BDGIS)
	Buildings Records Access and Viewing Online (BRAVO)
Civil Engineering and Development Department (CEDD)	Slope Information Systems (SIS)
	Geotechnical Information Infrastructure (GInfo)
Census and Statistics Department (CSD)	Digital Mapping System (DMS)
Department of Health	Public Health Information System (PHIS)
	Geospatial Information Platform (GIP) for Center of Health Protection (CHP)
Environmental Protection Department (EPD)	Environmental Database Model for Enforcement and Monitoring (ENDMEM)
	Pollution Complaint Management Module (PCMM)
	Web-based Road Traffic Noise Model
	Water Quality Pollution Load Information System (WQPLIS)
Highways Department (HyD)	Public Lighting Digital Data (PLDD) of Public Lighting Information System (PLIS)
	Excavation Permit Management System (XPMS)
	Intranet Mapping System (IMS)
	Electronic Mark Plant Circulation (EMPC)
	Electronic Maintenance Management System (EMMS)
Hong Kong Observatory (HKO)	Lightning Location Information System (LLIS)
	Integrated Meteorological Information Display System (MET-GIS)
Leisure and Cultural Services Department (LCSD)	Geographical Information System on Hong Kong Heritage (GISH)
	Tree Data Bank System
Planning Department (PlanD)	Core Planning Data Hub (CPDH)
Registration and Electoral Office (REO)	New Electoral and Registration System (NEARS)
Rating and Evaluation Department (RVD)	Integrated Property Database (IPDB)
Water Supplies Department (WSD)	Digital Mapping System (DMS)

In the beginning of the initiative, information on spatial data in Hong Kong was sceptical. Detailed information as to the types of data, the name of the systems, or the availability as well as the compatibility of the data were mostly unknown to external sources. This

does not only hinders the potential of creating a SDI for Hong Kong but also identifies the possibility of data duplication resulting in waste of resources.

3.1 Investigation Outcomes

Based on the returned questionnaires, the following assumptions are made. First, spatial data in the Hong Kong government sectors has been categorized into internal and external. Most of the spatial data are stored and maintained in systems that are mainly created for own internal purposes. On the other hand, these spatial data can also be distributed for other departmental purposes upon request. Even though these spatial data can be requested, the process of obtaining information from other departments can be time consuming. Thus, departments often create similar data. While most spatial data are internally stored, only a small selection of spatial data are exposed and offered to the public. From the results, only four systems targeted the general public as its primary user, including the Buildings Records Access and Viewing Online (BRAVO) from the Building Department, shown in Figure 2, the Slope Information System (SIS) from the Civil Engineering and Development Department, the Geographical Information System on Hong Kong Heritage (GISH) from the Leisure and Cultural Services Department, and the Lightning Location Information System (LLIS) from the Hong Kong Observatory. Even if these systems were to offer to the public, they can only be viewed online. This hinders the ability for public users to apply strategic analysis with the available resources. Moreover, the level of significance towards these spatial data and systems are questionable.

