Research Report

For

The Land Surveying Division of

The Hong Kong Institute of Surveyors

Studies on the Hong Kong Cadastral Survey System Performance by a Multi-Criteria Structured Assessment Model

By

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Note: one conference paper and one peer-reviewed journal paper of the study findings were published as follows:

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The scan copy of these two research papers are attached.

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Developing a Performance Review Questionnaire for Hong Kong Cadastral Survey System

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Key words: Fit-for-Purpose, Cadastral Surveying, Land Administration, Performance Review

SUMMARY

Performance review facilitates an organization to meet its user demands and achieve planned goals. Evaluation on the performance of a cadastral survey system helps decision makers understand the current development of cadastral survey industry and the way forward to enhance its performance. As an indispensable function of a land administration system, the cadastral survey and mapping activities provide spatial related descriptions on cadastral interests. A fit-for-purpose cadastral survey system should meet the requirements of the society. To evaluate how well the cadastral survey industry fulfills its professional responsibility, a set of pre-established criteria and organizational objectives and the corresponding questions for performance review are required. Certainly, each cadastral survey system has its own unique characteristics. A developed self-assessment model for cadastral survey systems was introduced during the FIG conferences in the past two years. Here, based on the previously established structured performance assessment model, we further developed a set of appraisal questions for Hong Kong cadastral survey stakeholders to review the system performance. With sufficient feedbacks, we aim to investigate the status of the Hong Kong cadastral survey system in fulfilling its internal land surveying responsibilities and external duties in supporting a fit-for-purposes land administration system and a sustainable society.

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1. INTRODUCTION

Cadastral surveying is an essential function of a modern land administration system. Cadastral survey and mapping activities support various types and levels of land administrative procedures by providing spatial-related cadastral datasets. Producing different types of cadastral plans is the most perceived contributions of a cadastral survey system to the society. In a modern land administration system, the cadastral mapping framework serves as the backbone platform to visualize and manage the rights, responsibilities and restrictions of the land.

The current survey and mapping technology is undergoing evolutionary change. Theoretically, the technology capability of cadastral survey and mapping activities are significantly improved. However, the development of a cadastral survey system always needs to consider the backgrounds and current conditions of the jurisdiction. The societal requirements of a cadastral survey system decide the practicing survey and mapping technology in the system. Thus, cadastral survey systems are still different from each other.

All cadastral survey systems under different topographical, economic, legal and institutional settings have same purpose which is to support land administrative activities efficiently and effectively. To serve this purpose, the regulations and procedures may vary from one jurisdiction to another jurisdiction. As a type of professional service, a cadastral survey system is constituted by the cadastral survey infrastructure, cadastral survey service provider and the user. Cadastral surveyors are the key service provider and the key operator in the cadastral survey infrastructure. The user of the system can be land-related professions in both public and private sector, and also the general public. A fit-for-purpose cadastral survey system should meet the demands of its system users in an effective way.

To check how well each cadastral survey system operates, opinions on the system performance are required to be collected from its stakeholders. A structured performance assessment was introduced during the International Federation of Surveyors (FIG) conferences (Zhang and Tang, 2014; Zhang and Tang, 2015). The general assessment framework is shown in Figure 1. A case study on the Hong Kong cadastral survey system performance has been conducted locally based on the established assessment model. Questionnaire has been distributed to local land surveyors to measure their opinions on the constitution of an ideal cadastral survey system performance and their satisfaction level on the achievements of the current Hong Kong cadastral survey system.

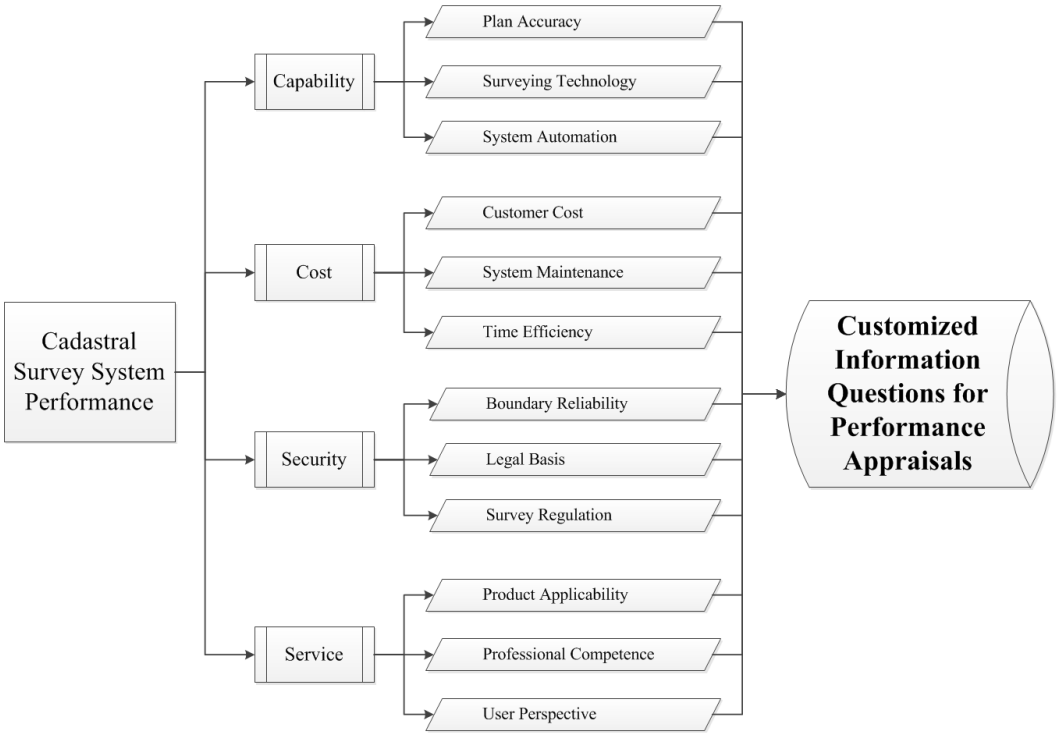

Fig.1 General framework of the established model

Results on the relative importance of the proposed assessment criteria and achieved performance level of current Hong Kong cadastral survey system have been collected from local land surveyors and now is distributing to stakeholders other than land surveyors. The next step in comprehensively evaluating the performance of Hong Kong cadastral survey system is to collect more detailed performance information of the system from its stakeholders. Again, to review the performance of local cadastral survey and mapping activities are twofold. One is from the side of local land surveyors who are the key service provider of the system. The other is from the side of the users of the system. Comments on the development of local cadastral survey infrastructures are needed from land surveyors. Opinions on the outputs of local cadastral survey system are sought from land users.

This paper introduces a further step in designing a questionnaire to collect information on the performance of Hong Kong cadastral survey system from both local land surveyors and land stakeholders other than surveyor. Data collected by this performance review questionnaire aims to attach to the previously established assessment criteria set and to correlate with currently acquired performance scores of the local cadastral survey system. The structure of this paper is as follows. First, the assessment strategy is briefly introduced. Then, a review of previously established evaluation model is represented. Next, the principles of the questionnaire design for Hong Kong land stakeholders are discussed. At last, this paper introduces how to implement the questionnaire survey to the local cadastral survey industry; and concludes with the expected outcomes of the proposed questionnaire and the entire evaluation project on the cadastral survey systems.

