 doi:10.20944/preprints202202.0210.v1

Article

Structuring a BIM Service Scoping, Tendering, Executing, and Wrapping-up (STEW) Guide for Public Owners

Kyoung-Jun Park[1] and Jong-Ho Ock[2]

[1] Dept. of Architectural Engineering, Korean Polytech University, Seoul, Korea and archijun@kopo.ac.kr
[2] Dept. of Architectural Engineering, Seoul National University of Science & Technology, Seoul, Korea; ockjh@seoultech.ac.kr
* Correspondence: ockjh@seoultech.ac.kr; Tel.: +82-10-7701-0504 (M.P.)
Current address: Gong-reung 2Ro, Nowon-Gu, Seoul, 139-743, Korea

Abstract: Building Information Modeling (BIM) has been one of the overwhelming trends in the worldwide. In Korea, from 2012, BIM application to the public construction projects worth more than $40 million was mandated. However, despite the policy, many public owners have hesitated to apply BIM to their projects. They generally view BIM very complex to manage and difficult to understand. While there have been diverse BIM guides as a reference, most of them have developed from BIM suppliers' perspective involving certain deficiency in meeting the public owners' taste. The public owners have addressed the necessity for developing an owner-oriented BIM guide on which they can understand the overall BIM procurement process thereby efficiently preparing their BIM service contracts. The main objective of this study is to develop the structure and contents guidance of the new guide to be developed that follows the public business process and mitigates the deficiency. To meet the research objective, a number of domestic and international BIM guides were analyzed and workshops were operated twice with the 12 BIM experts from the Korean construction industry. As a result of the study, a four-staged guide structure was developed consisting of the BIM service Scoping, Tendering, Executing, and Wrapping-up (STEW) guides.

Keywords: BIM; BIM Guide; BIM Deliverable; Public Owner; BIM Execution Plan

1. Introduction

1.1. Research Background and Objective

A Building Information Modeling (BIM) is "a digital representation of physical and functional characteristics of a facility" [1]. As construction projects have become larger and more complicated than before, the amount of information to be produced and managed while constructing the projects have also increased. As a result, there has been an escalating interest in BIM as a method for managing the information and supporting collaboration among project participants.

In Korea, since 2012, BIM application to the public construction projects worth more than $40 million has been mandated [2]. As well, the Architectural Service Industry Promotion Act (ASIPA) and the National Competency Standards (NCS) were enacted in 2014, which aim at enhancing architectural design quality in the public sector and standardizing technology levels of various industries including BIM, respectively [3, 4]. Given the ASIPA and the NCS, the role of public

 doi:10.20944/preprints202202.0210.v1

owners (PO hereafter) has been emphasized significantly in the field of project management containing BIM service management.

Construction works consist of the private and the public sector business depending on project ownership. In case of Korea, about 70% of total construction volumes nationwide belongs to the public sector [5]. To achieve high quality BIM service, the PO should play a pivotal role from the planning stage of the projects as a BIM coordinator. In accordance with the ASIPA, if the PO plan to build the facility of which design fee exceeds $200,000, they should get an official approval about preliminary feasibility of the facility including BIM service procurement. However, in spite of having to follow the new policy, there have been few BIM experts in PO organizations. Many PO in consequence are cautious in procuring BIM service [6]. There are rarely regular BIM education programs for the PO and since the workforces in the organizations are in general regularly rotated to different job positions mostly less than every two years, they have not been able to educate themselves and accumulated experience enough to be a competitive BIM coordinator [7].

The PO, in general, have a different perspective to BIM from private vendors and designers. While the private entities are interested in developing BIM models and products, the PO are concerned with a structured and justifiable buying process for BIM services from the private entities. They like to know how to develop proper specifications to well purchase the BIM services, what principles should be included in the specifications, how to manage rather than produce the intermediate products generated during the purchasing process, and how to verify the quality of the BIM services even if the services are produced in accordance with the specifications. In the past 10 years, several BIM guides have been developed and diverse international ones have been referred to for the PO to procure BIM service in Korea. Many PO have, however, considered that the guides involve certain deficiencies in meeting their taste such as easiness to follow and being tailored to meet the public procurement process, i.e., scope definition, supplier invitation, supplier choice, implementation, and closing and payment [7]. The PO have indicated that it is necessary to develop a more PO-oriented BIM guide that can deliver the requirements from the new BIM policies, i.e., ASIPA and the NCS, so that usable as a comprehensive reference for the PO to develop appropriate guidelines fit to their specific BIM service contracts.

At the beginning of 2021, the Ministry of Land, Infrastructure and Transport, Korea (MOLIT), the central governmental entity responsible for developing public guidelines and policies to provide quality infrastructures, established the hierarchical structure of BIM guidelines as shown in Figure 1 and developed Construction Industry Fundamental BIM Guideline (CIFBG) (i.e., Level 1-1 in Figure 1) as that sort of reference [8]. While a CIFBG defines step-by-step BIM application processes, BIM model development standards, and BIM interoperation principles, a more detailed implemental guideline (Level 1-2 in Figure 1) is on the way of development (Level 1-2 in Figure 1) as a supplementary one. Based on the two guidelines, the PO at various public entities are solicited to prepare their own BIM guidelines (i.e., Level 2-1 and 2-2 in Figure 1) which lead the workforces in their organizations to effectively manage BIM services.

The main objective of this study is to suggest the BIM Service Scoping, Tendering, Executing, and Wrapping-up (STEW, hereafter)

 doi:10.20944/preprints202202.0210.v1

guide structure on which the PO can tailor their own BIM guidelines applicable to a variety of project types. The STEW structure is developed reflecting step-by-step public BIM procurement processes and the essential contents in the processes, so that easy to understand and follow.

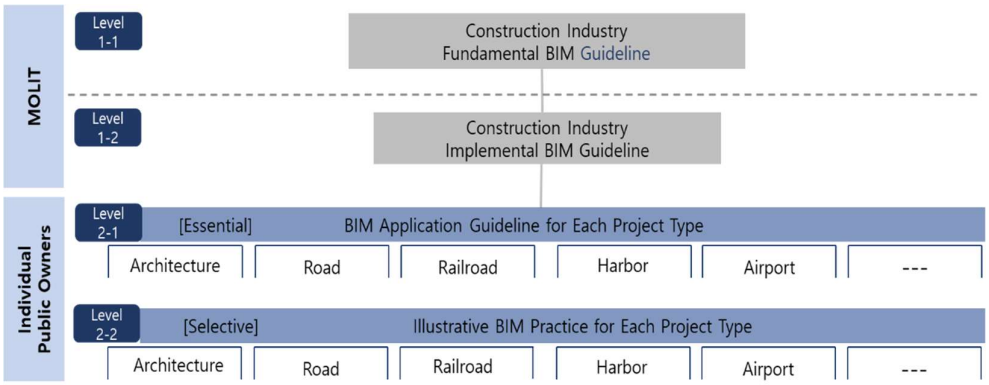

Figure 1. The Hierarchical Structure of Public BIM Guidelines in Korea [8] .

1.2. Research Rationale

In 2014, as stated above, the MOLIT enacted the ASIPA to enhance design quality of public buildings as well as to bring up the professional manpower through redefining the existing architectural design tender process [3]. Based on the ASIPA, the PO regardless of being in central governments or local provincial ones, if they build the facility of which design fee exceeds $200,000, are required to procure design works through a competitive designer selection process using a poster or oral presentation as to design concepts rather than a simple bidding on design fee.

