e-submission common guidelines for introduce BIM to building process

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WG1 e-submission guideline

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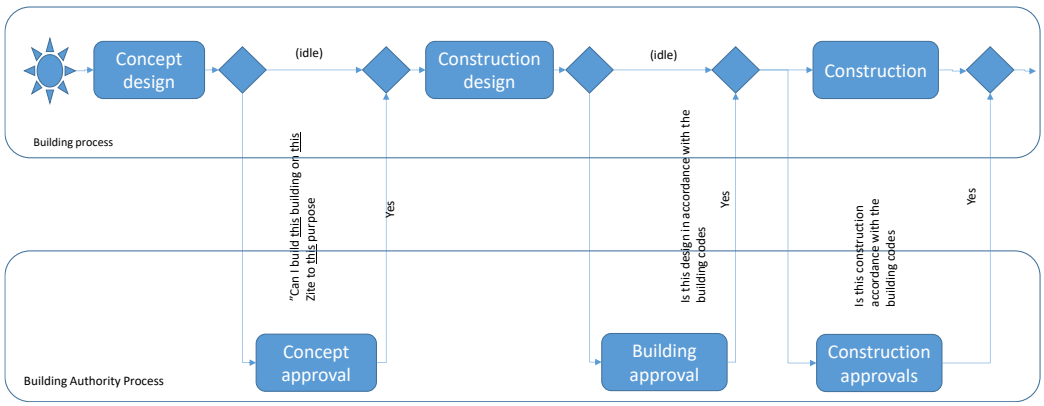

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Executive Summary

In buildingSMART International's four summits in Barcelona, London, Paris and Tokyo, Regulatory Room had these days' successful "BIM in planning and building permit processes seminar" and working group meetings. We had presentation from Building Authorities or Government Regulatory Agencies in many countries about what they have done so far, and what they think about BIM in regulatory processes in the future. It was reported that many more have recognized BIM and the AEC industry's rapidly movement against more use of ICT tools in their processes.

The conclusion from the meetings was that there is a need for common understandings were Government Regulatory Agencies together with the software industry and academia, can meet and share information, ideas and experiences and solve common issues together in the field of BIM in Regulatory processes.

This guideline evaluates use case reports that introduce BIM in the process of building bSI RR meetings so far, and clarifies the development goals and key technologies typically required to implement BIM in the building regulatory process. To do so, define a common understanding of maturity and level of development on the following topics:

- Approval step for Building Regulatory process
- BIM Institutionalization stages
- Level of Maturity and Development of BIM e-submission

Contributors

Thanks are recorded to many participants as this report is the result of the vision of attendees of the buildingSMART Standards Summit Regulatory Room in Barcelona, London, Paris and Tokyo, and the subsequent inputs from:

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1. Common understanding of approval stage, evaluation of common BIM Institutionalization stages and its key technology.

1.1 3 steps approvals: Concept, Building/Design and Construction approvals

In considering digitization of administrative procedures such as building permission and building confirmation, it is necessary to understand that the positioning of the procedures in each country in the building production process is different. There are three stages that roughly divided into the construction permission or the procedure of building confirmation. When considering common guidelines, it is necessary to consider these differences. (Fig. 1)

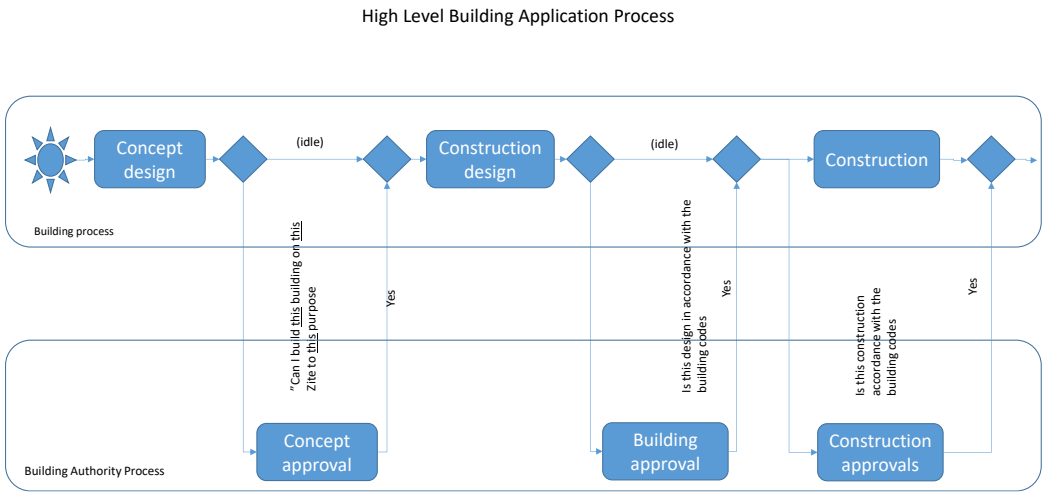


Fig. 1 Procedure of building permission and building confirmation

For example, in European countries and the United States, the administration emphasizes the examination of the basic design that approves the concept. On the other hand, in Asian countries such as Singapore, China, Korea and Japan, the administration emphasizes the detailed design and the inspection of the completion inspection for building approval as design approval.

The difference in the approval stage involving the administration is the difference in the building regulations that each country thinks and the guidelines do not ask for any difference.
However, as the stage of approval becomes higher, it is necessary to raise the degree of detail of the information to be subjected to the examination, so its difficulty level is expected to increase. (Fig. 2)

Figure 20 – Levels of model definition for building and infrastructure projects

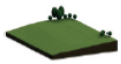
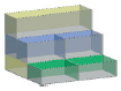
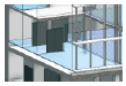
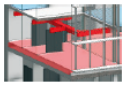
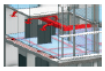
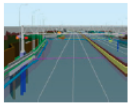
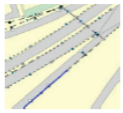
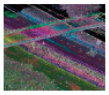
Stage number Model name	1 Brief	2 Concept	3 Definition	4 Design	5 Build and commission	6 Handover and closeout	7 Operation
Systems to be covered	N/A	All	All	All	All	All	All
Graphical illustration (building project)							
Graphical illustration (infrastructure project)							
What the model can be relied upon for	Model information communicating the brief, performance requirements, performance benchmarks and site constraints	Models which communicate the initial response to the brief, aesthetic intent and outline performance requirements. The model can be used for early design development, analysis and co-ordination. Model content is not fixed and may be subject to further design development. The model can be used for co-ordination, sequencing and estimating purposes	A dimensionally correct and co-ordinated model which communicates the response to the brief, aesthetic intent and some performance information that can be used for analysis, design development and early contractor engagement. The model can be used for co-ordination, sequencing and estimating purposes including the agreement of a first stage target price	A dimensionally correct and co-ordinated model that can be used to verify compliance with regulatory requirements. The model can be used as the start point for the incorporation of specialist contractor design models and can include information that can be used for fabrication, co-ordination, sequencing and estimating purposes, including the agreement of a target price/ guaranteed maximum price	An accurate model of the asset before and during construction incorporating co-ordinated specialist sub-contract design models and associated model attributes. The model can be used for sequencing of installation and capture of as-installed information	An accurate record of the asset as a constructed at handover, including all information required for operation and maintenance	An updated record of the asset at a fixed point in time incorporating any major changes made since handover, including performance and condition data and all information required for operation and maintenance The full content will be available in the yet to be published PAS 1192-3

Fig. 2 Levels of model definition (a part of Fig.20, BS PAS 1192-2: 2013)

According to the level of model definition (Fig.2), "Concept model" will be prepared at the concept approval stage, "Design model" will be prepared at the building approval stage, and "Handover and closeout model" will be prepared at the construction approval stage. The building regulatory body confirms the legal suitability of the building model to be built or the building as built on each contract stage, and according to the confirmation result, regulation or approval will be given to the building project. (Fig. 3)

Figure 7 – The whole supply chain contributes information to answer the Plain Language Questions