2. STRATEGY ON CADASTRAL SURVEY SYSTEM EVALUATION

In the field of cadastre and land management, the elements of a fit-for-purpose approach (FIG and World Bank, 2014) may not be regarded as brand-new concepts individually (see, Ting and Williamson, 1999; and Robertson, 2002). Nonetheless, it provides a comprehensive framework to instruct jurisdictions to build and develop their cadastral infrastructures with reference to the dramatically developed technology in the geo-informatics industry. The expeditious development of Information and Communication Technology (ICT) enables land users to have more demands on the land industry. This also urges the policy maker and service provider to re-evaluate and then enhance the existing institutional framework and the services they provide. Certainly, an inspired and attentive vision on how to build and sustain the infrastructures is required and the *Declaration on Fit-for-Purpose Land Administration* (FIG and World Bank, 2014) fills the gap timely.

Cadastral surveyor is always an active participant in the field of land administration. In this project, we evaluate the cadastral survey system instead of a land administration system. As an indispensable function, how well the cadastral survey and mapping activities meet the demands of the land industry and the society is checked. Cadastral surveyor is the key service provider in a cadastral survey system. Their opinions and judgments are required to be summarized and analyzed.

To evaluate the design of each individual cadastral survey system needs extensive resources and exhaustive research on every perspectives of each specific system. Evaluation on the performance of a system is more practical and widely applied in the field of cadastre and land management (Haldrup and Ktubkjær, 2013). In this research project, a set of assessment criteria has been proposed to measure the performance of cadastral survey systems from the technical, economic, legal and institutional perspectives as shown in Figure 1.

The key evaluation criteria on the general fitness of a cadastral survey system are: 1) whether the cadastral survey products are trusted by the land users; and 2) whether the cadastral survey services are widely used by land professions. This set of key evaluation criteria is first summarized by Williamson (2000) in assessing the successfulness of land administration systems. Here, then general assessment scheme is listed in Figure 2.

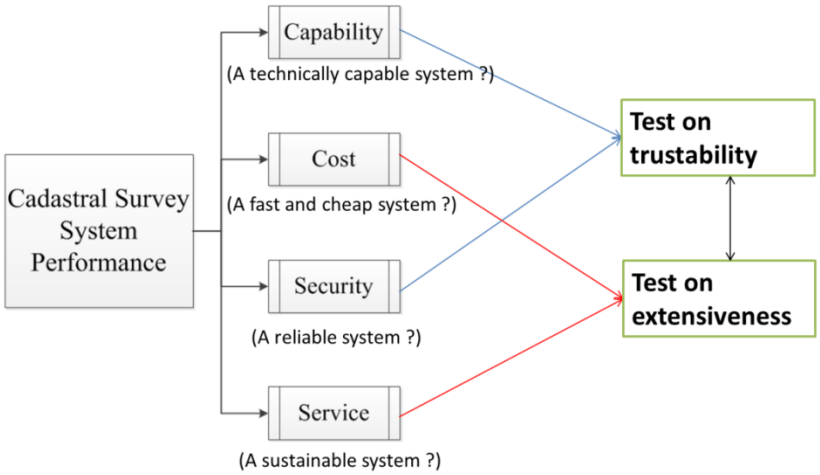

Figure 2. General assessment scheme

Case study is the selected methodology to evaluate the performance of individual cadastral survey systems. Here, a pilot study on the current Hong Kong cadastral survey system has been conducted to test the capabilities of established assessment model.

3. PERVIOUSLY ESTABLISHED ASSESSMENT FRAMEWORK

This research project aims to evaluate the general successfulness or fitness of the current cadastral survey systems. A structured assessment framework has been established based on a set of assessment criteria as shown in Figure 1. Here, the contents of the framework are briefly reviewed.

A set of performance indicators is proposed based on four general performance aspects of a cadastral survey system. They are *Capability*, *Cost*, *Security* and *Service*. Certainly, those performance perspectives are interrelated. In the established assessment, *Capability* more focuses on the technical performance of the system. *Cost* highlights the economic performance of the system. *Security* tests the reliability of the system more from the legal perspective. And the *Service* evaluates the performance of the institutional arrangements. Assessments on the aspects of *Capability* and *Security* are applied to measure the trustability of the current cadastral survey services. Assessments on the aspects of *Cost* and *Service* are conducted to test the extensiveness of the current cadastral survey services.

The assessment framework has been build based on a Multi-Criteria Decision Analysis (MCDA) model. Specifically, we adopted one of the most widely applied MCDA, Analytic Hierarchy Process (AHP), as the fundamental analyzing algorithm. This methodology is extensively used in the management level of almost every field (Vaidya and Kumar, 2006) to help people make decisions. In a general AHP based framework, there are three hierarchies: *Goal*, *Criteria* and *Alternatives*. Here, the *Goal* of the assessment project is an ideal cadastral survey system performance that best meets the demands of its stakeholders. The *Criteria* are the proposed key performance aspects and indicators of a cadastral survey system. The

Alternatives for each individual cadastral survey system are the *Should-be Performance* (best-fits current societal requirements) and the *Achieved Performance* (actually achieved system performance).

Questionnaire survey is the main data collection methodology to acquire opinions from cadastral survey stakeholders on: 1) the relative importance of each criterion; and 2) the performance level of the current system on each criterion. Questions for land surveyors and land stakeholders other than land surveyors are designed based on the same framework. Since stakeholders other than land surveyors normally do not have deep understandings on the detailed performance aspects of the cadastral survey and mapping activities, questions on the sub-criteria set are not required to be asked by them. Figure 3 shows the difference on the contents of questions for land surveyors and land stakeholders.

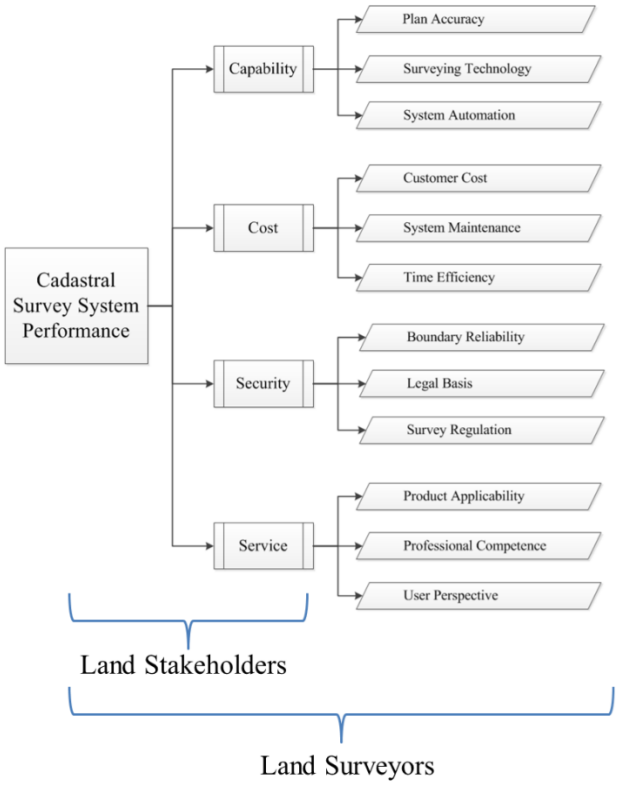

Figure 3. Assessment contents for land surveyors and other land stakeholders

Generally, there are two sets of questions are needed to be answered. The first set of questions asks participants on the relative importance of each criterion and the participant's satisfaction level of current system performance under each criterion. A questionnaire of this set of questions has already been distributed to the Hong Kong land surveyors under the coordination of the Land Surveying Division of the Hong Kong Institute of Surveyors. The second set of questions aims to collect information on the achieved performance of the current Hong Kong cadastral survey system. Compared with the first set of questions, this set of performance review questions aims to evaluate the local cadastral survey system in a closer view based on the same set assessment criteria. Feedbacks will be correlated with previously

collected evaluations on the weights of the assessment criteria and the participants' satisfaction level on each criterion.

