A Participatory Model for the Assessment of Cadastral Survey Systems – Case study report of Hong Kong

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Key words: Cadastral survey system, performance assessment, participatory approach, benchmarking

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 the cadastral survey industry and the way forward to enhance its performance. Previous evaluation and assessment datasets for the Hong Kong cadastral survey system are formed by readily available information and long-time field experiences of the assessor himself. There is a lack of "peer-review" design to incorporate industry practitioners' judgements in local cadastral survey evaluation projects. This paper introduces a research project which aims to measure the performance of individual cadastral survey system world-wide from practitioners' opinions of individual system. A structured multi-criteria assessment model based on the methodology of Analytic Hierarchy Process (AHP) has been established and then applied to measure the system performance in a holistic way. The case study of the Hong Kong cadastral survey system shows the capability of the designed assessment model and the applied participatory approach in investigating the development of individual cadastral survey systems. In addition, the assessment criteria set is not fixed. Different systems world-wide may adjust their evaluation criteria to better meet the design of their own cadastral survey systems. Meanwhile, those model normalized performance scores can still be valid as a set of international benchmarking elements to share understandings on the development cadastral survey systems and shed lights on areas for improvement.

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1. INTRODUCTION

Hong Kong was a British colony since 1840s and now being an autonomous territory of the People's Republic of China. After its reunification to the People's Republic of China in 1997, Hong Kong continues adopting the English Common Law system under the principle "One Country, Two Systems". The currently practicing cadastral model, which is an English system of deeds registration for transaction, is still solely under the Land Registration Ordinance enacted since 1844. The local system is regarded as satisfactory in supporting an easy and traceable land conveyancing system (Kowk and Tang, 2010 and Tang, 2010). However, as an indispensable component of the land administration system, the efficiency of the local cadastral survey services has long been complained by its practitioners (Tang, 2004; Wootten, 2004; Leung, 2007; Koo, 2013 and Lai et al., 2015).

As emphasized by Williamson (2001), a fuller understanding on the characteristics of the subject cadastral system is an essential prerequisite to implement new policy to the system. Evaluation on the system design and performance is one of the most applied methodologies in the field of cadastre and land management (see McLaughlin, 1978; Williamson, 1981; Enemark et al., 2004; and Mitchell et al., 2008) and the evaluation results can be regarded as an important knowledge base in further system developments.

Evaluation on the Hong Kong cadastral system is not new. Hong Kong has a well-developed land market with various segmented land professions responsible for different tasks on the land issues. Local cadastral survey practitioners, especially land surveyors, are more specifically focused 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 systems benchmarking project that coordinated by the International Federation of Surveyors (Steudler et al., 1997). The paper discussed the need of sufficient understandings on the local cadastral survey system to implement further enhancements or reforms. Local cadastral survey practitioners further reviewed the design of Hong Kong cadastral survey system in both a systematic way (e.g. Tang, 2002) and a piecemeal way (e.g. Cheung, 2016). The evaluation or assessment datasets for the Hong Kong cadastral survey system are formed by readily available information and long-time field experiences of the assessor himself. There is a lack of "peer-review" design to incorporate industry practitioners' judgements in previous local cadastral survey evaluation projects.

This paper introduces a research project which aims to measure the performance of individual cadastral survey system world-wide from practitioners' opinions of individual system. A structured multi-criteria assessment model based on the methodology of Analytic Hierarchy Process (AHP) has been established and then applied to measure the system performance in a holistic way. A

participatory scheme in implementing the established model has been developed and approached in Hong Kong 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 have been sent to its corporate members, associate members and probationers. Collected evaluation datasets have been imported to and then analyzed by the assessment framework. How well the current system meets the expectations of the industry would be identified. In particular, the performance gaps of the system are shown.

This paper is structured as follows. First, the backgrounds of the Hong Kong cadastral survey system is introduced with a focus on the settings of the system design. Secondly, the contents of the established evaluation framework are explained. Definitions of the proposed assessment criteria and the functions of applied AHP methodology are interpreted. And the implementation strategy and procedures are discussed. Thirdly, the results of this evaluation case study project are presented and analyzed. Findings on the performance of current Hong Kong cadastral survey system are pointed out. Finally, the capability of the design assessment scheme and further recommendations on the evaluation of cadastral survey systems are discussed and concluded.