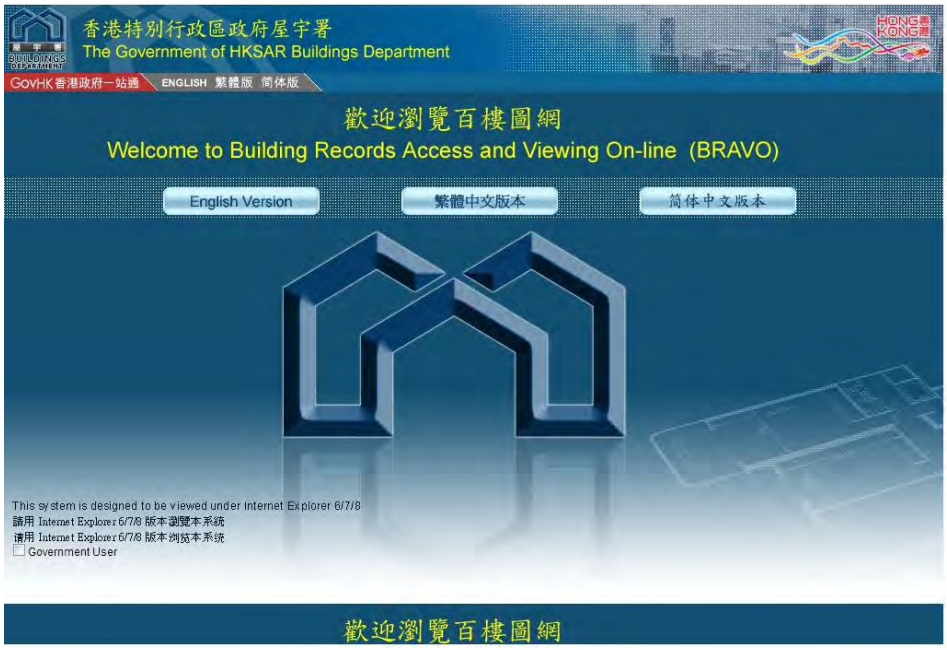

Figure 2 The Building Records Access and Viewing On-Line (BRAVO)

Secondly, spatial data in the Hong Kong government sectors are stored differently. The factors concerning the storage and maintenance of spatial data are the metadata, format and software. Knowing this, it allows the understanding of compatibility and usability within different systems between departments. Based on the findings, shown in table 2, ESRI's products are most used to manipulate spatial data. Other familiar software include MicroStation, Oracle, SQL Servers and Google API. Keeping in mind that not all software use a common version, an old and a newer version of software may exist among different departments. Despite that, the interoperability of the spatial data files matters the most. Since the primary software produces its format of the spatial data, the format revolves around geodatabase and shape files from ESRI, DGN from MicroStation and similarly, MDB from Microsoft Access. To complete the information about a spatial data system requires a good definition of metadata, which is a data about the data. Some departments chose to create data manuals while others produceD data dictionaries. With an exception from the CEDDs' Slope Information System, its metadata follows the FGDC-STD-001-1988, the US Federal Metadata standard.

Table 2 List of software, format and metadata used to store and maintain spatial data

Software				
ArcGIS Desktop	MicroStation Geographics	ArcInfo	ArcIMS	Google API
ArcSDE	Geomedia Web Publishing	ArcGIS Server	GeoMedia WebMap	Openlayers
Oracle	ArcMap	ArcCatalog	Intergraph Smartstore	Intergrated Data Viewer
SQL Server	Microsoft IIS	MicroStation	Weblogic Server	Aqualogic BPM

Format				
ESRI Geodatabase	E00 (ESRI shape files)	GeoTIFF	CSV	PNG
DGN (MicroStation)	MDB (Access database)	JPEG	SVG	PDF

Metadata				
Bravo Data Manual	B1000 Mapping Database Data Dictionary	B20000 Mapping Database Data Dictionary	Internal file format	Physical Data Design (T311) version 1.6
FGDC-STD-001-1998	B5000 Mapping Database Data Dictionary	Cadastral Information System Data Dictionary	Tree Data Bank System Data Dictionary version 2.0	NEARS Data Manual

Last but not least is the cooperation within the government sectors that possess ownership of spatial data in Hong Kong. To maintain and establish an efficient spatial data infrastructure, one of the critical elements is participation. It is the contributions from the participants that enable the infrastructure to operate as a whole. From the process to the result of this SDI research initiative, adequate effort and cooperation from the parties are evident. Most of the government sectors replied firmly to the request and completed the questionnaires. The willingness to elaborate and present their internal and external spatial data systems can be seen. But one of the obstacles observed throughout this initiative is the risk of releasing confidential data. Government sectors were being very cautious in understanding this research before committing to the questionnaires. Thus, only basic information of their spatial data was given. Issues in protecting the confidentiality of spatial data weigh heavily when government sectors only operate by themselves. The bigger picture moving forward with this initiative is if Hong Kong government sectors are willing to offer and share these kinds of spatial data to the public and interested parties.

4 HKSAR Geospatial Information Hub (GIH)

The Geospatial Information Hub (GIH) was established to enable availability and accessibility of geospatial data within the government sectors. The GIH is a portal within the government that contains geospatial data from various departments, shown in Figure 3. The successful model of GIH was launched in July 2004 and had been integrated into what is now known as the GeoInfo Map (GovHK, 2012).