4. THE DESIGN OF PERFORMANCE REVIEW QUESTIONS FOR HONG KONG CADASTRAL SURVEY SYSTEM

4.1 Backgrounds on the Hong Kong Cadastral Survey System Design

To design a performance review questionnaire for a specific cadastral survey system, understandings on the backgrounds of the system is required. Here, the backgrounds on the Hong Kong cadastral survey system will be briefly introduced.

Hong Kong has a land area around 1100 square kilometers. Most of the population dwells in the highly dense Hong Kong Island, Kowloon Peninsula and the flat land in the New Territories and outskirt islands. New Territories consists more than 80% of the total area of Hong Kong and much of the area are still rural areas. Hong Kong used to be a British Colony before its sovereignty transfer to the People's Republic of China in 1997. After that, Hong Kong maintains its autonomy as a special administrative region of the People's Republic of China. The legal system of Hong Kong continues based on the common law that follows the English system.

The Land Registration Ordinance was first enacted in 1844 and still in use to date. Land Titles Ordinance was enacted in 2004 but still not into effect. Strictly speaking, there is no cadastre in Hong Kong. The cadastral system has long been criticized by local land survey industry for its weakness in secure the cadastral survey results and the boundary rights. Enhancements on the functions and capabilities of the local cadastral system are progressively deployed. Yet, there is no cadastre law in Hong Kong. Laws covered on cadastral issues are regarded as insufficient by local land surveyors.

The Hong Kong cadastral system deals with basically land registration and cadastral survey. The contemporary exercised leasehold registration system started in 1842. The purpose of the system is mainly for the transaction of land ownership, and has remained largely unchanged since then. The land register is only an index of the registered documents and the property may be subjected to unregistered interests. The land register and memorial are kept in database and lease documents are stored in scanned image files by the Land Registry. The Survey and Mapping Office of the Lands Department keeps the graphic components of the cadastral survey records.

4.2 Previously Collected Assessment Elements

Currently, the established assessment framework mainly collects opinions from local land surveyors. Those land surveyors are divided into three groups: *Public Sector* (land surveyors from public sector), *Private Sector* (land surveyors from private sector) and *Young Surveyor*.

The collected results show their recognition on the relative importance of the performance aspects of the Hong Kong cadastral survey system. Also their satisfaction level on the current achieved performance is assessed. Figure 4 shows the flowchart of these two assessment elements.

Figure 4. Flowchart of two previously assessed elements

As shown in Figure 4, *Element 1* asks assessor to give his/her judgements on the relative importance of every pair of assessment criteria. By standard AHP weights determination algorithm (Satty, 1980), these pairwise comparisons forms the weights or relative importance of each performance aspects in constitution of a desired cadastral survey system performance. *Element 2* collects opinions on the fulfillment level of the current system under each performance indicators. Both these two assessment elements are focused on the generalized satisfaction perception on the cadastral survey system performance. A further step to collect actual datasets on the performance of current cadastral survey system is essential to explorer the development of the system and shed the lights on further system enhancements. Thus a set of performance review questions are designed to meet this purpose.

4.3 Contents on the Designed Performance Review Questionnaire

Performance questions are designed under four proposed performance aspects: *Capability*, *Cost*, *Security* and *Service*. Those selected questions are attached to the established performance indicators of the cadastral survey system. Ideally, more questions attract more information to be collected on the system performance. In practice, more questions in a questionnaire often lead to a less feedback rates. Thus, to balance this, only highly relevant survey questions are listed in the final questionnaire. Overall, twenty multiple choice questions are proposed in this performance review questionnaire to collect actual performance datasets that relevant to the assessment criteria. All those questions are available online (http://goo.gl/forms/qJxD8xS4s6). Here, the general dimensions are briefly discussed.

4.3.1 Performance Questions on Capability

There are three sub-criteria under *Capability*: *Plan Accuracy*, *Surveying Technology*, and *System Automation*. *Plan Accuracy* intends to measure the positional accuracy of the currently produced cadastral survey plans. *Surveying Technology* measures the technical capability and efficiency in survey and mapping required rights, responsibilities and restrictions by currently adopted surveying methodology. *System Automation* measures the automation level of the cadastral survey system with a focus on the database and data model approach.

4.3.2 Performance Questions on Cost

There are three sub-criteria under *Cost*: *Customer Cost*, *System Maintenance*, and *Time Efficiency*. *Customer Cost* measures the individual burden to use the cadastral survey services. *System Maintenance* measures the government burden in maintaining the current cadastral survey operations. *Time Efficiency* considers the cost in time dimension by measuring the time efficiency on using or providing cadastral survey services.

4.3.3 Performance Questions on Security

There are three sub-criteria under *Security*: *Boundary Reliability*, *Legal Basis*, and *Survey Regulation*. *Boundary Reliability* measures the stability of the boundary system and efficiency of the currently surveyed boundaries. *Legal Basis* intends to exam the performance of the updated legislation for the operation of cadastral survey services and authorization of legal boundary for surveying. *Survey Regulation* measures the appropriateness of the technical and administrative guidance for the cadastral survey industry.

4.3.4 Performance Questions on Service

There are three sub-criteria under *Service*: *Product Applicability*, *Professional Competence*, and *User Perspective*. *Product Applicability* measures the level of adopting cadastral survey outputs by land professions and the involvement of those products for further system development. *Professional Competence* considers the efficiency of professional services in fulfilling the requirements of the system end-users; it also aims to test the appropriateness of current licensing and practicing system for the cadastral surveyors. *User Perspective* measures the quality of the cadastral survey outputs from the perspective of system end-users.

5. IMPLEMENTATION OF QUESTIONNAIRE SURVEY AND FURTHER STEPS

Under the coordination of the Land Surveying Division (LSD) of The Hong Kong Institute of Surveyors (HKIS), this performance review questionnaire has been distributed to the local land surveyors in both public sector and private sector. A consultancy panel is established. These panel members are mainly from the Council Member of the LSD of the HKIS. Currently, 18 completed questionnaires are collected through interview of the panel members individually.

When sufficient feedbacks are collected from the local cadastral survey industry, a correlation study between the newly collected performance information and previously collected scores will be conducted. Figure 5 shows an example of further correlation studies.

Figure 5. Example of further correlation study

6. CONCLUSIONS

Performance review facilitates an organization to meet its user demands and achieve planned goals. Evaluation on the performance of a cadastral survey system helps decision makers understand the current development of cadastral survey industry and the way forward to enhance its performance. This study based on a previously established structured performance assessment model developed a set of appraisal questions for Hong Kong cadastral survey stakeholders to review the system performance. With sufficient feedbacks, robust correlations between the newly collected performance information of local cadastral survey system and preciously collected performance scores can be established. The proposed results aim to reflect the current status of the Hong Kong cadastral survey system in fulfilling its internal land surveying responsibilities and external duties in supporting a fit-for-purposes land administration system and a sustainable society.