Figure 2 shows the BIM procurement process at each of BIM development phases in conjunction with the entities involved in the process. According to the ASIPA, before proceeding the project procurement process, the PO should submit a formal document regarding their preliminary project feasibility analysis to the Public Architectural Support Center (PASC) led by the MOLIT (i.e., black-round No.1 in Figure 2). The document necessarily includes project scope, budget plans, design quality management plans including BIM scope and requirements, sustainability enhancement plans, project delivery methods to be applied such as Design-Build (DB), Technical Proposal (TP), Design-Bid-Build (DBB), Construction Management (CM), and so on [3]. The PASC then reviews the document in terms of appropriateness and comprehensiveness of the items and returns the review result to the PO. The PO necessarily reflect the review result in the final project procurement package for selecting a contractor/designer.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 17 February 2022 doi:10.20944/preprints202202.0210.v1

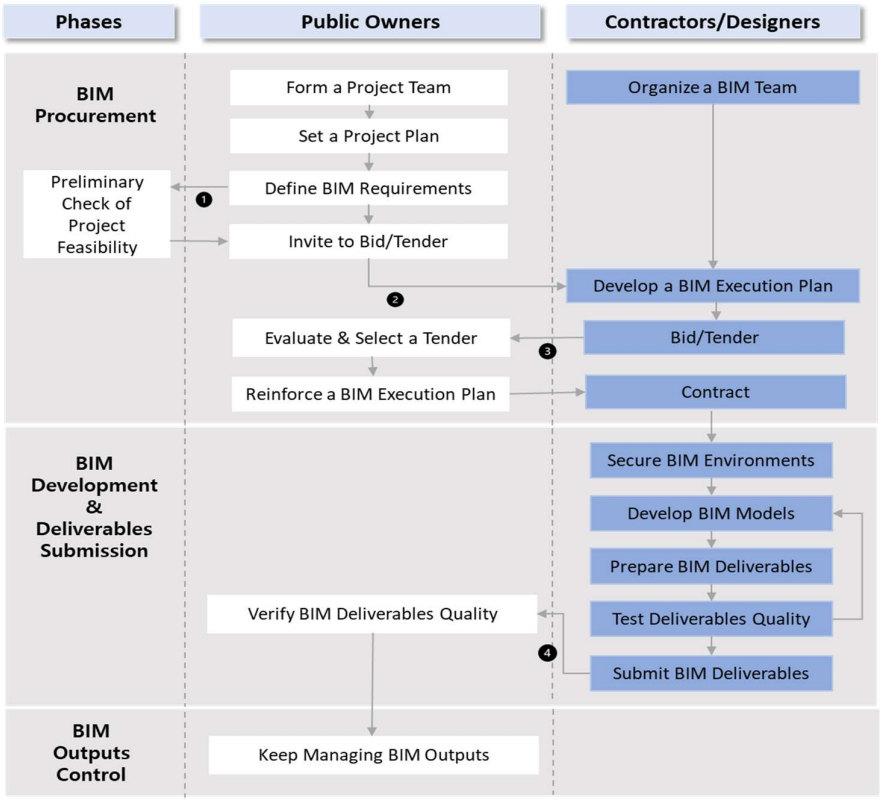

Figure 2. The BIM Procurement Process at BIM Development Phases (Modified from [8]).

The PO then invite contractors/designers through a competitive bid. Their invitation package essentially covers a Request for Qualification (RFQ), a Request for Proposal (RFP), BIM scope and requirements, BIM Execution Plan (BEP) development guidelines, and other reinforced documents by the PASC (i.e., black-round No.2 in Figure 2). The contents of the BIM vendor invitation are, in general, a part of the whole project bid invitation package and different on the basis of the PO' BIM intention and the project delivery method applied. Contractors/designers interested in the invitation package organize a project team including a BIM team and prepare a BEP according to the PO' request (black-round No.3 in Figure 2). Once selecting the most appropriate contractor/designer, the PO are likely to revise the BEP submitted by the selected to meet their BIM intention. The BEP clearly defines BIM deliverables and these should be carried out and submitted to the PO (black-round No.4 in Figure 2) on the designated BIM milestone in the contract.

The process described above includes step-by-step activities with diverse contents to address the PO' BIM intention. The PO are expected to be competitive enough to well prepare the activities, manage intermediate BIM deliverables produced during the procurement process, and verify the final BIM deliverables as a whole. If the PO can understand the structured relationships among PO' BIM scope, distinctive features of each project delivery method, and the contractual process and languages that are essential to meet the BIM scope and combine the relationships, they would feel more comfortable in tailoring their own BIM guidelines that can be well fit to their project types. The main objective of this study is to develop the STEW guide that supports the PO to understand those.

 doi:10.20944/preprints202202.0210.v1

In addition, referring to the NCS enacted by the Ministry of Employment and Labor, Korea in 2014, which aims to standardize knowledge bases and technology levels of various industries nationwide and to systematically raise the manpower in each industry according to the standardization, BIM has been one of the designated disciplines in the architectural industry. There are 4 sub categories involved in the architectural discipline, i.e., BIM preparation, BIM management, BIM production, and BIM usage [9]. The PO need to meet the NCS policy in doing their business and are expected to reflect the 4 BIM categories when planning their BIM services.

1.3. Research Methodology

The methodology of the study consisted of three activities: reviewing the existing body of knowledge on diverse BIM guides, identifying PO' opinion on the guides, and suggesting the structure and contents guidance of the new guide, the STEW guide. Developing a guide inevitably reflects the commonality from diverse approaches done by many professionals, so that very descriptive rather than analytical. This study is very exploratory in that there has not been such study before. To address the descriptive and exploratory research characteristics, the author formulated step-by-step research procedures as shown in Figure 1.

As the first step of research, the author investigated domestic and international BIM guides available and analyzed the contents of each guide. Workshops having a focused group interview format were conducted twice to meet the research objective. The author used a workshop rather than a questionnaire survey to accommodate the PO opinion on the existing guides because the former can get more specific and comprehensive critique from the PO. The eight public agencies from central and local public institutions were invited as the PO to provide their opinion and review on the existing guides. As well, 4 experts with profound BIM design experience contributed to the workshops as an advisor.

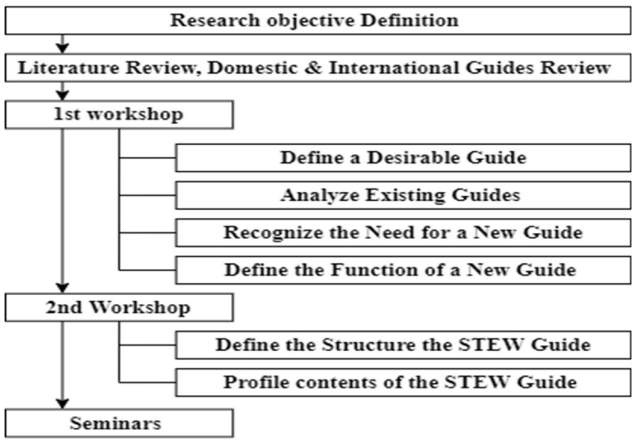

Figure 3. Research Methodology.

