



JÖNKÖPING UNIVERSITY

School of Engineering

**A STUDY OF NATIONAL BIM GUIDELINES
FROM AROUND THE WORLD
DETERMINING WHAT FUTURE SWEDISH
NATIONAL BIM GUIDELINES OUGHT TO
CONTAIN**

Isak Tage Karlsson

Christoffer Rönndahl

BACHELOR'S THESIS 2018

Architectural Engineering

Postal address:
Box 1026
551 11 Jönköping

Visiting address:
Gjuterigatan 5

Phone:
036-10 10 00

This thesis in architectural engineering has been done at Jönköping University in Jönköping. The authors themselves vouch for presented opinions, conclusions and results.

Detta examensarbete är utfört vid Tekniska Högskolan i Jönköping inom Byggnadsteknik. Författarna svarar själva för framförda åsikter, slutsatser och resultat.

Examiner: Martin Lennartsson

Supervisor: Peter Johansson

Scope: 15 hp

Date: 2018-06-06

Abstract

Purpose: The purpose of this study was to increase the efficiency of the planning stages in the building industry. The goal was to produce valuable information that will be useful in the future development of Swedish national BIM guidelines.

Method: The study has been conducted by following the principles of content analysis. “Content analysis is a research method that uses a set of procedures to make valid inferences from text” (Weber, 2011). By searching for and analysing the content of national BIM guidelines, valuable information for future development of Swedish national BIM guidelines would be produced. The BIM guidelines had to fulfil two criteria in order to qualify for the study:

1. Be a national BIM guideline.
2. Have a version in English.

Once selected, the guidelines were analysed using 11 topics, namely BIM execution plan, Level of Development, Format standards and their application – interoperability, accountability, filing, archiving, modes of collaboration, operations and maintenance, simulations, pre-qualifications, BIM functions through project phases. These were chosen based on works by R. Sacks, Gurevich, & Shrestha (2016) and Hooper (2015).

Findings: Out of the 81 BIM guidelines listed in the BIM guides project by BuildingSMART (2017), 10 national BIM guidelines from 10 different countries were chosen for further study. NATSPEC from Australia, Belgian guide for the construction industry, CanBIM from Canada, COBIM from Finland, HKIBIM BIM project specification from Hong Kong, New Zealand BIM handbook, Statsbygg BIM manual from Norway, Singapore BIM guide, Level 2 PAS from the UK and NBIMS from the USA.

All topics have a high level of inclusion, pointing to that the topics from (Hooper, 2015) and (Sacks, 2016) are relevant on a global scale. Pre-qualifications scored the lowest, and BIM functions through project phases scored the highest.

Implications: Cover all 11 topics reviewed in this study. Avoid strict protocols with excessive level of detail, but rather formulate guidelines as frameworks, thus making them user-friendly and usable. Formulate guidelines so details may easily and logically be worked out in a BIM execution plan. Make a plan to keep the documents up to date.

Limitations: This study only includes national BIM guidelines with English versions available. It has solely been conducted by document analysis and does therefore not provide much information on what current users of national BIM guidelines think of the guidelines reviewed, apart from what is mentioned from Hooper’s work (2015). The score of each guideline indicate how much information it contains, and a high score may therefore not necessarily indicate it is the most user-friendly and readable guideline.

Keywords: BIM guidelines, national BIM guidelines, BIM implementation

Table of Contents

I	Introduction	I
1.1	BACKGROUND.....	1
1.2	PROBLEM DESCRIPTION.....	1
1.3	PURPOSE AND RESEARCH QUESTIONS.....	2
1.3.1	What national BIM guidelines exist?	2
1.3.2	What key elements do these BIM guidelines contain?	2
1.3.3	What should future Swedish national BIM guidelines contain?	2
1.4	DELIMITATIONS	2
1.5	OUTLINE	4
2	Method and implementation	5
2.1	REVIEW TOPICS	6
2.2	INVESTIGATION STRATEGY	7
2.3	CONNECTION BETWEEN RESEARCH QUESTIONS AND INVESTIGATION STRATEGY	7
2.3.1	What national BIM guidelines exist?	7
2.3.2	What key elements do these BIM guidelines contain?	8
2.3.3	What should future Swedish national BIM guidelines contain?	8
2.4	LITERATURE STUDY	8
2.5	LEGITIMACY	8
3	Theoretical Background.....	9
3.1	CONNECTION BETWEEN RESEARCH QUESTIONS AND THEORY	9
3.1.1	Theory A: BIM guidelines in the world.....	9
3.1.2	Theory B: Realising the potential of BIM with national BIM Guidelines.....	9
3.1.3	Theory C: The demand for national BIM Guidelines in Sweden.....	9
3.1.4	Theory D: Content of national BIM Guidelines.....	10
3.2	SUMMARY OF CHOSEN THEORIES	11
4	Empiricism and analysis	12
4.1	WHAT NATIONAL BIM GUIDELINES EXIST?.....	12
4.2	WHAT KEY ELEMENTS DO THESE BIM GUIDELINES CONTAIN?.....	15
4.2.1	BIM execution plan (BxP).....	16

Table of Contents

4.2.2	<i>Level of Development</i>	<i>17</i>
4.2.3	<i>Format standards and their application - Interoperability.....</i>	<i>17</i>
4.2.4	<i>Accountability.....</i>	<i>17</i>
4.2.5	<i>Filing</i>	<i>18</i>
4.2.6	<i>Archiving</i>	<i>18</i>
4.2.7	<i>Modes of collaboration.....</i>	<i>19</i>
4.2.8	<i>Operations and maintenance requirements</i>	<i>19</i>
4.2.9	<i>Simulations</i>	<i>20</i>
4.2.10	<i>Pre-qualifications</i>	<i>20</i>
4.2.11	<i>BIM Functions through project phases.....</i>	<i>20</i>
4.3	<i>SUMMARY OF COLLECTED EMPIRICISM AND ANALYSIS</i>	<i>20</i>
5	Results.....	22
5.1	<i>WHAT NATIONAL BIM GUIDELINES EXIST?.....</i>	<i>22</i>
5.2	<i>WHAT KEY ELEMENTS DO THESE BIM GUIDELINES CONTAIN?.....</i>	<i>23</i>
5.3	<i>WHAT SHOULD FUTURE SWEDISH NATIONAL BIM GUIDELINES CONTAIN?</i>	<i>25</i>
5.4	<i>CONNECTION TO PURPOSE.....</i>	<i>26</i>
6	Discussion and conclusions	27
6.1	<i>DISCUSSION OF FINDINGS</i>	<i>27</i>
6.2	<i>DISCUSSION OF METHOD</i>	<i>27</i>
6.3	<i>DELIMITATIONS</i>	<i>27</i>
6.4	<i>CONCLUSIONS AND RECOMMENDATIONS.....</i>	<i>27</i>
6.5	<i>SUGGESTIONS FOR CONTINUED RESEARCH.....</i>	<i>28</i>
	References	29
7	References	29
	Appendices	32
	Appendix I	32

Words and abbreviations

As-Built – A model of how the house is finally built, functions as the model used in the service and maintenance of the finished built product.

AIM – Asset Information Model

Bim – Building Information Modelling/Management

BMP – BIM Management Plan

BxP – BIM Execution Plan

CDE – Common Data Environment

EIR – Employer's Information Requirements

Lod – Level of development

MEP – Mechanical Electrical and Plumbing

PFD – Program for Design

1 Introduction

1.1 Background

As stated in a report from The Economist Intelligence Unit (2015), the productivity in the construction business is lacking according to most leaders in the industry. Furthermore, some results of the poor productivity are mentioned, namely a limited capacity for companies to make valuable investments, the profit margins are decreased, and the risk is increased.

Building Information Modelling (BIM) and its potential to solve many of the issues mentioned above, has been studied for at least about a decade (Gu, Singh, London, Brankovic, & Claudelle, 2008). Although BIM has been in existence for well over two decades, only during the last 10 years has the use of BIM started to realise its potential to make planning and construction of buildings more efficient. A major part of this is a flawed understanding of BIM technology, and an incomplete implementation of systematic BIM management (Arayici, o.a., 2011).

As BIM is a vast and complex subject with many components and parties, a correct and complete implementation will be time consuming and require huge assets (Hooper, 2015). However, at the present stage, BIM has developed enough that it could be used in such a way as to considerably affect the efficiency in the construction industry (Ganah & John, 2014).

1.2 Problem description

Hooper (2015) mentions in his paper BIM standardisation efforts - The case of Sweden how different Swedish research and development efforts during the last 20 years have conducted research and development projects towards the cause of standardisation and use of object oriented information management. In part these efforts lead to the creation of the Swedish BIM Alliance. In Hooper's study, people within different parts of the industry were asked how positive they were to 10 standardization projects endorsed by the Swedish BIM alliance. The one they thought was the most important was National BIM Guidelines. Furthermore, Hooper mentions how companies in Sweden like Skanska have "in house BIM standards", this in itself suggesting that there is a desire for BIM guidelines in Sweden.

Public projects in the UK are mandated to upheave a certain level of BIM implementation and standards that are available to achieve this (Hooper, 2015). The US have the national BIM Standard (NBIMS) and industry produced support documents aimed towards the use of NBIMS.

Sacks, Gurevich, & Shrestha (2016) expound upon the differences in several factors between a number of BIM guidelines/recommendations. Their document review, which included 15 BIM documents of different nationality, detail and mandate, state that there are disparities regarding the level to which each factor is mentioned in the documents.

Organisations and government bodies in Sweden have been working with BIM, despite the lack of national guidelines. In July 2017 the EUBIM Task group published the

Handbook for the introduction of Building Information Modelling by the European Public Sector (2017).

This would indicate that there are multiple ways to do go about making BIM guidelines. So, what can Sweden learn from BIM documents that other countries have already produced?

1.3 Purpose and research questions

The purpose of this study was to increase the efficiency of the planning stages in the building industry. The goal was to produce valuable information that will be useful in the future development of Swedish national BIM guidelines. This was accomplished by searching for and analysing national BIM guidelines in the world.

The research questions that were studied are listed below.

1.3.1 What national BIM guidelines exist?

In order to conduct research on national BIM guidelines, it was necessary to determine which guidelines existed in the world, as of 2017.

1.3.2 What key elements do these BIM guidelines contain?

When the national BIM guidelines had been identified, their content was analysed with focus on similarities and differences.

1.3.3 What should future Swedish national BIM guidelines contain?

Key elements that ought to be involved in future Swedish national BIM guidelines were identified, based upon the analysis conducted around research question 1.3.2

1.4 Delimitations

The study does not encompass economics, simulations, or the direct application of BIM in the production phase. BIM guides written in any other language than English were not studied.

1.5 Outline

Chapter two consists of an explanation of the chosen method and its implementation, including the connection with the research questions. The theoretical background is found in chapter three, which is comprised of four theories supporting the study. In chapter four the empiricism is presented and analysed, followed by the result in chapter five. The discussion of this study, its method, findings and delimitations are written in chapter six, together with conclusions and suggestions for continued research. References are listed in chapter seven, and appendices are found at the very end.

2 Method and implementation

The study has been conducted by following the principles of content analysis. “Content analysis is a research method that uses a set of procedures to make valid inferences from text” (Weber, 2011). Furthermore, it includes strategies of document selection, how to control information loss when sampling parts of documents, how to ascertain a concise analytical procedure throughout the project and different methods of analysing the content and differences in documents. More specifically, the analysis followed the steps listed below, set by Krippendorff (2013, p. 358).

- **Formulating research questions** - The research questions follow the flow of content analysis, namely to obtain relevant texts to analyse, locate relevant units in text and analyse the texts.
- **Ascertaining stable correlations** - Analysis of BIM guidelines against BIM guidelines.
- **Locating relevant texts** - Found and choose BIM Guidelines to analyse using BuildingSMART (2017).
- **Defining and identifying relevant units in texts** – By looking through the content and searching for keywords in the guidelines, the units relevant for the topic being analysed were found. These are also called “context units” as referred to by Krippendorff (2013).
- **Sampling these units of text** - After finding units in the guidelines a relevance sampling was done, meaning selecting and analysing relevant text.
- **Developing coding categories and recording instructions** - The relevant units, keywords used and performed analysis of the Guidelines. Are recorded in tables for each topic located in appendix 1.
- **Selecting an analytical procedure** - Quantitate analysis was performed regarding the detail level of the located units of text and frequency of inclusion in the BIM Guidelines.
- **Adopting standards** - Start with the same basic table to record the analysis in. with the countries listed vertically, horizontally, search terms and sources.
- **Allocating resources** - Not applicable since we are a team of only two persons conducting the analysis. It is more aimed towards larger teams of people.