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A Performance Assessment Model for Cadastral Survey Systems – Case Study Report of Hong Kong

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Abstract

Performance-review facilitates an organization to meet its user demands and achieve planned goals. Through the proposed evaluation of cadastral survey system could help decision-makers to better understand the current development of the cadastral survey industry and the way forward to enhance its performance. Precedent evaluation and assessment datasets for the Hong Kong cadastral survey system are indeed formed by readily available information and long-term accumulated field experiences of the assessors. However, there is a lack of "peer-review" design model to incorporate practitioners' judgements across the industry with reference to the local cadastral survey evaluation projects. This paper introduces a research project aiming to measure the performance of individual cadastral survey system from practitioners in world-wide expressing their views of individual system. A structured multi-criteria assessment model based on the methodology of Analytic Hierarchy Process (AHP) has been established for the purpose of measuring the system performance in a holistic approach. The case study of the Hong Kong cadastral survey system shows the capacity of the designed assessment model and the application of industry participatory approach to investigate the development of individual cadastral survey system. In addition to the tailor-made assessment design, a set of assessment criteria is also to be established since it is currently not a standard mechanism. Different systems worldwide may adjust their evaluation criteria to meet the design of their own cadastral survey systems. These normalized model performance scores can consider as valid up to the standard of international benchmarking system in order to increase the understandings on the development cadastral survey systems and shed lights on particular areas presumably that had a room for improvement.

Keywords: Cadastral survey system, performance assessment, participatory approach, benchmarking

1. Introduction

Hong Kong was a British colony since 1840s and now is a Special Administrative Region of the People's Republic of China. After its sovereignty handover to the People's Republic of China in 1997, Hong Kong is still applying the British common law system under the principle "One Country, Two Systems". The current practising cadastral model is a British successive system of deeds registration for the transaction, where similar to the previous system under the Land Registration Ordinance enacted since 1844. The local system was regarded as satisfactory to support an easy and traceable land conveyance system (Kwok and Tang, 2010; Tang, 2010). On the other hand, the efficiency of the existing local cadastral survey services has been commented by practitioners due to an indispensable component of the land administration system (e.g. Tang, 2004; Wootten, 2004; Leung, 2007; Koo, 2013; Lai et al., 2015).

The understanding of the subject cadastral system is an essential prerequisite to formulate a new policy for improving the system as emphasized by Williamson (2001). Evaluation on the system design and its performance is one of the common methodologies in cadastral and land management field (McLaughlin, 1978; Williamson, 1981; Enemark et al., 2005; Mitchell et al., 2008), of which the evaluation result through this proposed methodology can be regarded as an important knowledge ground of system development in the future.

The evaluation of the Hong Kong cadastral system is not a completely new idea. Hong Kong has a well-developed and mature land market trade system with various segmented land professions responsible for different perspectives on the land issues. Local cadastral survey practitioners, especially land surveyors, are the expertise specifically focusing on the evaluation of the cadastral survey and mapping activities. Tang (2001) introduced a conceptual assessment framework for the Hong Kong cadastral survey system based on the findings of an international cadastral system benchmarking project that was coordinated by the International Federation of Surveyors (Steudler et al., 1997). The need of adequate understanding on the Hong Kong cadastral survey system to implement enhancements or policy reforms was highlighted by the author. The review of local cadastral survey practitioners suggested the design of Hong Kong cadastral survey system should be of a systematic way (Tang, 2002) and a piecemeal way (Cheung, 2013). Currently, the evaluation or assessment dataset for the Hong Kong cadastral survey system is built up by readily available information and long-time field experiences of the assessors. There is a lack of "peer-review" design to incorporate practitioners' judgements with previous local cadastral survey evaluation projects among the industry. Also, the government has the major role to manage its owned land and yet no direct approach to evaluate and improve the performance of local cadastral survey system, resulted of limiting the evaluation on the efficiency of the current system design.

This paper introduces a research project aiming to measure the performance of individual cadastral survey system from practitioners in worldwide. A structured multi-criteria assessment model based on the methodology of Analytic Hierarchy Process (AHP) was established for the application of measuring the holistic system performance. A participatory scheme to implement the established model was developed to conduct a case study on the assessment of local cadastral survey system. Under the coordination of the Land Surveying Division (LSD) of The Hong Kong Institute of Surveyors (HKIS), questionnaires were sent to its members to evaluate the datasets for the assessment such as the performance of the current system. The collected data were also analyzed, with the results particularly on the interviewees' expectation of the system were shown.

This paper introduces the background of the Hong Kong cadastral survey system with a focus on the settings of the system design, followed by the contents of the established evaluation framework with the interpretation of the proposed assessment criteria and the application of AHP methodology. Furthermore, implementation strategy and procedures, as well as the outcome of the evaluation case study project, will be presented and analyzed together with the findings on the performance of current Hong Kong cadastral survey system, while the last part will be the capacity of the design assessment scheme and recommendation on the cadastral survey system.

2. Hong Kong Cadastral Survey System, the Design

Hong Kong locates at the south-eastern of China with around 1,100 square kilometres of the total land area. Most of the population dwells are concentrated in the highly dense area like Hong Kong Island, Kowloon Peninsula and the flat land in the New Territories and some of the outskirt islands. New Territories consists of more than 80% of the total area of Hong Kong and a large proportion of the area are in rural. Around 40% Hong Kong land cover are country parks and nature reserves, in addition to 25% of the developing land area. The population in Hong Kong is approximately 7.4 million in 2016 (Census and Statistics Department, 2016).

The cadastral system in Hong Kong includes basic land registration and land boundary survey. The purpose of the local cadastral system is mainly for the transaction of land ownership, similar to the previous system that has remained almost unchanged. The general boundary system is designed for the identification of the location of a land lot only, under the deed registration system governed by the Land Registration Ordinance (LRO) which was enacted in 1844. Prior to the enactment of Land Survey Ordinance (LSO) in 1996, no legal provision was used to regulate land subdivision, the local cadastral survey procedures or standards, whereas the enacted Land Survey Ordinance is not able to monitor local cadastral survey services due to the lack of measures but not include subdivision. In 2004, Land Titles Ordinance (LTO) as a parallel registration mode was introduced. Land Registry

planned to convert the existing deeds system to titles system upon the commencement of the Land Titles Ordinance. As at 2012, a "Two-Stage Conversion Mechanism" (The Land Registry, 2015) was being considered and a continuing discussion with the stakeholders was being held.

Almost all 300,000 land lots in Hong Kong are registered and surveyed. Land Registry is a self-financing government department to provide registration service, whereas the Survey and Mapping Office of the Lands Department maintains the cadastral survey records. The documents kept by the Land Registry, such as the register, memorial, government lease and land grant document, are the basic legal textual components of the cadastral system. The land register and memorial are kept in a database and the leased documents are stored in scanned image files. Other government departments keep land data without cadastre law prescriptions. For example, the Survey and Mapping Office keeps the spatial components (land boundary records) of the cadastral system and the Planning Department keeps the land use designation data, while Rating and Valuation Department keeps the property valuation data.