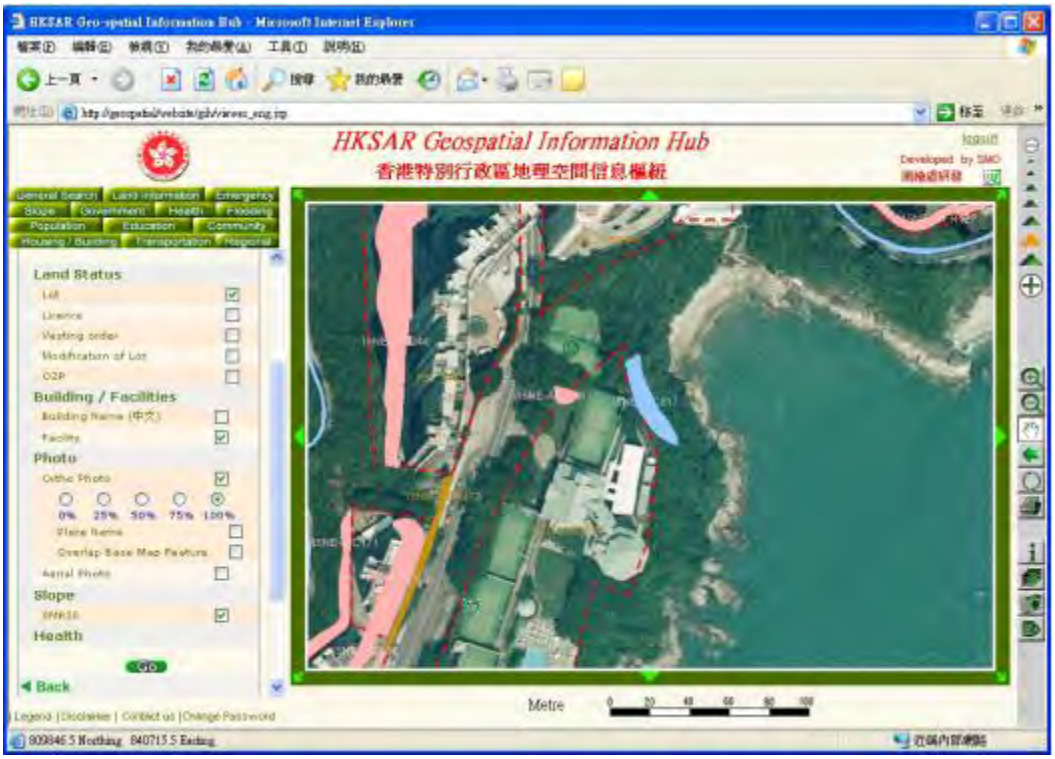

Figure 3 The HKSAR Geospatial Information Hub

The GeoInfo Map is the latest government online map portal, managed by the LandsD, to provide the general public with geospatial information. The geospatial information offered by the platform is contributed by multiple government departments. The GeoInfo Map provides various functions and tools to utilize geospatial data enquiries and analysis. The search function offers public users the ability to locate interest points in Hong Kong. In addition, public users can also organize outdoor activities on the platform by utilizing the built-in functions including the Global Positioning System (GPS) and Universal Transverse Mercator (UTM) coordinates (Sung, 2007).

The Survey and Mapping office (SMO) of the LandsD is responsible for providing the base map details, building information and the photo maps. In addition, other relevant government departments are responsible for providing their departmental and public facilities information. Useful geospatial information available on the map include mobile network coverage in country parks, locations of hiking trails, cycling tracks, barbecue sites, government offices, leisure, cultural and sports facilities, schools, libraries and hospitals, as well as geo-tagged photos (GovHK, 2012).