The selection of all the BIM documents are based on the list of BIM Guides from BuildingSMART (2017) and their BIM Guides Project which had 81 BIM guides listed when this study was conducted. Out of these, documents that fulfilled the following two criteria were selected for further analysis:

1. It has to qualify as national BIM guidelines.
2. There must be an English version of the document.

2.1 Review Topics

The selected documents will be analysed in the following categories, based on the work by Hooper (2015), the research and development projects backed by The Swedish BIM alliance and the content review from Sacks et al. (2016).

BIM execution plan

“...a formal document that defines how the project will be executed, monitored and controlled with regard to BIM.” (NATSPEC, 2016, p. 3). The BxP is connected to several of the topics reviewed in this study, and may include information about “assignment of roles, responsibilities for model creation and data integration” (NATSPEC, 2016, p. 3).

“Many guides call for each project team to establish a formal and specific plan for integration of BIM in a project’s information flows, rather than stipulating these conditions in the document itself.” (Sacks, Gurevich, & Shrestha, 2016, p. 8).

Level of Development/Level of Detail

Instructions regarding the degree to which a model should be developed or detailed by each design discipline at each phase of the project. “(level of maturity, modelling requirement, level of model definition): most guides specify the degree to which a model should be developed or detailed by each design discipline at each phase of the project.” (Sacks, Gurevich, & Shrestha, 2016, p. 8).

Format standards and their application – interoperability

“Requirements that stipulate how service providers are to provide their building model data, and specifically in what formats, so that information can be exchanged between providers in any given project team and between the project and downstream information clients, such as facilities maintenance and operations.” (Sacks, 2016).

Accountability

Regulations regarding the different disciplines and their accountability and responsibility for proper deliveries of building model data, with regards to specifications on format standards. Instructions on how deliveries are to be made and with whom the responsibility lies.

Filing

Systematic naming of folders and files.

Archiving

Instruction on how information is to be stored and archived.

Modes of collaboration

“(Coordination, Clash detection): some guides dictate how project partners are to collaborate, in some cases defining technical information sharing arrangements, and in others going so far as to define the contract forms that are to be used (such as IPD).” (Sacks, Gurevich, & Shrestha, 2016, p. 8)

Operation and Maintenance Requirements

“What are the contents and formats of building information required for handover to the operations and maintenance functions?” (Sacks, Gurevich, & Shrestha, 2016, p. 8).

Simulations

Instructions on the analysis and simulation of models with BIM pertaining to energy usage and behaviour of the building in relation to requirements and specifications.

Pre-qualifications of designers (BIM proficiency)

“What is the minimum set of skills and experience in BIM required for designers and other partners to participate in a construction project, and what are the methods for establishing conformance to that set?” (Sacks, Gurevich, & Shrestha, 2016, p. 8)

BIM functions through project phases

“What are the major phases of the project, what are the deliverables in each phase?” (Sacks, Gurevich, & Shrestha, 2016, p. 8)

2.2 Investigation strategy

The research method used is content analysis with a small number of documents in form of the BIM Guidelines. The data is in the form of the comparison of the BIM guides. The discussion and analysis of each category result in quantitative comparisons, e.g. to check how often something occurs. The analysis is also based on qualitative data.

2.3 Connection between research questions and investigation strategy

2.3.1 What national BIM guidelines exist?

With BuildingSMART’s BIM Guides Project map that lists 81 BIM Guidelines. The BuildingSMART BIM Guides Project is a good resource for this because it’s made to be a resource for the creation, modification and review of BIM guides.

2.3.2 What key elements do these BIM guidelines contain?

Content analysis based on the data from the BIM Documents themselves as it is the original form of the data. Since all the documents altogether number well over some 2000 pages. Relevance sampling (Krippendorf, 2013, p. 120) was used to distil the data in this stage.

2.3.3 What should future Swedish national BIM guidelines contain?

The distilled data and quantitate results from **Error! Reference source not found.** was the foundation for identifying what Swedish national BIM guidelines should contain.

2.4 Literature study

Two main databases were used during the literature study, namely Science Direct and Google Scholar. Keywords pertaining to BIM guidelines were used in the search. When something of interest was found, other published work from the same author was searched for. The keywords used are found below.

Keywords: BIM, BIM Potential, BIM Guide, BIM Guidelines, BIM Guidelines in the world, BIM guides in the world, BIM Global, BIM Standards, National BIM Standards

2.5 Legitimacy

By collecting the information from the documents, themselves from a curated specialist organization.

The contents of the BIM documents will at first simply be listed in an excel grid with no analysis, just the answer to a visible question. Copies of these forms are provided in appendix 2.

During the Analysis of each category, cite research within that category that backs the conclusion.

3 Theoretical Background

The following text describes the underlying theory and research that has been done on BIM Guides, their necessity and formation.

3.1 Connection between research questions and theory

3.1.1 Theory A: BIM guidelines in the world

Several BIM guidelines have been created throughout the world during the last 20 years (Sacks, Gurevich, & Shrestha, 2016). As of September 2017, BuildingSMART had 81 documents listed in their BIM Guides Project (2017) from North America, Europe, Asia and Australasia. Cheng and Lu (2015) listed 123 BIM documents from the same four regions.

This theory is directly connected to research question one.

3.1.2 Theory B: Realising the potential of BIM with national BIM Guidelines

It is possible to reduce time and costs in building projects using BIM, when working after a set of rules or guidelines (Bryde, Broquetas, & Volm, 2013). In countries where no guidelines are set, organisations need to produce their own regulations on how to operate with BIM, in order to more fully unleash its potential (Gercek, Tokdemir, Ilal, & Gunaydin, 2017). The very core of BIM is organisation and structure, which implies the difficulty of realising its potential without guidelines. National guidelines may reduce the time and effort spent on planning in building projects, as organisations will not have to come up with own regulations for each project. Furthermore, when guidelines cover the entire nation, they will likely be more uniform, which will facilitate collaboration and adaption amongst different disciplines and organisations.

Understanding the resulting benefits from national BIM guidelines and how they may be realised, are requisite when determining what they ought to contain. This theory is thus connected to research questions two and three.

3.1.3 Theory C: The demand for national BIM Guidelines in Sweden

Standards are beneficial for the progress and wellbeing of society as a whole (Hooper, 2015). In construction projects, or any temporary project organisation in a fragmented industry, it is implied that standards play a vital role, even a critical one in the communication between stakeholders.

In a study by Hooper (2015), experienced BIM professionals were asked to comment on the relevance of certain standardisation projects and research themes in relation to BIM initiatives on a national scale. The statement below is found in the report.

We found broad underlying support of the ongoing BIM standardization efforts happening in Sweden. Results indicate scepticism over standardised BIM-Planning protocols such as those to be found in the US, but strong support for national BIM guidelines and associated state-driven vision. (Hooper, 2015, p. 332)

As can be seen in Figure 1, the third most important topic, or with greatest impact, was considered to be national BIM guidelines. This motivates further studies on the subject. The theory is connected to research questions two and three. There is a relation between demand and supply, suggesting that the demand affects the content of both existing and future national BIM guidelines.

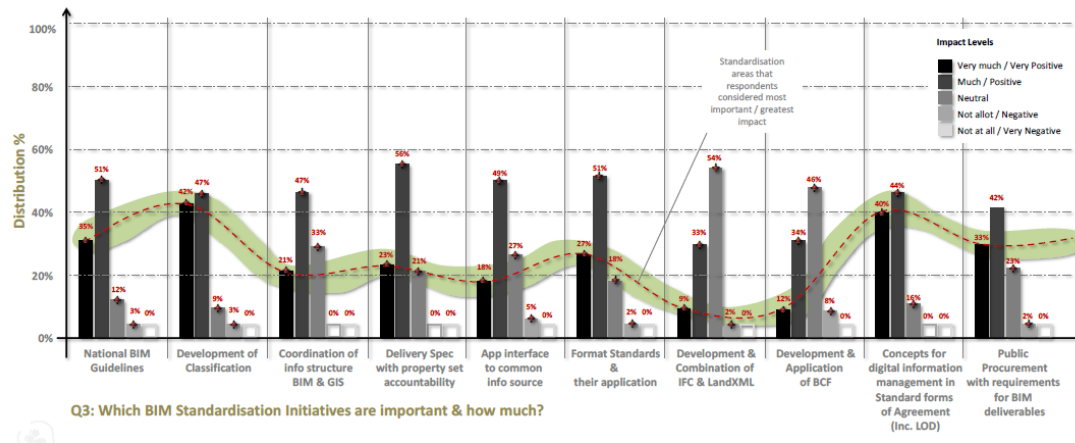


Figure 1 Diagram on important BIM standardisation initiatives (Hooper, 2015).

3.1.4 Theory D: Content of national BIM Guidelines

Several studies have been made on the subject of BIM guidelines and standards as the awareness of the importance of standardisation processes has been growing (Hooper, 2015). Sacks, Gurevich and Shrestha (2016) analysed 15 BIM guideline, standard and protocol documents and provide recommendations meant to aid organisations and governments establishing their own policies.

This study, together with the one conducted by Hooper (2015), provide an insight on what ought to be considered when studying the content of future national BIM guidelines in Sweden. The two studies have investigated similar topics with two different approaches, namely interviews and document analysis.

Both studies comprise an individual set of 10 topics with slight variation. A combination of these topics has served as the outline of issues examined in this study.

When creating new BIM guidelines, it is favourable to investigate what has been done previously on the subject. By studying the most recent BIM guidelines, it is possible to map out the categories and topics that necessarily ought to be covered in new BIM guidelines. Studying interviews with BIM experts may also provide equally important insight about relevant concerns that ought to be managed in national BIM guidelines.

This theory is connected to research questions two and three, as it expounds on what has been done in existing BIM guidelines, and what is desired to be included in future ones.

3.2 Summary of chosen theories

Theory A has a strong connection to research question number 1. The following three theories, B, C and D are all respectively more or less connected to research questions two and three, and thus even connected to each other. Realising the potential of BIM makes it easier to understand why or if there is a demand for national BIM guidelines, and whether or not the demands could be satisfied. It will also add to the explanation as to why the content of the guidelines is what it is, and consequently contribute to answering the question what future national BIM guidelines in Sweden ought to contain. The connection between the theories and the research questions is illustrated in figure 2.

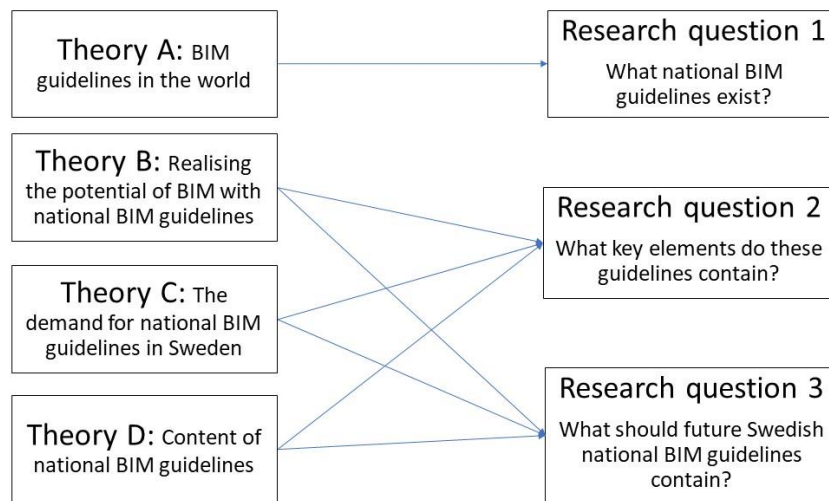


Figure 2 Illustration of the connection between the research questions and theories.