2. HONG KONG CADASTRAL SURVEY SYSTEM, THE DESIGN

Hong Kong locates at the south-eastern tip of China and 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. Around 40% Hong Kong land are country parks and nature reserves and the currently developed land area is about 25% of total area. Hong Kong's population is approximately 7.4 million in 2016 (Census and Statistics Department, 2016).

The cadastral system in Hong Kong includes basically land registration and land boundary survey. The purpose of the local cadastral system is mainly for the transaction of land ownership, and has remained largely unchanged. The general boundary system is only designed for the identification of the location of a land lot. Hong Kong adopts a 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 1995, no legal provision was applied to regulate land subdivision, the local cadastral survey procedures or standards. In essence, the enacted Land Survey Ordinance still lacks of measures to monitor local cadastral survey services other than subdivisions. In 2004, Land Titles Ordinance (LTO) as a parallel registration mode was introduced. Land Registry planed 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) is being considered and continuing discussed with the stakeholders are being held.

Almost all 300,000 land lots in Hong Kong are registered and surveyed. Land Registry is a self-financing government department providing registration service, and the Survey and Mapping Office of the Lands Department maintains the cadastral survey records. The documents kept by the Land Registry, including 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

database and lease documents are stored in scanned image files. Other government departments keep land data without direct cadastre related law prescriptions. For example, the Survey and Mapping Office keeps the graphic components (land boundary records) of the cadastral system. Planning Department keeps the land use designation data. 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. Too 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, we land surveyors should also admit that these settings do call for more land surveying services in current land development industry.

Basically, there exists a three-tier structure of land surveying professional organizations. The Hong Kong Institute of Surveyors (HKIS) is the professional organization for surveyors and the institute is incorporated under The Hong Kong Institute of Surveyors Ordinance (Cap.1148). A LSD corporate member of the HKIS may apply for the Registered Professional Surveyor (RPS) after one year of local practice and 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. To date, there are total 270 corporate members registered in the LSD (HKIS, 2016). After the enactment of the LSO in 1995, ALS from the private sector takes up the bulk cadastral survey services which include the subdivision, re-definition lot boundaries and setting out of boundary marks. Land surveyors in the public sector are responsible for the survey and definition of new land parcels. They also maintain the cadastral survey records and provide cadastral survey related information and advices to stakeholders from both public sector and private sector.

Both the Hong Kong Government and the private sector spend a considerable sum of money in the maintenance of the cadastral records. Hong Kong does not lack of survey data but the survey results are not legally ensured. We need a comprehensive measure of the performance of the current system. This research project attempts to collect system performance data through an established framework and compares local cadastral practitioners' understandings on the system performance.

3. AN ASSESSMENT FRAMEWORK TO MEASURE THE PERFORMANCE

Evaluation on the design of individual cadastral survey system needs extensive resources and exhaustive research on every perspectives of the specific system. Measuring the systems' performance is the methodology that widely applied in the cadastral evaluation projects. To measure the fitness of a cadastral survey system in a holistic way, a structured assessment framework covers the technical, economic, legal and institutional settings is designed. Figure 1 lists the general framework of the assessment elements for the performance evaluation of a cadastral survey system. The overall performance of a cadastral survey system is divided into four assessment dimensions, termed as: *Capability*, *Cost*, *Security* and *Service*. Under each assessment

dimension, three performance perspectives as indicators are selected to measure the system performance specifically.