In the first workshop, the author presented the analysis results of the existing guides to the 12 workshop subjects. They defined the desirable BIM guide that could satisfy this research objective. The subjects then reviewed the analysis results of the existing guides

 doi:10.20944/preprints202202.0210.v1

delivered by the author to figure out whether the guides could meet the desirable BIM guide contents. The review results addressed yes or no as to the need for a new guide. In the second workshop, based on the results of the first workshop, the subjects were solicited to identify the STEW guide as the structure and contents guidance of a PO-oriented new BIM guide to be developed.

To enhance the comprehensiveness and practicality of research, the author presented the findings to domestic research seminars. The seminars were held four times on a quarterly base to report and discuss research findings from the Architecture & Urban Development Research Program (AUDRP) funded by the MOLIT for a couple of years. This study belonged to the research program. Through the discussion and critique in the seminars, improvement needs for the STEW guide were identified.

2. Literature Review

2.1. The Previous Studies on the Public BIM Guide Development

Table 1 represents the previous studies regarding the BIM guides and instructions performed in Korea. While most of the studies focused on the guides, guidelines, and manuals to support the BIM work at the design stage, there has been hardly any study to develop PO-oriented BIM guides. Furthermore, whereas a few governmental institutions in Korea promoted BIM guides, they rarely provided comprehensive and step-by-step BIM procedures for the PO. The MOLIT, as the central governmental authority in manipulating the national construction business policy, initiated "Architectural BIM Application Guide [5]." It consisted of three sections, i.e., BIM operation principles, BIM technologies guide, and BIM management guide. The MOLIT, however, announced that the guide was not recommendable to use for a specific project directly due to its roughness.

Table 1. Previous Studies on BIM Guides and Instructions.

Authors	Major Contents
[10]	Investigation of the previous BIM guides in Korea and abroad for developing open BIM guidelines in Korea
[11]	Preliminary study on the level of information and standardization in the BIM design process in Finland and Denmark
[12]	Setting the direction of BIM quality criteria through analyzing the existing quality management approaches among domestic and foreign BIM guides
[13]	Identifying the role of BIM guidelines through case studies in foreign countries and deriving the direction of BIM guidelines development
[14]	Investigation of BIM procurement instructions in foreign countries for the development of BIM guide criteria applicable to the overall areas in the construction industry
[15]	Analysis of BIM guidelines in Korea and foreign countries for the application of BIM to the project planning stage and deriving the elements in BIM guidelines
[16]	Analysis of the items necessary for Green BIM guideline in conjunction with LOD and suggesting the measurements in each LOD stage

Korean Land & Housing Corporation (KLHC), a unique public firm for furnishing the apartment housing, exploited a BIM guide for its own usage, called "The KLHC BIM Usage Guide [17]." Although the guide was more comprehensive than the one from the MOLIT covering

 doi:10.20944/preprints202202.0210.v1

BIM application principles in the conceptual and detailed design stage as well as construction stage, it has been difficult for generic usage since tailored for residential apartments.

The Public Procurement Service (PPS), a public entity for providing contract service for public institutions, developed "The Primary BIM Guideline for Construction Projects [2]." It consisted of four parts, that is, PPS BIM management principles and the BIM application principles in the concept design phase, the detailed design phase, and the construction phase respectively. While the guide has been the most sophisticated one in Korea up to date and referred to widely by public and private entities, since it was developed for designers and contractors, it addressed little as to the sequential and necessary tasks that the PO need to perform in procuring BIM services [7]. The sequential and necessary tasks specifically mean the PO' activities following the public business procedures such as defining service scope, choosing service suppliers, contracting service, managing service, and compensating for service.

2.2. Review of Global BIM Guides

Table 2 shows the foreign BIM guides frequently referred to when major public and private organizations in the BIM-advanced countries have developed their own BIM guides. Most of the guides just like the domestic ones above mainly have dwelled on the BIM design stage. However, the guide developed by Pennsylvania State University, USA, addressed performance of the PO at the BIM design procurement stage [1]. Another guide by the Corps of Engineers (USACE), USA provided the contents related to the BEP for the PO in the form of a template [18].

Table 2. Previous Studies on BIM Guides and Instructions.

Country	Guide Name	Major Contents
America	[19]	Produces all the information available during the lifecycle of projects from BIM perspective
	[20]	Suggests measures of BIM standardization of a project
	[1]	Suggests instructions and execution plans in the procurement stage of facilities for the owners
	[21]	Suggests a work template related to BIM project execution for project owners
Finland	[22]	Suggests plans for efficient information exchange in the fields of BIM design quality in all areas of design
Germany	[23]	Suggests efficient exchange of plans and operation of IFC, the standard of international BIM
England	[24]	Suggests BIM data exchange methods based on the design work
Norway	[25]	Suggests modeling required quality according to general requirements of BIM application for public projects and specific conditions
Canada	[26]	Suggests a guide for project owners and designers including BIM execution and performance plans, joint operation of information, collaborative work, data composition and division, modeling plans, folder structure, software, and others
New Zealand	[27]	Addresses the items related to plans at design stage in BIM execution and performance (process, LOD, delivery, software, and so on), purpose and definition of BIM application, and others
Hong Kong	[28]	Suggests the templates of requirements for establishment of execution plans and implementation of BIM projects
Italy	[29]	Prescribes coding principles, the required contents and levels of data models, and the templates for enhancing interoperability among diverse software

 doi:10.20944/preprints202202.0210.v1

As well, the National Institute of Building Sciences (NIBS), USA specifically prepared a BIM guide for the PO [19]. It outlined for the PO how to develop and implement requirements for the application of BIM and explain how to include these requirements in contracts to plan, design, construct, and operate buildings. It also provided recommendations for processes, standards, and deliverables for BIM operation that can be shared by the PO and other project participants to meet specific BIM needs based on individual project conditions.

Italian State Property Agency (that is, Agenzia Del Demanio) developed the BIM guide to digitalize the information of the Italian real estate properties [29]. The agency is the public entity to manage the Italian State's real estate assets value and administer a portfolio of around 42,000 assets worth 61 billion Euros. From 2016, it has adopted the BIM methodology to create three-dimensional digital files of each property managed in order to optimize property maintenance operation and verify service performance for the purpose of public savings through cutting down management costs. The BIM guide it prepared mainly included the principles for systematically coding documents, the required contents and levels of data models, and the templates for enhancing interoperability among diverse software, all of which were tailored to focus on its business purpose.

3. The 1st Workshop: Reviewing Existing BIM Guides

To meet the research objective, as stated earlier, twelve workshop subjects were invited: (1) 8 as the PO from public institutions, i.e., 2 from KLHC, 3 from local governments managing administration buildings, and 3 from local governments handling educational facilities, where they had been responsible for BIM project management; (2) 2 from international BIM design firms in which they had involved in domestic and foreign public BIM projects to build free-form buildings for several years; and (3) another 2 from the public research institutions, i.e., Korea Institute of Construction Technology (KICT) and Korea Educational Development Institute (KEDI). This study calls the workshop participants from the public entities the PO subjects and the other 4 participants the advising subjects hereafter.