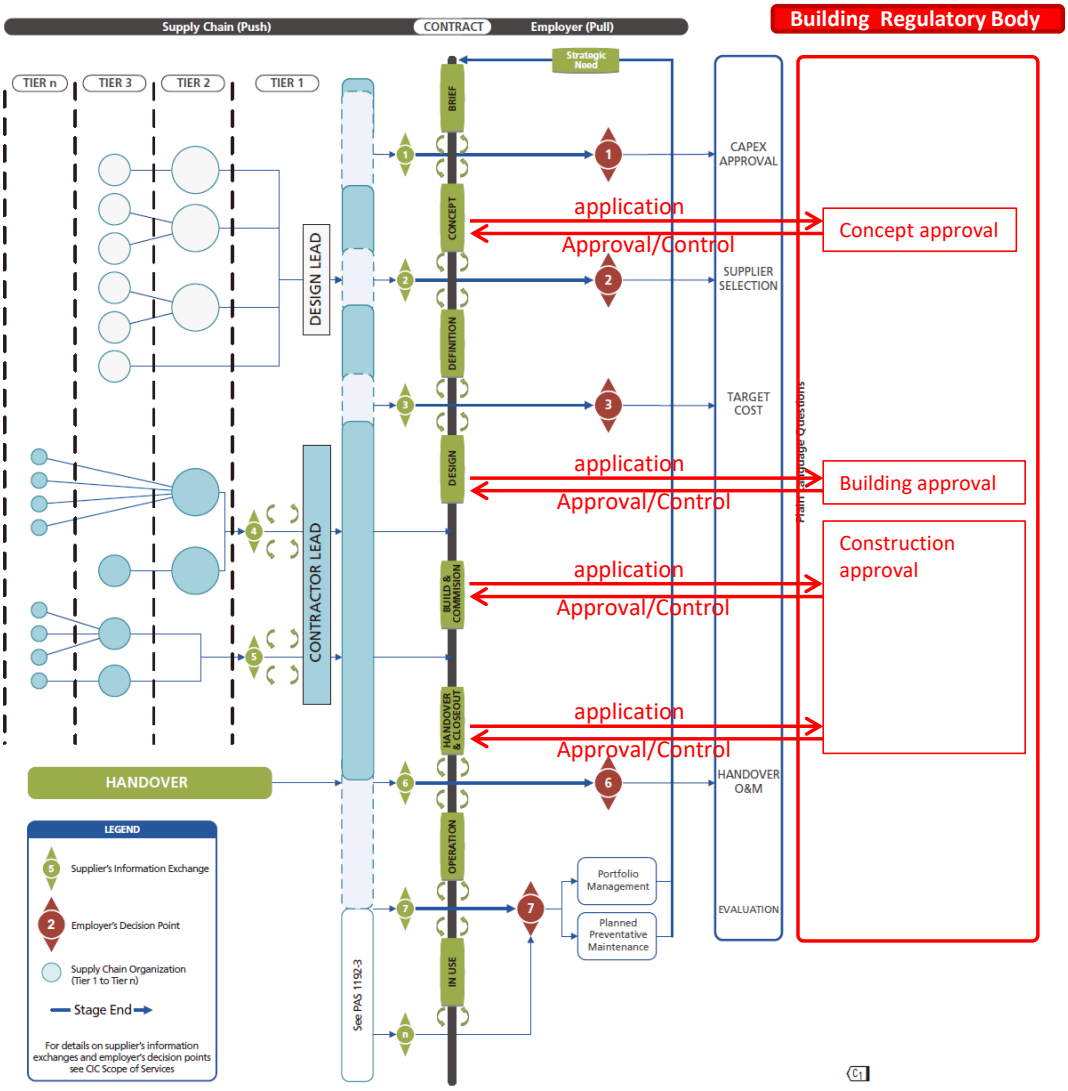


Fig. 3 Positioning of 3 step approvals on information provision for whole supply chain (added articles to Fig.7, BS PAS 1192-2: 2013)

The building regulatory process has the purpose of controlling whether the building is legally designed, constructed and used safely. It goes without saying that it is important to check whether the planed or designed buildings are legally suitable or not, and check whether the buildings are constructed according to the building approval. But more to the point, these checks are recorded as to what procedure and when it was done, and to archive the materials as evidence of these procedures.

Under the e-submission, data that is insubstantial like the paper document of the application document is exchanged between the applicant and the building regulatory body. Therefore, electronic signature (e-signature) technology is used for a method to ensure the authenticity and completeness of the applied data. Regarding the archive of information, in order to ensure the authenticity and integrity of the applied data during the retention period, an archive format that does not permit change of its contents and a long-term signature technology to make it possible to confirm the electronic signature at the time of e-submission can be applied. For maintaining readability of archives, open format documents are strongly recommended. (Fig.4)

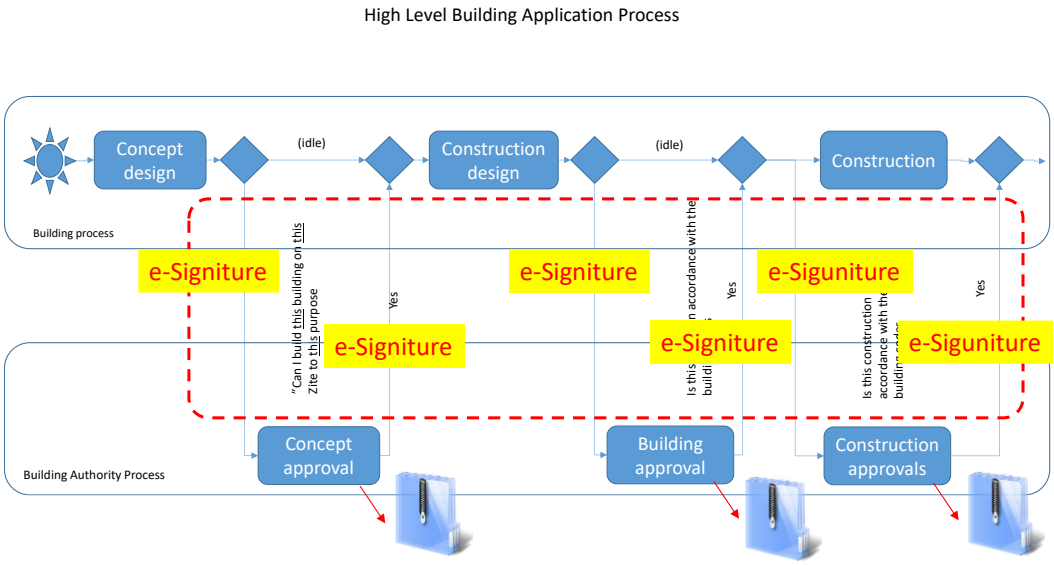


Fig. 4 e-signature and archive in data exchange between applicant and building regulatory body

BS PAS 1192-2 specified data information management for the capital/delivery phase of construction projects using building information modeling, and the common data environment (CDE) is introduced as a model of data management sequence for designer and contractor side. In order to ensure continuity with the building regulation process, it should be extended to the range of application of CDE for the building regulatory body side. (Fig. 5)

Figure 15 – Extending the common data environment (CDE)

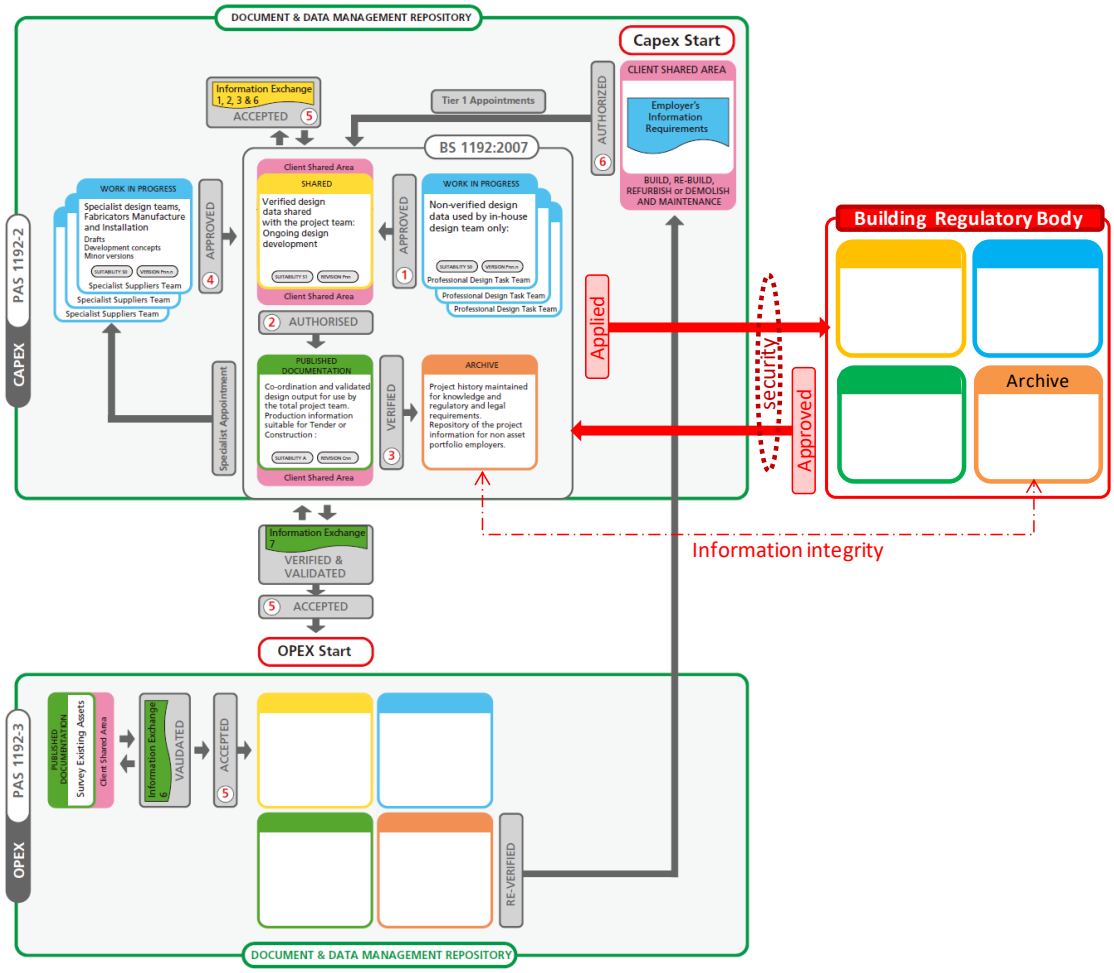


Fig. 5 Further extending the common data environment for building regulatory process (added articles to Fig.15, BS PAS 1192-2: 2013)