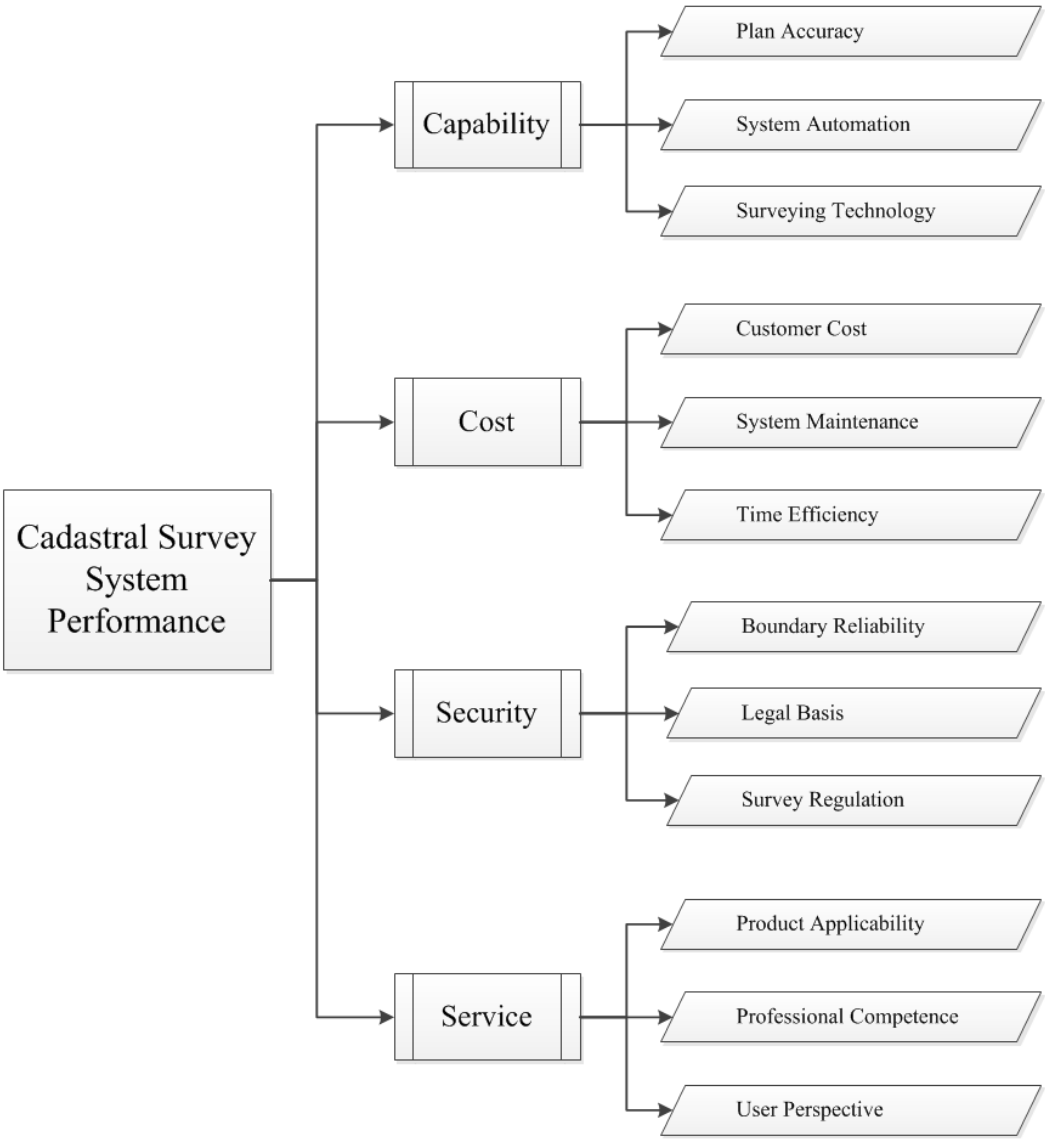

Figure 1. Assessment dimensions and performance indicators

The key evaluation criteria on the general fitness 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 professions. This set of key evaluation criteria is first summarized by Williamson (2000) in assessing the successfulness of land administration systems. Here, those evaluation principles are applied. The assessment objectives are represented in Figure 2. 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.