3.1. Defining a Desirable Guide

The author presented the following questions to the PO subjects: (1) what projects BIM services were involved in; (2) why BIM services were applied to; (3) what project delivery methods were used in conjunction with BIM services; (4) what guides, guidelines, or manuals were referred to when procuring BIM services; (5) why those references were adopted; and (6) if possible, what structure of guides would be desirable or recommendable for public entities. The PO subjects freely delivered their experience, feeling, and thought on the questions and the followings are summaries of their responses:

1. The typical motives the PO decided to promote BIM on a project embrace: when BIM application was required by public policies; when a project was very expensive and the efficiencies gained through BIM seemed to be great; and when a project had the complicated applications, just like free-form buildings, that would be tough to construct without BIM. The PO subjects added that most of the PO have not been familiar with BIM services yet. They considered BIM very difficult to learn or understand.
2. Due to legal and different situational restrictions from project to project, the PO necessarily procure projects using different project delivery methods. For BIM to achieve its greatest benefit, it is essential for project participants to be openly working together and sharing

 doi:10.20944/preprints202202.0210.v1

information. Although Integrated Project Delivery (IPD) is known as the most fit to BIM services, it has been seldom applied yet to the public projects in Korea due to ambiguity of responsibility limits among project participants [30]. For public projects, mostly DBB and CM methods have been adopted in Korea. BIM services were in general contractually combined in design projects and rarely procured separately. In consequence, BIM scope was quite different from project to project depending on the decision of a project master architect if it had not been clearly requested by the PO.

3. When the PO procured a BIM service contract, the most widely referred guide to describe BIM service requirement and delivery procedures was the Primary BIM Guideline for Construction Projects by the PPS [2]. It presented BIM application principles in the concept design phase, the detailed design phase, and the construction phase respectively. The PPS guide, however, had been criticized for having certain deficiencies to be used as a one-stop reference. It did not provide a guidance, for example, to meet the ASIPA requirements and to develop the RFQ and the RFP.
4. A desirable and recommendable guide would be the one of which structure follows the public procurement process and contents deliver very comprehensive BIM instructions, so that provide one-stop reference for the PO to develop the appropriate guidelines fit to their BIM service contracts. The one-stop signifies that the reference equips almost everything about BIM service procurement and in consequence, the PO unnecessarily rummage among a variety of domestic and international guides to find out what they want.

3.2. Reviewing Existing BIM Guides

The author reviewed 4 domestic and 7 international BIM guides to figure out how much they would be fit to the desirable BIM guide. Table 3 shows the review results of the 11 guides. Five categories to classify the contents of the guides were established as follows: Generals, BIM Definition, BIM Modeling, BIM Usage at Design Stage, and BIM Usage at Construction Stage. The classification was made for convenience to grouping a great amount of descriptions in the guides. The BIM contents were further grouped into 27 sub-categories and named shown in Table 3. The dark rectangular boxes represent whether each guide included the named contents or not.

Four advising workshop subjects were requested to estimate if the 27 items could systematically guide the PO to understand the tasks they are supposed to do in procuring BIM services. Additionally, they were solicited to address if there would be a guide among the elevens that could be used as the one-stop reference the PO subjects described. The subjects pointed out that while some of the guides were relatively more comprehensive than the others, barely could any of them be usable as that type of reference. The subjects apparently indicated that none of the international guides had been used in Korea. The first workshop concluded that a more comprehensive new BIM service guide needed to be promoted.

According to PSU [1], there are three categories where the PO need to focus on when planning BIM service: BIM Team Selection, Contract Procurement, and Project Execution. Within these three categories, four documents are to be prepared including the RFQ, the RFP, BIM Contract Requirements, and Standard BEP Template. The contents of BIM Team Selection need to be addressed in the RFQ and RFP development. Likewise, the category of Contract Procurement is related to BIM Contract Requirements and the category of Project Execution to Standard BEP Template.

The advising subjects described that a new guide should necessarily include the three parts and the 4 documents since these cover the fundamental tasks when the PO procure BIM services. They

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 17 February 2022 doi:10.20944/preprints202202.0210.v1

added that as a matter of course, a few of the categories and documents would be either modified or invented to meet research purpose; however, the items still provide insight about what the PO should concentrate on to be successful in procuring BIM service.

4. The 2nd Workshop: Structure and Contents of the STEW Guide

The second workshop was conducted to configure the STEW guide as the structure and contents of a PO-oriented new BIM guide to be developed. The subjects were firstly asked to advance an opinion concerning the function of the STEW guide. They all had the same view as to the STEW guide pointing out that the guide would be a supplementary guide that provides a direction on which comprehensive and easy to follow BIM guidelines for diverse project types can be developed. As well, they added that as a supplement, the STEW guide needs to be very neat to address key points of BIM service procurement procedures, and not to be a BIM encyclopedia.

4.1. The Structure of the STEW Guide

In order to identify the format of the STEW guide, referring to Figure 2, the following sequential approaches were implemented: (1) figure out the workflows of the tasks that the PO or BIM suppliers will perform in procuring BIM service in parallel with meeting the ASIPA and NCS policies; (2) group the tasks into the sequential processes in procuring BIM service referring to such as scoping, contracting, monitoring, and compensating or the three categories in PSU [1]; (3) distinguish the tasks the PO should facilitate in each of the groups categorized in step (2); (4) among the tasks from step (3), recognize just the tasks that had not been adequately addressed in the existing guides.

Table 3. BIM Design Requirement Frame.

Items Included in the Guides Reviewed	Four Cases in Korea				Seven Cases in BIM Advanced Countries						
	A	B	C	D	E	F	G	H	I	J	K
Generals											
Generals and Specifications		■	■				■				
Summary of Terms and Abbreviations	■	■	■				■				
BIM Definition & Planning											
BIM Execution Objectives	■	■	■	■	■	■					
BIM Execution Entity and Role		■	■		■	■					
BIM Development Procedure Plan			■	■			■				
BIM Management Procedure Plan			■	■			■				
Cooperative Work Plan					■				■		
BIM Data Quality Management Plan	■		■		■		■	■	■		
BIM Hands-on Plan			■	■							
BIM Model Functions and Usage	■						■				
BIM Execution Team Selection					■						
Expenses in BIM Execution			■							■	
BIM Modeling											
BIM Design Process Definition	■		■	■	■	■		■			
BIM Data Management Plan										■	■
BIM Data Classification System		■	■								■
BIM Data Distribution Plan			■	■	■	■	■	■	■	■	■

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 17 February 2022 doi:10.20944/preprints202202.0210.v1

BIM Data Format Definition		■	■		■	■						■		
BIM Usage Software Definition		■	■		■	■					■			
BIM Modeling Plan at Each Process								■	■	■				
Templates Development				■	■									
BIM Usage at Design Stage														
BIM Model Usage Areas		■		■				■	■	■	■	■		
Final Output and Deliverables	■	■	■	■	■					■				
Criteria of Report, Output, and Deliverables Submission		■		■						■				
BIM Usage at Construction Stage														
Objective and Major Work	■													
Bidding Process Definition	■													
BIM Usage in Construction Initiation, Completion, and Approval Stage	■	■						■		■	■			
Output and Deliverables Definition	■									■	■			

* Explanatory Notes
A: Guideline for BIM Applied Design [31]
B: BIM Application Guide for Architecture [5]
C: The Basic Guidance Document of Facility Project BIM Applied Version 2.0 [2]
D: Design Competition Guidelines (Application of BIM Design) [32]
E: BIM Planning Guide for Facility Owners [1]
F: BIM Project Execution Plan [18]
G: National BIM Guide for Owners [19]
H: BIM Requirement [22]
I: BIM Guide Series [20]
J: The VA BIM Guide [33]
K: BIM Guide: CAD Manual [34]

The subjects got to suggest that the sequential processes in step (2) could represent the format of the STEW guide and the instructions to take care of the missed tasks in step 4 would be the main contents of each format component.