1.2 Evaluation of common BIM Institutionalization stages from use cases

bSI Regulatory Room (bSI-RR) started activities from the Toronto Summit in 2014 and has investigated the use cases of building administrative procedures by BIM in member countries. In addition, as a Government Session, we hold seminars to invite government agencies in the venue and gather wide knowledge on the efforts of administrative agencies in each country.
Through such activities, bSI-RR were able to find commonality in the process of applying BIM to building administrative procedures. That is 5 stages as follows;

a) Establish e-submission platform
b) Initiation of BIM to paperless process as trial

c) Adaptation of guideline of preparing BIM model for submission
d) Step by step mandatory e-submission
e) Seeking further efficiency

Even in countries where BIM electronic applications are progressing, it is said that the introduction process was exceeded though one-by-one small steps. One of the reasons for this is that it is difficult to select technologies that can be used by these entities, while a wide variety of entities constitute the value chain in the building production process. (Fig.6)

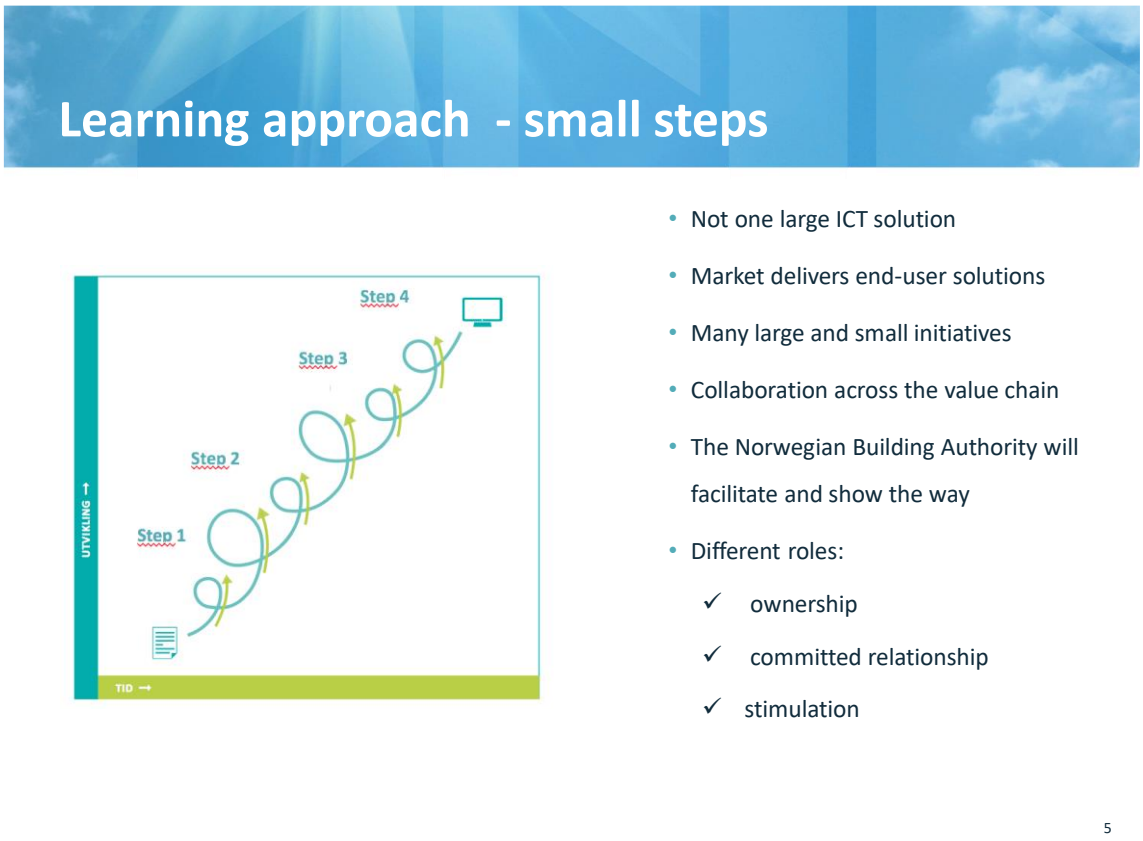


Fig. 6 Learning small step approach by Norway Building Authority

a) Establish e-submission platform

This stage is the first step to prepare the e-submission environment and to become accustomed to the electronic procedures by building regulatory body. Here, the information exchanging method between the applicant and the building regulatory body and the information processing process from accept to archive are defined. Before BIM was put into practical use, there are many countries that develop electronic application base, and bSI-RR acknowledge the situation of the following countries;

Singapore : CORENET (2000-)/ePlancheck (2004-)
Norway : ByggSøk (2003-)
Finland : Tekra-GIS, Lupapiste.fi (2012? -)
Korea : SEUMTER (2002? -)
Japan : for small wooden houses (2015-)

In early adopted countries of e-submission, it is treated e-documents in csv, xml, tiff or pdf format and the like and communication data accompanying them. Such file formats have a long history of use and readability is secured. Also, there is no problem with the application of e-signature. In some countries that adopt e-submission in recent years, there are countries that allow handling of multimedia formats such as voice and move file as well as documents and image data as a response to new information technology. (e.g. Lupapisute.fi) Building regulatory body that newly constructs an e-submission platform conforming to the practical application of BIM are also there. (Fig. 7, 8, 9)