4 Empiricism and analysis

4.1 What national BIM guidelines exist?

From the 81 BIM guides all Guidelines with the “National Bim guideline” tag were chosen. This was complemented with the “other” tag which was deemed relevant because Finland was categorized under it. Since GSA BIM Series 3-8 were listed as National BIM Guidelines Series 1&2 were also included. No BIM guides from Africa or South America were listed among the 81 BIM Guides.

Table 1. List of all National BIM Guidelines chosen from BuildingSmart listed by country A-Z.

Country	Type	Name	Introduced	Last Update	Version
Australia	Natbim	NATSPEC National BIM Guide	2011	2016*	1.0
Australia	Natbim	ACIF & APCC Building and Construction Procurement Guide	2015	-	-
Australia	Natbim	National Guidelines for Digital Modelling	2009	-	-
U.S.	Other	ConsensusDocs301	2008	-	-
U.K	Natbim	CIC - BIM Protocol	2013	-	-
U.S.	Natbim	GSA BIM Series 07 - Building Elements		2016	1.0
U.K	Natbim	NBS BIM Object Standard	2014	2016	1.3
Belgium	Natbim	Building Information Modelling – Belgian Guide for the Construction Industry	2015	2015	1.0
U.S.	Single Federal Agency Guidelines	GSA BIM Series 02 - Spatial Program Validation		2015	2.0
U.S.	Natbim	GSA BIM Series 05 - Energy Performance		2015	2.1
U.S.	Natbim	NBIMS-US (National Building Information Modeling Standard - United States)		2015	2.4
Canada	Single Association Guidelines	CANBIM Protocol	2012	2014	2.0
New Zealand	Natbim	New Zealand BIM Handbook	2014	2014	-
Germany	Natbim	BIM-Leitfaden für Deutschland		2013	-
Norway	Natbim	Statsbygg BIM Manual 1.2	2009	2013	1.2.1
Singapore	Natbim	Singapore BIM Guide - Version 2.0	2013	2013	2
U.S.	Natbim	Penn State - BIM Planning Guide for Facility Owners		2013	2.0

U.S.	Natbim	The Uses of BIM: Classifying and Selecting BIM Uses		2013	0.9
Australia & New Zealand	Natbim	ANZRS - Australia & New Zealand Revit Standard	version 2 2011	2012	3
Singapore	Natbim	Singapore BIM Guide - Version 1.0	2012	2012	1
Hong Kong	Single State Guidelines	HKIBIM - BIM Project Specification	2010	2011	3.0
U.S.	Natbim	GSA BIM Series 08 - Facility Management		2011	0.5
U.S.	Natbim	Penn State - BIM Project Execution Planning Guide v2.1	2007	2011	2.1
U.S.	Natbim	GSA BIM Series 03 - BIM Guide for 3D Imaging	2009	2009	1.0
U.S.	Natbim	GSA BIM Series 04 - BIM Guide for 4D Phasing	2006	2009	1.0
Denmark	Other	bips CAD Manual	2004	2008	2
U.S.	Single Federal Agency Guidelines	GSA BIM Series 01 - Overview	2007	2007	0.6
Dutch	Natbim	Dutch National BIM Guidelines			
Finland	Other	COBIM - Common BIM Requirement	2012	-	1.0
U.S.	Natbim	GSA BIM Series 06 - Circulation And Security Validation			
U.K	Natbim	LEVEL 2 - PAS	2013	-	-

After analysing table 1, guidelines from 10 different countries were chosen for further analysis. If a country had multiple national guidelines listed, a decision of what guidelines to use was made. NBIMS was for example chosen instead of the GSA series because NBIMS is aimed towards the industry whilst GSA is intended for GSA employees and consultants. How recent and extensive the guidelines were also considered, resulting in the selection of PAS for the UK.

Table 2. Countries national BIM Guidelines chosen for further Study.

Country	Type	Name	Introduced	Last Update	Version
Australia	Natbim	NATSPEC National BIM Guide	2011	2016*	1.0
Belgium	Natbim	Building Information Modelling – Belgian Guide for the Construction Industry	2015	2015	1.0

U.S.	Natbim	NBIMS-US (National Building Information Modeling Standard - United States)		2015	2.4
Canada	Single Association Guidelines	CANBIM Protocol	2012	2014	2.0
New Zealand	Natbim	New Zealand BIM Handbook	2014	2014	-
Norway	Natbim	Statsbygg BIM Manual 1.2	2009	2013	1.2.1
Singapore	Natbim	Singapore BIM Guide - Version 2.0	2013	2013	2
Hong Kong	Single State Guidelines	HKIBIM - BIM Project Specification	2010	2011	3.0
Finland	Other	COBIM - Common BIM Requirement	2012		1.0
U.K	Natbim	LEVEL 2 - PAS	2013	-	-

The total amount of national BIM guides was 31. However, after a brief scan and overview of the 31 BIM guides, only 10 of interest remained. Several BIM guidelines listed were merely parts of other more extensive BIM guides in the list, and therefore lowered the number of actual BIM guides. Some countries did not have BIM guides in English and were therefore not selected for further study.

Table 3. BIM Guidelines not Chosen and Reason why.

Country	Type	Name	Reason
Australia	Natbim	ACIF & APCC Building and Construction Procurement Guide	NATSPEC chosen instead
Australia	Natbim	National Guidelines for Digital Modelling	NATSPEC chosen instead
Australia & New Zealand	Natbim	ANZRS - Australia & New Zealand Revit Standard	Revit Guidelines
Denmark	Other	bips CAD Manual	Cad Guidelines
Netherlands	Natbim	Dutch National BIM Guidelines	Not available in English
Germany	Natbim	BIM-Leitfaden für Deutschland	Not available in English
Singapore	Natbim	Singapore BIM Guide - Version 1.0	Old Version
U.K	Natbim	CIC - BIM Protocol	Pas chosen instead
U.K	Natbim	NBS BIM Object Standard	Pas chosen instead
U.S.	Single Federal Agency Guidelines	GSA BIM Series 01 - Overview	NBIMS-US chosen instead
U.S.	Single Federal Agency Guidelines	GSA BIM Series 02 - Spatial Program Validation	NBIMS-US chosen instead
U.S.	Natbim	GSA BIM Series 03 - BIM Guide for 3D Imaging	NBIMS-US chosen instead

U.S.	Natbim	GSA BIM Series 04 - BIM Guide for 4D Phasing	NBIMS-US chosen instead
U.S.	Natbim	GSA BIM Series 05 - Energy Performance	NBIMS-US chosen instead
U.S.	Natbim	GSA BIM Series 06 - Circulation And Security Validation	NBIMS-US chosen instead
U.S.	Natbim	GSA BIM Series 07 - Building Elements	NBIMS-US chosen instead
U.S.	Natbim	GSA BIM Series 08 - Facility Management	NBIMS-US chosen instead
U.S.	Natbim	Penn State - BIM Planning Guide for Facility Owners	NBIMS-US chosen instead
U.S.	Natbim	Penn State - BIM Project Execution Planning Guide v2.1	Included in NBIMS-US
U.S.	Natbim	The Uses of BIM: Classifying and Selecting BIM Uses	NBIMS-US chosen instead

Henceforth the guides will be referred to as stated by table 4.

Table 4. Names of National BIM Guidelines in the report.

Country	Name	Name in text
Australia	NATSPEC National BIM Guide	NATSPEC
Belgium	Building Information Modelling – Belgian Guide for the Construction Industry	B Guide
Canada	CANBIM Protocol	CANBIM
Finland	COBIM - Common BIM Requirement	COBIM
Hong Kong	HKIBIM - BIM Project Specification	HKBIM
New Zealand	New Zealand BIM Handbook	BIMinNZ
Norway	Statsbygg BIM Manual 1.2	Statsbygg
Singapore	Singapore BIM Guide - Version 2.0	S BIM
U.K	LEVEL 2 - PAS 1192-2:2013	PAS
U.S.	NBIMS-US (National Building Information Modeling Standard - United States)	NBIMS

4.2 What key elements do these BIM guidelines contain?

This chapter presents the data that was collected and analysed from the 10 BIM guidelines when determining what key elements they contain. 11 topics were reviewed in relation to each guideline, and with these topics as a foundation, key elements from each document were extracted. The subheadings of this section are based on the 11 topics, under which the data collected from each respective document is presented. The places from where the 10 national BIM guidelines were retrieved are listed in table 5.

To view the complete data collected, please refer to appendix 2.

Table 5 URLs to the sources of the 10 national BIM guidelines.

Country- BIM Guideline	Source
Australia- NATSPEC	http://bim.natspec.org/documents/natspec-national-bim-guide
Belgium- B Guide	http://adeb-vba.be/the-guide-to-bim.pdf
Canada- CANBIM	http://www.canbim.com/canbim-documents
Finland- COBIM	http://www.en.buildingsmart.kotisivukone.com/3
Hong Kong -HKBIM	http://www.hkibim.org/?p=1937
New Zealand- BIMinNZ	https://www.biminnz.co.nz/bim-tools/
Norway- Statsbygg	http://www.statsbygg.no/Files/publikasjoner/manualer/StatsbyggBIM-manual-ver1-2-1eng-2013-12-17.pdf
Singapore- S BIM	https://www.corenet.gov.sg/media/586132/Singapore-BIM-Guide_V2.pdf
United Kingdom- PAS Level 2	http://bim-level2.org/en/standards/downloads/ CIC – (http://cic.org.uk/download.php?f=the-bim-protocol.pdf)
U.S.A- NBIMS	https://www.nationalbimstandard.org/
Current as of 2017-10-17	

4.2.1 BIM execution plan (BxP)

The BIM execution plan is mentioned in all but two of the guidelines. There is a great difference in how extensive they are, from only mentioned as in the B Guide (ADEB-VBA, 2015) to a 37-page document found in COBIM thoroughly explaining the BxP (The COBIM Project, 2012).

Although the name varies slightly in some cases, the purpose of a BxP is rather similar in all guidelines where it is mentioned. Most mention the need to update the BxP throughout the project and consider it a live document.

Three of the guidelines have divided the BxP into two parts, either Design/Construction, or pre-/post-contract BxP. The NATSPEC and BIMinNZ are two of these and share more similarities in their BxPs. It is strongly connected to the LOD for example.

If the BxP is not mentioned, some documents or functions that partly may function as a BxP are sometimes indicated, as in HKIBIM and Statsbygg BIM manual.

A 37-page document is found in COBIM Series 11, which thoroughly explains what needs to be done by whom, and in what order. There are also appendices with examples of a Building Information Plan, Duties of a BIM Coordinator and a Project Schedule. (The COBIM Project, 2012).

The S BIM guide refers to the more extensive BIM Essential Guide for BIM Execution Plan, which also includes a BIM Execution Plan template, and a quick step-by-step guide. Pedagogical and easy to follow (Building and Construction Authority, 2013).

The NBIMS contain information on BxP planning in Ch. 2.3, and execution in Ch. 4.1. The BxP is the result of the BIM Execution Planning (National Institute of Building Sciences, 2017).

4.2.2 Level of Development

The study found that all BIM guidelines contained information on LOD. Some of them link to “<http://bimforum.org/LOD/>” for further details on LOD levels. A number of the guides mentions the different levels of LOD and provides descriptions what they are. Throughout the project. Several of the Guidelines states that LOD: levels through the project should be defined at the start of a project as to avoid over specifying. “It is wasteful for the supply chain to deliver a greater level of detail than is needed” (PAS 1192-2:2013, 2013).

4.2.3 Format standards and their application - Interoperability

All guidelines mention interoperability, except for BIMinNZ. Most of them also agree on the necessary use of IFC for interoperability between different kinds of software, export for energy analysis and facility management. S BIM claims that open BIM standard should be used, but it does not necessarily have to be IFC (Building and Construction Authority, 2013).

In some guidelines, there is a strong connection between interoperability and the BxP, and in CanBIM and the S BIM (CanBIM, 2014) (Building and Construction Authority, 2013).

Interoperability is not mentioned per say in COBIM, but COBIM 6 is about ensuring and maintaining quality of models, which is done by doing various checks that are described in the document.