The followings explain in detail the identified workflows in step (1):

1. The PO define briefly the desired scope of BIM services in conjunction with the project delivery method to be used in the preliminary project feasibility report.
2. The PO submit the report to the PASC and get an approval.
3. The PO write out in detail their BIM service requirements based on the brief BIM service scope already defined, which is so-called 'Owner Information Requirements (OIR)' in the international BIM industry [19].
4. The PO issue the RFQ and the RFP with the OIR to prospective BIM suppliers.
5. The suppliers prepare a pre-contract BEP in accordance with the OIR.
6. The PO choose a winning supplier who satisfies the RFQ, the RFP, and the OIR and prepare contract documents.
7. The supplier revised a detailed post-contract BEP according to the OIR and submit it to the PO.
8. The PO review the BEP and approve it or notify the supplier in case of any changes required.
9. The supplier proceeds BIM services according to the BEP and the PO perform model quality check as BIM services progress.
10. The supplier delivers the final BIM deliverables to the PO. The PO evaluate and approve them as the final products of the BIM services. Compensation is delivered according to the contract.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 17 February 2022 doi:10.20944/preprints202202.0210.v1

After defining the workflows, the subjects divided the tasks into four stages as follows: a BIM service scoping stage (BSS) - Task 1, 2, and 3; a BIM service tendering stage (BTS) – Tasks 4, 5, and 6; a BIM service executing stage (BES) – Task 7, 8, and 9, and a BIM service warping-up stage (BWS) – Task 10. Figure 4 shows the configuration of the stages.

This result shows the different frame from the three categories described in PSU (2012), providing a comprehensive view to overall BIM service procurement process. The two categories of BIM team Selection and Contract Procurement in PSU [1] obviously belong to the BTS and the category of Project Execution is covered by the BES. While configuring this structure, the subjects discussed a lot about whether distinguishing the BWS from the BES was practical because the BWS could be viewed as a part of the BES, specifically the ending part of the BES, and most of the guides in Table 3 did not specifically describe compensation details for BIM service.

Determining the issue, the subjects considered the fact that the PO should prepare inspection by public auditors regarding what they have done as a public servant. In case of a BIM service contract, the auditors will concentrate not only on suitability of the budget spent for BIM services but also on quality of the services designated in the contract. The inspection is usually taken place at a few year interval after the contract has been over. Once mistakes are found in products through auditing, it is the PO that must be seriously responsible for them. In this sense, it is very significant for the PO to well wrap-up their BIM contract with quality BIM products, i.e., deliverables, as designated in the contract. Therefore, emphasizing necessary activities at the end of the BES is very essential, so that it is very thoughtful to distinguish the BWS from the BES, identify the things that the PO need to keep in mind in the BWS, and present a guide for the PO to well manage them.

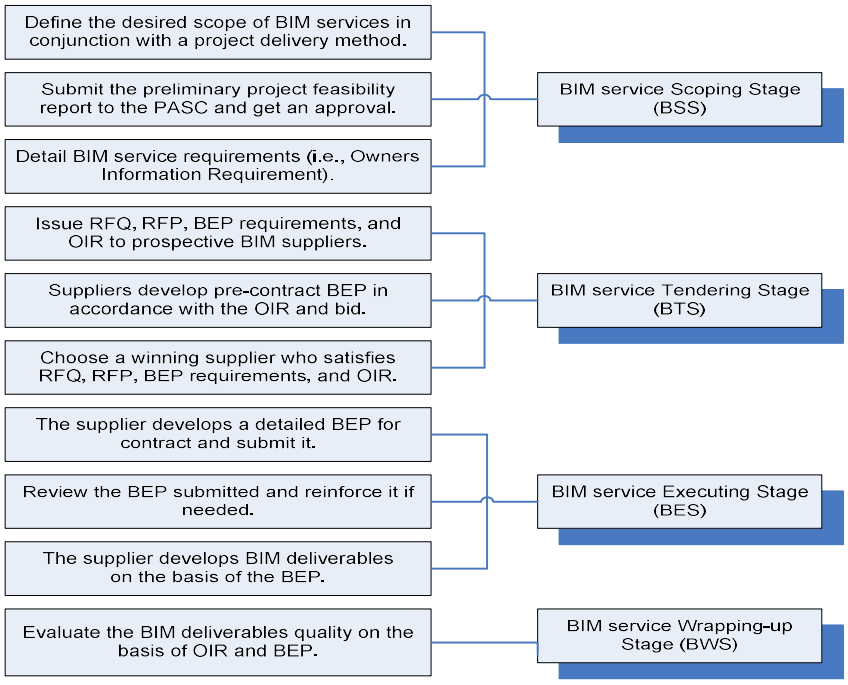

Figure 4. BIM Services Procurement Stages Identified.

Given the four stages above, the workshop members named four guides as follows: a BIM service Scoping Guide (BSG), a BIM service

 doi:10.20944/preprints202202.0210.v1

Tendering Guide (BTG), a BIM service Executing Guide (BEG), and a BIM service Wrapping Guide (BWG). Combined together, being named as the STEW guide, it was expected to provide the PO with insight to understand BIM service procurement procedures as a whole.

The following sections from 4.2. to 4.5 present the summary of the contents of each guide that the workshop subjects considered as necessary to be included. The contents of each stage did not intend to cover all of the relevant items from the existing guides but the instruction-wise necessary substances to address the tasks that had not been adequately lectured in the existing guides.

4.2. The Contents of BIM service Scoping Guide (BSG)

At the beginning of a public project, the PO ascertain their vision and requirements for a building. These are recognized as the Owner's Project Requirements (OPR), defined as the 'Owner's written document of the functional requirements of the facility and the expectations of how it will be used and operated. They include project and design goals, budgets, limitations, schedules [1].' The requirements are then shifted into the design specification of the building for the designer to define the method and limits in planning the building to meet the OPR.

Defining BIM service scope is a part of the OPR. This activity has been stated as the OIR in the NIBS [19] or Employer's Information Requirements (EIR) [35]. While the names are different, both of them have addressed almost the same contents: 'The information that will be required by the owners/employers from both their own internal team and from external suppliers for the development of the project and for the operation of the completed built asset.' The two references point that the OIR/EIR should clearly convey the information requirements for BIM suppliers, depict the expected BIM deliverables in terms of documents, model files, and structured information, and define how and when information should be exchanged among project stakeholders in the project lifecycle.

In defining the BIM scope, the PO need to understand that the nature of the OIR/EIR hinges on not only the complexity of the project but also the experience and requirements of the PO. The experienced PO can develop very comprehensive OIR/EIR while others can only establish high level requirements and some straightforward rules, leaving suppliers to suggest how those requirements will be met. To allow BIM to be used successfully on a project, therefore, the PO need to define minimum BIM requirements based on their experience and knowledge thereby staying in a manageable boundary in the contract with BIM suppliers.