As the land register is only an index of the registered documents, properties may be subjected to unregistered interests. Other land rights, as well as boundary rights, have to be traced back to the original grant document yet many of these attached cadastral plans were surveyed in the early 1900s. In addition, adverse possession is allowed, if not encouraged. To acquire a title by adverse possession under the Limitation Ordinance, it takes 12 years (20 years before 1991) for private lots and 60 years for government land. These settings certainly increase the uncertainties of local land boundary system. Meanwhile, the land surveyors should also admit that these settings do call for more land surveying services in the current land development industry.

In general, land surveying professional organizations are operated under a three-tier structure. The Hong Kong Institute of Surveyors (HKIS) is the professional organization for surveyors and the institute is under The Hong Kong Institute of Surveyors Ordinance (Cap.1148). An LSD corporate member of the HKIS may apply for the Registered Professional Surveyor (RPS) after one year of local practice and promote to the Authorized Land Surveyor (ALS) after one year of local cadastral surveying practice. Both registration boards are formed under the Surveyors Registration Ordinance (Cap.417) and Land Survey Ordinance (Cap.473) respectively. There is a total of 270 corporate members registered in the LSD (HKIS, 2016). After the enactment of the LSO in 1996, ALS from the private sector takes up a large proportion of cadastral survey services for the private land lots which includes the subdivision, re-definition lot boundaries and setting out of boundary marks and other boundary survey tasks. Cadastral surveyors in the public sector are mainly responsible for the boundary survey tasks in the government land, with such another important duty to maintain the cadastral survey records and to provide advice on cadastral survey-related information to land stakeholders.

Both the Hong Kong SAR Government and the private sector spend a considerable amount of money on the maintenance of the cadastral survey records. Hong Kong has adequate survey data, but the survey results are not legally assured. A comprehensive measure of the current system performance is required This research project attempts to collect system performance data through an established framework and to compare the understanding of local cadastral practitioners on the system performance.

3. An Assessment Framework to Measure the Performance

Qualitative measurement of the system performance is a common methodology that widely adopted in the cadastral evaluation projects. The evaluation design of cadastral survey system needs extensive resources and long-lasting research on every perspective that are required for the individual system. To measure the capacity of a cadastral survey system in a holistic approach a structured assessment framework covers the technical, economic, legal and institutional settings was designed. Figure 1 lists the general framework of the proposed assessment elements for the performance evaluation of a cadastral survey system. The overall performance of a cadastral survey

system was divided into four assessment dimensions, termed as *Capability*, *Cost*, *Security* and *Service*. Under each assessment dimension, three performance indicators were selected to measure the system performance.

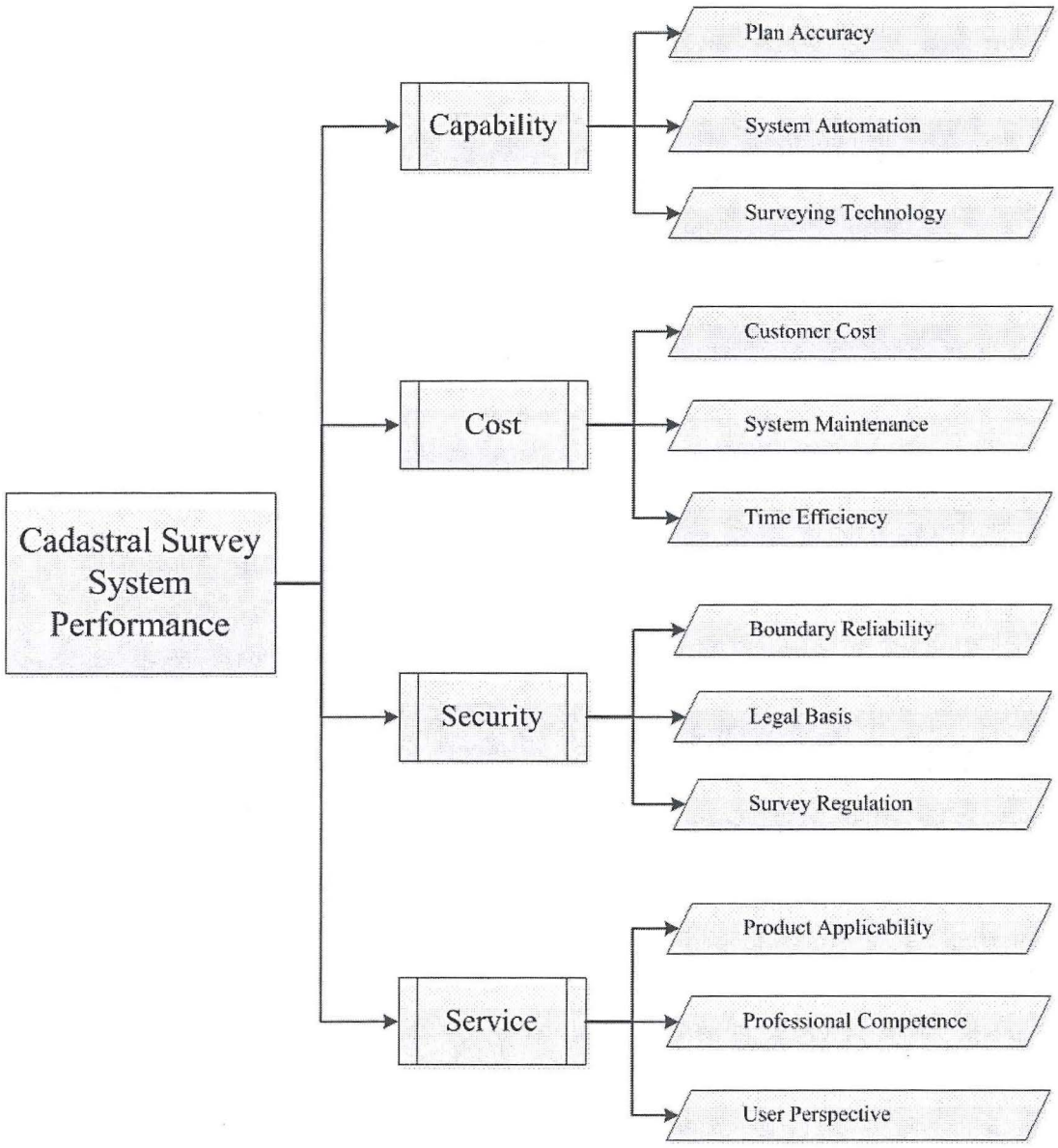

Figure 1: Assessment dimensions and performance indicators

In this project, the key evaluation criteria to determine the performance of a cadastral survey system are 1) whether the cadastral survey products are trusted by the users; and 2) whether the cadastral survey services are widely used by land profession. This set of key evaluation criteria was first summarized by Williamson (2000) in assessing the extent of the performance of land administration systems. The assessment objectives are demonstrated in Figure 2. Assessment on the aspects of *Capability* and *Security* are measured by the trustability of the current cadastral survey services. Assessment on the aspects of *Cost* and *Service* were conducted to test the degree of extensive cadastral survey services at the current stage.