In BIMinNZ a common data environment (CDE) is mentioned, which will be specified and rely on the BxP. The CDE is divided in two areas, Company based (CB) and Project based (PB), and is used through four distinct phases, namely Work in progress (CB), Shared(PB), Published Documentation(PB), Archive(CB) (MBIE, 2014).

The BIM collaboration format (BCF) is described in NBIMS Ch. 2.6 and uses an XML schema to carry critical information between software in an improved collaboration workflow (National Institute of Building Sciences, 2017).

4.2.4 Accountability

The study found that 7 out of 10 BIM guidelines had information concerning accountability. Among the 7 BIM Guidelines containing information the main theme concerning accountability is that should be contractually defined.

NATSPEC applies legal definitions to the model, concerning its intended purpose and the usage to determine the accountability of the model, for example binding means that

all information in the model is binding. Any faults in the model is considered the modellers responsibility. (Binding, Informational, reference, and Reuse) (NATSPEC, 2016). NBIMS-US writes that the commonly used standard contracts are not suited due to contractual terms and definitions not aligning with the workflow of BIM. It goes on further that work on new standard contracts is in the process but that it's not completed.

Meanwhile “Businesses must therefore work with legal counsel to develop and negotiate special contract clauses that include:

- Allocation of responsibility for creating information
- Appropriate access to, reliance on and use of electronic information handed over
- Responsibility for the updating and security of the data
- Ownership and downstream uses of the information, and
- Compensation for team members that recognize the costs and risks they incur and the value they deliver. “

Items from the list reoccurs in some form or another in other guidelines when explaining extend of responsibility and accountability.

4.2.5 Filing

9 out of the bim guides contained information on filing in a project. The information ranged from “The BIM models, family and drawing file names should follow a consistent file naming convention” (HKIBIM, 2011) Decide a file system protocol, document the system used along with relevant Meta data at the start of every project. Use Guideline specified file systems and naming conventions.

For example, CANBIM shown in *Figure 3* specifies that file names are to follow specific naming conventions to determine for example the model author and discipline in the file name.

1811003-DLG-MECH.dgn	Project 1811003, DLG Model Author, Mechanical, Central File
1811004-MMM-ELEC.rvt	Project 1811004, MMM Model Author, Electrical, Central File

Figure 3, CANBIM naming conventions for model files.

4.2.6 Archiving

8 out of 10 Guidelines contained information regarding archival according to the analysis. S BIM and NBIMS both bring up concerns regarding archival with S BIM stating “Before the industry is ready to accept BIM as part of the contractual documents, there is a need for project members to agree on the standard for 2D drawings that form part of the contract documents. “ NBIMS bring up the issue of storage media obsolescence and format obsolescence.

The models several guides states as the final delivery and to archive is the As-built Bim models. Several Guidelines states that the models are to be delivered with accompanying Meta data stating software used and version with B GUIDE calls these

Modell's identification (M.IDs) and states that without the (M.IDs) the model file is useless because the models capabilities and limitations are unknown.

NATSPEC requires that the final delivery is also delivered physically "All digital deliverables are to be submitted on DVD/CD with the data clearly organised and software version(s) labelled."

4.2.7 Modes of collaboration

All guidelines mentioned collaboration, but in varying levels of detail. The three main instructions found in most guidelines are about meetings, collaboration platforms and clash detection, although not all specify how clash controls are to be performed. There is usually a strong connection between the BxP and the mode of collaboration.

The necessity to segregate the model into smaller sub-models, at least in large, complex projects is mentioned in some guidelines.

According to the B Guide, the following two rules should always apply:

"An actor does not alter the contribution of another actor.

A document is exchanged/shared only if it is accurate and properly described." (ADEB-VBA, 2015).

In CanBIM it is stated that "Each separate discipline, whether internal or external, involved in a project should have its own model and is responsible for the contents of that model. A discipline can link in another discipline's shared model for reference." (CanBIM, 2014). BIMinNZ has a similar approach to this.

In the HKIBIM, the project BIM Manager oversees the collaboration.

"The BIM Project Manager should combine all of the different discipline specific models using a model compiler. The entire BIM model should be provided to all of the project team on a regular or continual basis." (HKIBIM, 2011).

Statsbygg provides some information and advice on the matter, no requirements.

In PAS it is written "Key to the process is the management of moving the data between each of the four phases (see 4.2.2, 4.2.3, 4.2.4 and 4.2.5), it is here that vital checking, approving and issuing processes are executed." (BS 1192:2007+A2:2016, Ch. 4).

4.2.8 Operations and maintenance requirements

The only guideline that did not mention this was CanBIM. In most guidelines there is a plan to in some way hand over models and data in a facility management delivery, and with it some recommendations or requirements. Others do not have a plan, like HKIBIM, where it simply states that after completion, the models may be used for facility management by the facility management team.

NATSPEC provides an example of what may be required when handing over to the facility management team. "As a minimum, facility management information should be provided in a digital form and organised and indexed in a clear, logical manner that

allows the information to be easily retrieved by anyone with basic computer skills using readily accessible software.” (NATSPEC, 2016).

No requirements are stated by Statsbygg at the moment about FM&O utilisation due to little knowledge. Amendments are anticipated as knowledge increases. It does however refer to the BIM Guide Series “Series 08 - Facility Management”⁵ by GSA. “This document is expected to provide good guidance when issued.” (Statsbygg, 2013).

In S BIM, modelling guidelines for Facility Management will be addressed in the future version of the guide.

4.2.9 Simulations

The analysis found that all of the BIM guidelines included in the study contain information about simulations. They list several different simulations, energy analysis, solar analysis, 4d and 5d planning, quantity take off and collision detection to name a few. The degree of detail varies between the guidelines. Some have entire documents dedicated to analysis and how they are to be performed, such as COBIM and NBIMS, the latter having a document for energy analysis. Other guidelines list different analyses that exist and that can be used but doesn’t provide information on how to perform them for example NATSPEC, CANBIM and Statsbygg.

4.2.10 Pre-qualifications

The study found that 7 out of the 10 BIM guidelines contained something about pre-qualifications. The majority of these BIM guidelines states in some way that. Skill and experience working with the applicable technical field and BIM is required in leading project roles to ensure project success.

Exceptions to this are HKIBIM that also states that "The BIM Modellers (technicians and operators) will have particular discipline experience (ARC, STR or MEP) with a minimum of 3 years of 3D CAD modelling knowledge." NBIMS-US has a test for users to “self-evaluate their own processes or BIMs.”

4.2.11 BIM Functions through project phases

All guidelines mentioned BIM functions, and with a relatively high level of detail. Most of the guidelines state that it should be planned out during the making of the BxP or its equivalent where such does not exist. Some guidance in the form of lists are sometimes also provided, as in NATSPEC and COBIM.

The B guide clarifies that the BIM roles do not replace the classical responsibilities and duties, but are meant to be a support to them.

The S BIM and NBIMS both have extensive matrix templates regarding BIM functions.

4.3 Summary of collected empiricism and analysis

The findings of the ten BIM guidelines and eleven review topics. Presented in *Table 6* that shows an approximated summary. Of how the different Guidelines detail levels compare to each other, how much each topic is covered and how often they are included in the guidelines. The table summarises these factors in three sets of parameters, guideline total score, review topic total score and review topic frequency. The scores are based on the detail of the review topic in a BIM guideline. If the field is empty when

the keywords did not turn up any units for analysis in the text. Mentioned means that the topic was mentioned but not described further. Detailed means the topic was elaborated on and explained. Very detailed is that specific work procedures are mentioned, or different implementations are discussed.

Table 6. Summary of empiricism, (empty)=0. ○ Mentioned=1. ● Detailed=2. ●● Very detailed =3.

BIM Guidelines Review topics	NATSPEC	B Guide	CANBIM	COBIM	HKBIM	NZ BIM	Statsbygg	S Guide	PAS	NBIMS	score Σ (Max 30)	Frequency (Max 10)
BIM Execution Plan	●●	○	○	●●		●●		●●	●●	●●	20	8
Interoperability	●	○	○	●	○		●	●	●●	●●	17	9
Modes of Collaboration	●●	●	●	○	●	●●	○	●	●	●	20	10
Operation and Maintenance Requirements	●	●		●	○	●●	●	●	●●	●●	20	9
BIM Functions Through Project Phases	●●	●	○	●●	●	●●	●	●●	●	●●	24	10
Pre-qualifications	○		●	○	●	○			○	●●	13	7
Accountability	●●	○	●●	●●				●	●●	●●	18	7
LOD	●●	●	●	●●	○	●●	○	●	●	●●	22	10
Simulation	○	○	●●	●	●	●	○	●	●	●●	19	10
Archival	●●	●	○	○			○	●	●●	●●	16	8
File System	●	●	●●	●●	○		●	●	●●	●	20	9
Guidelines Σ (Max 33)	26	16	19	24	12	18	12	22	24	28		

5 Results

5.1 What national BIM guidelines exist?

Apart from Spain, every individual country listed among the 81 BIM guides by BuildingSMART (2017) are included in Ch. 4.1. *Figure 4* shows how the ones chosen are spread across the world. The country guidelines omitted from the study due to not being available in English are all European countries (including Spain). So where are the national bim guidelines?

- Australia - NATSPEC
- Belgium - B Guide
- Canada – CANBIM
- Finland – COBIM
- Hong Kong – HKIBIM
- New Zealand – BINinNZ
- Norway – Statsbygg
- Singapore - S BIM
- United Kingdom - PAS
- USA – NBIMS



Figure 4. BIM guidelines studied across the globe.

A paper by (N.Bui, 2016) studies the BIM implementation in 135 developing countries as listed by the World Bank. They found that three countries, China, India and Malaysia out of 135 countries listed as developing countries by the World Bank had published BIM research during the period 2007-2015 with a majority of it being published in the last three years. According to (Smith, 2014) BIM usage in several countries, India, South Korea and Brazil were on the way up. But at the time the BIM use was limited. This may explain the omission of large parts of the world in the BuildingSMART BIM guide list. Simply that countries currently working with BIM have yet to produce any country wide guidelines.

This can be seen in China's establishment of China BIM Union in 2013 (China BIM Union, 2017). In a report by J.Bo (2015) where different BIM policy documents and BIM standards in China are listed, China's continued work can be seen in that China BIM union and NATSPEC signs a Memorandum of Understanding (MoU) (Miletic, 2017).

The same can be seen in Europe where the EU BIM task group published in 2017 "Handbook for the introduction of Building Information Modelling by the European Public Sector". Created by public sector organisations across 21 countries in the EU (EUBIM Task group, 2017). And in the standardization effort of the European committee for standardization technical committee 442. (CEN/TC 442) (European committee for standardization, 2017).

So there is work being conducted around the globe regarding BIM standardization and more BIM Guidelines outside of the ones listed in BuildingSMART's list are likely to exist and more are very likely to come soon.

5.2 What key elements do these BIM guidelines contain?

The figures within this section illustrate how the information is spread across the different topics and BIM guidelines based on the results from Table 6.

Table 7. Summary of empiricism, ○ Mentioned=1. ● Detailed=2. ●● Very detailed =3.

BIM Guidelines \ Review topics	NATSPEC	B Guide	CANBIM	COBIM	HKBIM	NZ BIM	Statsbygg	S Guide	PAS	NBIMS	score Σ (Max 30)	Frequency (Max 10)
BIM Execution Plan	●●	○	○	●●		●●		●●	●●	●●	20	8
Interoperability	●	○	○	●	○		●	●	●●	●●	17	9
Modes of Collaboration	●●	●	●	○	●	●●	○	●	●	●	20	10
Operation and Maintenance Requirements	●	●		●	○	●●	●	●	●●	●●	20	9
BIM Functions Through Project Phases	●●	●	○	●●	●	●●	●	●●	●	●●	24	10
Pre-qualifications	○		●	○	●	○			○	●●	13	7
Accountability	●●	○	●●	●●				●	●●	●●	18	7
LOD	●●	●	●	●●	○	●●	○	●	●	●●	22	10
Simulation	○	○	●●	●	●	●	○	●	●	●●	19	10
Archival	●●	●	○	○			○	●	●●	●●	16	8
File System	●	●	●●	●●	○		●	●	●●	●	20	9
Guidelines Σ (Max 33)	26	16	19	24	12	18	12	22	24	28		

Overall the guidelines scored 209 across the eleven review topics which is 63% of the max score 330. *Figure 5* shows how the detail score is distributed among the *BIM* guidelines. This illustrates how extensive the different bim guidelines are and how detailed they are.