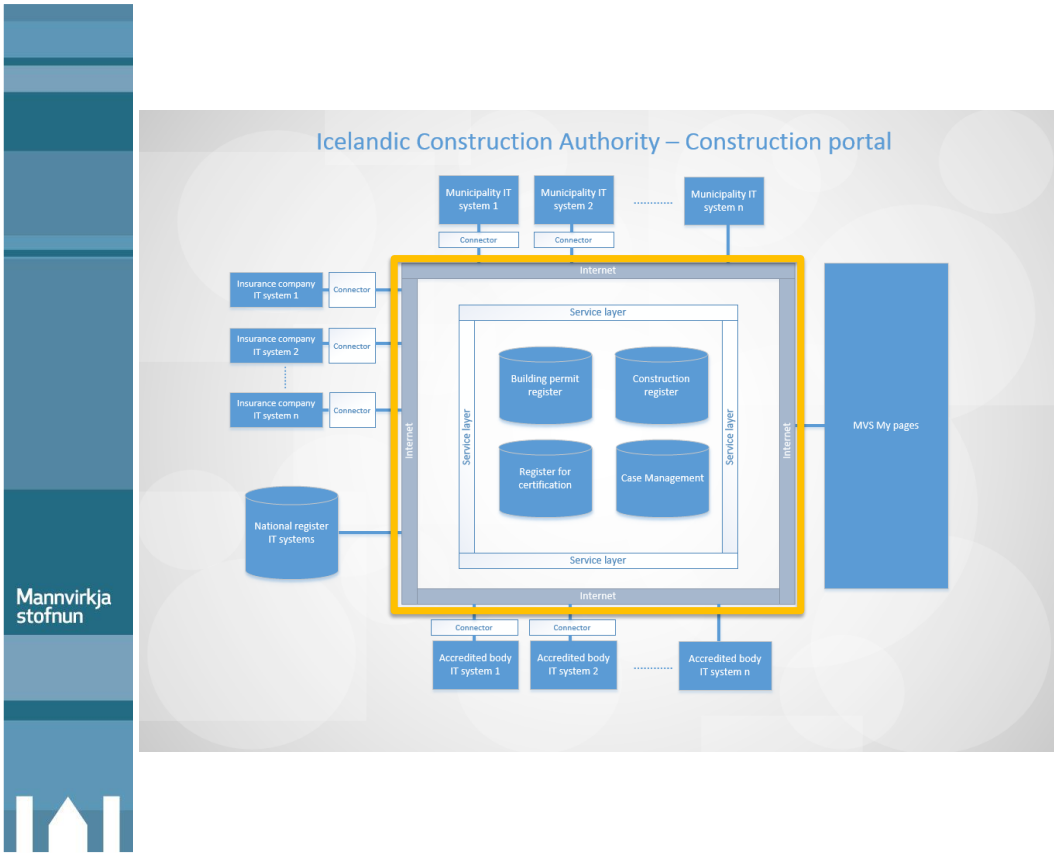


Fig. 7 case of Iceland

Govermental mandate

Boverket

- Digital first
- Prerequisite for digital detalied development plan

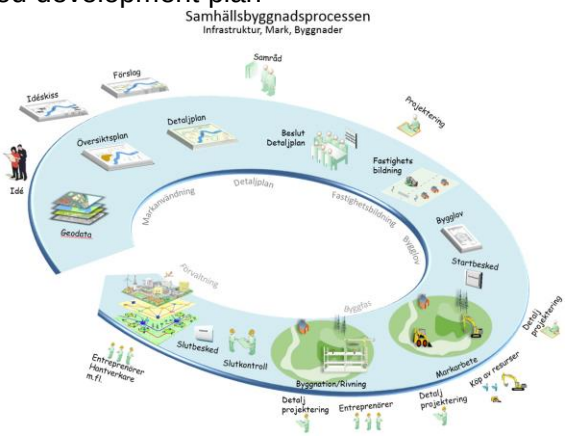


Fig. 8 case of Sweden

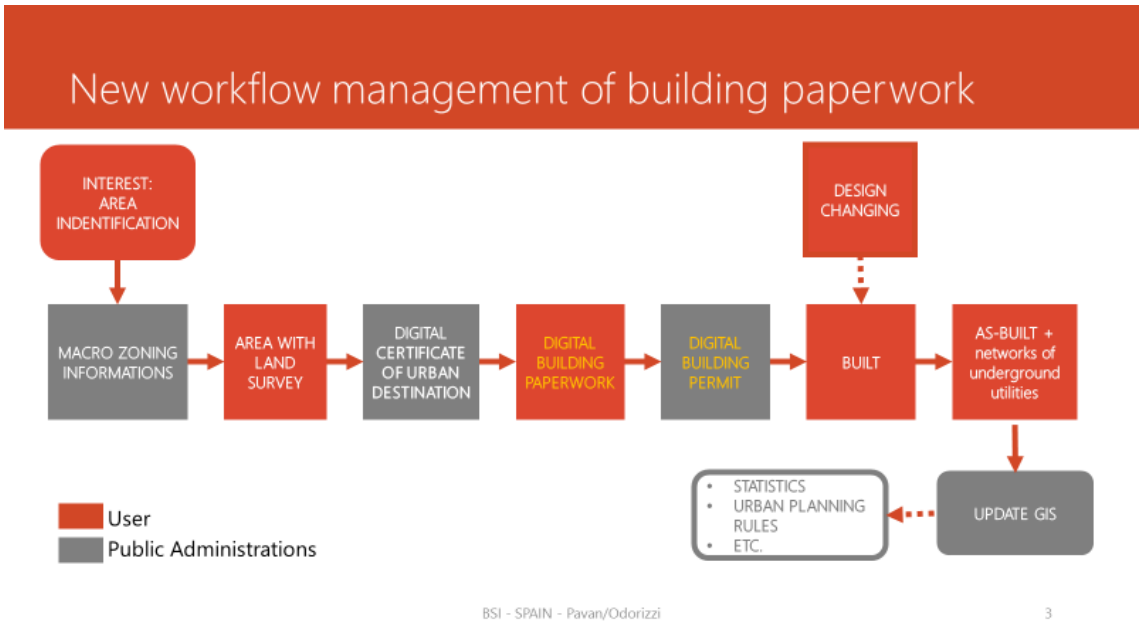


Fig. 9 case of Milan, Italy

b) Initiation of BIM to paperless process as trial

When BIM becomes commonly used, the applicant begins requesting the reviewer to approve the electronic application by the BIM model file. A major reason for requesting BIM e-submission is that it is necessary to perform work for building regulatory procedures in parallel. On the other hand, the judges will not admit it by giving technical reasons such as reliability in many cases. (Fig. 10)

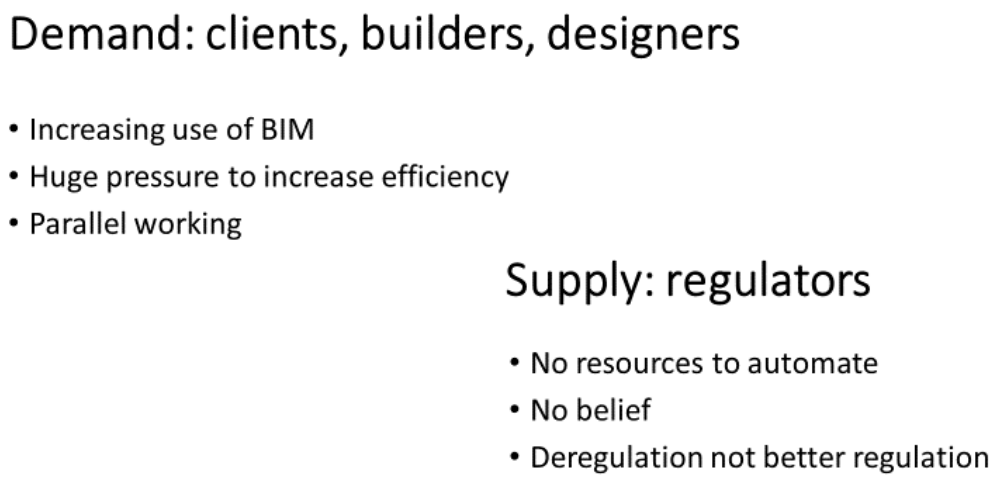


Fig. 10 Difference in consciousness of BIM between applicant and regulators

In order for BIM e-submission to proceed, it is necessary for building regulatory body's juries to recognize the effect of using BIM. In other words, when executing BIM e-submission as a trial, it is important to clarify what building regulatory body expects from using BIM. It can be said that building regulatory body's expectation is similar to the expectation that BIM has been introduced in the process of being introduced. For example, the functionality of Visualization helps to understand details that are difficult to understand in 2D drawings. Various drawings drawn by using BIM authoring software that is an integrated design environment are highly consistent between themselves. Even if it does not actively use the properties of IFC, the building regulatory body's benefits are great. Such expectations are summarized as shown in the table. (Table 1)

Table 1 building regulatory body's expectation in BIM e-submission

Level of Development	Conformation body expects…	Work object	IFC expression of legal issue
1 <Manual checking w/o IFC>	a. Compatibility among application forms and drawing. b. to recognize complicated shape easily by 3D view	a. 2D drawing issued from BIM model b. 3D view of BIM model	(n/a)
2 <Manual checking w/ IFC>	to find lack of expression legally needed on application docs.	2D drawing and Model Data	Indication of legal objects
3<Hybrid> 3+<ACC>	to check building codes semi/full automatically. a. Number of targets b. Numerical value of targets c. Spatial / Geometrical relation of targets d. Simulation / Analysis	<Hybrid> 2D drawing and Model Data <ACC> Model Data	Value of legal objects a. Object Type b. Numerical Value c. Code checking Rule d. Exporting to external program

This stage is the stage where the judge side tries BIM e-submission within the scope of the current procedure or limited case. A typical example is to attach a BIM model file with a conventional application file and check 3Dview. In addition, by introducing the BIM process to the pre-check, there is a method of trying out the effect of BIM without changing the conventional submission procedure.

The next two examples are examples in which the BIM model file was submitted at the pre-check phase. The first case in Japan as examples in which drawing is expected to be consistent under BIM environment and applicate drawings is submitted as BIM model file. By submitting the BIM model file in the state immediately before drawing output to the regulatory body and outputting it on the agency side instead of submitting the individually outputted PDF drawing in the conventional procedure, consistency of the outputted drawing is maintained. (Fig. 11)