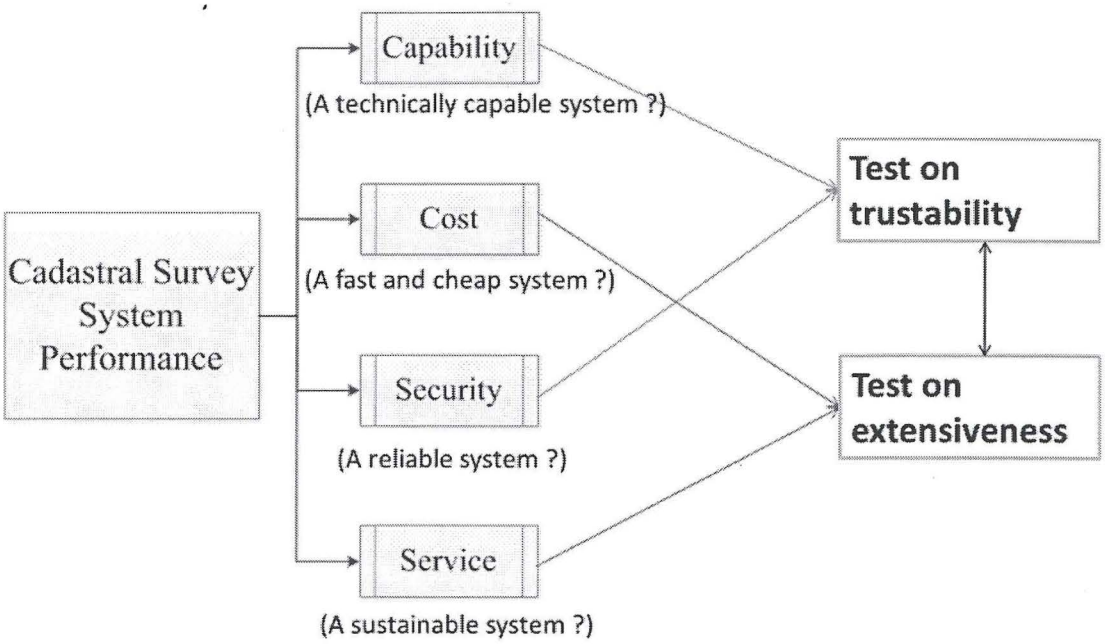

Figure 2: Assessment objectives of the framework

3.1 Assessment Criteria

Achieving a common understanding on the assessment items is always complicated in cadastral evaluation projects (Steudler, et al., 1997; Mitchell, et al., 2008). The definitions of generalized term and assessment aim are required to be illustrated explicitly. This is also important to make a balance between the length and the degree of content showing in this questionnaire during which the questionnaire is designed for data collection.

3.1.1 Capability

There are three performance indicators under *Capability*: *Plan Accuracy*, *Surveying Technology*, and *System Automation*. *Plan Accuracy* intends to measure the positional accuracy of the currently produced cadastral survey plans. *Surveying Technology* measures the technical capability and efficiency in survey and mapping required rights, responsibilities and restrictions by currently adopted surveying methodology. *System Automation* measures the automation level of the cadastral survey system with a focus on the database and data model approach.

3.1.2 Cost

There are three sub-criteria under *Cost*: *Customer Cost*, *System Maintenance*, and *Time Efficiency*. *Customer Cost* measures the individual burden to use the cadastral survey services. *System Maintenance* measures the government burden to maintain the current cadastral survey operations. *Time Efficiency* considers the cost in term of time dimension and time efficiency on the use of cadastral survey services.

3.1.3 Security

Three sub-criteria are selected under *Security*: *Boundary Reliability*, *Legal Basis*, and *Survey Regulation*. *Boundary Reliability* measures the stability of the boundary system and efficiency of the currently surveyed boundaries. *Legal Basis* intends to examine the performance of the updated legislation for the operation of cadastral survey services and authorization of legal boundary for surveying. *Survey Regulation* measures the suitability of the technical and administrative guidance for the cadastral survey industry.

3.1.4 Service

There are three sub-criteria under *Service*: *Product Applicability*, *Professional Competence*, and *User Perspective*. *Product Applicability* measures the level of adopting cadastral survey outputs by

land professions and the involvement of those products for further system development. *Professional Competence* considers the efficiency of professional services in fulfilling the requirements of the system end-users; it also aims to test the appropriateness of current licensing and practising system for the cadastral surveyors. *User Perspective* measures the quality of the cadastral survey outputs from the perspective of system end-users.

3.2 Assessment Methodology

The established assessment criteria set a protective cover of the fundamental cadastral survey system. A successful evaluation project also requires an appropriate assessment methodology and adequate feedback to analyse the system performance and identify the gap.

Generally, there are three sets of datasets or judgements that are required to be collected from local cadastral practitioners through questionnaire or interview. Firstly, the relative importance of each criterion is required to be determined by the assessors' judgements. It reflects a significant influence on different performance perspectives when constructing the desired system performance. Secondly, the fulfilment level of the current system is required to be evaluated under each criterion, where the performance gap can be identified by this set of evaluation data. Thirdly, a set of performance data or empirical data were collected from experienced local practitioners to take reference of the current performance of the system. That dataset would be correlated with the first two sets of evaluation data to contribute a comprehensive view of the performance level of current Hong Kong cadastral survey system.

3.2.1 Criteria Weight Determination Methodology

Analytic Hierarchy Process (AHP) considered as one of the most widely used Multi-Criteria Decision Analysis (MCDA) methodology was applied to determine the weight of the selected assessment criteria listed in Figure 1. The function of AHP pairwise comparison is the foundation of this MCDA methodology where complex decisions from a set of pairwise comparisons can be constructed (Satty, 2008), in the form of the fundamental AHP algorithm with the most common Satty's 9-point pairwise comparison scale to derive the weight of the criteria set (Satty, 1980). A thorough explanation of AHP algorithms will not be a focus in this paper but can be found in the review papers publicised by Satty (1980).

In this project, a total of five pairwise comparisons groups were to be settled by the assessors. The first group pairwise comparisons were among the four selected assessment dimensions. Under each assessment dimension, the weight of the performance indicators was also determined, as such the relative importance of each performance indicators and the assessment dimensions can be settled. The criteria weight pattern reflects assessor's recognition on the constitution of an optimal system performance.

3.2.2 Performance Gap Evaluation Methodology

Subsequent to the finding of the weight of different performance indicators which had been contributed to a desired cadastral survey system performance, the next step was to evaluate the current system performance level under each criterion. The established model adopted the scheme of self-assessment to evaluate the current cadastral survey system. Benchmarking with the *Should-be Performance*, assessors were requested to give their own judgements on their satisfaction level of the *Achieved Performance* under each assessment criterion. Here, *Achieved Performance* indicates the actual achieved performance level; *Should-be Performance* indicates the performance level that best-fits the current industry requirements. A total of five performance levels and their corresponding performance scores were predefined between a range of *Very Poor* (0 marks) and *Very Good* (100 marks).

3.2.3 Performance Data Collection and Correlation Exercises

The first two sets of evaluation data focused on the relative importance of each performance aspects and the fulfilment level of the current system under a number of performance indicators. These two assessment objectives aim to test the generalized satisfaction perception on the current cadastral

survey system from each assessor. A further step is to collect achieved system performance datasets which are essential to explore the development of the system and shed the lights on upcoming works on system enhancements. A set of performance review questions was designed and distributed to the experienced local cadastral surveyors. The acquired performance and empirical datasets would further correlate to that of the previously collected performance scores.