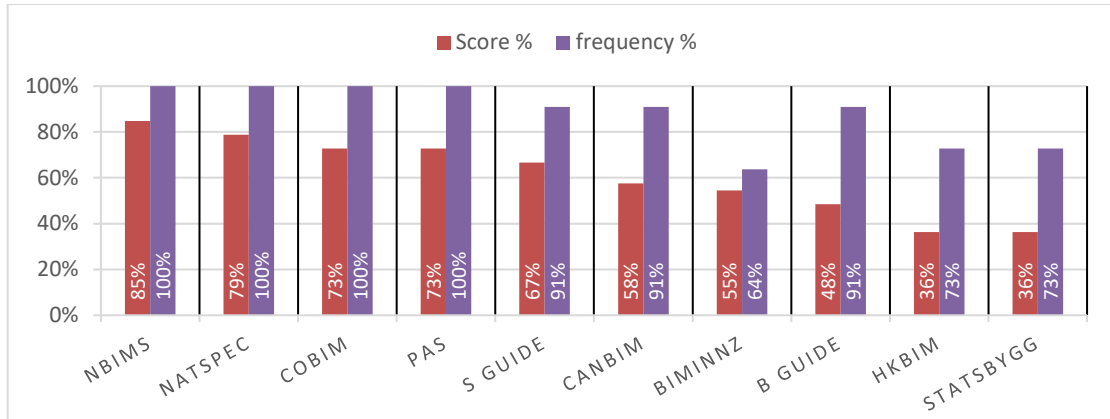


Figure 5. BIM guidelines % of total score (33) achieved and Frequency % out of 11.

All topics have a high level of inclusion, pointing to that the topics from (Hooper, 2015) and (Sacks, 2016) are relevant on a global scale. For this study that means, countries have guidelines for the topics reviewed and can be used as a tool when creating guidelines. The topics total detail score varies, Illustrated in Figure 6. Detail scores are lower the lower the frequency is. The topics are sorted after detail score and this illustrates how extensive the review topics are covered in the BIM guidelines overall.

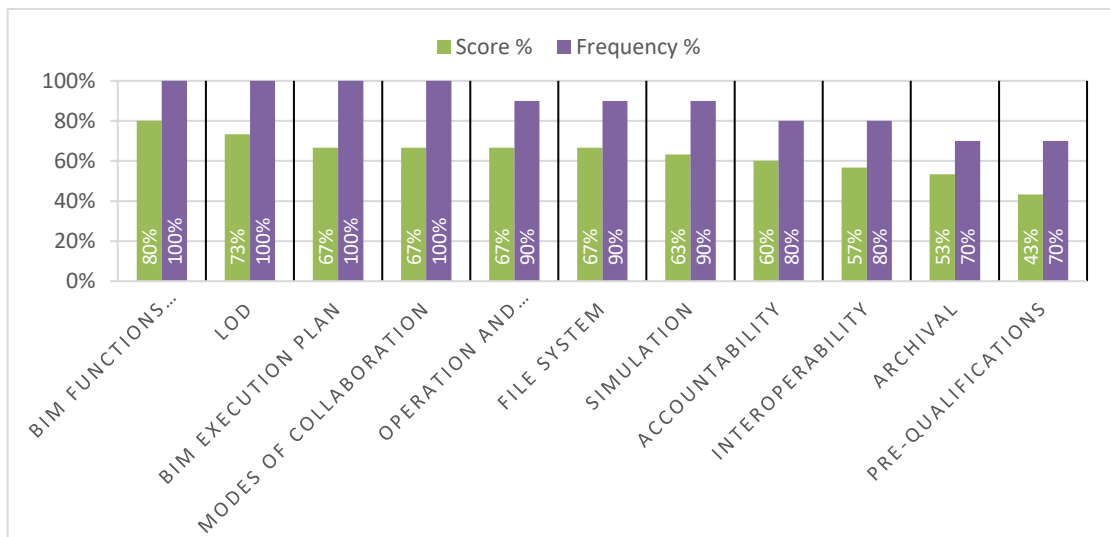


Figure 6. Frequency in %, of review topics included in BIM guidelines out of 10 and % of max score (30).

The overall score distribution is presented in Figure 7. It illustrates the distribution of scores from Table 6. 13 results from the table are that the guideline didn't contain anything about the topic, 23 mentioned the topic investigated, 38 had detailed information about the topic and 36 where very detailed.

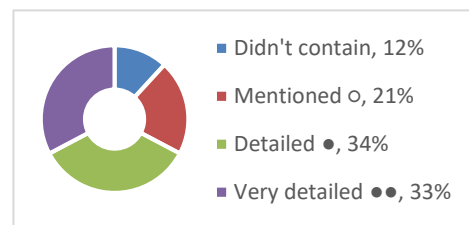


Figure 7. Detail score distribution.

Figure 7 shows that, 2 out of 3 results contain more than superficial information about the topic. Suggesting that much of the information present in the bim guidelines can directly aid in the creation of BIM guidelines (BuildingSMART, 2017).

NBIMS, CANBIM, BIMinNZ and Statsbygg. NBIMS have all topics included and generally very detailed. CANBIM with high inclusion of topics but a low detailed level compared to other guides with similar number of topics covered. BIMinNZ low frequency and high score, Statsbygg low score and high frequency.

5.3 What should future Swedish national BIM guidelines contain?

Four of the eleven topics were mentioned in all national BIM guidelines that were studied, namely:

- BIM functions through project phases
- Level of detail
- BIM execution plan
- Operations and maintenance

According to this research, these four topics ought to be included in national Swedish BIM guidelines. There may however be reason to cover all eleven topics in future Swedish national BIM guidelines, as the least represented topics were still mentioned in seven of the ten guideline documents.

Based on the extent and composition of most documents studied, national BIM guidelines ought to have the role of a framework, with instruction on work procedures. To this framework, organisations and government institutions may relate and rely on from project to project. As a BIM execution plan ought to be established early on in each project, details may appropriately be worked out during that stage.

During the analysing process it became clear that some documents were in need of an update. NBIM had documents from 2011 which had not been updated since. HKIBIM had hardware and software specifications, which tend to get outdated rather quickly. NATSPEC when describing LOD fails to mention LOD 350. This may be because it was introduced in 2011 and BIM forum introduced LOD 350 in 2013 (BIM Forum, 2013) making the guides content regarding LOD incomplete.

This would indicate that if the guide contains specifics, consideration needs to be taken regarding the longevity of the guidelines and corresponding work that needs to be performed in order to update the guide. Alternatively, some guides like CANBIM and BIMINNZ state that something ought to be in the process but doesn't in the guide itself give examples of what that would be. Consequently, the user needs to consult external documents that can always be changed from project to project so these standards function as a backbone for the process, and the user continues to add the necessary parts to make it complete for each project's needs.

To prevent problems connected to outdated documents from occurring in future Swedish national BIM guidelines, instructions for routines to keep the guidelines and their content up to date ought to be included in the guide.

5.4 Connection to purpose

All three research questions played an important role in achieving the goal, which was to produce valuable information that will be useful in the future development of Swedish national BIM guidelines. By finding and analysing the national BIM guidelines of the world, it was possible to attain information on important factors that should be included in future BIM guidelines. The BIM documents have, together with research from the literature study, provided answers to all three research questions and ultimately valuable information in the future development of Swedish national BIM guidelines.

6 Discussion and conclusions

6.1 Discussion of findings

The planning and organisational work was followed rather well. As one of the authors moved to Singapore at the final stages of writing the thesis, there was a stagnation of work for almost five months before the final presentation. This did however not affect the results as they were identified before the move.

Overall, national BIM guidelines ought to provide instruction on work procedures and how to operate, rather than specific protocols with excessive level of detail. This is to minimise the risk of getting lost in bureaucracy and legislative texts, which would defeat the purpose of BIM guidelines, which is to streamline the use of BIM. Furthermore, documents with unnecessarily high level of detail will require more work on updates.

The study has focused on the content of BIM guidelines, and virtually nothing on the usability and pedagogical qualities of them. NBIM and PAS scored highly, meaning they contain most of the topics covered in the study, and to a relatively high level of detail. They are however considerably more complicated to read and their usability is hidden beneath heavy, bureaucratic text and poor design. Natspec, which also got a high score, is more readable and user-friendly than NBIM, and could therefore be a better BIM guideline overall, despite the fact that it scored lower than NBIM. Future studies on pedagogical qualities and usability would be relevant.

6.2 Discussion of method

The method used has not provided information on usability or pedagogical qualities. Neither does it consider data from professionals using the national BIM guidelines, or to what extent the different guidelines are being used. It does however provide information on the content of national BIM guidelines, which indeed is valuable in the future creation of national BIM guidelines in Sweden. Thus, it has been a favourable way of working to accomplish the goal.

However due to using BuildingSMART as the single source of Bim guidelines the selection of guides relies on the accuracy and relevance of that information. In hindsight using more than one source for the selection of guidelines would have been preferable but at the time due to BuildingSMART's list being included in multiple sources like Sacks (2016), them being involved in the creation of Cobim (2012) and uBim spains Bimguide based on Cobim (BuildingSmart Spain, 2018). BuildingSMART were chosen as the single source.

6.3 Delimitations

The delimitation to only consider national BIM guidelines in English was decided at the start of the project, due to the authors' restrictive linguistic capabilities.

6.4 Conclusions and Recommendations

As the nature of the problem is described in 1.2, it is clear that there is room for improvement on the implementation of BIM in Sweden and a desire for Swedish national BIM guidelines. The findings of this study contribute by providing valuable information on what Swedish national BIM guidelines ought to contain, and thereby facilitate the making of these guidelines and increase their quality. Hopefully this thesis

will also add to the increasing awareness of the problem of not having national BIM guidelines.

The results of this study may later lead to a more efficient way of designing and planning in the building industry due to an increased use of BIM because of the national BIM guidelines

Recommendations in the future development of Swedish national guidelines are as follows:

- Cover all 11 topics reviewed in this study.
- Formulate guidelines as frameworks with instruction on work procedures and operations rather than strict protocols with excessive level of detail.
- Create a framework on which organisations and governments may rely and relate to, and strategically work out details in a BIM execution plan.
- Make a plan for keeping the guidelines up to date.
- Make the guidelines user-friendly and pedagogical for effective schooling and implementation of BIM procedures.

6.5 Suggestions for continued research

Further studies on the relationship between the use of national BIM guidelines and economic gain, as it is always incumbent to decipher how to streamline and save time, money and resources. Social and environmental relations to national BIM guidelines from a sustainability point of view would also be of interest, as these matters are connected to the economy, but also because a more sustainable world is indeed desirable and a direction well worth pursuing (Thomson Reuters, 2018). Pedagogical qualities and usability of guidelines would be of value, as it would give a broader and more correct view on which national BIM guidelines are exemplary.

The authors have not conducted research on what current users think about the guidelines reviewed in this study. Guidelines that got a high score do indeed contain much information, but may not be the best to use in the eyes of a professional BIM user, due to complex systems and documents for example.