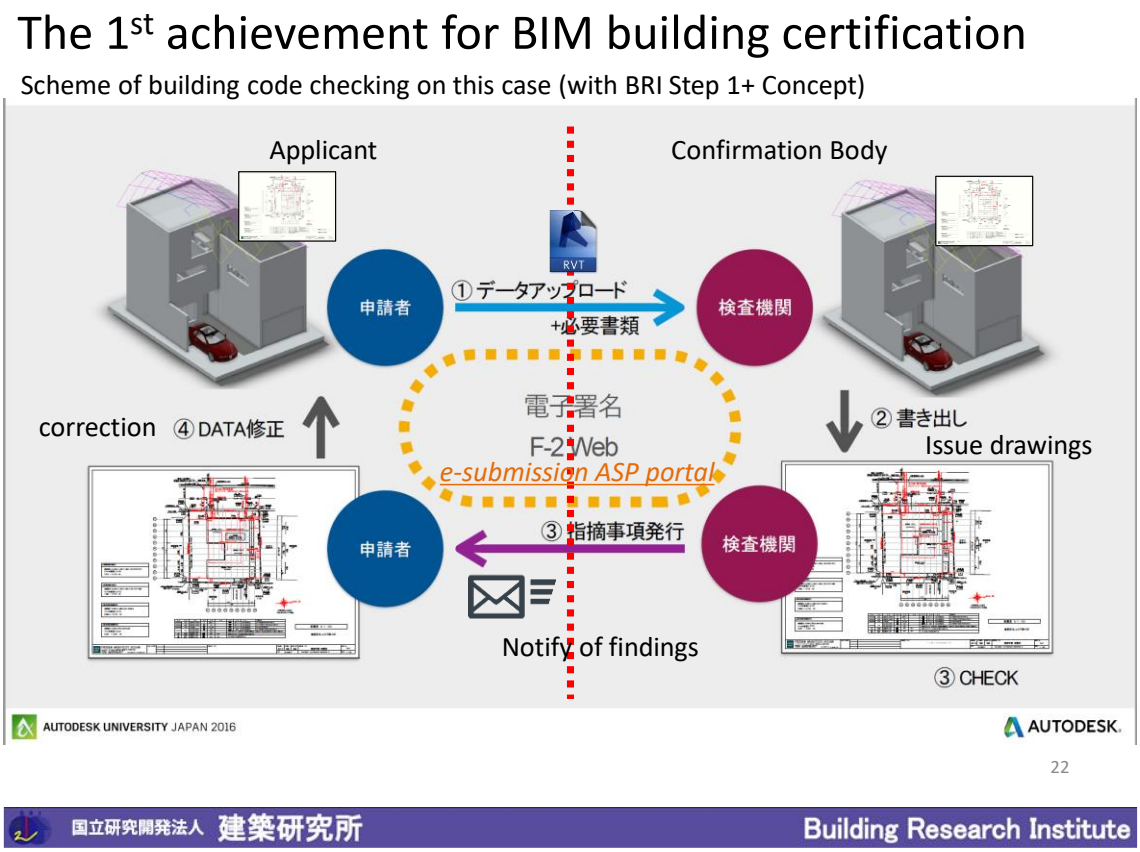


Fig. 11 Case of Japanese BIM e-submission as trial

The case in Milan is an example of applying the function of a commercially available model checker to pre-check. In advance, the code check rule is installed to the model checker, the applicant checked application BIM model for the building code's suitability using the model checker, and the output of checking result is shared between applicant and jury. (Fig. 12)

Both cases are implemented in a software native environment, but from the perspective of the trial stage that the reviewer understands the effect of BIM, the use of the native environment should not be excluded, it is recommended.

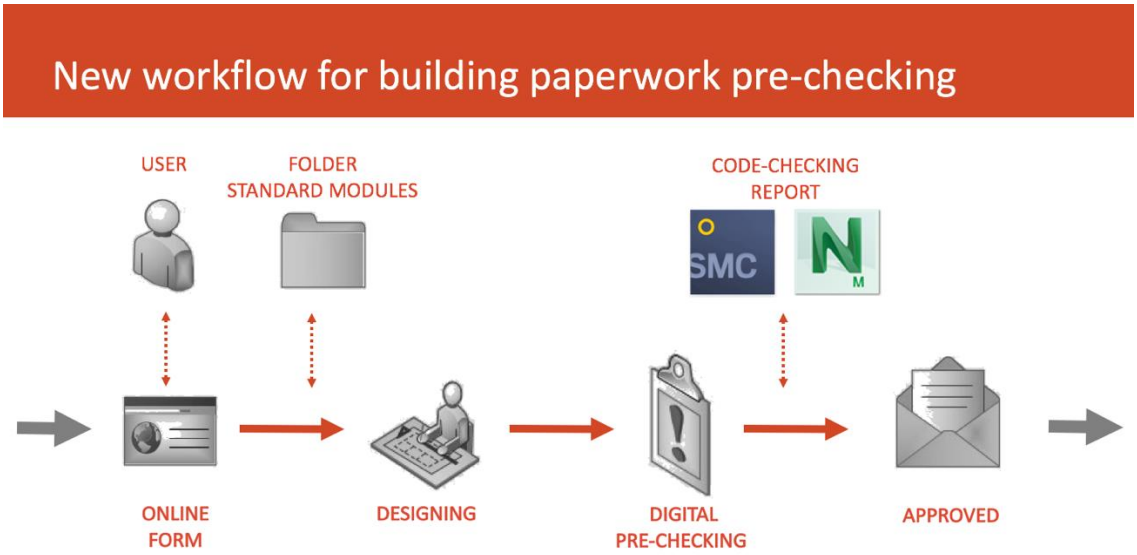


Fig. 12 Case of Milanese BIM e-submission as trial

c) Adaptation of guideline of preparing BIM model for submission

Through the stage of trial, at this stage, guidelines for implementing BIM e-submission will be developed. There are few countries that conduct BIM e-submission on a practical basis even from a global perspective.

When submitting the BIM model, it can be easily imagined that it will hinder the examination if a different expression is given by the applicant. When conducting BIM electronic application in earnest, it is necessary to confirm the expression method for building review in the BIM model. In Singapore, as an application requirement, BIM's expression style is summarized and published as "code of practice". This is an expression style defined for the BIM authoring tool with high market share in Singapore so that the judges will clearly indicate the subjects to be checked by the judges during the examination process. By simultaneously providing a template file corresponding to this "code of practice", it improves the effectiveness of BIM electronic application. (Fig. 13)

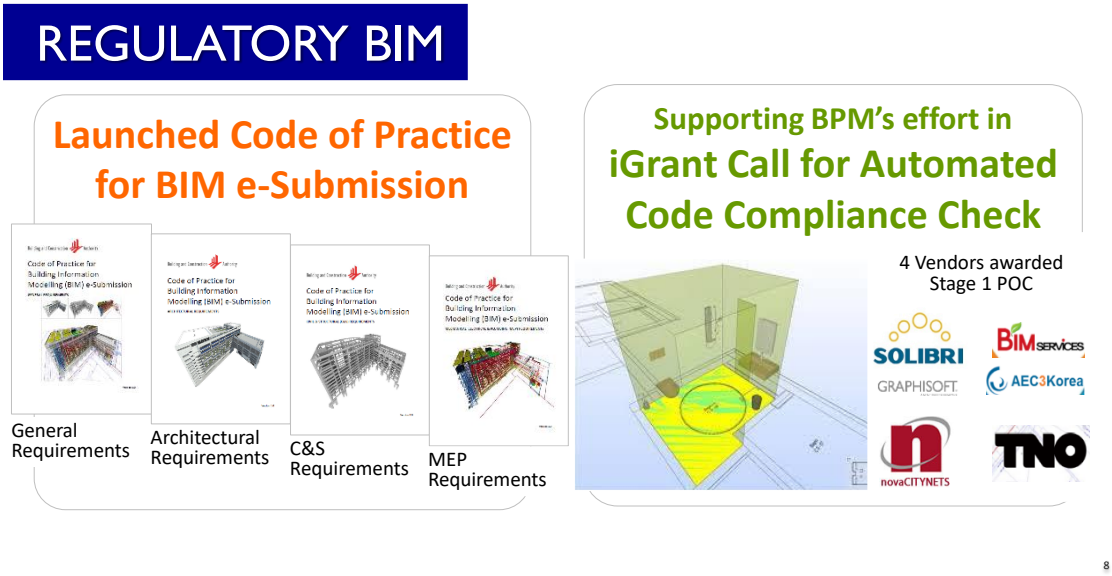


Fig. 13 Code of Practice of Singapore BIM e-submission

Norway establishes information exchange specification by “mvdXML" as an open format, and promotes software vendors to develop software compatible with the required specifications. This approach is also strongly recommended from the viewpoint of ensuring readability of archived data. (Fig. 14)

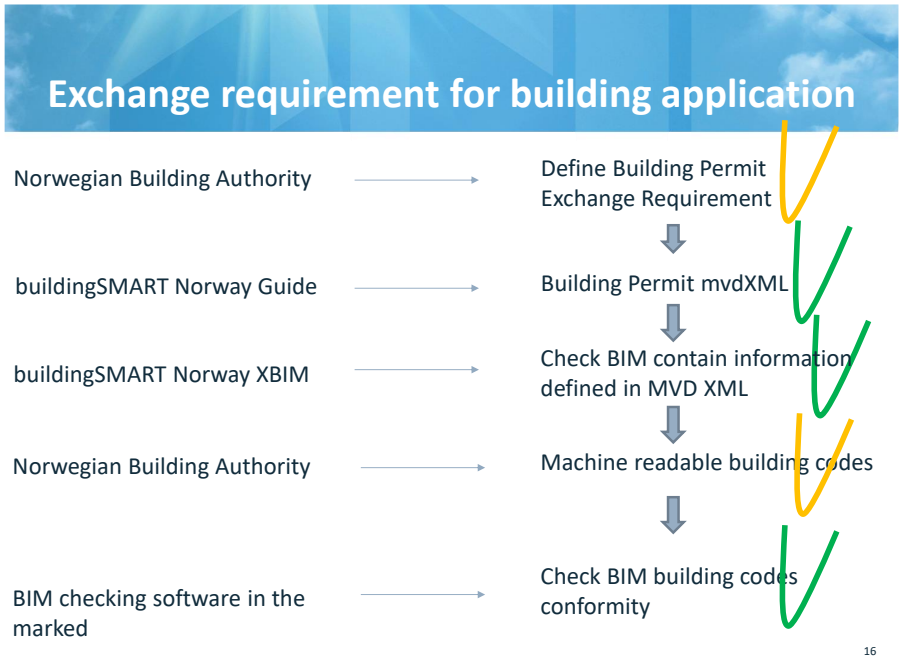


Fig. 14 Norwegian approach of Building Permit mvdXML establishment

d) Step by step mandatory e-submission

This stage is the stage of expanding BIM e-submission which was started by limiting target. Since the target that we limited at the trial stage will be extended, the difference in the way of thinking by each country appears. In general, like Singapore, starting from architectural code checking of large-scale buildings with a small number, the target of the categories of code checking and the scale of buildings will be expanded. As another way of thinking, there are approaches that start from simple rules and widen the target like Japan. (Fig. 15)