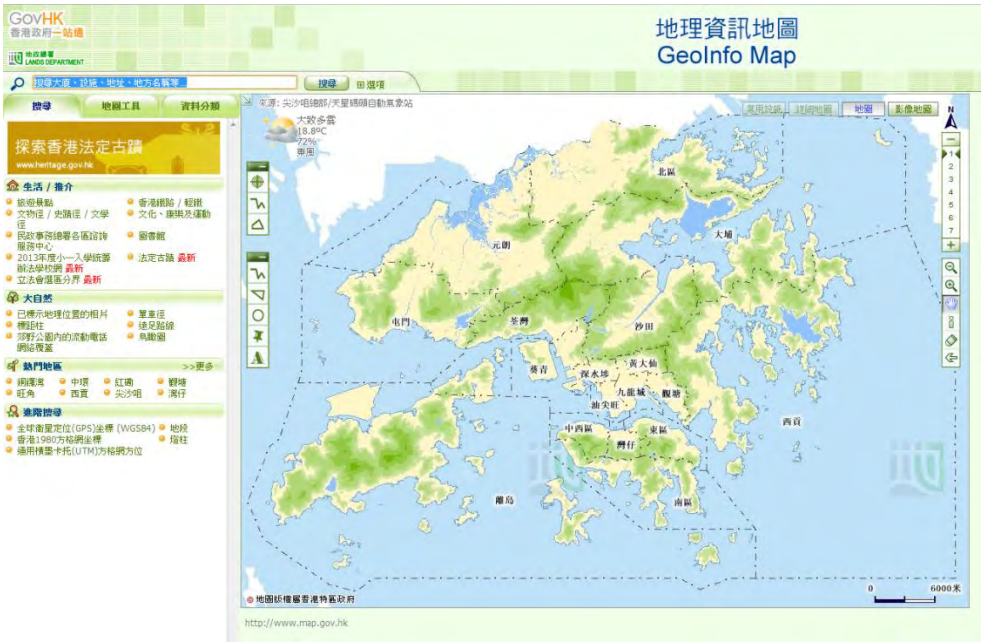

Figure 4 The GeoInfo Map

5 Issues and Challenges

Independent GIS systems are constantly created to maintain similar geospatial data in Hong Kong. However, the policies and standards for how these data should be captured, stored, maintained, and distributed are lacking. As a result, efforts in collecting and maintaining geospatial data are duplicated and inefficient. For instance, the Highway Department is maintaining a public lighting system in Hong Kong while the Transport

Department is responsible to maintain a transportation system that uses similar data. Consequently, the lack of collaboration and participation further hinders the feasibility of implementing a SDI in Hong Kong. Major challenges and issues include:

- The GeoInfo Map. Despite the rich geospatial information the Geoinfo Map provide for the public, the system still lack of analytic and dissemination ability. The GeoInfo Map does not provide comprehensive strategic analysis. Moreover, the geospatial data in GeoInfo Map can only be viewed but not downloaded thus prevents the dissemination of geospatial data. Overall, it is the cultural aspect of data sharing which hinders the development of GeoInfo Map into a feasible SDI.

- Metadata. Metadata in Hong Kong is deficient and unclear. The government and private sectors are constantly creating GIS systems to utilize geospatial data. Yet, it lacks a complete directory to document and display created systems.

- Policies and standards. Hong Kong strongly lacks the necessary laws and legislations to govern the data collection, management, and dissemination of geospatial data. As a result, the form of any geospatial data collected could be in various formats, structures and systems, such as vector and raster files, CAD drawings, excel spreadsheets or even paper maps;

- Institutional agreement. The roles and responsibilities within the government and private sectors for producing and utilizing geospatial information need to be defined. Additionally, an issue that concerns the institutional arrangement addresses if the established SDI office in Hong Kong should be independent or departmental;

- Participation. Government departments and private sectors, specifically the utility companies, need to participate in order to facilitate the components of the SDI in Hong Kong;

- SDI training. The implementation of a SDI in Hong Kong requires manpower and technical skills to collect, convert, and maintain new and existing geospatial data.