References

7 References

- ADEB-VBA. (2015, October). Building Information Modelling – Belgian Guide for the construction Industry. Brussel: ADEB-VBA.
- Arayici, Y., Coates, P., Koskela, L., Kagioglou, M., Usher, C., & O'Reilly, K. (2011). BIM adoption and implementation for architectural practices. *International Journal of Building Pathology and Adaptation*, 7-25.
- BIM Forum. (2013, 08 22). *2013 LOD Specification - released*. Retrieved from BIM Forum: <http://bimforum.org/2013/08/22/2013-lod-specification-released/>
- Bryde, D., Broquetas, M., & Volm, J. M. (2013). The project benefits of Building Information Modelling (BIM). *International Journal of Project Management*, 971-980.
- BSI. (2013). PAS 1192-2:2013. United Kingdom: BSI Standards Limited.
- Building and Construction Authority. (2013, August). Singapore BIM Guide. Singapore, Singapore: Building and Construction Authority.
- BuildingSMART. (2017, 09 06). *Welcome to the BIM Guides Project*. Retrieved from BuildingSMART BIM guides Project: <http://bimguides.vtreem.com/bin/view/Main/>
- BuildingSmart Spain. (2018, 06 05). *Guías uBIM*. Retrieved from BuildingSmart Spain: <https://www.buildingsmart.es/bim/gu%C3%ADas-ubim/>
- CanBIM. (2014, September). AEC(CAN) BIM Protocol. AEC(Can)BIM.
- Cheng, J. C., & Lu, Q. (2015). A review of the efforts and roles of the public sector for BIM adoption worldwide. *Journal of Information Technology in Construction (ITcon)*, 442-478.
- China BIM Union. (2017, 12 22). *About Us*. Retrieved from China BIM Union: <http://www.bimunion.org/html/aboutUs/index.html>
- EUBIM Task group. (2017). *Handbook for the introduction of Building Information Modelling by the European Public Sector*. Brussels: European Union.
- European committee for standardization. (2017, 12 22). *CEN/TC 442 - Building Information Modelling (BIM)*. Retrieved from European committee for standardization: https://standards.cen.eu/dyn/www/f?p=204:7:0:::FSP_ORG_ID:1991542&cs=16AAC0F2C377A541DCA571910561FC17F
- Ganah, A., & John, G. (2014). Achieving Level 2 BIM by 2016 in the UK. *2014 International Conference on Computing in Civil and Building Engineering*. Orlando: American Society of Civil Engineers.

- Gercek, B., Tokdemir, O. B., Ilal, M. E., & Gunaydin, H. M. (2017). BIM execution process of construction companies for building projects. *9th International Structural Engineering and Construction Conference: Resilient Structures and Sustainable Construction*. Valencia: Universitat Politecnica de Valencia.
- Gu, N., Singh, V., London, K., Brankovic, L., & Claudelle, T. (2008). BIM: expectations and a reality check. *2008 International Conference on Information Technology in Construction*. Beijing: Queensland University of Technology.
- HKIBIM. (2011, June 13). BIM Project Specification. Hong Kong: Hong Kong Institute of Building Information Modelling.
- Hooper, M. (2015). BIM standardisation efforts - the case of Sweden. *The massive Journal*, 35-37.
- J.Bo, R. R. (2015). BIM Implementation in China: A Case Study Approach. *International Conference on Information Technology and Management Innovation (ICITMI 2015)*. Shenzhen: atlantis press. Retrieved from https://www.google.se/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjPjsHtsJvYAhVCPFAKHdpcDisQFgg4MAA&url=https%3A%2F%2Fwww.atlantis-press.com%2Fphp%2Fdownload_paper.php%3Fid%3D25840051&usg=AOvVaw0y3NGZWui2R-VePv184bj
- Krippendorff, K. (2013). *Content Analysis, An introduction to its methodology*. Thousand Oaks: Sage.
- MBIE. (2014). The New Zealand BIM Handbook. New Zealand: The Ministry of Business, Innovation and Employment.
- Miletic, B. (2017, 08 25). *NATSPEC teams up with China BIM Union*. Retrieved from Architecture and design: <http://www.architectureanddesign.com.au/news/natspec-teams-up-with-china-bim-union>
- N.Bui, C. B. (2016). A review of Building Information Modelling for construction in. *Procedia Engineering*, 487 – 494.
- National Institute of Building Sciences. (2017). National BIM Guide for Owners. USA: National Institute of Building Sciences.
- NATSPEC. (2016). NATSPEC National BIM Guide. Australia: Construction Information Systems Limited.
- Sacks, R. (2016). A REVIEW OF BUILDING INFORMATION MODELING PROTOCOLS, GUIDES AND STANDARDS FOR LARGE CONSTRUCTION CLIENTS. *Journal of Information Technology in Construction*.
- Sacks, R., Gurevich, U., & Shrestha, P. (2016). A review of building information modeling protocols. *ITcon*, 479-503.

- Smith, P. (2014). BIM implementation - global strategies. *Procedia Engineering*, 482 – 492.
- Statsbygg. (2013, December 17). Statsbygg BIM Manual 1.2.1. Oslo, Norway: Statsbygg.
- The COBIM Project. (2012, 03). COBIM Series 11 Management of a BIM project. Finland: The COBIM Project.
- The Economist Intelligence Unit. (2015). *Rethinking productivity across the construction industry: The challenge of change*. Autodesk.
- Thomson Reuters. (2018, 06 06). <http://reports.thomsonreuters.com>. Retrieved from 7 reasons the world will be sustainable: <http://reports.thomsonreuters.com/susty7/>
- Weber, R. (2011). *Basic Content Analysis*. Thousand Oaks: Sage.

Appendices

Appendix 1

The collected data from all ten national BIM guidelines

Accountability

Country	Mentioned	Search terms (accountable - responsible-e/its - law - legal - binding)	Source
Australia	yes	<p>"Legal status of the Design Model to construction:</p> <p>Binding: Imposing a legal (contractual) obligation between the author/s and recipient/s. Used in this context to mean a Design Model that represents what has to be constructed under the terms of the contract.</p> <p>Informational: A Design Model that conveys non-binding information relevant to the project that may be useful to its recipient/s. No formal claims are made about its accuracy and it is provided on an 'as is' basis.</p> <p>Reference: A Design Model that is intended to be used for 'read-only' purposes such as recording model development at different stages of the project or clash detection. Once Design Models are designated 'Reference', they shall not be edited further. Reference Design Models can be used as the basis for bid preparation but cannot form part of the contract documents. A model has to be designated 'Binding' for this purpose. Reference models shall be sufficiently accurate for their intended purpose.</p> <p>Reuse: A Design Model authorised by its authors for modification or further development by its recipients."</p>	3.2 Design BMP 13 GLOSSARY
Belgium	yes	<p>"Based on the BIM objectives, the BIM requirements are determined by the BIM process manager and the BIM discipline managers. Modelling requirements and content must be presented in all design contracts in a binding and consistent manner."</p> <p>"-- Plan the exchanges, define deadlines and moments when the models are frozen (legal aspects, clash detections, collaboration meetings)"</p>	DESIGN PHASE b.
Canada	yes	Mentions terms of usage between party's and model copyright.	2 LEGAL DOCUMENTS AND CONSIDERATIONS
Finland	yes	<p>"The quality assurance task must have a person responsible for it and if this person is not able to do the work a substitute person. Accountable parties may be for example the Chief Architect, construction consultant or other specialist authorized by the client."</p> <p>"In all cases designers are responsible for the quality of BIM files delivered. Even if the client has approved files the full responsibility remains with the designer. In other words, the responsibility is on the person who made the mistake not on the one not finding it."</p>	4.1 Appoint Person to be Accountable 2.2.3 Tasks of the Client
Hong Kong	no	BIM Project Objective specifies who is responsible for objectives, but it's not mentioned that they are accountably	2.0 BIM Project Objective
New Zealand	no	appendix G specifies key people and their responsibilities, but it's not mentioned that they are accountable.	3— Legal implications of BIM
Norway	no	"SBM does not describe legal contractual conditions – however, clauses, chapters or the entire manual may be specifically assigned a legal role in individual projects by the project management."	A.2 Out of Scope (Informative)

Appendices

Singapore	yes	"The Contractor shall be solely responsible for claims and liability arising from the use of or access to the BIM Model mentioned in items 20 to 25 below as provided under this stage." stated in a matrix with Project members involved in fulfilling the objective. items 20-25 mainly cover production and delivery of documents by different parties involved with the project.	Appendix B – BIM Objective & Responsibility Matrix
United Kingdom	yes	"Responsibility for the delivery of information in principle rests with the employer who discharges accountability to the design or construction team as appropriate. Allocation of these responsibilities shall be project specific and documented in the contract."	PAS 1192-2:2013 - 5.1 General
USA	yes	<p>states that the standard roles and responsibilities of the project member should stay the same but that the commonly used standard contracts are not suited due to contractual terms and definitions not aligning with the workflow of BIM. It goes on further that work on new standard contracts is in the process but that it's not completed.</p> <p>Meanwhile "Businesses must therefore work with legal counsel to develop and negotiate special contract clauses that include:</p> <ul style="list-style-type: none"> • Allocation of responsibility for creating information • Appropriate access to, reliance on and use of electronic information handed over • Responsibility for the updating and security of the data • Ownership and downstream uses of the information, and • Compensation for team members that recognize the costs and risks they incur and the value they deliver. " 	<p>NBIMS-US_V3_5.6_Planning_Executing_and_Managing_Information_Handover.pdf</p> <p>5.6.4.5.1.2 Contractual terms</p>

Archive

Country	Mentioned	Search Terms (ARCHIV - final delivery publish)	sources
Australia	yes	<p>"One of the primary benefits of the BIM model for the client is to use it for Facilities Management upon Occupancy."</p> <p>client is required to receive a cleaned model empty from "scrap" produced during work from the bim process.</p> <p>"Unless the project procurement strategy realigns these responsibilities, the client shall receive the following"</p> <p>"3D Geometric Deliverables – Construction Coordination Model"</p> <p>"3D Geometric Deliverables – Design Intent Model"</p> <p>"Data Deliverables"</p> <p>"2D Deliverables"</p> <p>"The Contractor shall be responsible for providing the client consolidated as-built Model(s) for all building systems."</p> <p>"All digital deliverables are to be submitted on DVD/CD with the data clearly organised and software version(s) labelled."</p>	10.10 Final bim deliverables
Belgium	no	The "M.IDS" is a document that defines and completes a specific BIM (model). Each model has its own M.IDS that identifies the model and documents its content. A model without M.IDS is useless because one does not have any information about its content and limitations.	5 COLLABORATION PLATFORM AND COMMON DATA ENVIRONMENT
Canada	no	Refer to the appropriate BIM Protocol for your specific application more information.	10.5 Model Archiving Practice
Finland	Yes	"The as-built BIMs shall be supplied to the property to be archived and utilized for the needs of operation and facility management. "	cobim_12_bim_fm_v1- 8.2 Construction project as-built BIMs
Hong Kong	no	empty	
New Zealand	no	empty	
Norway		<p>BIM authoring tool information</p> <p>Original digital storage format for BIM to be submitted to client</p>	<p>B.1 Basic BIM requirements</p> <p>6. BIM authoring tool information</p> <p>7. Original digital storage format for BIM to be submitted to client</p>
Singapore	yes	<p>"All output data from BIM models, including published, superseded and 'as-built' data, should be archived in the project folder. "</p> <p>"Before the industry is ready to accept BIM as part of the contractual documents, there is a need for project members to agree on the standard for 2D drawings that form part of the contract documents. " " All drawing sheets and extraneous views should be removed from the BIM "</p>	<p>4.3.3 Documentation after Coordination</p> <p>4.3.1 Publishing 2D Drawings</p>
United Kingdom	yes	"A process should be put in place to enable the continued availability of ARCHIVE information..."	<p>BS 1192:2007+A2:2016</p> <p>4.2.5 ARCHIVE</p>
USA	yes	<p>Archiving the data in active, online storage rather than on external media best solves the media problem.</p> <p>Requiring information to be handed over in formats that are defined by de jure standards organizations</p> <p>such as the International Organization for Standardization (ISO) is the best protection against format obsolescence.</p>	5.6.4.4.13 Storing and preserving handover information