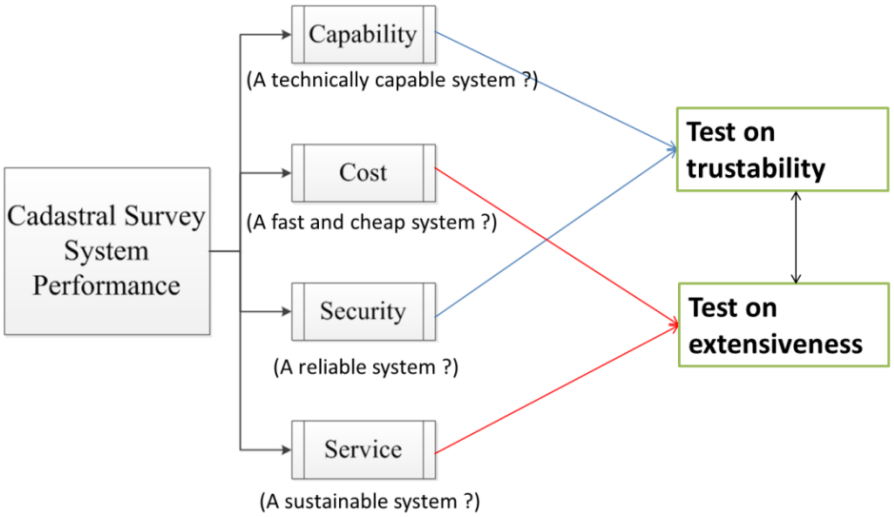

Figure 2. Assessment objectives of the framework

3.1 Assessment Criteria

Achieve common understandings on the selected assessment criteria is always difficult. Explanations on the definitions of generalized terms and assessment aims are required. In addition, a balance between length of the explanations and the degree of the details must be achieved when designing the questionnaire for data collection. Here, the proposed definitions and objectives of each selected assessment elements are illustrated.

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

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.

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 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.

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 practicing 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 covers the fundamental aspects of a cadastral survey system. A successful evaluation project also needs appropriate assessment methodology and sufficient feedbacks to analyze the system performance and identify the gaps.

Generally, there are three sets of datasets or judgements are required to be collected from local cadastral practitioners through questionnaire or interview. Firstly, the relative importance of each criterion needs to be determined by the assessors' judgements. It reflects the weight of different performance perspectives in constructing a desired system performance. Secondly, the fulfillment level of the current system needs to be evaluated under each criterion. Performance gaps can be identified by this set of evaluation data. Thirdly, a set of performance data or empirical data needs to be collected from experienced local practitioners to check what the current performance of the system is. Those datasets will be further correlated with the first two sets of evaluation data in contributing 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) as one of the most widely used Multi-Criteria Decision Analysis (MCDA) methodology is applied in determining the weight of the selected assessment criteria listed in Figure 1. The function of AHP pairwise comparison is the foundation of this MCDA methodology. It is capable to structure complex decisions from a set of pairwise comparisons. Here, we adopted the fundamental AHP algorithm with the most common Satty's 9-point pairwise comparison scale (Satty, 1980) to derive the weight of the criteria set. A thorough explanation of AHP algorithms will not be discussed in this paper, but can be found at Satty (1980).

In this project, total five groups of pairwise comparisons are required to be settled by the assessor. The first group pairwise comparisons are among the four selected assessment dimensions. Under each assessment dimension, the weight of the performance indicators is also needed to be

determined. Hence, 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

After settle the weight of different performance indicators in contributing a desired cadastral survey system performance, the next step is evaluating the current system performance level under each criterion. The established model adopts the scheme of self-assessment to evaluate the current cadastral survey system. Benchmarking with the *Should-be Performance*, assessors are required 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. Total five performance levels and their corresponding performance scores are predefined from *Very Poor* (0 marks) to *Very Good* (100 marks).

3.2.3 Performance data collection and correlation exercises

The first two sets of evaluation data focus on the weight or relative importance of each performance aspects and the fulfillment level of the current system under each performance indicator. Both these two assessment issues are aim to test the generalized satisfaction perception on the current cadastral survey system from each assessor. A further step to collect achieved system performance datasets on is essential to explore the development of the system and shed the lights on further system enhancements. Thus a set of performance review questions are designed and distributed to experienced local cadastral surveyors. The acquired performance and empirical datasets can be further correlated with those previously collected performance scores.

3.3 Implementation Strategy

The core task of implement the proposed assessment model is 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 can be divided into three stages.

At stage 1, a consultancy panel has been established. We supposed land surveyors are the type of stakeholders who know the system most. At this stage, as the key players of the system, 14 land surveyors or surveying backgrounds members from public sector, private sector and academic are formed this consultancy panel. Through interview and questionnaire, opinions and comments have been collected to calibrate and refine the assessment criteria and model structure.