The implementation of Hong Kong SDI should not solely rely on the technical developments but should also rely on the significance of cultural aspects of data sharing. The Hong Kong SDI developments should aim to change the data sharing culture from an

institutional view. While many government departments and private sectors in Hong Kong now possess geospatial data, the idea of integration and data sharing is still skeptical and reserved due to the undiscovered benefits from a SDI implementation. By implementing institutional laws and frameworks, it can ease a lot of uncertainties and provide a clearer guide. This can increase the incentive for government and private companies to embrace the data sharing culture.

6 World Model

Many countries have started to implement SDI to support their geospatial development. Well known SDIs are developed in countries including United States, Europe, Singapore and Malaysia. Unique models and standards are adopted by different countries, as shown in Table 3.

In United States, the Executive Order of 12906 initiated the development of National Spatial Data Infrastructure (NSDI) in 1994 to enable the exchange and sharing of geospatial data among public and private sectors (Clinton, 1994). In addition, the Federal Geographic Data Committee (FGDC) was created to be responsible for managing and developing the standards for implementation of NSDI.

In the development of European-wide SDI, the European Commission from the body of the European United (EU) directed the Infrastructure for Spatial Information in Europe (INSPIRE) (INSPIRE, 2010). The INSPIRE aimed to connect and synchronize geospatial information within Europe. The European Commission created implementation rules for the existing SDI in Europe to meet the requirements of INSPIRE. The components of INSPIRE contain metadata, data specifications, network services, data and service sharing, and monitoring and reporting.

Malaysia Geospatial Data Infrastructure (MyGDI) is the SDI in Malaysia. In 2006, the MyGDI Circular Letter No.1, "Guidelines for the Implementation of Malaysia Geospatial Data Infrastructure" defined the person, policy, standard, geospatial information and technology contained in the MyGDI (MySDI, 2011). The MyGDI is governed by its committees, with the Malaysia Centre for Geospatial Data Infrastructure (MaCGDI) as its coordinator. Unlike other countries, the MyGDI initiatives in Malaysia began from **A** national level, down to the states, and finally to the local level.

Table 3 Summary of World SDI components

SDI Components					
Country	Model	Components			
United States	NSDI	Participation	Metadata Framework GEOdata	Data Standards	Geospatial Clearinghouse
Europe	INSPIRE	Data and Service Sharing	Metadata	Data Specifications	Network Services Monitor and Report
Singapore	LandNet	Unique Model Funding	Framework Data	Technical Standards	
Malaysia	MyGDI	Policy and Guideline	Framework Data	Metadata Standard	Catalogue Gateway

Hong Kong SDI should thrive for a similar concept and vision like Singapore's LandNet. LandNet is an online GIS data storage dimension for the government agencies in Singapore. LandNet provides an online platform that allows agencies to view, manipulate, and contribute directly from the Land Data Hub, established by the Singapore Land Authority (SLA). The LandNet comprised of more than 15 participating agencies and 30 types of geospatial data made available to the public (Ng, Chim, Lim, & Anupam, 2008). The success of LandNet is said to be from long years of trial and error. Due to similar environment, the Singapore LandNet model has great traits for Hong Kong to learn and adapt from. These models include:

- Governance of SDI. The SDI Office in Singapore is an independent department under the Land Authority. The Land Data Hub was established and managed by the Singapore Land Authority;

- Sharing. LandNet contributes to the sharing of 1.2 million map sheets yearly. LandNet often follows the saying of "created once and used many times";

- Interoperability of spatial data. By incorporating new data conversion tools with the LandNet, it allowed participants to provide spatial data in standard formats and also aid in revamping their existing systems;

- Unique data model. A cooperative funding model was implemented to continuously provide funding for the LandNet system. Together, members share their data and the operational costs for the data sharing. By doing so,

this funding model ensured fully cooperation and accountability from every member agencies.

- Participation. The LandNet is overseen by the Singapore Land Authority. Departments that hold spatial data in Singapore were voluntarily participated in the project to promote exchanging and sharing of spatial data.

7 Future Directions

The complexity of implementing a HKSDI goes beyond the basic component of metadata, standards, policies, institutional framework, clearinghouse and partnership. Numerous factors within the components will affect the efficiency and effectiveness of a HKSDI. Therefore, further investigation is needed in areas including (but not limited to):

- Further development of Hong Kong's Geospatial Information Hub into an feasible SDI;
- Status of SDI office in Hong Kong;
- Roles within the SDI committees;
- Copyright, liability and privacy of spatial data;
- Methods for data integration;
- Pricing strategies for data interchange;
- Modified data models, standards, policies and framework;
- Research and development.