BIM Functions Through Project Phases

Country	Mentioned	Search terms	Comment	Source	Note
Australia	Yes	Function, Functions, BIM function, BIM functions, BIM roles		Ch. 2.1 and 2.2, Implementation, p. 2 Ch. 4 BIM roles and responsibilities, p. 5	A list of roles and their responsibilities is provided in chapter 4. Chapter 2 mentions how BIM is to be implemented
Belgium	Yes	Functions	BIM process manager, BIM discipline manager and third-party control offices	p. 10-12	A short chapter about BIM functions with an illustration of the roles. Clarifies that the BIM roles do not replace the classical responsibilities and duties but are meant to be a support to them.
Canada	Yes	Function, functions, BIM function, BIM functions, Roles, BIM roles, BIM uses		Ch. 3.2, p. 12	Should be included in the BxP.
Finland	Yes	Function, functions, role, roles, bim function, bim role		CoBIM 11 ch. 3.4 p. 8 CoBIM 11 ch. 4	Should be included in the BIM plan, or linked to it. Thorough explanation on BIM role and function through each phase in chapter 4.
Hong Kong	Yes	Function, functions, role, roles, bim function, bim role		ch. 2.0, p. 2	Decided in the BIM project objective table in chapter 2.0, an approximate equivalent of a BxP.
New Zealand	Yes	Function, functions, role, roles, bim function, bim role		Appendix D Ch. 2.1, p. 10-11	Thorough explanation on BIM uses in appendix D, 31 pages. Also mentions it briefly in chapter 2.1
Norway	Yes	Function, functions, role, roles, bim function, bim role		D.1, p. 62-65	Decided when working out the BIM objectives. Guidelines on how to do that are provided in D.1. Some topics are discussed, others are only mentioned as headings.
Singapore	Yes	Function, functions, role, roles, bim function, bim role, BIM objective	The BIM Objective and Responsibility Matrix indicates the basic BIM deliverables (1) required to meet each BIM Project Objective (2). A BIM Project Objective also refers to the use of BIM in a particular stage of the project. It also shows which project members (3) are involved in each objective. Columns can be increased or reduced, depending on the number of users (by discipline) involved in the BIM process of the project (4). The last step of defining the matrix is to indicate whether the selected project member is a model author or model user for each deliverable. (5) A matrix template can be found in Appendix B.	Ch. 3, mainly 3.3, p. 11. Appendix B	Extensive matrix template on BIM objective in Appendix B. Functions are decided when working out BIM objectives.
UK	Yes	Function, functions, role, roles, bim function, bim role, BIM objective, bim process		PAS 1192-2:2013 Ch. 6.2 and 7.2	Should be included in the BxP.
USA	Yes	Function, functions, role, roles, bim function, bim role, BIM objective, bim process		NBIMS-US_V3_2.4.4.7_OmniClass_Table_31_Phases	Extensive matrix template complicated to use. Clear definitions of the number codes. Excel-files.

BIM Execution Plan

Country	Mentioned	Search terms	Comment	Source	Note
Australia	Yes	BIM Execution Plan, BIM Management Plan	<p>"It is required that a BMP be developed to provide a master information/data management plan and assignment of roles and responsibilities for model creation and data integration at project initiation."</p> <p>"The BMP shall align the project procurement strategy needs and requirements with the PFD, client technical standards, team member skills, construction industry capability, and technology maturity. Through this process, the team members and the project management shall jointly agree on how, when, why, to what level, and for which project outcomes BIM will be used."</p>	Natspec National BIM Guide ch. 3, p. 3-5	Called BIM Management Plan. Divided in Design BMP (18 points) and Construction BMP (17 points). These two are further divided in three categories, namely <i>Project Scope</i> , <i>Exchange Considerations</i> and <i>Modelling Considerations</i> . The use of software that is not Industry Foundation Class (IFC) compliant in the preparation of models is only permitted with the approval of the client. BMP is strongly connected to the LOD.
Belgium	Yes	BIM Execution Plan	<p>"document exchange with the third-party control office is treated in the BIM execution plan; -- rules with respect to production of execution drawings used in factory or on site, are described in the BIM execution plan as well"</p>	The guide to Building Information Modelling, ch. "BIM Functions", p. 10-12	Mentions BxP twice but has no proper description. Refers to it but is not explained anywhere. Seems like the BxP falls under the responsibility of the BIM Process Manager (BIM Functions 1, p. 10).
Canada	Yes	BIM Execution Plan	<p>"A BIM Execution Plan (BxP) is a living, collaborative document used to communicate the overall vision and procedures for BIM implementation to project stakeholders. Developed at the early stages of a project, the BxP should continually grow and be updated according to changing project requirements."</p> <p>"· Identify the appropriate BIM goals and uses for the project. · Design the BIM execution process. · Define the BIM deliverables. · Identify the supporting infrastructure needed to successfully implement the plan."</p>	AEC(CAN) BIM Protocol, ch. 3.1, p. 12	Includes an IDM (Information Delivery Manual).
Finland	Yes	BIM Execution Plan, BIM Execution, BIM Management	<p>"The objectives for the use of building information modelling are concretized in the design program, which is prepared during the design preparation stage at the latest, and in the BIM plan linked to or included in this."</p>	COBIM 11, ch. 3.3, ch. 4	A 37-page document called "COBIM 11 Management of a BIM project" has an extensive explanation on what needs to be done, by whom, and in what order. Appendices with examples of a Building Information Plan, Duties of a BIM Coordinator and a Project Schedule.

Hong Kong	No	BIM Execution Plan, BIM Management	"Project Team Interaction, Revision Management, Quality Control, Drawing & Documentation Production, Statutory Submissions, Quantification" are all included in ch. 3 about BIM Methodologies and Processes, which is the closest thing to a BxP in the document.	HKIBIM Project Specification	No real BIM Execution Plan is mentioned. BIM Project Objective, a list of what is required and not and what discipline is responsible for the delivery. In ch. 4, the role of the BIM Project Manager is described. It seems like the purpose of a BxP would fall under that person. Ch. describes the "BIM Methodologies and Processes", which could serve as a framework for something filling the purpose of a BxP.
New Zealand	Yes	BIM Execution Plan	Design BxP <ul style="list-style-type: none"> • project information • key project contacts • project goals • BIM Uses • information management and exchange • collaboration • project deliverables • quality control • model element authoring schedule • reference documents and standards. Construction BxP Same as Design BxP, and <ul style="list-style-type: none"> • Handover model and data details 	The New Zealand BIM Handbook, ch. 4.4, p. 16-17, ch. 4.7, p18-19	Similar to Australia there are two BxPs in the document, "The Design BxP" and "The Construction BxP". Thorough examples and pedagogical templates are included in appendices. The Design and Construction BIM Execution Plans are live documents and should be updated if project drivers change.
Norway	No	BIM Execution Plan, BIM Management		Ch. D.3, p. 75, (p. 88-95)	In ch. D.3 on p. 75 there is a list of things to do before modelling, which may serve as a part of a BxP. Project Specific Contract Addendum (Informative) on p. 88-95, serving as a legal document, project-specifically declaring how BIM is to be implemented.
Singapore	Yes	BIM Execution Plan	<ul style="list-style-type: none"> · Project information; · BIM goal & uses; · Each project member's roles, staffing and competency; · BIM process and strategy; · BIM exchange protocol and submittal format; · BIM data requirement; · Collaboration procedures and method to handle shared Models; · Quality control; and · Technology infrastructure & software 	Ch. 2, p. 3-4	<p>Short and sweet, stating 9 points to cover, and some explanation on why. Refers to the more extensive "BIM Essential Guide for BIM Execution Plan", which also includes a BIM Execution Plan template, and a quick step-by-step guide. Pedagogical and easy to follow.</p> <p>"Updates to the BIM Execution Plan should be made with the permission of the Employer or his appointed BIM Manager and should not go against conditions of the Principal Agreement."</p>
UK	Yes	BIM Execution Plan, BIM Execution, BIM Management		ch. 6.2, p. 14 7.2, p. 16	There are two kinds of BEP in PAS, one Pre-contract BIM execution plan, and one post contract-award BIM execution plan. Both BEPs are to include everything in the EIR (Employer's Information Requirements) plus some additional points mentioned in 6.2 and 7.2. The post contract-award BEP is considerably more specified and extensive.

USA	Yes	BIM execution plan, BIM execution, Execution Plan, BIM Management		<p>Nat BIM Guide for Owners, ch. 2.3 and 4.1.</p> <p>NBIMS- US_V3_5.4_BIM_PxP_Content</p> <p>NBIMS- US_V3_5.3_BIM_PxP_Guide</p>	<p>Explains the meaning of a BxP thoroughly. Information on BxP planning (Ch. 2.3) and execution (Ch. 4.1). The BxP is the result of the BIM Execution Planning. BxP should be considered a living document that evolves throughout the project.</p> <p>PxP Content explains what a BxP should contain. The PxP Guide provides guidelines on a structured procedure for creating and implementing a Building Information Modelling (BIM) project execution plan</p>
-----	-----	---	--	---	---

File system

Countries	Mentioned	Search terms (Folder- file- name- data)	sources
Australia	yes	"the Design and Construction Teams shall define a file protocol for the team during the development of the BIM Management Plan (BMP)." followed by guidelines for the folder structure	11.1 Project Folder Structure
Belgium	yes	Allow an organised files storage (e.g. tree structure)	H. MODEL IDENTIFICATION AND INFORMATION DATA SHEETS – MODEL.IDS/M.IDS
Canada	yes	"Project folders are an important part of being able to support multiple users on workshare enabled projects. The following recommendations are made to establish primary content locations in order to support these shared projects." 7.2 Shared Content Folder Structure 7.3 Local Project Folder Structure 7.4 Project Folder Structure	10.5 Model Archiving Practice 7 PROJECT FOLDERS Introduction 8 PROJECT NAMING CONVENTIONS
Finland	yes	"The BIM specification depicts the source data of the inventory model, modelling principles and other issues affecting the use or the reliability of the model." "Guideline Matters to be documented: -software used -coordinate system, coordinate corresponding points and information on names, amount and location of stories -naming conventions of files and building elements	cobim_2_inventory_bim_v1 - 3.8 BIM specification
Hong Kong	yes	" The BIM models, family and drawing file names should follow a consistent file naming convention"	3.2.4 File Management
New Zealand	No	empty	
Norway	yes	BIM file naming conventions "Statsbygg currently uses the database/client program tool dRofus – http://www.drofus.no for expressing the Requirement BIM."	8. BIM file naming conventions
Singapore	yes	"Validation of BIM data to be used for Cross-Disciplinary Model Coordination" "File format and naming conventions conform to project Data Exchange protocols. "	4.5 QUALITY ASSURANCE AND QUALITY CONTROL
United Kingdom	yes	Has a chapter dedicated to naming, directory's and Containers (folders)	BS 1192:2007+A2:2016 5Naming of containers
USA	yes	"select an appropriate form and format for their handover and determine metadata requirements."	5.6.4.3 Information handover requirements

Format standards and their application - Interoperability

Country	Mentioned	Search terms	Comment	Source	Note
Australia	Yes	Interoperability	<p>"All BIM software used on the project shall be as documented in the <i>Project BIM Brief</i>."</p> <p>"Preference is given to object-oriented software applications that comply with current industry interoperability standards and are able to be used in a collaborative environment."</p>	<p>Project BIM Brief</p> <p>Natspec national BIM guide v 1 Ch. 9 "Technology platform and software"</p>	<p>All client required BIM software need to be approved and shall be determined in the BMP. Follow the "Project BIM brief". IFC in model authoring to both use and export IFC files without geometric data loss. Commercially available model Checking software with interoperability between the different software applications. Traditional 2D documentation prepared with approved IFC compliant BIM authoring software and plans, elevations, sections, schedules and details. BIM based energy analysis software should support IFC. BIM software support tools to be configured and operated as to not compromise the integrity of the model.</p>
Belgium	Yes	Interoperability, collaboration platform	<p>"Reducing the amount of imports and exports will always reduce the number of errors and the number of unnecessary reworks and increase the quality of the embedded information."</p> <p>"A process reducing the needs for export/import cycles will allow less information losses. However, even when using different software products, the information can easily be shared if well-structured and hierarchized."</p> <p>"A distinction between one-way and two-way exchanges has to be made in order to optimize the collaborative process (if one needs to read the information a pdf/picture/3d model is sufficient but if one needs to edit it, an editable document is more convenient)."</p> <p>"If a "simple" one-way exchange is sufficient for a specific task, then do not implement a "complex" two-way exchange."</p> <p>"There is no need to export a full model if a simple data sheet/document is able to store the information needed."</p>	Ch. 5, p. 23	<p>No requirement to use IFC. Information on the matter a little scattered. Much text on inefficient, older ways of solving interoperability and too much basic explanations. Seems like old logic, despite the fact that the guide is from 2015.</p> <p>"Sending documents by e-mails is not a solution in the context of thorough collaboration and document sharing because it generates issues related to doubles and revisions management."</p> <p>Advices to use a collaboration platform. No specific platform has to be used, only one that fulfils all the criteria listed in ch. 5 (p. 24-24).</p> <p>"A practical working process and a list of practical collaboration rules still have to be determined by the BIM coordinator and the BIM discipline managers."</p> <p>Two main rules should always apply: "An actor does not alter the contribution of another actor. A document is exchanged/shared only if it is accurate and properly described."</p>