At stage 2, a performance evaluation questionnaire aims to collect practitioners' evaluation on the weight of different assessment criteria and the current performance level has been sent to all HKIS LSD members to collect their feedbacks. Local cadastral survey practitioners as the assessors are categorized into three types: *Public Sector, Private Sector* and *Young Surveyor*. Total 52 feedbacks have been collected.

At stage 3, a performance review questionnaire has been introduced and sent to experienced local cadastral practitioners from both public sector and private sector. Performance data on the local cadastral survey system with their experiences on the system performance have been collected through this set of questionnaire. Total 17 feedbacks have been collected.

Two key strategies in design the questionnaire are: 1) to be concise and 2) kept the privacy of individual assessor. The objective of the data collection is to recognize different groups of practitioners' understandings on the performance of a cadastral survey system. Thus, individual results will not be discoursed. The privacy of individual participants can be kept and only combined group results will be presented.

4. ASSESSMENT RESULTS AND FEEDBACKS

Currently, we have received 52 feedbacks on the performance evaluation questionnaire and 17 feedbacks on the performance review questionnaire. Except the overall results from all assessors, group results of three types of practitioners are distinguished. *Public Sector* (surveyors from the public sector), *Private Sector* (practitioners from private sector) and *Young Surveyor* are the three groups. Here, overall questionnaire survey results and the comparisons of those three groups' results are shown respectively. The criteria weight distribution pattern, the performance scores and the supplementary performance datasets are presented below.

4.1 Criteria Weight

Figure 3 shows the weight determination results of four assessment dimensions. Results indicate the participated local cadastral survey practitioners pay more attentions on the system performance under criterion *Capability* and *Security*. As defined in Figure 2, this results showing that the trustability of local cadastral survey services is highly considered. Relatively, *Private Sector* is more sensitive in *Cost* and less sensitive in *Security* than the *Public Sector* and *Young Surveyor*.

