sciendo

CIVIL AND ENVIRONMENTAL ENGINEERING REPORTS

E-ISSN 2450-8594

CEER 2022; 32 (4): 0001-003
DOI: 10.2478/ceer-2022-0041
Original Research Article

LEVEL OF INFORMATION NEED FOR BIM MODELS: AUSTRALIA, NEW ZEALAND AND ISO 19650

DSc. PhD. Eng. Krzysztof ZIMA,
prof. CUT, MSc. Eng. Ewelina MITERA-KIEŁBASA[1]
Cracow University of Technology, Faculty of Civil Engineering, Division of Management in Civil Engineering

A b s t r a c t

Publishing BIM standards can facilitate the implementation of BIM construction projects. Their compilation, as in the article, allows to improve them, create or specify requirements. The publication of the international standard ISO 19650 for BIM resulted in numerous revisions to national guidelines. In the aspect of the degrees of detailing of BIM model is visible the development of their definition. Initially, they were divided according to the project phases, over time, into industries, and finally within the types of elements and separately for geometric and alphanumeric information, as well as the attached documentation. ISO 19650 uses the term *Level of Information Need*.
Due to the quantity of global standards in various countries, the article focuses on the Oceania area and ISO 19650.

Keywords: level of information need, level of development, level of detail, LOD, degrees of detailing, BIM model, BIM standards, BIM requirements

1. INTRODUCTION

The awareness of the existence of BIM technology in construction investments management is growing. According to *the NBS* report, in 2011 43% of respondents neither knew nor implemented BIM, while in 2020 it was already 1%, the

[1] Corresponding author: Cracow University of Technology, Faculty of Civil Engineering, Division of Management in Civil Engineering, Cracow, Poland, e.mitera@pk.edu.pl

percentage of respondents aware and currently using BIM increased from 13% in 2011 to 73% in 2020 [26]. *Australian Institute of Architects AIA* in a report from 2021 described BIM implementation in Australia as mature. 50% of respondents feel quite confident in their BIM skills and knowledge, and 35.71% are confident. In addition, 82% believe that in 5 years BIM will be used in most projects [4]. In New Zealand, according to a report from 2021, in the construction industry, 70% of respondents use BIM in their projects [7]. The availability of national guidelines may facilitate adaptation, the mandatory in a given country increases the motivation for implementation. An example is the United States, where *the United States Army Corps of Engineers USACE* already in 2006 published a *Roadmap* for BIM implementation [30] or the United Kingdom, which has required BIM for projects funded by central government institutions since 2016 [11].

The authors made a comparison and analysis of BIM standards in various countries. Due to the limitations of the length of the published articles, it was decided to divide them. Hereby the article in accordance with the breakdown drawn up by *the United Nations Statistics Division* UNSD is for Oceania area. The international standard ISO 19650 also has been added, which refers to investments in BIM technology. The implementation policy was also checked, which also shows how often they are used. Qualitative analysis was performed in the context of degrees of detailing, presented results and conclusions .

2. BIM POLICY

According to *the United Nations Statistics Division* UNSD, the Oceania area includes Australia and New Zealand, Melanesia, Micronesia and Polynesia. Australia and New Zealand have BIM standards, and therefore they are taken for analysis.

2.1. Australia

BIM is not mandatory. In 2016, *The Parliament of the Commonwealth of Australia*, in the *Smart ICT* report [28], recommended the creation of a BIM task force in the area of infrastructure projects, similar to group created in Great Britain, which would deal with standards, BIM policy, and coordinate it in the country. In addition, it recommends using BIM for infrastructure procurement that receives government funding, with a cost of more than 50 million dollars. In 2018, the state of Queensland released *The Digital Enablement for Queensland Infrastructure* [13] for infrastructure projects. They are for government officials in this state. With these short rules, Queensland wants to prove the gradual implementation of BIM, which they plan over 5 years. They indicate, inter alia, using Open BIM defined by *buildingSMART Australasia*), using BIM information throughout the life cycle of the building, collaborating on the development of best practices, using the best current practices and standards in consultation with *the NATSPEC* and relevant to ISO 19650.