Further actions can be taken, including:

- A Policy Committee, Execution Committee and Technical Committee need to be established to develop strategies and hold authorities for implementation of HKSDI. The policy committee will have the highest authority in implementing legislation. The execution committee consists of directors from government departments and utility companies complying with the legislations and policies. Lastly, the technical committee will be developing the technical building blocks for HKSDI;
- Metadata project needs to be initiated. Every geospatial data available in

Hong Kong should be documented with detailed attributes.

- Begin raising awareness through different sources in Hong Kong such as academia, seminars, workshops, and conferences. Initiate an outreach programme for HKSDI. Ultimately, aiming to change the cultural data sharing practices in Hong Kong to increase transparency and promote participation;

- Data integration when the metadata in Hong Kong is known.

8 Conclusion

In conclusion, a questionnaire along with a letter has been sent to the directors of the 14 government sectors in Hong Kong. The results were received and observations have been discussed. The research initiative in discovering the SDI situation in Hong Kong is successful and rewarding as it opened many ideas and direction for future improvements.

The development of components for HKSDI needs to be unique and carefully tailored according to the geospatial environment in Hong Kong. The HKSDI should serve as a platform for active data sharing thus promoting Hong Kong into a spatially enabled society.

References

Clinton, W. J. (1994, April 11). *Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure*. Retrieved November 14, 2011, from National Archives: http://www.archives.gov/federal-register/executive-orders/pdf/12906.pdf

FIG. (2007, May 19). *FIG Commission 7*. Retrieved November 14, 2012, from Annual Meeting 2007 and Symposium on "Good Practice in Cadastre and Land Registry": http://www.fig.net/commission7/seoul_2007/index.htm

GovHK. (2012). *GeoInfo Map*. Retrieved November 14, 2012, from Lands Department: http://www2.map.gov.hk/gih3/view/index.jsp

HPLB. (2004). *Implementation of Data Alignment Measures for the Alignment of Planning, Lands and Public Works Data*. Hong Kong: The Government of the Hong Kong.

INSPIRE. (2010, My 4). *INSPIRE*. Retrieved November 14, 2011, from http://geostandards.geonovum.nl/index.php/6_INSPIRE

MySDI. (2011). *Malaysia Geoportal*. Retrieved November 14, 2011, from Offical Portal for Malaysia Geospatial Data Infrastructure: http://www.mygeoportal.gov.my/

Ng, S. Y., Chim, V. H., Lim, M. K., & Anupam, M. (2008). *Land Information Network (LandNet): Transforming Land Information Sharing to Support an Intergrated Government Vision*. Singapore: Singapore Land Authority.

Rajabifard, A., Wallace, J., & Binns, A. (2007). *Spatial Enablement Current Activties and Future Directions*. Australia: The University of Melbourne.

SMO. (2012, Feburary). *Land Information Centre: GIS Projects Section*. Retrieved November 14, 2012, from Survey and Mapping Office: http://www.landsd.gov.hk/mapping/text/lic/lic_gis.htm

Sung, H. K. (2007, May 20). *Annual Meeting 2007 and Symposium on "Good Practice in Cadastre and Land Registry"*. Retrieved November 14, 2012, from Geospatial Information Hub in Hong Kong Special Administrative Region Government: http://www.fig.net/commission7/seoul_2007/papers/am_20_05/6_6_country_rep_hk.pdf

Tang, C., & Lam, L. (2011, May 19). *FIG Working Week 2011 - Bridging the Gap between Cultures*. Retrieved November 14, 2012, from Benchmarking Spatial Data Infrastructure: http://www.fig.net/pub/fig2011/ppt/ts03c/ts03c_lam_5127_ppt.pdf

Williamson, I., Rajabifard, A., & Holland, P. (2010). *Spatially Enabled Society*. Australia: FIG Congress 2010.