As stated earlier, the PO should submit an official project feasibility document to the PASC when constructing a facility with design fee exceeding $200,000. According to 'the Guide for Preparing the Pre-Review Request on the Planning of Public Architectural Projects,' the PO are asked to turn in the Project Outline such as site conditions, project areas and stories, construction purpose, and project duration, architectural design strategies, budget, design management methods including the project delivery methods, i.e., DBB, DB, TP, except for IPD, and design management organizational hierarchy [36]. Before writing down the project outline, the PO are expected to have already defined the OPR as well as the OIR.

Since the ASIPA's main concern is enhancing design quality of public buildings, the PASC tends to emphasize the project feasibility

from architectural design perspective with little addressing construction. The PO need to focus on design strategies and management methods in conjunction with diverse project delivery methods. Preparing the BIM service scope is quite different from project to project in accordance with the delivery methods. Although BIM can be used with all kinds of delivery methods, benefits from BIM application will become bigger when coupled with the distinctive characteristics of each project delivery method [1]. Depending on the delivery methods, the level of collaboration and financial risks/rewards among project stakeholders are quite different.

4.3. The Contents of BIM service Tendering Guide (BTG)

Getting the document review results from the PASC, the PO will be ready to select the proper supplier for a BIM project. The BTG is to guide the PO to issue the RFQ and the RFP with the OIR to prospective BIM suppliers, choose a winning supplier who is expected to satisfy the OIR by the project delivery method designated, and prepare contract documents. In the market place, while many public and private entities have talked about the BIM RFQ and RFP, there are very few samples of the RFQ and the RFP that the PO can conveniently adopt for their projects.

The RFQ and the RFP should contain adequate BIM language for the PO to select the competent BIM supplier possessing the necessary skills. The RFQ is the first tool the PO are supposed to have for determining the BIM experience of prospective suppliers. When analyzing the submitted RFQ, it is often helpful to use a scoring matrix [1]. Using a matrix supports the PO to organize the proposals into a quantifiable score that can rapidly and easily be ranked. As well, it is significant to demand proof of qualifications because many suppliers in the market place will amplify their expertise so as to win a contract. To filter through overstated qualifications, the PO can require the prospective suppliers to describe how they devise BIM uses, processes, information exchanges, and collaboration procedures and provide examples of BIM projects where they previously implemented BIM applications.

The RFP should be incorporated with the OIR/EIR and prepared in the manner that fair and certain contractual relationship is established by accurately specifying BIM design scopes, design execution procedures, deliverables evaluation methods, and payment options. The RFP can provide the PO with a price and description of the proposed BIM uses to be performed by suppliers. Just like the RFQ scoring matrix, the BIM proposal scoring matrix will provide the PO with the capability to grade the proposals on the basis of the BIM services of greatest importance, and detect deficiencies in proposals before any contract award [1]. To score the proposals precisely, the PO should provide a detailed description of BIM services they expect to procure.

The RFP needs to clearly demonstrate PO′ intention to a contract. There are several contract options developable from PO′ perspective in conjunction with project delivery methods and BIM contract scope. For example, the PO make a contract with the BIM supplier separately from the main architect responsible for the overall project design contract. It will be beneficial for the BTG to include diverse sample RFPs corresponding to the scenarios of the diverse contract formations, on

 doi:10.20944/preprints202202.0210.v1

which the PO can develop their own RFP very fit to their BIM requirements.

In developing the RFP, the PO need to clearly address the step-by-step procedures of pre-contract and post-contract activities. At tender stage, before a contract is agreed, prospective suppliers will develop the BEP, of which requirements have been specified in the RFP and OIR/EIR, with the aim of demonstrating their proposed approach, capability, competence to meet the OIR/EIR. Once a contract has been awarded, the winning supplier should comprehensively further set out how the information requested in the OIR/EIR will be provided. The post-contract BEP document will therefore require far more effort from the supplier [35].

4.4. The Contents of BIM service Executing Guide (BEG)

The BEG was set up to briefly guide the PO about 2-HOWs: how to develop a PO' BEP that is necessarily included in the OIR/EIR and how to monitor a supplier's BEP throughout a BIM service contract. The BEP outlines the overall vision along with BIM implementation details for both the PO and suppliers to follow throughout a BIM contract. In this sense, the BEP should define the scope of BIM execution on the project, identify the process flow for BIM tasks, define the information exchanges between BIM stakeholders, specify the quality deliverables from BIM implementation, and describe the required project and company infrastructure necessary for supporting the implementation [19].

The BEP should be developed in the early stage of a project. In parallel with PO' defining BIM scope, they need to develop their own BEP. In general, it is a four-step approach that is followed when developing a BEP by project owners: identify the appropriate BIM goals and uses, design BIM execution process and information exchange, define BIM deliverables, and identify the supporting infrastructure to successfully implement the BEP. While this approach looks simple, it provides an adequate skeleton for developing a BEP.

The BEP by the PO will be included in the OIR/EIR as a part of the RFP in a BIM tender process [1]. The OIR/EIR in general specifies high-level BIM requirements for a project while leaving project specific requirements such as processes, individual responsibilities, and collaboration procedures to the supplier-proposed BEP. At tender stage, prospective BIM suppliers will exploit their BEP for showing proposed approach to satisfy the OIR/EIR. Once the contract has been awarded, the winning supplier then submits a advanced BEP to confirm the supply chain's capacities [35]. Since the BIM contract necessary involves a BEP, it is beneficial for the PO to have the BEP templates which not only inform the potential BIM suppliers of the BIM expectation from the PO but lesson their time and effort to foster the BEP requirements of each project [19].

At the end of tender stage, as the project specific BEP is established in collaboration of the PO with the supplier, the BEP will be included into the contract document so that communication procedures and collaboration processes among the architectural, electrical, mechanical, and civil BIM suppliers can be clear thereby manifestly understanding individual responsibility for BIM modeling, level of development, and deliverables. The PO should require the supplier to review and coordinate the BEP with entire BIM project team prior submitting to

 doi:10.20944/preprints202202.0210.v1

them for final approval. The BEP needs to be considered as an alive document that progresses throughout the project [1, 19, 23].

Utilizing lists of exactly what information or deliverables are required by whom at certain stages is very beneficial for both the PO and suppliers in communicating and collaborating each other. Around the inception of most BIM projects, the PO are unlikely know much to generate a full list of BIM modeling information and deliverables when they choose a supplier. This implies that the lists are likely to be fostered over time with input from the right personnel at the right time. Table 4 presents an example of the BEP development guide. The PO can use this list to plan and produce a BEP for each project and an on-going checklist as BIM contract proceeds.

4.5. The Contents of BIM service Wrapping-up Guide (BWG)

The BWG was established to guide the PO regarding BIM deliverables. As the supplier have implemented BIM service according to the BEP, the BIM deliverables as planned are delivered to the PO gradually. The PO should perform quality verification of the outputs at the stages notified in the BEP, offer guidelines to come up with the desired quality at each stage, and provide timely payment for the suppliers on the basis of the verification results. The PO should make sure that the BEP clearly defines the deliverables that are to be transmitted to them at each stage of a BIM service contract. The deliverables should be compensated for the payment to be processed at each stage. Requiring a deliverable is not adequate. The PO should specify the level of development, quality desired, and the format desired. The BWG needs to include the guides on which the PO can understand and prepare these tasks.

