Developing information requirements for BIM-enabled quantity surveying practice: An adaptation approach

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ABSTRACT: Numerous studies have reported the benefits of building information modelling (BIM) to enhance the accuracy and efficiency of quantity surveying (QS) practice. Yet, its real-life application is largely limited. A significant barrier lies in the formulation of BIM information requirements to facilitate evaluate/enrich designers' BIM product for estimation. This paper aims to propose a process model to formulating QS BIM information requirements. It advocates the adaptation approach to reference and adapt the prevailing BIM guidelines for local use to ensure the guidelines' development efficiency and local applicability. It does so by presenting the findings of a case study investigating the BIM adoption practice of a Hong Kong QS consultant. The study outcomes will inform QS firms, especially the early adopters of a locality, to devise BIM strategies and enhance BIM adoption to a higher maturity level.

1 INTRODUCTION

Numerous studies have reported the benefits of building information modeling (BIM) for quantity surveying (QS) tasks. With a visualized representation of design information, BIM facilitates understanding the designer's intentions and preparing the conceptual estimate (Matipa et al. 2008). BIM integrates information from multiple professionals into a single platform, providing more reliable, detailed and organized design information for QS than that in 2D drawings (Kaner et al. 2008, Arayici et al. 2011, Monteiro and Martins 2013). Embedded with predefined rules, BIM has the potential to automatically produce quantity takeoff, cost estimations, and bills of quantities (Sabol 2008, Ma et al. 2011, Wu et al 2014), and timely updated the design documents based on design changes along with the project process (Raphael & Priyanka 2014). In a nutshell, BIM can offer tremendous opportunities for quantity surveyors to simplify, speed up, automatize, and perhaps the most importantly, increase the accuracy of the quantity surveying tasks.

Despite many benefits, the adoption of BIM in real-life applications is largely lagging. The barriers can be multifaceted, such as the lack of training, software toolkits and so on. This paper focused on two critical barriers. First, there lacks a comprehensive set of rules to inform how BIM-enabled QS practice can be unfolded (Wu et al. 2014), e.g., to govern its procedures, deliverables, and collaboration among different professionals (Lu, Lai & Tse 2018). The other barrier is rooted in the relationship and collaboration between quantity surveyors and other designers. Using BIM for QS requires upfront collaborations between quantity surveyors and designers, e.g., providing more detailed design information, inputting the correct coding, zoning and ensuring that each BIM object contains essential information for quantity take-off. The reality is that quantity surveyors cannot clearly convey their requirements to designers, let alone having such a BIM handed over for subsequent QS tasks.

This has given rise to the need for a set of clearly-defined requirements to support BIM-enabled QS practice. While the QS professionals are shifting towards a BIM-based practice, i.e., estimate based on geometric and non-geometric information in BIM, they need to ask for a BIM product containing specific information from designers, or modify the designer's BIM to the specific QS requirements by themselves. To ensure a smooth BIM process, it is important to have a set of BIM requirements with the appropriate amount of details and preferable presentation formats to specifically target QS practice (Cavka et al. 2017). Currently, several organizations have developed their own information requirements for QS BIM practice, e.g., Singapore's Quantity Surveying BIM Attribute Requirements (QSBAR).

Developing QS BIM requirements can be rather challenging. For one thing, the majority organizations are either late adopters or small- and medium-size companies; they lack sufficient resources to develop BIM requirements on their own, e.g., BIM experience, expertise, and professionals. Furthermore, the requirements are usually embedded into various sources, e.g., standard methods of measurement (SMM), contracts, BIM technical manuals, etc. To efficiently solve the problems, QS organizations tend to follow the existing information requirements and adapt them to suit the specific local requirements, e.g., local business targets, SMM, etc. In this regard, the development of BIM requirements can be translated into a series of challenges of identifying local QS needs, collect existing BIM requirements, and adapt the BIM requirements based on the local QS needs.

The primary aim of this paper is to formulate a process model to characterize the BIM requirements that support QS tasks. The proposed process model highlights an adaptation thinking – instead of developing the BIM requirements from a blank, this process can be enhanced by referencing and adapting the high-quality BIM requirements for local QS practice. The remainders of the paper are organized as follows. Subsequent to this introduction presents the research method which involves a case study to investigate the development of QS BIM information requirements by a Hong Kong quantity surveying consultant. Based on the investigation, a four-step process model was proposed in Section 3. Discussions and conclusion are drawn in the last section.