2.2. New Zealand

BIM is not mandatory. In 2014, *the New Zealand's BIM Acceleration Committee* was established [10] to help implement BIM in the country. Since 2019, *the Ministry of Business, Innovation and Employment MBIE* and *NZTech* have been *the Digital Technologies Industry Transformation Plan ITP*. In 2022, *Digital Technologies Draft Industry Transformation Plan 2022-2032* was published, which also applies to the construction sector. In 2021 were presented goals regarding changes in the digitization of public infrastructure projects, recommending, among others, standardization and pilot projects using *digital twin*, integrated BIM and refreshing *the New Zealand Digital Strategy* [5].

3. DEGREE OF DETAILING IN BIM STANDARDS

Table 1 lists BIM standards from Australia and New Zealand containing information on degrees of detailing of BIM models.

Table 1. BIM standards with degrees of detailing in Australia and New Zealand. Own study based on: [6, 12, 20-22, 24]

Country	Standard	Year	Name of degrees of detaling	Notes
Australia	NATSPEC National BIM Guide Appendix containing LOD[2]: 1. Object/Element Matrix (2011) 2. NATSPEC BIM Paper. BIM and LOD (2013)	2016, v1.0 2011	Level of Development (LOD)	*LOD definition from AIA Document E202-2008 BIM Protocol and G202-2012* *1. Worksheet with information expected on different LODs* *2. LOD interpretation, implementation recommendations*
	NATSPEC BIM Properties Generator (online)	2022	Level of Development (LOD)	*Improved and extended version of NATSPEC BIM Object / Element Matrix*

[2] *NATSPEC National BIM Guide* was updated in 2016, and the appendices in others

	National Guidelines for Digital Modelling	2009	Model development phase Object data levels	*Model development phase is a general description taking into the division of models depending on the stage of the investment process on a scale from 0 to 6, and Object data levels on a scale from A to E describing information in virtual objects that may be at the same level at several stages*
New Zealand	New Zealand BIM Handbook v.3.1 Appendix containing LOD: Appendix C. Level of Development definitions	2019, v1 2014	Level of Development (LOD)	*Relates to the BIM Forum specification, refers to model elements.*

Figure 1 shows on the timeline BIM standards, other documents and portals from Australia, New Zealand containing information on degrees of detailing of BIM models, as well as the international standard ISO 19650 describing processes, definitions for implementation of BIM technology.

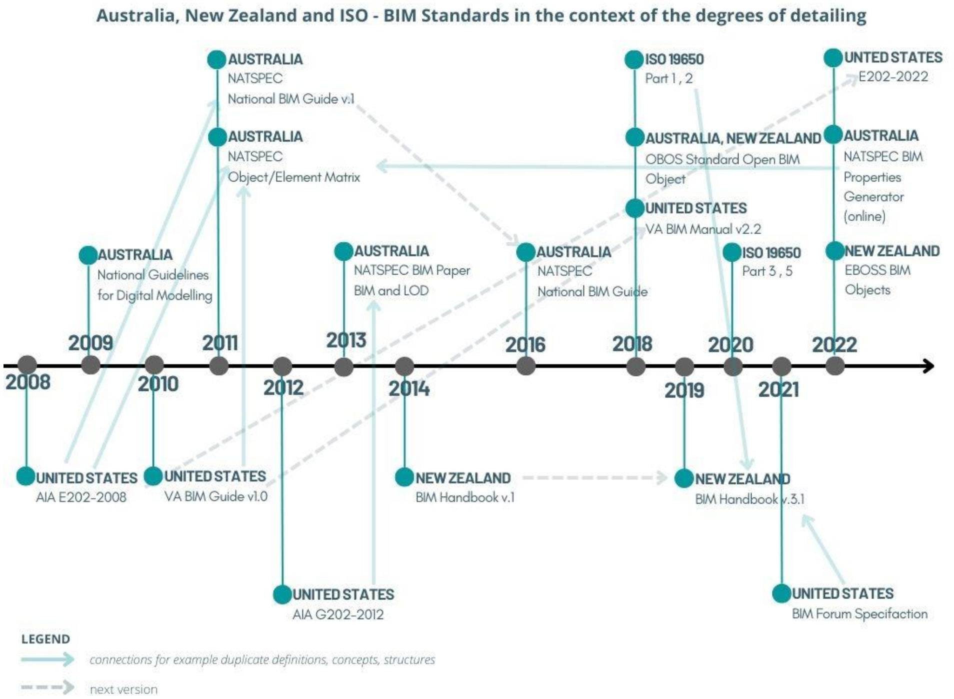

Fig. 1. BIM Standards in the context of the degrees of detailing in Australia, New Zealand and ISO 19650. Own study based on [1- 3, 6, 8, 12, 14-24]