There are many types of deliverables from BIM service such as design intent model, construction model, as-built model, record model, operations and maintenance data, and so on [19, 38]. Record models represent BIM models regarding the facility elements, surrounding conditions, and assets of a facility. The record models contain information relating to the architectural, structural, and MEP systems. The PO need to obviously understand that the deliverables to be transmitted to them must be different in accordance with the project delivery method implemented. “Define BIM Deliverables at Each Design Stage” in Table 4 illustrates the prospective design deliverables from a design BIM supplier under the DBB scheme. In case of a DB or a TP mechanism, in addition to the design intend model, construction model, as-built model, and record model will be included. Therefore, the PO have to comprehend the difference of the deliverables and differentiate them in conjunction with the project scope and delivery methods.

As stated above, using lists of the deliverables provide the PO or their representatives with the means to check if they have received the deliverables they plan. Table 4 demonstrates the example of deliverables. If the BWG provides various sample tables of the deliverables at each stage of a BIM contract, the PO can more conveniently develop their own scheme with confidence. Providing the deliverables in compliance with the stages described in the BEP, a supplier should submit a written report confirming that consistency checks have been completed. The BWG needs to provide instructions on checking for consistency of BIM modeling results including clash

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 17 February 2022 doi:10.20944/preprints202202.0210.v1

check at each stage, comparison check for the modified BIM model after clash check, and so on.

As well, the BWG needs to address that the deliverables and their deadlines are better to be aligned with project milestones, e.g., schematic design, detailed design, construction documents, bid/procure, contract, notice to proceed, construction, substantial completion, commissioning, final inspection, occupancy/operations and maintenance, and warranty review [19]. In general, the payment for certain services in public entities are likely to be implemented at the milestone schedules.

1. Discussion

To enhance practicality of the STEW guide, the author presented the STEW guide twice in the seminars, which had been operated to share research findings from the AUDRP funded by the MOLIT. In the seminars, the author explained the needs for a new BIM guide, the STEW guide development methodology, and the STEW guide development results. The experts participating in the seminars consisted of the diverse BIM-interested from private BIM companies, contractors, sub-contractors, central and local governments, and policy makers. While there were diverse issues discussed, the followings summarize the main discussions in the seminars:

1. Several personnel argued the difference between guidelines and guides. The final consensus of the argument was that while guides were likely to be instructions, state of the art trends and procedures, and advices based on principles, social or human behavior and thought, experience, and history, to solve specific issues or identify approaches or directions to anything interested in, guidelines were boundaries or rules that need to be followed in doing something. Based on the consensus, it could be said that a guide for a BIM service procurement is an archive usable to develop a guideline for procuring a specific BIM project.
2. The majority of participants from public institutions criticized that the STEW guide did not address how to define the minimum BIM requirements in conjunction with diverse project delivery methods although it was significant issue at the very early stage of a BIM service project. They pointed that the templates providing the formats of combining the project delivery methods with minimum BIM requirements at each project implementation stage would be very helpful and useful for the PO, especially BIM-unsophisticated PO, to settle their BIM scope in a project.

Table 4. An Example of BIM Execution Plan Development Checklist (Modified from [34]).

Contents	Project Milestone			
	Pre Tender Stage	**Contract Stage**	**Detailed Design Stage**	**Submittal Stage**
Define BIM Requirements				
Define BIM Deliverables at Each Design Stage				
Inception Stage BIM delivarables				
Feasibility & Planning Stage BIM Deliverables				
Conceptual Design Stage BIM Deliverables				
Detailed Design Stage BIM Deliverables				
Submission to Approving Authority Stage				
Construction Stage BIM Deliverables				
As-Built Stage BIM Deliverables				
Specify LOD of BIM Deliverables				
Define Responsibility Matrix for Every Discipline				

 doi:10.20944/preprints202202.0210.v1

Specify BIM Team Resources and Competency
Specify BIM Deliverables Schedule
Define BIM Process
Discipline Modeling
Revision Management
Collaboration & Modeling Sharing
Coordination & Clash Detection
Drawing Production
Approval of BIM Submissions
Model Archive
Quality Control
Specify BIM Procedsures
Model Origin & Orientation
Model Division
Building Levels
Model Units
File Naming Convention
Folder Structures
Specify Hardware & Software
Software Version
Model & Data Exchange Rormats
Data Security & Back-up
Hardware Requirements

1. Many participants mentioned that the STEW guide would be useful as a teaching guide to educate both private personnel who are not much familiar with the public project procurement process and public agencies who do not understand much about the BIM service.
2. Most of the participants agreed that no matter what types of guides were developed, they could not be better than standardization. As a matter of course, BIM service in the private business area is not the subject of standardization. However, in the public business area, the certain level of standardization in BIM service contents such as the deliverables at each project milestone and the BEP template is desirable to confirm quality of public products and maintain market progress.

1. Conclusion

In Korea, from 2012, BIM application to the public construction projects worth more than $40 million was mandated. Other national policy changes, i.e., ASIPA and NCS, have led BIM to be a kind of "must" in the construction industry. In parallel with these trends, the role of the PO has been significantly stressed. The PO have been expected to be a central BIM player from the planning stage of the construction projects.

When procuring BIM service, the PO refer to diverse domestic or very rarely international BIM guides. Many PO, however, have insisted that the existing guides involve deficiencies in delivering their needs for procuring BIM service. They have emphasized that it is necessary to develop a more PO-oriented BIM guide that goes along the public business procedures, address the ways to release the requirements from the policies changes, and usable as a one-stop reference for the PO to develop appropriate guidelines fit to their specific BIM service contracts.

This research aimed at suggesting the BIM service Scoping, Tendering, Executing, and Wrapping-up (STEW) guide as the structure and contents guidance of a new PO-oriented BIM guide to be developed. Research methodology of the study consisted of three activities: reviewing the existing body of knowledge on diverse BIM guides, identifying PO' opinion on the guides, and developing the STEW guide.

Workshops with a focused group interview format were conducted twice to meet the research objective. Twelve workshop subjects were invited: 8 from public institutions; 2 from international BIM design firms; and another 2 from the public research institutions. In the first workshop, they defined the desirable BIM guide that could satisfy PO' need for a new guide. The subjects then reviewed the existing guides to figure out whether the guides could meet the desirable BIM guide contents. The review results addressed yes or no as to the need for a new guide. In the second workshop, based on the results of the first workshop, the subjects were solicited to identify the STEW guide as the structure and contents guidance of a PO-oriented new BIM guide to be developed.

While it is expected that the STEW guide can provide the PO with insight on which they can develop a comprehensive BIM guide meeting their taste, to enhance the comprehensiveness of the STEW guide, the author presented twice the STEW guide in the AUDRP seminars. Through the discussion and critique in the seminars, improvement needs for the STEW guide were identified and reflected to wrap up the STEW guide. Standardization of BIM service contents such as the deliverables and the BEP template was discussed in depth as a methodology to release PO' stress from BIM application, confirm quality of public BIM products, and maintain market progress.

Acknowledgements: This study was supported by the Research Program funded by the SeoulTech (Seoul National University of Science and Technology), Korea.