2 RESEARCH METHODS

The research methods of this study involved a case study to investigate the development of BIM requirements by a leading QS consultant in Hong Kong (denoted as *Firm A*). Amid the BIM trend in Hong Kong, Firm A joined the early BIM adopter group to explore using BIM for QS practice. The firm set up a short-term target to achieve BIM-enabled pre-tender practice, including preparing the BIM model specifically for QS use, BIM-based quantity takeoff, cost estimate, and bills of quantities, and a long-term target to adopt BIM for its full business. The firm also actively explored BIM technological and process solutions for their own practice. However, they encountered difficulties hindering further BIM adoption. The reality was that architects did not offer BIM models or merely provide a visual representation; it was rather time-consuming to develop and enrich the BIM model with sufficient information for QS tasks. To solve the problem, the management head decided to devise a set of QS BIM information requirements to convey specific QS requirements to designers and facilitate quantity surveyors to develop and enrich BIM models for QS tasks.

During the past two years, the authors work closely with Firm A to help the firm developed BIM strategies. The engagement, in turns, enabled the researchers to closely observe, investigate, and reflect from the real-life BIM adoption practice. Data was collected from various sources. First, the data was collected and analyzed to understand the overall BIM requirement development process, including the minutes of meeting, BIM strategic plan, emails, and organizational manual and technical guidelines. After that, interviews will be arranged with BIM experts, senior quantity surveyor and project team leaders within the organization to further refine the process model and understand the advantages and problems of developing BIM requirements following such a process model.

3 LOCALIZING BIM GUIDELINES – AN INVESTIGATION FROM A HK QS CONSULTANT

To ensure smooth BIM-based quantity takeoff and tender document (e.g., bills of quantity) preparation, Firm A aimed to develop a guideline specifying its BIM information requirements. The proposed guideline will serve for two purposes – conveying the detailed QS requirements to designers or BIM modelers, and facilitating QS to enrich the hand-over BIM models for the subsequent measurements and tender document preparation. The authors' investigation suggested that Firm A adopted a four-step process model to develop its BIM information requirements (See Figure. 1), including:

1. Specifying the requirements to unfold QS tasks in the local organization environment by understanding the existing QS practice and its local operating environments;
2. Collecting and organizing prevailing QS BIM information guidelines from leading organizations in the globe;
3. Analyzing the alignment between the collected BIM guidelines and local specific QS requirements; and; and
4. Devising a localized version of BIM requirements by rejecting/adapting/adopting the collected BIM guidelines, followed by reviewing and finalizing the requirements.

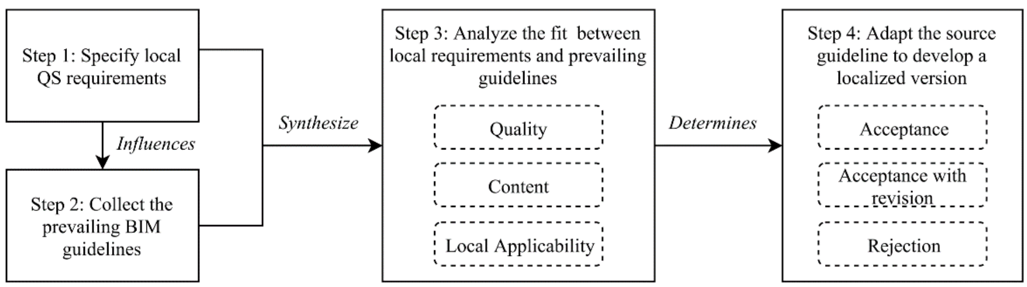

Figure 1. A four-step process model to adapt and develop local BIM information requirements.

3.1 *Specifying local QS requirements*

The first step was to specify the requirements that QS tasks can unfold in the locality. To do so it required to collect different sources of data to develop an in-depth understanding of the existing process to conduct quantity take-off and prepare tender documents based on 2D drawings. The data were collected via mixed methods, with desktop studies to acquire knowledge, project engagement to closely observe the process, and expert interview probing into the detailed QS requirements. The data sources are summarized in Table 1.