3.1 Australia

In Australia, the national non-profit organization NATSPEC provides a web portal [25] with BIM requirements. There is possibility to download BIM standards and tools, and generate element properties, as discussed below. The main Australian standard is published in 2011 at first, currently from 2016 *NATSPEC National BIM Guide* [22]. Here is defined the concept of Level of Development LOD. It has been assumed that it depends not only on the element, the investment phase, but also on the system in which it is built (DBB Design-Bid-Build/ D&C Design and Construct/ IPD Integrated Project Delivery). Defines and splits the LOD according to the *AIA Document E202 BIM Protocol* [1] (from 2008, the current version is E202-2022 [3]. The portal also provides *BIM Object/Element Matrix* [20]. This is an Excel spreadsheet from 2011, based on the developed by *the United States Department of Veteran Affairs* [14], which by describing information for various *Level of Development* for life cycle of building extends *AIA Document E202-2008*. There is possibility to download also *NATSPEC BIM and LOD* [21], which explains how to interpret and implement LOD. There, the LOD definition from the 2012 draft *AIA* protocol was updated [2]. The study has a table that describes the levels from LOD 100 to LOD 500 for the various aspects of design ie analysis, cost estimating, scheduling, coordination and other, if there are, "authorized uses" (term and definition from *AIA E203-2012*, section 4.4). Figure 2 shows the process of defining LOD according to *NATSPEC BIM and LOD* [21].

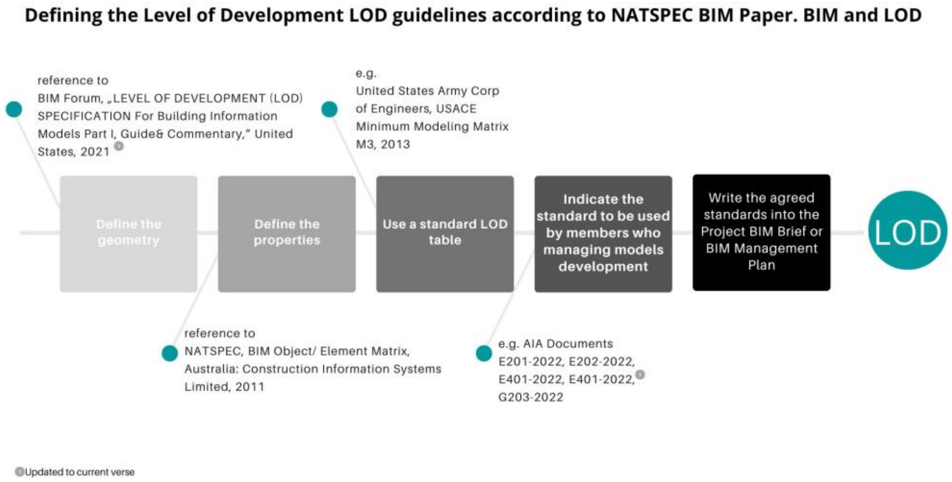

Fig. 2. Defining the Level of Development LOD guidelines according to *NATSPEC BIM Paper. BIM and LOD*. Own study based on [21]

In order to standardize BIM objects, implementing the *buildingSMART* IFC *NATSPEC* schemas in cooperation with *the Masterspec* from New Zealand made *the OBOS Standard Open BIM Object* document available to stakeholders [23].
The NATSPEC BIM Properties Generator [24], an improved and extended version of *the NATSPEC BIM Object / Element Matrix*, is an even greater convenience available on the portal. After selecting a given group of elements is possible to receive proposed metadata and properties. For example, metadata includes the name of the object type, the suggested discipline, and the LOD for the design model. It also contains information about the object-specific differences for IFC version 2x3 and version 4 (if applicable). In the properties, you can select the information source and categories. For example, for thermal insulation in the metadata, the LOD level 300 was suggested for the Design Model model, the basic discipline architecture, IfcElementType IfcCovering, IfcPredefinedType INSULATION, as well as the nomenclature and item property items depending on the sources, i.e. COBie, IFC 2x3, IFC4, NATSPEC BIM, NATSPEC Spec. , categories incl. information on costs, scheduling, coding, facility management, Masterformat classifications, NatspecWroksection, Omniclass, Uniclass.