Abbreviations: The following abbreviations are used in this manuscript:

BIM	Building Information Modeling
ASIPA	Architectural Service Industry Promotion Act
NCS	National Competency Standards
PO	Public Owners
MOLIT	Ministry of Land, Infrastructure and Transport, Korea
CIFBG	Construction Industry Fundamental BIM Guideline
PASC	Public Architectural Support Center
DBB	Design-Bid-Build
DB	Design-Build
CM	Construction Management
IPD	Integrated Project Delivery
AUDRP	Architecture & Urban Development Research Program
RFQ	Request for Qualifications
RFP	Request for Proposals
BEP	BIM Execution Plan
KLHC	Korean Land & Housing Corporation
PPS	Public Procurement Service, Korea
USACE	Corps of Engineers, USA
NIBS	National Institute of Building Sciences
KICT	Korea Institute of Construction Technology, Korea
KEDI	Korea Educational Development Institute, Korea

OIR	Owner Information Requirements
BSS	BIM service Scoping Stage
BTS	BIM service Tendering Stage
BES	BIM service Executing Stage
BWS	BIM service Warping-up Stage
OPR	Owner's Project Requirements
EIR	Employer's Information Requirements
BSG	BIM service Scoping Guide
BTG	BIM service Tendering Guide
BEG	BIM service Executing Guide
BWG	BIM service Wrapping-up Guide

References

1. The Computer Integrated Construction (CIC) Research Program. *BIM Planning Guide for Facility Owners, Version 1.01,* Department of Architectural Engineering, the Pennsylvania State University (PSU), Pennsylvania, USA, **2012**.
2. Public Procurement Service (PPS). *The Basic Guidance Document of Facility Project BIM Applied Version 2.0* Public Procurement Service, Seoul, Korea, **2010-2019**.
3. Ministry of Land, Infrastructure and Transport (MOLIT). *Architectural Service Promotion Act*, Ministry of Land, Infrastructure and Transport, Seoul, Korea, **2014**.
4. Ministry of Employment and Labor (MEL). *National Competency Standard (NCS),* Ministry of Employment and Labor, Seoul, Korea**, 2014**.
5. Ministry of Land, Transport and Maritime Affairs (MOLTM). *BIM Application Guide for Architecture*, Ministry of Land, Transport and Maritime Affairs, Seoul, Korea, **2010.**
6. Lim, M. S. Reasons why BIM is Competitive in Korea, Editorial, Korean Specialty Construction Business Newspaper, December 28, **2020.**
7. Kim, M. W. and Ock, J. H. Development of a Project Design Stage BIM Guide for Project Owners, *Transactions of the Society of CAD/CAM Engineers,* ***2015,*** 3, *271-280.*
8. Ministry of Land, Infrastructure and Transport (MOLIT). *Construction Industry Fundamental BIM Guideline,* Ministry of Land, Infrastructure and Transport, Seoul, Korea, **2020**.
9. Park, M. Y. and Koh, I. L. Study on the Improvement of Architectural Curriculum and BIM Curriculum in Accordance with the NCS System, *Proceedings of Architectural Institute of Korea (AIK), Spring*, **2016**, 64, 39-40.
10. Seo, J. C. and Kim, I. H. A Study on the Current Guideline Trends and Strategic Directions for Developing Open BIM Guideline, *Korean Journal of Construction Engineering and Management*, **2009,** 4, 58-66.
11. Kim, B. K., and Kim, K. C. A Study on the Level of Information Which Integrated Design Process for BIM Application - Focus on the Level of Information in Finland and Denmark BIM Guideline, *Journal of the Architectural Institute of Korea***, 2009,** 1, 317-321.
12. Kwon, O. C., and Jo, C. W. The Proposal of BIM Quality Management Standard by Analyzing Domestic and International BIM Guides, *Journal of the Korea Institute of Building Construction*, **2011**, 3, 265-275.
13. Seong, J. H., and Kim, G. C. A Study on the Development of BIM Guideline, *Journal of KIBIM,* **2011**, 2, 1-5.
14. Kim, J. H., Kim, Y. J., Kim, S. A., and Chin, S. Y. Proposal of BIM Guideline development direction by analyzing domestic and foreign BIM based delivery guides, *Korean Journal of Construction Engineering and Management,* **2011**, 3, 101-102.
15. Choi, S. Y., Kim, J. H., and Kim, J. J. A Basic Study on the Guideline for Applying of BIM (Building Information Modeling) to Pre-Design Stage, *Korean Journal of Construction Engineering and Management,* **2011,** 4, 219-220.
16. Choo, S. Y., Lee, K. H., and Park, S. K. A Study on LOD (Level of Development) for Development of Green BIM Guidelines - Focused on Energy Performance Estimation, *Journal of the Architectural Institute of Korea: Planning & Design*, **2012**, 6, 37-47.
17. Korean Land & Housing Corporation (KLHC), *The KLHC BIM Usage Guide,* Korean Land & Housing Corporation (KLHC), Seoul, Korea, **2018.**
18. United States Army of Corps. of Engineer (USACE). *BIM Project Execution Plan*, USACE, USA, **2012.**
19. National Institute of Building Science (NIBS). *National BIM Guide for Owners*, NIBS, Washington D.C., USA, **2017**.
20. General Services Administration (GSA). *BIM Guide Series,* GSA, Washington D.C., USA, **2006.**
21. The Computer Integrated Construction (CIC) Research Program. *BIM Project Execution Planning Guide, Version 2.0,* Department of Architectural Engineering, The Pennsylvania State University (PSU), Pennsylvania, USA, **2016**.
22. Senate Properties. *BIM Requirement 2007*, Senate Properties, Helsinki, Finland, 2007.

 doi:10.20944/preprints202202.0210.v1

23. Industry Alliance for Interoperability (IAI). *BIM/IFC User Guide*, IAI, Germany, 2006.
24. AEC (United Kingdom). *AEC(UK) BIM Standard*, AEC (UK), UK, 2014.
25. Statsbygg. *Statsbygg BIM Manual 1.2.1,* Statsbygg, Norway, 2013.
26. AEC (Can). BIM Protocol, AEC (Can), Canada, 2012
27. Building and Construction Productivity Partnership. *New Zealand BIM Handbook*, Building and Construction Productivity Partnership, New Zealand 2014.
28. HKIBIM. *CIC Building Information Modeling Standards Draft 5.0*, HKIBIM, Hong-Kong, 2014.
29. http://www.agenziademanio.it/export/sites/demanio/download/documentigare/181205_DRV_-Capitolato-Technico-Processo-BIM-Corporate.pdf, 2019.
30. Kim, J. P. *A Study on issues and Effective measures for apply Building Information Modeling in Domestic Construction Industry*, Yong-Nam University, Daegu, Korea, 2012.
31. Virtual Construction Research Group. *BIM Application Design Guidelines*, Virtual Construction Research Group, Korea, 2010.
32. Korea Land and Housing Corporation, (2010). "Design Competition Guidelines (Application of BIM Design)." KLHC, Korea, 2010.
33. Department of Veterans Affairs (DVA). *The VA BIM Guide*, Department of Veterans Affairs, USA, 2010.
34. Bips. *BIM Guide: CAD Manual*, Bips, Denmark, 2013.
35. British Institute of Facility Management. *Employer's Information Requirements (EIR) Template and Guidance - Facilities Management and Client Operating Requirements in the BIM Process*, BIFM, London, UK, 2017.
36. The Public Architectural Support Center (PASC). *The Guide for Preparing the Pre-Review Request on the Planning of Public Architectural Projects,* PASC, Seoul, Korea, 2014.
37. Building and Construction Authority. *BIM Essential Guide for BIM Execution Plan*, Building and Construction Authority, Singapore, 2013.
38. Stanford University. *Building Information Modeling (BIM) Project Delivery Standards (PDS),* Stanford University, USA, 2017.