Table 1. Overview of collected data

Data collection methods	Source of data	Description
Desktop studies	Hong Kong Standard Methods of Measurement 4 (HKSMM4)	– Providing the mutually accepted rules for measurement and a standard format to present the measured work
	Organization's training materials	– Used for training the newly-employed quantity surveyors; – Revealing the general process and common practice to unfold QS tasks in the firm
	Technical solutions	– The in-house applications that support data management and document preparation during the lifecycle of the firm's business
	Organization's technical guidelines	– Guiding quantity surveyors to use the in-house technical solutions
Project engagement	Contract documents	– Setting out the detailed contract requirements that QS should fulfill
	Schedules of different materials	– The detailed arrangement of measured quantities of different building objects; – Generated by applications and revised/grouped by quantity surveyors

	Bills of quantities	– One of the most important tender documents prepared by quantity surveyors. – Presenting an itemized list of the component parts of the building, and sets out the quality and quantity of all the component parts necessary for the construction of the works
	Project models and drawings	– The BIM models and drawings of the projects, – helping to understand how the design information is presented and integrated into BIM and drawings and utilized for QS tasks
Interviews	Interviews with the senior quantity surveyors	– To develop a deeper understanding of the existing process and the detail information requirements that support QS tasks
	Interviews with the BIM managers	

A deeper probe into the data uncovered that the QS requirements can be grouped under three categories – industry-level, organization-level, and project-level requirements. The industry-level requirements comprised local codes and guidelines, e.g., HKSMM4, which set out local-accepted requirements on how building works should be measured, grouped and presented. They also specified the codes to represent each measured building components. Notably, the industry level requirements vary in different countries/regions; this should be carefully considered when adapting the BIM requirements from overseas organizations. The organization-level requirements were aligned to the firm’s specific business targets and BIM objectives, e.g., BIM for quantity takeoff and tender document preparation. It determined the scopes of the QS BIM requirement. The project-level requirements regulated how different stakeholders should collaborate, and how BIM and related information should be exchanged. This required the QS BIM information requirement guidelines should contain a certain level of flexibility such that it can be tailored to different projects.

3.2 *Collecting and organizing prevailing guidelines*

In the second step, the prevailing BIM requirements were collected from the global organizations that lead the QS BIM practice. The data collection mainly focused on documented and published guidelines from the organizations sharing similar QS practice with the Hong Kong QS consultant, such as the UK, Singapore, Australia, and New Zealand. This is because information requirements are largely localized products that are shaped by QS practice procedures. Referencing the guidelines from those regions sharing similar QS practice could incur fewer adaptation efforts. Table 2 summarized some guidelines and information requirements used as reference by Firm A. Notably, the outcome of this step was an organized set of documented information requirements, which will serve as the basis for analysis, adaptation, and consolidation into a clear set of requirements to inform BIM-based design handover and QS tasks.

Table 2. Global prevailing BIM information requirements

Name of files	Issuing years, bodies, and countries	Description
BIM for cost managers: requirements from the BIM model	2015, Royal Institution of Chartered Surveyors (RICS), UK	– Providing a guidance note for quantity surveyors for delivering BIM-based cost consultancy services – Developed in conjunction with other protocol documents in the UK, such as New Rules of Measurement.
Quantity Surveying BIM Attribute Requirements	2018, Singapore Institutes of Surveyors and Valuers, Singapore	– A set of documents including detailed cost breakdown structure of the elemental attributes and geometry required within a BIM model; – Act as a guide for design consultants to model BIM to quantity surveyors’ requirements;

		– Aligned to the SMM of Singapore.
Product Data Templates	2016, Chartered Institutes of Building Service Engineering (CIBSE), UK	A recommended template for manufacturers to generate a set of information about a given manufacturer's product.
BIM Object/Element Matrix	2013, NAPSPEC, Australia and New Zealand	– Defining a large number of objects and elements and their properties concerned by different professional activities including cost estimate; – Providing standards for BIM creation and information exchange at various stages of BIM develop and use. – Developed based on Uniformat/OmniClass classification and LOD at different stages in the building's lifecycle