CRC for Construction Innovation i *Austialian Instutute of Architects* also published guidelines [12]. According to the division called *Model development phases*, the detail of the models was divided into several phases from 0 to 6, where the zero phase concerns the *Briefing / Pre-design*, and the last, sixth stage, *the Post construction / Facility management facility*. As the numbers increase, the detail and complexity of the model increases. Then, according to the division called *Object data levels*, the information levels for (virtual) objects were classified, denoted from A to E. The aim was to define the levels of detail in general that could correspond to the different phases of the design. For example, level A contains only a block model, preliminary, non-geometric information on the planned measures of area, volume, estimated cost limit, total duration of construction or divided only into main elements, environmental requirements. Level C provides detailed alphanumeric and geometric information, information assumptions for individual execution stages, exact quantities of materials, analyzes and simulations, clash detection, sequencing of construction works, as well as information on estimated costs. Another division, called *Modeling implementation*, is divided into stages from 0 to 3, and in each of them into two subsequent stages. They concern 2D documentation (stage 0), modeling (stage 1), cooperation (stage 2) and integration (stage 3). For example, stage 1A deals with *3D modeling*, and stage 1B *intelligent 3D modeling*. In the further part of the study, the expectations towards models of individual industries are explained in more detail, e.g. a structure model that should contain information, analyzes, summaries at stages of execution. Examples of non-geometric information for individual model components, e.g. for windows, along with position nomenclature are also given.

3.2 ISO 19650

In 2018-2020 several parts of the international standard ISO 19650 for *Building Information Modeling* were published [16-19]. As recommended in ISO 19650-2, since then some countries have introduced local annexes, e.g. in Hong Kong, Canada, supplementary manuals e.g. in Great Britain or national guidelines taking into account the nomenclature, concepts or methodology from ISO 19650 e.g. in Poland, Norway, Germany. ISO 19650 focused on the whole lifecycle of building. Uses the concept of *Level of Information Need*, defining it as *determined by the minimum amount of information needed to answer each relevant requirement*. Therefore, there should be neither too much information, leading to waste (the risk of excess, however, should be taken into account in accordance with ISO 19650-1), nor too little (failure to meet the investor's expectations). *Level of Information Need* contains geometric information *(Level of Geometry)*, alphanumeric *(Level of Alfanumerical Information)*, which are at least as important as geometric and *Documentation.*

3.3. New Zealand

In New Zealand, *the BIM Acceleration Committee* BAC provides a web portal [9] with handbooks, tools and other resources to help implement BIM. These are among others *The New Zealand BIM Handbook*, version 3.1 (the first from 2014) with attachments A-Jii [6]. It follows ISO 19650 Part 1 and 2, which were published until *The New Zealand BIM Handbook* is available. as well as to the *the New Zealand Construction Industry Council NZCIC* guidelines [27]. Annex C contains the definitions *Levels of Development*. He describes them as a scale used to show *the reliability of content*, are the degrees to which model elements have been developed in the various stages of execution. The handbook refers to the *BIM Forum*'s definition [8], emphasizes that elements consist of geometric and non-geometric information. The focus was also on distinction *Level of Detail* from *Level of Development*. The first are the input information, the amount of detail in the element, and *Level of Development* are the result, the degree to which team members can rely on information, geometric and other. LOD is information about the graphic model, documentation and non-graphical information, on a six-point scale from LOD 100 to LOD 500, including LOD 350.

As noted above, *the Masterspec* from New Zealand and *the NATSPEC* from Australia have provided *OBOS Standard Open BIM Object* unifying the nomenclature of item property items in BIM models. The online catalog of BIM objects is also available from the *EBOSS* platform [15].