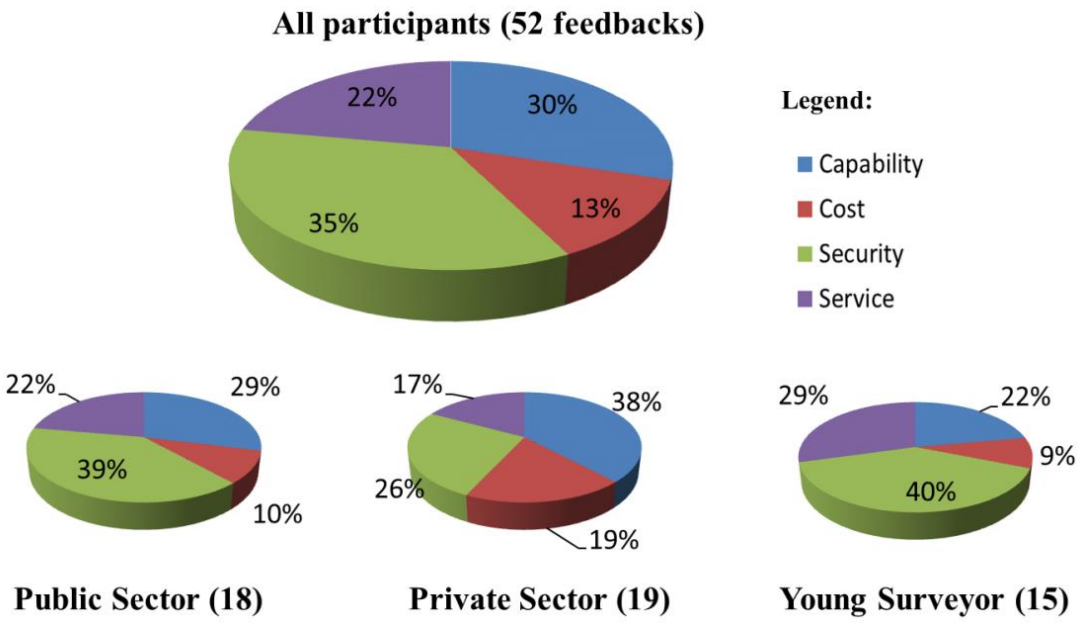

Figure 3. Results on weight distribution pattern of four assessment dimensions

Table 1. Weight distribution under four performance dimension`ns

	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 shows the detailed weight distribution pattern of three sub-divided professional groups under each criterion. Under *Capability*, the weight distribution patterns indicate local cadastral survey practitioners pay more attentions on quality of the cadastral survey outputs: *Plan Accuracy*. Both *Surveying Technology* and *System Automation* have very similar weights among three sub-divided groups. Results of the weight distribution of *Cost* show local practitioners assign more weight to the *Time Efficiency* of the cadastral survey services. Among those three surveyor groups, practitioners from *Young Surveyor* consider the time cost most. The weight determination results under *Security* indicate the participated local cadastral survey practitioners consider the *Legal Basis* of the cadastral survey services should have the heaviest weight. Relatively, practitioners from *Private Sector* and *Young Surveyor* consider more on the *Boundary Reliability* of the current cadastral survey records. The averaged weight determination results of three performance indicators under *Service* indicate the participated local cadastral survey practitioners concern more about the *Professional Competence* of the cadastral survey practitioners, especially from the results of *Public Sector*.

4.2 Performance Scores

Results in Figure 4 shows the overall performance scores of current Hong Kong cadastral survey system are regarded between the level of *Fair* and *Good*. *Young Surveyor* group gives the highest score to current system performance among these three groups. Relatively, all of these three groups rate the highest scores to the *Capability*. Practitioners from public sector rates the lowest criterion performance score to the *Security*.

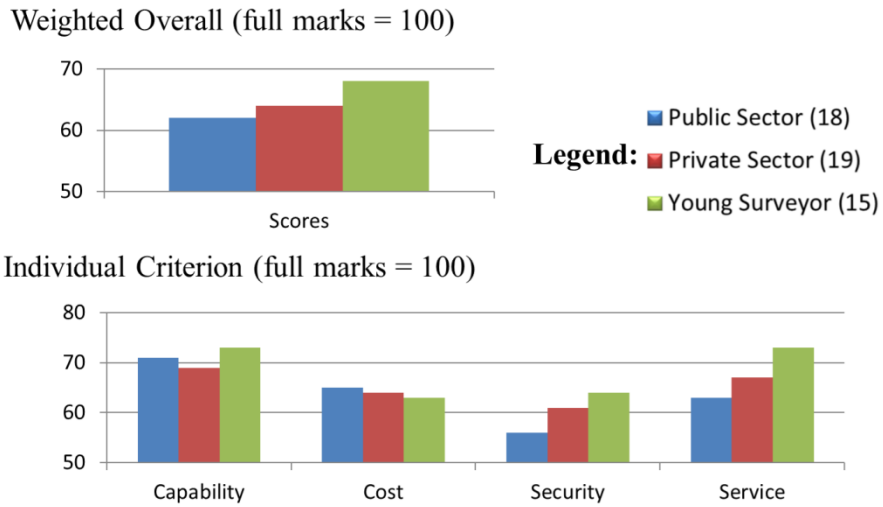

Figure 4. Results on the system performance scores

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 shows the detailed performance scores of three sub-divided professional groups under each criterion. Under *Capability*, *System Automation* is the relatively weakest performance aspect. Especially in the eyes of practitioners from the public sector, the performance under *System Automation* is below the level of *Fair*. Under *Cost*, *Public Sector* is more satisfied with the performance of *Customer Cost* but has more expectations on the *Time Efficiency*. Under *Security*, *Public Sector* rates the lowest scores in *Legal Basis*. *Young Surveyor* gives the highest score to the performance of *Survey Regulation.*Under *Service*, *Public Sector* has more concerns on the system performance of this criterion and *Young Surveyor* rates the highest score to this set system performance indicators.

4.3 Performance Datasets

After the performance evaluation datasets were collected and analyzed from local cadastral survey practitioners, a set performance review questionnaire was designed and sent to experienced local cadastral survey experts to invite opinions and judgments from them. Those valuable empirical datasets serves a supplementary knowledge base to the previously analyzed assessment results. Total 17 feedbacks are collected from local cadastral survey experts in both public sector (9 feedbacks) and private sector (8 feedbacks). Some findings from those feedbacks are represented.