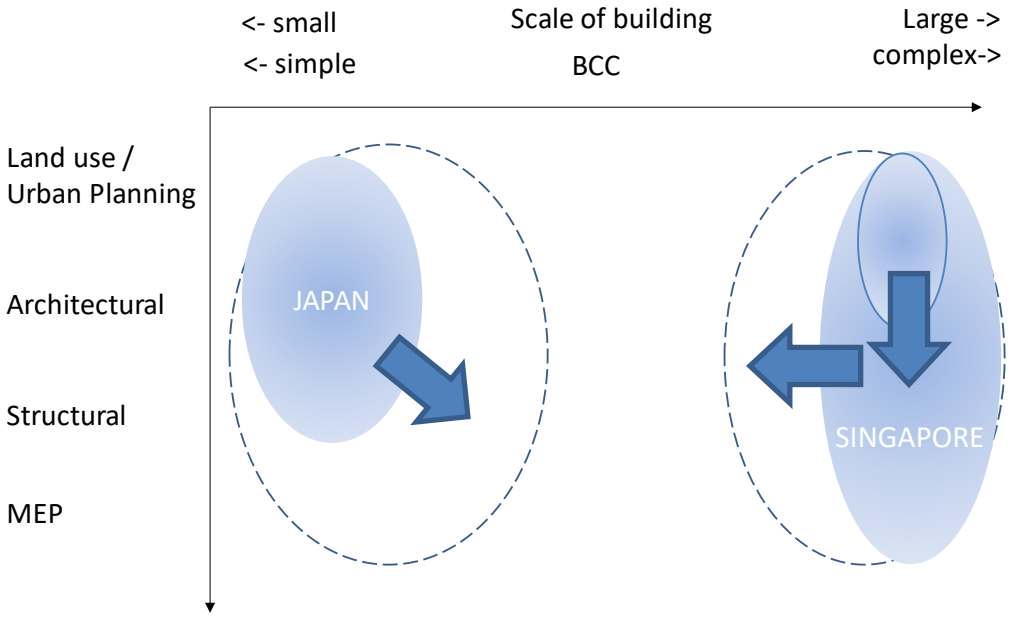


Fig. 15 Different of strategy on BIM e-submission enhancement

e) Seeking further efficiency

When the BIM e-submission is generalized, the case not only to conduct electronic information exchange but also to further rationalize the code checking procedure itself (e.g. automatic code checking, ACC) and to improve productivity in other fields adjacent to the building regulatory procedure comes up.

(1) Automated code checking (ACC)

The feasibility of ACC is detailed in the report from bSI RR WG2 “Auto Code Checking”. To establish ACC, machine-readable code (e-Law) is required. Legal statements of natural language are not necessarily mathematically normalized. Therefore, it takes a lot of work to create a machine-readable code. Also, it can be easily imagined there are concerned about whether machine readable code

is reliable. Therefore, in order to establish ACC, social consensus based on technical backing, such as ensuring the verifiability of results at the same level as paper-based application, is strongly required. (Fig. 16, 17)

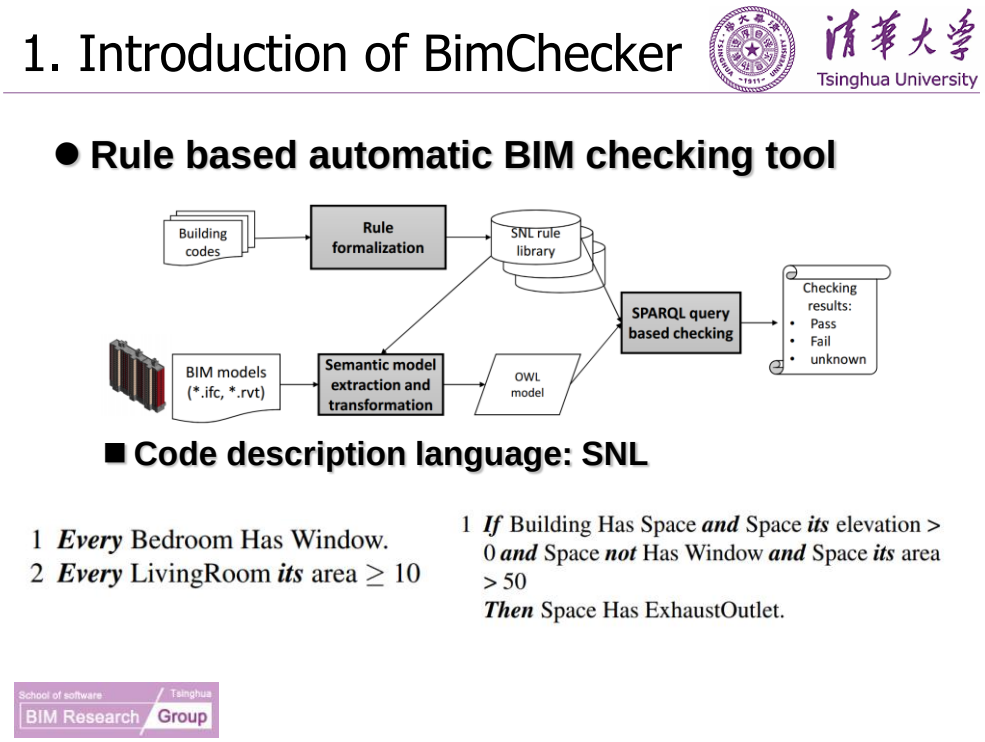


Fig. 16 Practical case about ACC trial in China

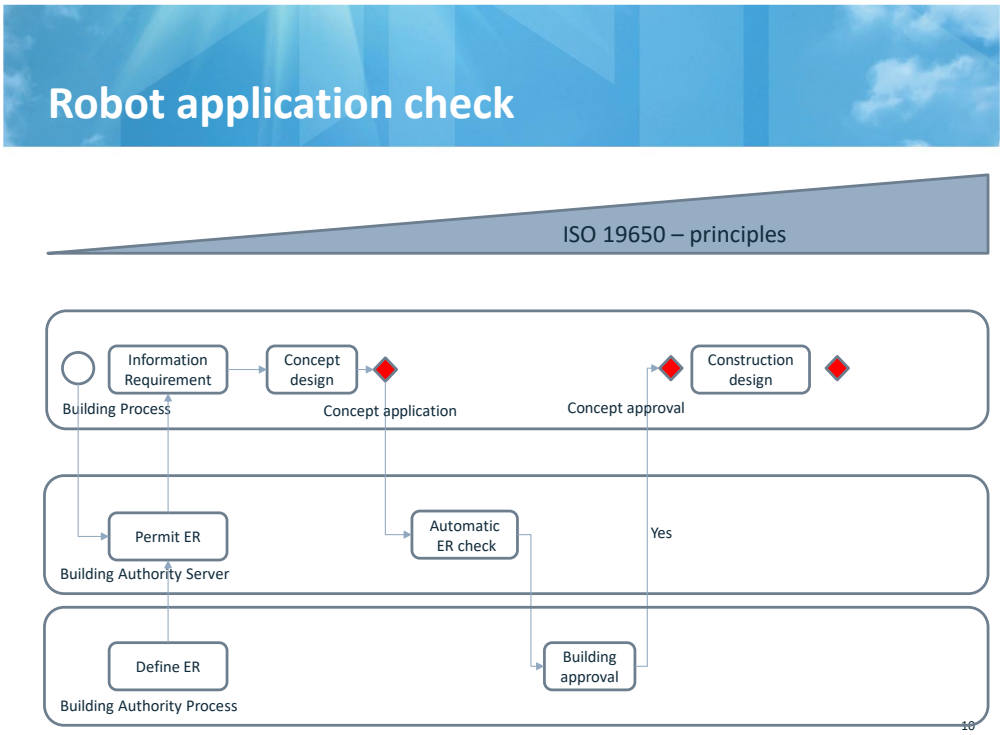


Fig. 17 Practical case about ACC trial in Norway

(2) Integration to the business field which connect to concept, building and construction approval process

In order to make BIM electronic application, the CDE corresponding to BIM is established. It is resulting in streamlining building regulatory process by the operation of the CDE itself. (Fig. 18)

In addition, since it is possible to manage the property data sets of the building elements of approved building, linking the common data infrastructure corresponding to BIM to various business areas related to the building and it is possible to improve the productivity of the relevant business domain. (Fig. 19, 20)