4. SUMMARY AND CONCLUSIONS

Publication of national and / or international standards is to facilitate the precision of investor requirements and process management in BIM technology by stakeholders. The mandatory use of BIM technology, e.g. for public procurement, from a certain amount, encourages contractors to implement it. Australia and New Zealand do not have it, but surveys show that the public is aware of BIM and is becoming more widely used over time. However, awareness does not mean application. The discovery of the benefits of BIM adaptation resulted in the organization of national committees to help implement it. Since then, several BIM guidelines have been developed in both countries. In the international market, the publication of ISO 19650 has introduced changes to the guidelines of various countries, including New Zealand. In terms of degree of detailings of BIM models is possible to see the development of definition and perspective of studies (table 1). The ISO 19650 standard states that the guidelines require information at the *Levels of Information Need*, i.e. information that is to meet the set goals and assumptions. It is therefore important to focus due attention in the development of requirements [31], covering the entire life cycle of building [29]. Information overload is a common occurrence today, the ability to manage it can bring tangible benefits. The excess of information in BIM models is associated with, for example, unnecessary costs related to the amount of time that designers or contractors need to introduce them to the models. It also demotivates designers to variant analyzes due to the number of changes. Lack of sufficient information is also a negative event. They do not allow to meet the goals expected from the organization, the constructed object. Information in accordance with ISO 19650 can be divided into geometric information concerning graphic representation, symbology, visualization, alphanumeric information concerning the properties of model components and documentation, i.e. attached files, such as plans, reports, photos or others. This breakdown is important in defining the requirements. Different details can be expected depending on industries, types of elements, type of information. For example, the geometry of the reinforcement (visible ribs) is not as important as alphanumeric information related to the steel grade. The granularity of information does not necessarily always increase with the stage of investment process. For example, at the beginning, in the conceptual stage, there may be greater geometric detail regarding interior furnishings, e.g. tables, chairs, to visualize the stakeholders functionality of the room, but they do not have to be exactly the same elements as in the detailed design stage. The chairs from the conceptual stage in the next stage may have a reduced level of geometric detail, in order to select the most appropriate functional concept of the object during the variant analysis, and then be increased again. The development of standards regarding the required information can be seen in the timeline (Fig. 1). The Australian *the National Guidelines for Digital Modelling* (2009) describe requirements regarding the detail of information depending on the projects phases. Another, *the NATSPEC National BIM Guide* with attachments (2011-2016) presents in detail the elements of models, broked down also by industries and types of elements. Moreover, it draws attention to the complexity of the definition process (Fig. 2). The standard also duplicates information from other standards, such as AIA, BIM Forum, USAGE from the United States. This is a good practice observed in the guidelines in many countries, because it is based on previously published standards, and thus, experienced in their implementation and verification. *The New Zealand BIM Handbook* (2019), published after the ISO 19650 standard (parts 1 and 2 of 2018) apart from distinguishing information into graphic, non-graphical and documentation, divided by types of model elements, also described the definition of input information *Level of Detail* and output information, in the sense of the expected result *Level of Development*. Implementation is also facilitated by the ease of obtaining information about the management process with BIM technology, such as providing online platforms, where is possible to download stadards with attachments, there are BIM objects and their properties [9, 15, 23-25], for various levels .

In the future, it may be considered whether or not to standardize the concepts used in the guidelines of different countries, such as the *Level of Information Need*. This would make it easier for construction companies managing investments with BIM in the international market, and more construction projects increase the amount of experience. The compilation of standards as in this article allows them to be improved (as part of subsequent national versions), created (in countries that have not yet introduced them) or specified (by stakeholders developing requirements).
In subsequent articles, the authors plan to publish a *Level of Information Need* analysis for other countries. They have intention on a more detailed analysis of the standards for investments with BIM technology.

REFERENCES

1. American Institute of Architect AIA 2008. *E202-2008 Building Information Modeling Protocol Exhibit*, United States.
2. American Institute of Architect AIA 2012. G202-2012 Draft Document. Building Information Information Protocol Form, United States,
3. American Institute of Architect AIA 2022. E202-2022 BIM Exhibit for Sharing Models with Project Participants, Where Model Versions May Not be Enumerated as a Contract Document, United States.
4. Australian Institute of Architects AIA 2021. BIM and beyond. Design technology in architecture, Australia.
5. BECA Ltd,; Waihanga, Polis Consulting Group Ltd for New Zealand Infrastructure Commission Te 2021, Preparing for Technological Change in the Infrastructure Sector, New Zealand.
6. BIM Acceleration Committee, BRANZ, Ministry of Business Innovation & Employment 2019. The New Zealand BIM Handbook v.3.1. A guide to enabling BIM on built assets, New Zealand.
7. BIM Acceleration Committee, Ministry of Business, Innovation & Employment, Branz, EBOSS 2021. BIM in New Zealand - an industry-wide view. Baseline information on the use of BIM across the New Zealand construction industry, New Zealand.
8. BIM Forum 2021. Level of Development (LOD) Specification For Building Information Models Part I, Guide& Commentary, United States.
9. BIM in New Zealand < https://www.biminnz.co.nz/>, available 14.10.2022.
10. BRANZ, Curtis, M, Gordon, G 2018. SR375 Building-quality issues: A literature review, New Zealand, Porirua.
11. Cabinet Office 2011. Government Construction Strategy, United Kingdom.