3.3 *Assessing the referencing BIM requirements and devising BIM requirements for local QS practice*

Once the referencing guidelines were collected, the next step went to analyze and assess the guidelines to formalize recommendations to develop the BIM requirements for local use. The assessment was unfolded in three dimensions, i.e., the quality, content, and applicability of referencing BIM requirements. The standards and thresholds of each dimension were determined by an expert panel consists of BIM experts and senior quantity surveyors. The collected guidelines were first scanned to determine its quality and inclusion for local guideline development. A detailed analysis was then conducted to critically analyze the selected referencing guidelines, especially their scopes of applications, structural framework, and presentation formats. The selected guidelines will be further analyzed to identify its alignment with the local QS requirements, and applicability to the local QS practice. The assessment of these three dimensions will provide the basis for inspiring decision making about which referencing guidelines are relevant and for identifying which recommendations can be directly applied or adapted.

3.4 *Devising a localized BIM guideline*

The acquired knowledge and information from referencing information requirements were consolidated in the last step, which adapted the referencing BIM requirements into one suitable to use in the local context. In the case studies, local BIM requirements were consolidated and developed during a number of internal meetings and penal discussions amongst the management head, the senior quantity surveyors, the team leader of trial BIM projects, the BIM center directors, and in-house technicians. Five decisions were documented during this process, including:

- **Rejection** of the whole referencing guidelines. This decision was made in considering the poor quality of the guidelines per se or the huge incompatibility between the guideline and local QS practice;
- **Acceptance** of the referencing guidelines or a part of the guidelines. The decision was made in considering that both the quality and the compatibility of the referencing guideline, or a part of it, reaching the pre-defined thresholds, and thus can be directly used in the local QS practice and its specific local industry, organization, and project requirements.
- **Acceptance with revision**. This is an intermediate decision. The decision was made in considering that the quality or the compatibility of the referencing guidelines reach a lower threshold. The referencing guidelines could be useful for the local practice subjected to a certain level of adaptation to their frameworks or contents based on the local industry, organization, and project requirements. The adaptation may involve adding new data and rephrasing certain expressions to better reflect the firm's context.

Following the decisions to adapt the referencing guidelines, a draft document was produced to consolidate the study outcomes. Notably, the document was presented at the elemental level to suit the object-based parametric presentation of BIM, i.e., the information of BIM is represented, included and organized into BIM objects as their attributes. The drafted BIM requirement was then evaluated by both external panels, including staff in the firms who did not participate in the guideline development, research institutes, designers, BIM modelers, owners, and other parties with no conflict of interests to ensure the applicability and readability of the requirements.

4 CONCLUSIONS

Adaptation of prevailing practice guidelines for local use has been advanced as an efficient means to improve the applicability of the developed guidelines. Yet, such an adaptation process is still unclear and remained challenging, as the prevailing practice, mainly developed in other countries/regions, are developed with embeddedness of local factors such as specifications and standard methods of measurements. It needs a solid process to identify the embedded contextual factors and adapt the referencing guidelines accordingly for specific local needs.

This paper provides valuable information for guideline adaptation and development for the local use. It aims to formulate a process model by investigating the QS BIM information requirement development and adaptation process by a Hong Kong quantity surveying consultant, also an early explorer of BIM in QS practice in Hong Kong. It identified four essential steps, namely specifying the local requirements underpinning the QS practice, collecting the prevailing guidelines from leading organizations/countries as the reference, analyzing the referencing guidelines, and adapt/develop a localized version of the BIM requirements.

The adaptation approach helps with the efficient development of a BIM guideline for local use. It eases the intensive learning process for BIM information guideline development, and facilitate the preparation of an applicable guideline especially for the organizations that are still struggling to explore BIM. However, this does not mean that the adaptation approach significantly reduces time and efforts. Indeed, the adaptation process still incurs lots of time and efforts. For one thing, the real-life QS practice is very complex; the local QS specification is complicated and can vary in individual's interpretations. Also, the guideline development needs to overcome the different information grouping principles underpinning QS and BIM practice – the former clusters information from different types of building elements based on local standards while the latter dispersed information in each BIM object. Therefore, it may involve an iterative process to evaluate and revise the draft BIM requirements to truly suit the real-life QS practice.

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