3.3 Implementation Strategy

The core task of the implementation of the proposed assessment model was to collect judgments and performance datasets from local cadastral survey practitioners. Under the coordination of LSD, the strategy of implementing the established model in the Hong Kong cadastral survey industry was divided into three stages.

At stage one, a consultancy panel is established, and its panel members is proposed to include land surveyors that are likely possessing more knowledge towards the system operation. A majority of around 14 land surveyors are selected, and the remaining members with surveying background from the public sector, private sector and academic institution become the key players to contribute in this consultancy panel. Through panel interview and questionnaire, the assessment criteria have been refined, incorporating the opinions and comments collected to calibrate for the model structure.

At stage two, a performance evaluation questionnaire aims to collect practitioners' evaluation on the weight of different assessment criteria and the current performance level was sent to all HKIS LSD members for feedback. Local cadastral survey practitioners as the assessors were categorized into three types: *Public Sector*, *Private Sector* and *Young Surveyor*. In a total of 52 feedback were collected.

At stage three, a performance review questionnaire was introduced and sent to those experienced local cadastral practitioners in both public sector and private sector. Performance data on the local cadastral survey system with their experiences on the system performance were collected through this set of questionnaires, eventually with 17 of responses were received.

Two key strategies in designing the questionnaire were: 1) to be concise and 2) to keep the privacy of individual assessor. The objective of the data collection was to recognize different groups of practitioners' understandings on the performance of a cadastral survey system. Thus, individual results would not be discoursed. The privacy of individual participants was contained confidential and only those combined group results would be publicised.

4. Assessment Results and Feedbacks

Participants have been categorized into three groups: *Public Sector* (surveyors from the public sector), *Private Sector* (practitioners from private sector) and *Young Surveyor* (surveyors under age 35). 52 of the feedback on the performance evaluation questionnaire and 17 of the feedback on the performance review questionnaire were received from local cadastral survey practitioners. To summarise the overall questionnaire results, the comparisons among three groups in the presentation of the criteria weight distribution pattern, the performance scores and the supplementary performance datasets can be obtained.

4.1 Criteria Weight

Results of the weight distribution pattern for four assessment dimensions are listed in Figure 3. The weight distribution pattern showed the local cadastral survey practitioners had a higher tendency to assign more weights to *Capability* and *Security* where it indicates the trustability of local cadastral survey services and is favourable by the local cadastral survey practitioners. Rather than the *Public Sector* and *Young Surveyor*, *Private Sector* is more sensitive to *Cost* and less sensitive in *Security*.

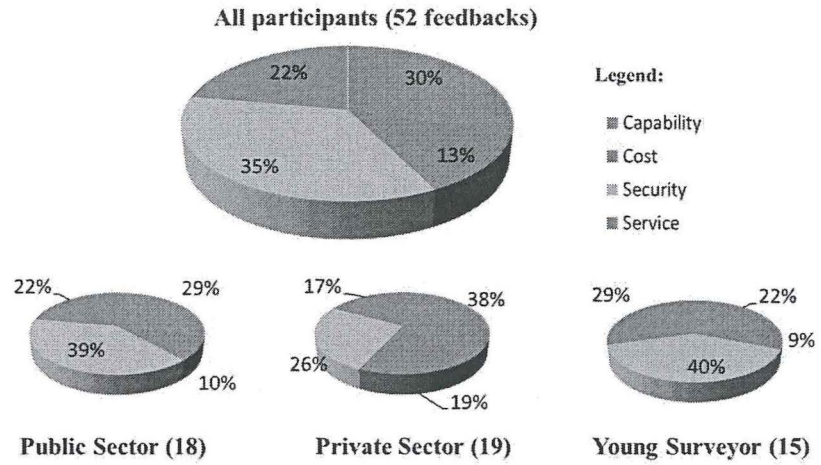

Figure 3: Results on weight distribution of four assessment dimensions

Table 1: Weight distribution of four performance dimensions

	Public Sector (18)	Private Sector (19)	Young Surveyor (15)	**All (52)**
1. Capability				
1.1 Plan Accuracy	60	52	60	**57**
1.2 Surveying Technology	21	23	18	**22**
1.3 System Automation	19	25	22	**21**
Sub-Total	100	100	100	**100**
2. Cost				
2.1 Customer Cost	23	30	19	**24**
2.2 System Maintenance	34	29	31	**31**
2.3 Time Efficiency	43	41	50	**45**
Sub-Total	100	100	100	**100**
3. Security				
3.1 Boundary Reliability	24	40	38	**34**
3.2 Legal Basis	50	33	42	**41**
3.3 Survey Regulation	26	27	20	**25**
Sub-Total	100	100	100	**100**
4. Service				
4.1 Product Applicability	29	34	36	**33**
4.2 Professional Competence	56	46	32	**45**
4.3 User Perspective	15	20	32	**22**
Sub-Total	100	100	100	**100**

Table 1 showed the detailed weight distribution pattern of three participant groups. Under *Capability*, the weight distribution pattern indicated the level of attention by the local cadastral survey practitioners on the quality of the cadastral survey outputs (*Plan Accuracy*). The sub-criteria of *Surveying Technology* and *System Automation* had similar weights among three groups. Results of the sub-criteria weight distribution of *Cost* showed local practitioners assigning more weight to the *Time Efficiency* of the cadastral survey services. Participants from *Young Surveyor* group considered the time cost sub-criterion most significant. The weight determination results under *Security* criterion indicated the *Legal Basis* of the cadastral survey services were the most important issue. Correspondingly, *Private Sector* and *Young Surveyor* considered more on the *Boundary Reliability* criterion of the current cadastral survey records. The results of weight distribution pattern under *Service* criterion indicated the local cadastral survey practitioners have shown higher concern over the *Professional Competence* of the cadastral survey practitioners, especially from participants in the *Public Sector*.

4.2 Performance Scores

Figure 4 showed the overall performance level of current Hong Kong cadastral survey system were regarded between the level of *Fair* and *Good*. *Young Surveyor* contributes to the highest score to current system performance among all three groups. Furthermore, all of three groups rated the highest scores to *Capability* against four different assessment dimensions. Practitioners from public sector contribute the lowest performance score to *Security*.