Project Diagram

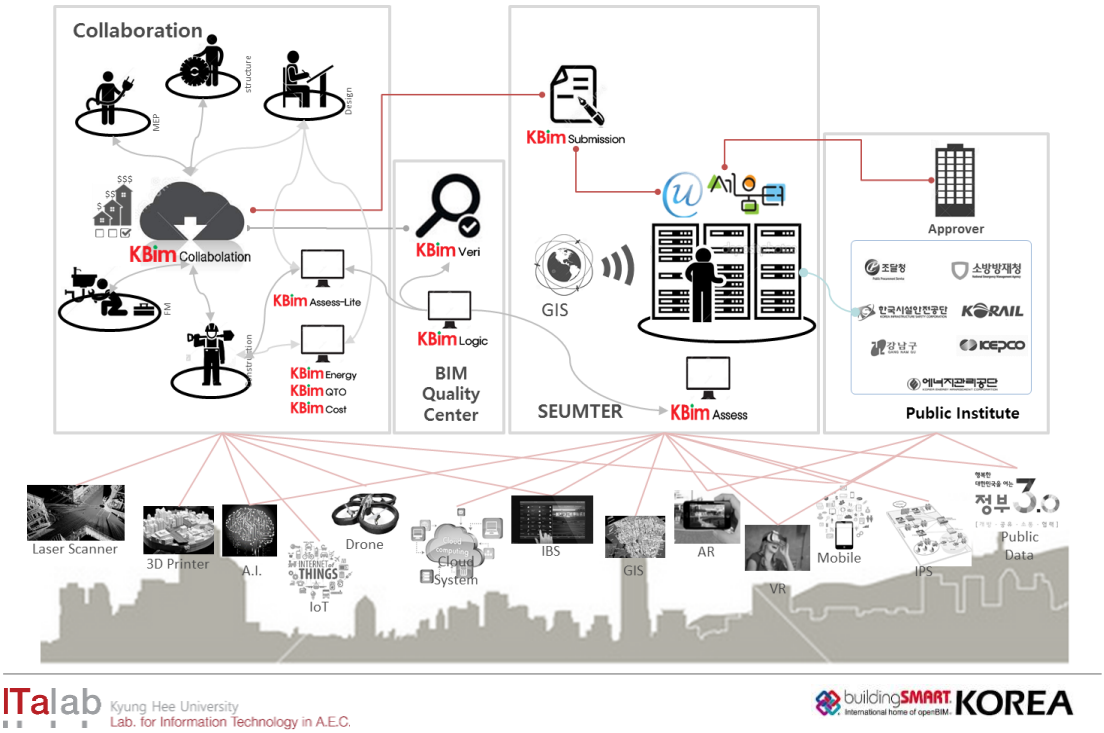


Fig. 18 Practical case about process improvement trial in Korea

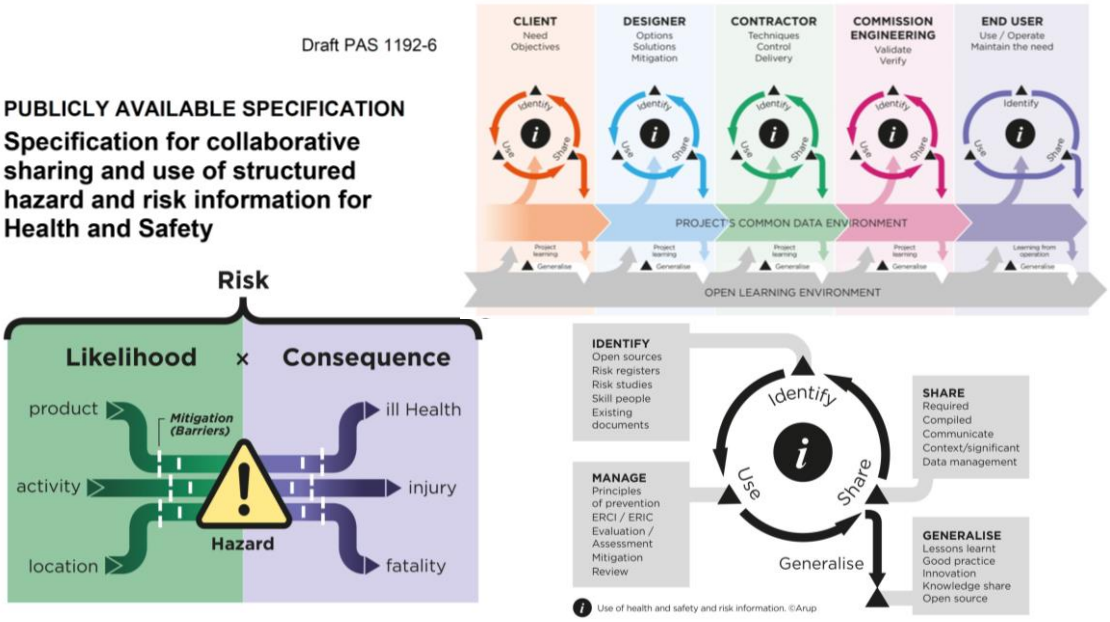


Fig. 19 Practical case about adopting to building risk evaluation in UK

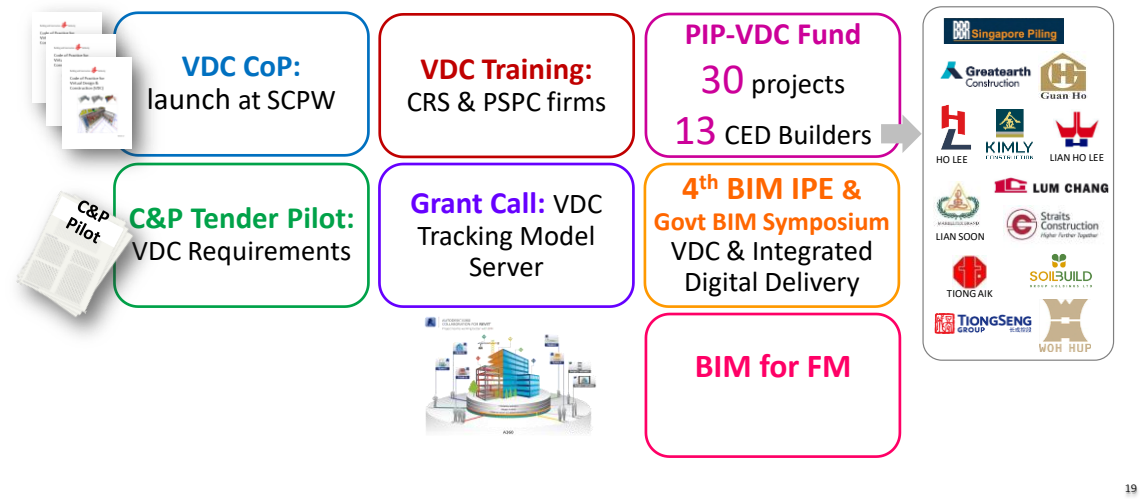


Fig. 20 Practical case about enhancement to construction phase in Singapore

2. Definition of LoX for BIM e-submission

2.1 Level of Maturity of BIM e-submission

Looking at the process of institutionalization the BIM e-submission, the direction to enhance the efficiency of the code checking work by BIM can be found and the stage of the technology to be implemented can be defined.

Lv.0 Manual / Paperless
Lv.1 BIM Initiation
Lv.2 Hybrid
Lv.3 Automated

a) Lv.0 Manual / Paperless

This stage is the transition from conventional paper procedure to paperless procedure. Although it is the stage of the origin of the electronic application by BIM, the This stage is the transition from conventional paper procedure to paperless procedure. Although it is the stage of the origin of the electronic application by BIM, the electronification required here means that replacing the physical paper medium with an electronic file is regarded as important. Therefore, it can be said that there is almost no ambition at this stage to use the description content of the documents and drawings exchanged in the application as information. required here means that replacing the physical paper medium with an electronic file is regarded as important. Therefore, it can be said that there is almost “no ambition” at this stage to use the description content of the documents and drawings exchanged in the application as information.

b) Lv.1 BIM Initiation

This stage is the first stage to apply BIM to electronic applications. There is no consistent way to use BIM at this stage and it is expected streamlining the procedure by adding the initial or intermediate stage of the Level of Development described later to the conventional method. The use of BIM at this stage can be limited to necessary parts and it can be said that it is a stage where solution can be easily solved for practical implementation as a “Low Hanging Fruit”.

c) Lv.2 Hybrid

This is the intermediate level between BIM initiation and Automated, the value of BIM property is actively used for specific code checking.
At this stage, the role of BIM in electronic application is focused on information exchange between the applicant and building authority. The scope of information exchange at this stage is not necessarily holistic, and manual procedures may be present in some procedures. In that sense, the use of BIM is advancing more

than BIM initiation level.

d) Lv.3 Automated

This is the level of auto code checking by computer, the value of BIM property is used for holistic code checking.
At this stage, the information exchange between the applicant and the Building Authority is automated and manual procedures are completely eliminated. Therefore, machine-readable laws, integration of information necessary for review into BIM models, and Open Standard that does not depend on the software environment must be prepared. It can be said that “long term ambition” is required to prepare these conditions.