12. CRC Construction Innovation, Australian Institute of Architects 2009. National Guidelines for Digital Modelling, *CRC Construction Innovation*: Australia.
13. Department of State Development. Manufacturing, Infrastructure and Planning 2018. Digital Enablement for Queensland Infrastructure. Principles for BIM Implementation, Australia. Queensland.
14. Department of Veterans Affairs VA 2010. Object Element Matrix as an appendix from The VA BIM Guide v1.0, United States.
15. EBOSS Building confidence in building products < https://www.eboss.co.nz/>, available 14.10.2022.
16. International Organization for Standardization 2018. ISO 19650-1:2018 Organization and digitization of information about buildings and civil engineering works, including BIM - Information management using building information modelling - Part 1: Concepts and principles, Switzerland, Geneva.
17. International Organization for Standardization 2018. ISO 19650-2:2018 Organization and digitization of information about buildings and civil engineering works, including BIM - Information management using building information modelling - Part 2: Delivery phase of the assets, Switzerland, Geneva.
18. International Organization for Standardization 2020. ISO 19650-3:2020 Organization and digitization of information about buildings and civil engineering works, including BIM - Information management using building information modelling - Part 3: Operational phase of the assets, Switzerland, Geneva.
19. International Organization for Standardization 2020. ISO 19650-5:2020 Organization and digitization of information about buildings and civil engineering works, including BIM - Information management using building information modelling - Part 5: Security-minded approach to information management, Switzerland, Geneva.
20. NASTPEC the National Building Specification 2011. NATSPEC BIM Object/ Element Matrix, *Construction Information Systems Limited*: Australia.
21. NASTPEC the National Building Specification 2013. BIM and LOD. Building Information Modelling and Level of Development, *Construction Information Systems Limited*: Australia.
22. NASTPEC the National Building Specification 2016 (reconfirmed, first published 2011). NATSPEC National BIM Guide, *Construction Information Systems Limited*: Australia.
23. NATSPEC, Masterspec 2018. OBOS Open BIM Object standard. An international standard for object Developers v1.0, *NATSPEC Construction Information Limited, Masterspec Construction Information Limited*: Australia, New Zealand.

24. NASTPEC BIM Properties Generator <https://www.propgen.bim.natspec.com.au>, available 14.10.2022.
25. NATSPEC Building Information Modelling Portal < https://bim.natspec.org/>, available 14.10.2022.
26. NBS Enterprises Ltd 2020. 10th Annual BIM Report, United Kingdom.
27. New Zealand Construction Industry Council 2016. CIC Guidelines v1.0, New Zealand.
28. Parliament of the Commonwealth of Australia 2016. Smart ICT. Report on the inquiry into the role of smart ICT in the design and planning of infrastructure, Australia.
29. Przesmycka, A and Wieczorek, D 2021. Maintenance strategies, periodic renovations and building modernisation in the aspect of the criterion of the whole life costs. *Civil and Environmental Engineering Reports* **31 (2)**, 15-29, https://doi.org/10.2478/ceer-2021-0017.
30. US Army Corps of Engineers USACE 2006. BIM A Road Map for Implementation to support MILCON Transformation and Civil Works Projects within the U.S. Army Corps of Engineers, United States.
31. Zima, K and Mitera-Kiełbasa, E 2021. Employer's information requirements: a case study implementation of BIM on the example of selected construction projects in Poland. *Applied Sciences* **Vol. 11, Iss. 22**, Spec. Iss., https://doi.org/10.3390/app112210587.

Editor received the manuscript: 03.11.2022