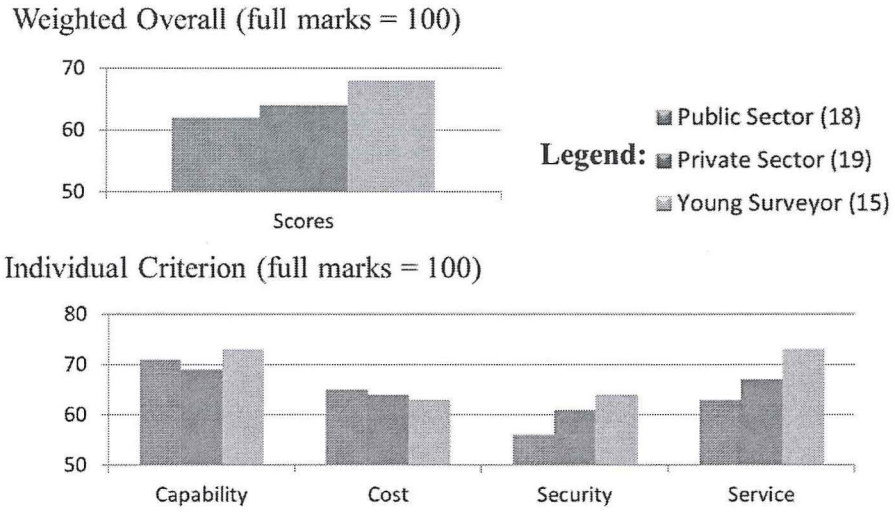

Figure 4: Results on the system performance scores

4.2.1 Performance Indicator Scores Under Each Criterion

Table 2: Performance scores under four assessment dimensions

	Public Sector (18)	Private Sector (19)	Young Surveyor (15)	**All (52)**
1. Capability				
1.1 Plan Accuracy	71	68	72	**70**
1.2 Surveying Technology	73	75	68	**72**
1.3 System Automation	57	69	65	**64**
2. Cost				
2.1 Customer Cost	69	66	65	**67**
2.2 System Maintenance	63	58	63	**61**
2.3 Time Efficiency	57	60	66	**61**
3. Security				
3.1 Boundary Reliability	56	57	56	**56**
3.2 Legal Basis	48	55	57	**53**
3.3 Survey Regulation	62	64	69	**65**
4. Service				
4.1 Product Applicability	56	60	68	**61**
4.2 Professional Competence	65	68	71	**68**
4.3 User Perspective	57	61	71	**63**

Table 2 showed the detailed performance scores under each criterion. Under *Capability*, *System Automation* was the relatively weakest performance aspect. (a) Under *Cost*, *Public Sector* was more satisfied with the performance of *Customer Cost* but had more expectations on the *Time Efficiency*. (b) Under *Security*, *Public Sector* rated the lowest scores to *Legal Basis*. *Young Surveyor* assigned a relatively highest score to the performance of *Survey Regulation*. (c) Under *Service*, *Public Sector*

had a higher expectation rather than other two groups on those three selected performance indicators and *Young Surveyor* rated the relatively highest scores to this set of system performance indicators.

4.3 Performance Datasets

A set performance review questionnaire was designed and sent to local cadastral survey experts to invite opinions and judgments. The performance evaluation datasets were collected and analysed from local cadastral survey practitioners, those empirical datasets were served as a supplementary knowledge base to the previously calculated performance scores. A total of 17 feedback were collected from local cadastral survey experts in public sector (9 responses) and private sector (8 responses).

4.3.1 Performance Review of Capability

The performance review of *Capability* focused on the particular users demanding a higher accuracy of cadastral survey plan, their openness to adopt a newly-emerged surveying technology and the automation level of the current cadastral survey system. A majority of participants required the cadastral plan with accuracy to millimetre to centimetre level in urban areas, i.e. 15 out of 17 responses, whereas the accuracy to centimetre level to sub-meter level in rural areas i.e.16 out of 17 responses. In addition, 14 participants regarded the newly emerged surveying technology (e.g. UAV survey and mobile mapping) had a medium to high capability improving the current local cadastral survey services. However, all assessors revealed that the application of new surveying technology was inadequate in local cadastral survey processes, and fortunately experts from public sector were slightly more optimistic towards the application of new surveying technology, while for system automation, most of the participants identified the current application of cadastral survey data model level was between analogue files and digital modelling stage.

4.3.2 Performance Review of Cost

Around 50 to 100 licensed land surveyors are recorded as cadastral surveying expertise serving in the public sector and around 20 to 50 serving in the private sector. The performance review of *Cost* focused on a wide spectrum of cost-related matter, including the financial burden to the customer when using cadastral survey services, the number of cadastral surveyors in both public sector and private sector and the time span on the cadastral survey. Many assessors reported the cadastral survey cost is around 20,000 Hong Kong Dollar (HKD) per lot in urban area (11 out of 17 responses) and less than 10,000 HKD in the rural area (10 out of 17 responses). However, inconsistent analytics resulted in the issue of the time span of cadastral survey activities. This might because of the different interpretations of the definition of the term and the complexity of this issue in nature.

4.3.3 Performance Review of Security

The performance review of *Security* focused on the ratio of inaccurate boundary records and boundary dispute cases, legal support on carrying out cadastral survey activities and the appropriateness of current institutional rules and guidelines for the cadastral survey industry. Results showed a majority of the local cadastral survey experts less than 10% problematic boundaries in the urban area (10 out of 17 responses) and 25% or fewer in the rural area (13 out of 17 responses). This can also draw a sparking attention from this result because the surveyors from the public sector would have more confidence on the reliability of current boundary system in both urban and rural area. A majority of assessors (11 out of 17 responses) indicated the current legal system is insufficient (8 responses) or very insufficient (3 responses) in supporting the cadastral survey industry, while there were 11 responses on the current cadastral survey rules and guidelines which expressed the standard of meeting the demands of the industry was fairly satisfied.

4.3.4 Performance Review of Service

The performance review of *Service* focused on the level of adoption and sufficiency of the cadastral survey products, the performance of current education, practising system and the accessibility of cadastral survey records. The results showed that a portion of participants (10 out of 17 votes) have expressed the existing cadastral survey products were sufficient enough and were frequently applied by the local land stakeholders. Nearly all the assessors revealed the current education system (16 out

of 17 votes) and practising scheme (15 out of 17 responses) are fairly satisfied or well performed. Meanwhile, 14 out of 17 cadastral survey experts from both public sector (7 responses) and private sector (7 responses) respectively expressed the private practitioners would have a certain extent of difficulties to collect the cadastral information from different government departments or organizations.

5. Conclusion

Performance-review facilitates an organization to meet its user demands and achieve planned goals. Evaluation on the performance of a cadastral survey system helps decision makers better understand the current development of the cadastral survey industry and the way forward to enhance its performance. As an indispensable land administration function, the performance of the cadastral survey system provides an indicator of the land industry operations. There is no easy way to assess a cadastral survey system. The land administration becomes a growingly important issue, especially on the land surveying cadastral system which highly urged for a refinement as the inter-connected regime between Hong Kong and PRD after the sovereignty of Hong Kong returned to China. Performance-review facilitates an organization to meet its user demands and achieve planned goals. Evaluation on the performance of a cadastral survey system helps decision makers better understand the current development of the cadastral survey industry and the way forward to enhance its performance.

Through the introduction of the project design relating to a structured multi-criteria performance assessment model, this could enhance its capacity to assess individual cadastral survey systems in a holistic way. The established structured model could help to settle the question of what to measure and how to measure by considering a set of assessment criteria and performance indicators. The proposed model parameters intended to bring various understandings of a cadastral survey system performance into a common and universal framework and its achievements can be measured by normalized yardsticks. To move further step, the implementation strategies, including a participatory scheme proposing the merging of the judgments from local cadastral survey practitioners was introduced.

A case study had been demonstrated through a custom fit methodology to evaluate the performance of current Hong Kong cadastral survey system from the views of practitioners, together with a detailed assessment analysis and promising result that had been presented. A "multi-view" of the current status of the Hong Kong cadastral survey industry has been illustrated by the "peer-review" survey feedback under the proposed assessment criteria set in this study, which can serve as a reference for the development of new land policies and enchantment projects.

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