4.3.1 Performance review of *Capability*

The performance review of *Capability* focuses on the user required cadastral survey plan accuracy, the adoption of newly emerged surveying technology and the automation level of the current cadastral survey system. Majority of participated experts identify the required cadastral plan accuracy is millimeter level to centimeter level in urban areas (15 votes) and centimeter level to sub-meter level in rural areas (16 votes). In addition, 14 experts regards the newly emerged surveying technology (e.g. UAV survey and mobile mapping) has a medium to high capability to improve the current local cadastral survey services. However, All assessors identify those new surveying technology is not frequently applied in local cadastral survey processes. Meanwhile, experts from public sector are slightly more optimistic on the issues of applying new surveying technology. In the issue of system automation, most of the participated experts identify the current Hong Kong cadastral survey data model is between analogue files and digital modelling stage.

4.3.2 Performance review of *Cost*

The performance review of *Cost* focuses on the customer burden on using cadastral survey services, the number of cadastral surveyors in both public sector and private sector and the time span on cadastral survey issues. A large number of assessors indicate the cadastral survey cost is around 20,000 Hong Kong Dollar (HKD) per lot in urban area (11 votes) and less than 10,000 HKD in the rural area (10 votes). Questionnaire results indicates there are around 50 to 100 licensed land surveyors are major in cadastral surveying in the public sector and around 20 to 50 in the private sector. Relatively inconsistent results are collected on the issue of the time span on cadastral survey issues. This may because of the different interpretations on 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* focuses on the ratio of inaccurate boundary records and boundary dispute cases, legal support on conduct cadastral survey activities and the appropriateness of current institutional rules and guidelines on cadastral survey industry. Results shows majority of the local cadastral survey experts thought there are less than 10% problematic boundaries in the urban area (10 votes) and 25% or less in the rural area (13 votes). Results also shows surveyors from the public sector has more confidence on the reliability of current boundary system in both urban and rural area. Majority of assessors (11 of 17) regard the current legal system is insufficient (8 votes) or very insufficient (3 votes) in supporting the cadastral survey industry. While there are 11 votes to indicate that the currently applied cadastral survey rules and guidelines are fairly meet the demands of the industry.

4.3.4 Performance review of *Service*

The performance review of *Service* focuses on the level of adoption and sufficiency of cadastral survey products, the performance of current education and licensing/practising system and accessibility of cadastral survey records. Result shows the majority of participated local cadastral survey experts (10 votes) indicate the cadastral survey products are sufficient and frequently applied by the local land stakeholders. Almost all assessors thought the current education system (16 votes) and practising scheme (15 votes) are fairly or well performed. Meanwhile, survey experts from both

public sector (7 votes) and private sector (7 votes) frankly thought private practitioners are not easy to collect cadastral information from different government departments or organizations.

5. 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 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.

This paper first introduces the design of a structured multi-criteria performance assessment model to assess individual cadastral survey systems in a holistic way. The established structured model settles the question of what to measure and how to measure through a set of assessment criteria and performance indicators. The proposed model parameters intend to bring different understandings of a cadastral survey system performance into a common framework and measuring its achievements by normalized yardsticks. Further, the implementation of a participatory scheme to incorporate judgments from local cadastral survey practitioners is introduced.

A case study applies the model methodology to evaluate the performance of current Hong Kong cadastral survey system from its practitioners. Detailed assessment results are presented and analyzed. Opinions and judgements from practitioners in the public sector, private sector and young surveyors are compared and analyzed. A "multi-view" of the current status of the Hong Kong cadastral survey industry is represented by the "peer-review" survey feedbacks under the proposed assessment criteria set. Through the assessment model, solid performance evaluation and review datasets are formed by the local cadastral survey industry and can serve as references for new land polices and enchantment projects.

The case study of the Hong Kong cadastral survey system shows the capability of the designed multi-criteria assessment model and the applied participatory approach in investigating the development of individual cadastral survey systems. In addition, the assessment criteria set is not fixed. Different systems world-wide may adjust their evaluation criteria to better meet the design of their own cadastral survey systems. Meanwhile, those model normalized performance scores can still be valid as a set of international benchmarking elements to share understandings on the development cadastral survey systems and shed lights on areas for improvement.

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