Maturity map construction permit process with BIM

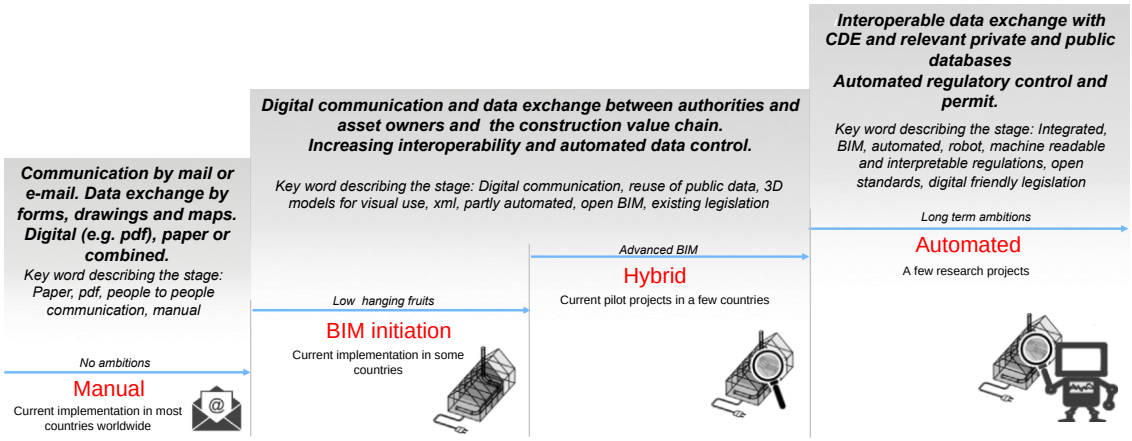


Fig 21. Level of Maturity and key word describing each stage (by Tomi Henttinen)

2.2 Level of Development for BIM e-submission

Also, it can be classified as follows, depending on the visualization of BIM 's feature, use of ensuring consistency and the degree of utilization of IFC-property values.

Lv.1 Visualization
Lv.2 Hybrid / Information flow
Lv.3 Automated Code Checking

a) Lv.1 Visualization

This is the level of the jury expects the function of Visualize of BIM model, the value of BIM property is not actively used. For example, the following case is this stage;

- Checking application formats and 2D drawings outputted from BIM model which have highly consistent
- Confirmation by detailed 3D view of difficult to understand in 2D drawing

In this stage, it is necessary to define the model view required for the checking process such as the definition for 2D drawing expression and the definition of viewpoint of 3D view. These requirements are prescribed in the implementation guidelines or code of practice. For applicant, Templates or plug-in programs for BIM authoring software may be provided to support execution of visualized level BIM e-submission. And for jury, viewing software are needed to prepare for checking.

b) Lv.2 Hybrid / Information Flow

This is the intermediate level between Visualized and Automated Code Checking, the value of BIM property is actively used for specific code checking. For example, usage of property information is as follows;

- To find lack of expression legally required on application documents and drawings.
- To check on the following building codes;
  - existence or numbers of target objects
  - numerical value of target objects
  - special or geometrical relation of target objects
  - calculation, simulation, and analysis using BIM property value

In this stage, IFC-based MVD and IDM are required as information definitions necessary for mechanically read and understand the contents by computer program. At this stage, MVD and IDM may be defined for the part to be examined. Applicants and juries use the model checker program to verify the appropriateness of the submitted BIM model and check the building code. For sophisticated calculations and simulations, a verification program can be used in addition to the model checker program.

c) Lv.3 Automated Code Checking

This is the level of auto code checking by computer, the value of BIM property is used for holistic code checking.
To realize Auto code checking at this stage, the e-Low as a machine-readable building code is required. Even in the case where Auto code checking is executed, it should be maintained that the jury could verify the results of the auto code checking.

Relation of Institutionalization stages, Level of Development (LOD) is shown as Fig.21. Institutionalization stages and Level of Development (LOD) are correlated at human and machine ratability of BIM model. Because of the reliability, verifiability should be secured in all stages.

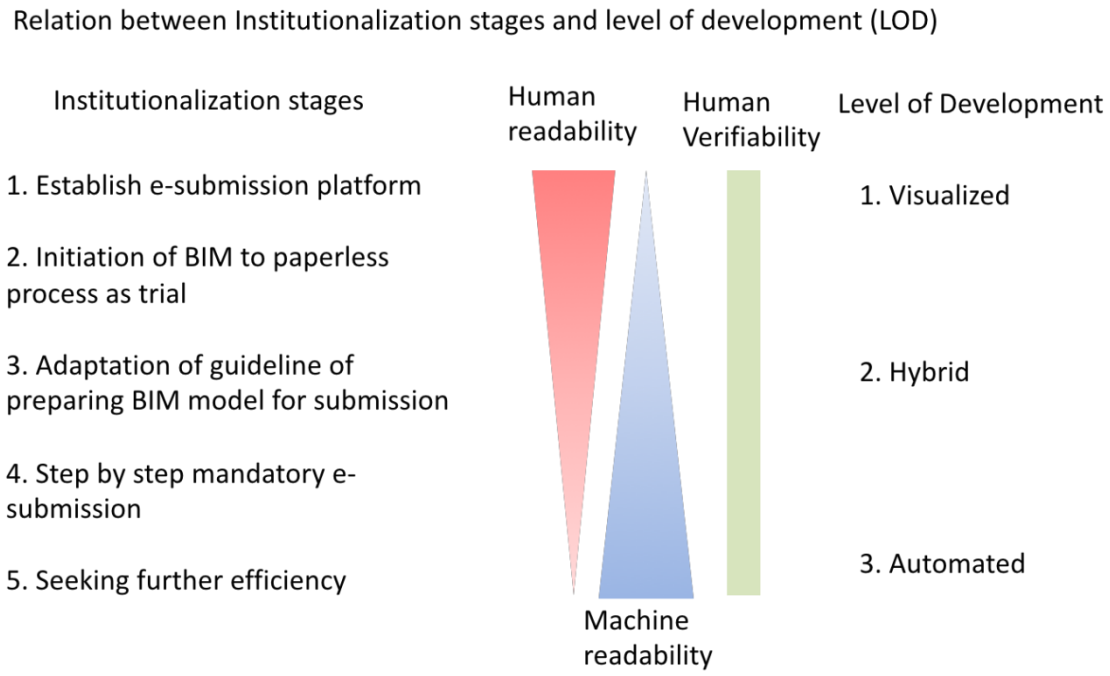


Fig.22 Relation of Institutionalization stages, Level of Development (LOD)

3. Conclusion

In bSI RR WG 1, we tried to evaluate the tendency of introducing BIM into building regulatory process and to organize key technology used for BIM regulatory process from report of use case at RR meetings and RR seminars. As a result, we were able to define the level of maturity for BIM e-submission and the level of development for BIM e-submission.
These LoX definitions will make it possible to accurately evaluate the situation of BIM e-submission in their respective countries. It will also make it possible to clarify development goals for BIM e-submission.

As a next step, the issues to be addressed by RR are as follows.

- Further analysis of use case for RR road map creation
- Generalization of information exchange requirement at approval stages
- Development of IDM/MVD for building regulatory process
- Development of ACC method

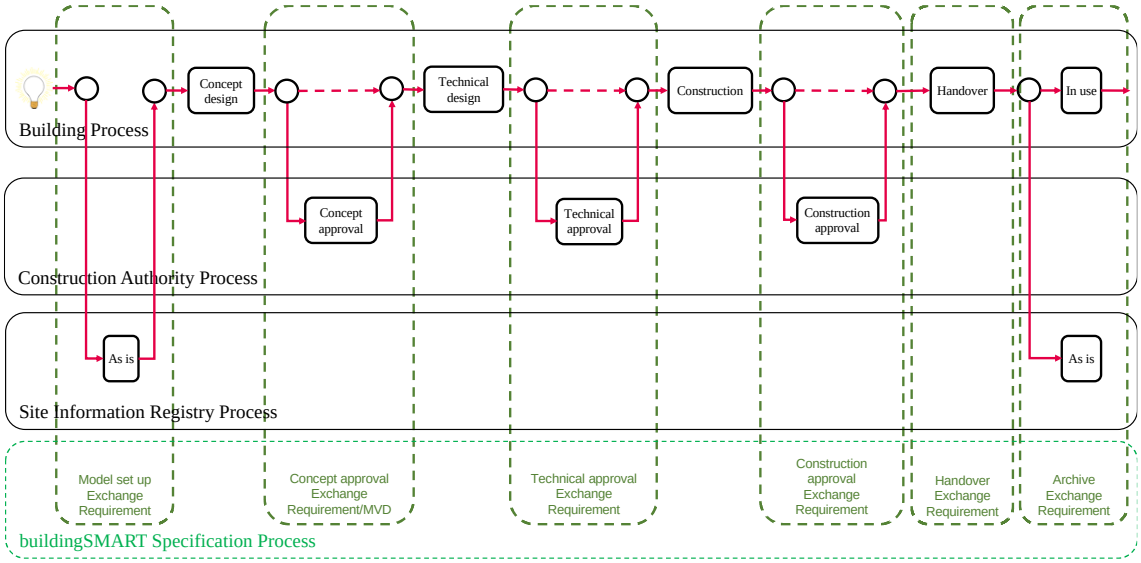


Fig.23 Mapping of generic building regulatory process and role of bSI RR

Regarding these themes, bSI RR already sets working groups and is under consideration work. Please expect future activities of standardization in RR.