Canada	Yes	Interoperability	<p>"Interoperability allows for the concept of geometry and data to flow smoothly between major project phases (Design, Design Development, Contract Documents, Construction, and Operation). As a guiding principle, keep models in their native authoring formats to help maintain model integrity, reduce data loss, and reduce rework. Interoperability relies heavily on the project BxP and helps facilitate data transfers.</p> <p>Modelling protocols are required for interoperability to help promote data transfer with minimal reworks and data loss. To help support downstream modelling, the protocol should be stated within the project BxP and strictly adhered to." (This is everything that is mentioned in the guide)</p>	CanBIM ch. 4 "Interoperability" p. 15	Interoperability relies heavily on the BxP.
Finland	Yes			COBIM 6	IFC is to be used for various checks. Interoperability is not mentioned per say, but COBIM 6 is about ensuring and maintaining quality of models, which is done by doing various checks that are described in the document.
Hong Kong	Yes	Interoperability	<p>"The models will all be created using suitable BIM authoring software applications that allow the assembly of data rich models and the production and checking of co-ordinated documentation. In order to allow BIM model interoperability, the BIM authoring tools must be IFC compliant." (That is all)</p>	HKIBIM ch. 3.7, p. 23	Must be IFC compliant, not much more than that. Scarce.
New Zealand	Yes	Common data environment	<p>The use of a Common Data Environment (CDE) will be specified in the Design BIM Execution Plan as a means of managing project information. The Common Data Environment is defined as a single source of information for any given project. It functions as a digital hub within which project stakeholders can collect, manage and disseminate all relevant approved project data in a managed environment. This data includes Building Information Models, drawings, reports and all other project-related information.</p>	BIMinNZ ch 4.5, p. 17-18	Use a common data environment, which will be specified and rely on the BxP. The CDE is used through four distinct phases, namely Work in progress (CB), Shared(PB), Published Documentation(PB), Archive(CB). Two main areas comprise the CDE, Company based (CB) and Project based (PB).

Norway	Yes	IFC, Main targets, Generic requirements	"A digital 3D building information model (subsequently denoted as "the BIM" or similar) based on object-based design (using objects with properties and relationships) and using open BIM standards/formats is a main deliverable. This implies that the Model Element Authors (MEA) must use a suitable object-oriented BIM authoring tool that efficiently supports the specified open standards as defined in this specification. "	Statsbygg BIM-manual, ch. B1, p. 10, ch. D.1 p. 64, C11 #132	Open BIM author software. IFC is required when submitting to client, both IFC STEP and ifcXML, Part 28 files are accepted. IFC 2x3. "Designed Geometric 3D Inter-disciplinary Coordination" is a headline under D.1 on page 64, but has no text under it, and it "appear(s) on the list because they(it) have (has) a potential "productivity effect" utilising open BIM data exchange for one or more stakeholders in the AEC value chain". It is mentioned that "as-built" BIM Models will have to be transformed into "Facility Management and Operations BIM models", but statsbygg claims the do not possess enough knowledge on the matter, so no specific requirements have been stated. Anticipated to be amended in time.
Singapore	Yes	Collaboration, Cross-disciplinary model coordination	"A typical BIM process involves model creation (1), model coordination and data exchange (2) involving a team of model authors and users. Upon resolution of identified issues (e.g. coordination clashes) during each project milestone, a version of model can then be frozen and released to the model users (3). "	Singapore BIM Guide v.2, ch. 4, 4.2, p. 15, 17	Strongly connected to BxP. Open BIM standard, not necessarily IFC, could be any of the open prevailing format. Freezing models.
UK	Yes			Ch 3, 4, 5, 7 PAS 1192-3:2014	
USA	Yes		The BIM Collaboration Format (BCF) represents a standard for communication between BIM Models. The BCF format allows for all parties involved transferring critical information and viewpoints between individuals independent of the software being used. The BCF uses an XML schema to carry critical information between software in an improved collaboration workflow.	2.6; BIM Project execution planning guide p. 24	The BCF uses an XML schema carry critical information between software in an improved collaboration workflow. In most real-life projects import IFC models from other disciplines.

LOD

Countries	mentioned	Search Term, LOD	Source
Australia	Yes	Defined in glossary with lod 100, 200, 300, 400, 500 with each described. The guide is also accompanied with a document "NATSPEC BIM Object-Element Matrix" that among other things defines lod at different stages of a buildings lifetime.	13 glossary, 1.3 natspec Bim Guide Documents
Belgium	yes	describes Lod 100, 200, 300, (350), 400, 500, gives document for the user themselves to define Lod through the project	4.2. Model content and level of developments, Annex F
Canada	yes	describes that the information exchange should be documented in an information exchange worksheet and that different levels of lod should be defined through different stages through the project. It links to http://bimforum.org/lod/ for further information on lod levels	3.4 Information Exchanges & Software Proficiency, Appendix A - Definitions and terms
Finland	yes	requires the level of detail to be defined when an order for the modelling is placed. gives guidelines in cases concerning LOD and how to use them in a model. Doesn't mention specific lod levels. Ex LOD 100	series 7 Quantity take-off - 3.4 Level of detail of the BIM
Hong Kong	yes	mentions Level of detail but the information given is more akin to object attributes.	3.1 Model data & Level of detail
New Zealand	Yes	links to https://bimforum.org/lod and specifically explains the differences between Lod 300 and lod 250. Specifies the lod delivery thought the project phases with a Model Element Authoring Schedule (MEA) established during the bim execution plan. Appendix with all definitions lod 100-500+ 350	4.6 Model Element Authoring Schedule, 5.4 Level of development (LOD) appendix C levels of development definitions
Norway	No	"The level of detail to which the model shall be developed is somewhat dependent on the contract and must be agreed in the project (dependent on the contractor/sub-contractor and when they enter the project). "	C.5 Structural Engineering Modelling
Singapore	Yes	links to https://bimforum.org/lod for specifications "There are a number of national and international efforts attempting to define and standardise the attributes for each BIM element. It is recommended that attributes of a BIM element be determined to meet their intended usage so as to avoid over specifying. References include: VA Object/Element Matrix www.cfm.va.gov/til/bim/BIMGuide/downloads/oemf.xls : Level of Development (LOD) Specification bimforum.org/lod/ " "This chapter defines "what" – the BIM deliverables" to be produced by the respective project member(s) at different stages of a project to meet a set of BIM objectives." "BIM project deliverables should be agreed upon together with deliverable dates at the start of the project and after the main project members have been appointed so as to accommodate their participations."	3.2 ATTRIBUTES OF BIM ELEMENTS
United Kingdom	Yes	"The minimum level of detail needed by the team or the employer for each model's purpose shall be defined. NOTE 1 Key to the success of information management is clear definition of requirements as defined by the information exchanges and including COBie and geometry. NOTE 2 It is wasteful for the supply chain to deliver a greater level of detail than is needed which may also overload the IT systems and networks available." and requires that the lod levels are defined in EIR and the CIC BIM Protocol (2013). and should be "defines with reference to industry standards."	9.8 Levels of model definition
USA	Yes	links to - http://bimforum.org/lod/ "The intent of the Specification is to help explain the LOD framework and standardize its use so that it becomes more useful as a communication tool. It does not prescribe what Levels of Development are to be reached at what point in a project but leaves the specification of the model progression to the user of this document."	NBIMS-US_V3_2.7_LOD_Specification_2013 2.4.7.1 Version

Modes of Collaboration

Country	Mentioned	Search terms	Comment	Source	Note
Australia	Yes	Collaboration, clash detection	<p>"In the absence of existing documented information management standards mandated by the client, the BIM Team shall nominate the Collaborative Information Management Standard to be used on the project"</p> <p>At a minimum, the Collaborative Information Management Standard shall address the following: Lines of responsibility. Modes of communication. Reporting procedures. Approval and Sign-off procedures. Information management and exchange protocols. Model sharing protocols. Model coordination procedures. Model and drawing versioning procedures.</p> <p>Prior to each fabrication submittal for approval, fabrication contractors shall submit their models to the Contractor's BIM Manager for integration and clash detection/coordination and resolution.</p>	Ch. 6, p. 9, Ch. 7.6.1, p. 13-14 for clash detection	<p>Mentions topics that should be covered, however little specification. Face-to-face meetings are recommended. Remote web conferencing may only be used if no other practical alternative exists.</p> <p>Extensive info on clash detection, however no specs on what software or way of checking. Minimum of things that should be checked are listed.</p>
Belgium	Yes	Collaboration, clash detection	<p>"Reducing the amount of imports and exports will always reduce the number of errors and the number of unnecessary reworks and increase the quality of the embedded information."</p> <p>"A process reducing the needs for export/import cycles will allow less information losses. However, even when using different software products, the information can easily be shared if well-structured and hierarchized."</p> <p>"A distinction between one-way and two-way exchanges has to be made in order to optimize the collaborative process (if one needs to read the information a pdf/picture/3d model is sufficient but if one needs to edit it, an editable document is more convenient)."</p> <p>"If a "simple" one-way exchange is sufficient for a specific task, then do not implement a "complex" two-way exchange."</p> <p>"There is no need to export a full model if a simple data sheet/document is able to store the information needed."</p>	Ch 5, p. 23	<p>"Sending documents by e-mails is not a solution in the context of thorough collaboration and document sharing because it generates issues related to doubles and revisions management."</p> <p>Advices to use a collaboration platform. No specific platform has to be used, only one that fulfils all the criteria listed in ch. 5 (p. 24-24).</p> <p>"A practical working process and a list of practical collaboration rules still have to be determined by the BIM coordinator and the BIM discipline managers."</p> <p>Two main rules should always apply: "An actor does not alter the contribution of another actor. A document is exchanged/shared only if it is accurate and properly described."</p> <p>Nice visual image on page 14</p> <p>Coordination meetings to include clash detection reports.</p>

			<p>"Different BIM authoring applications have different requirements for collaborative working. Please refer to the appropriate BIM Protocol for your specific application. If one has not yet been created, please contact the CanBIM Designers Committee to discuss the creation of a new BIM Protocol for your specific application"</p> <p>"Worksets" Refer to the appropriate BIM Protocol for your specific application more information.</p> <p>Element Management Refer to the appropriate BIM Protocol for your specific application more information."</p>		<p>Use linking model files. In large, complex projects, segregate the model into smaller sub-models (to what extent documented in the BxP, determined by lead architect and/or engineer in conjunction with BIM Co-ordinator). Task allocation should be considered to minimize the need to switch between models. Real world coordinates established using "shared coordinates" for relinking models with "project Location" tools. Each sub-model should be reopened, and the other sub-models linked in as required using the "Specify Shared Coordinates" insertion method.</p> <p>"Each separate discipline, whether internal or external, involved in a project should have its own model and is responsible for the contents of that model. A discipline can link in another discipline's shared model for reference."</p> <p>Not much on clash detection, mentioned under "Model Consolidation". Coordination meetings weekly, Issue resolutions (solve problems early on).</p>
Canada	Yes	Collaboration, organization		Ch. 6, p. 20, Ch. 11, p. 32	
Finland					
			<p>"As a minimum, the design consultants should share, link and exchange drawings and BIM models with all of the other project participants. Every project team member should have access to the models. Each model author should be able to link or reference to other discipline models and they should have direct access to make modifications to the data in their own discipline specific model."</p> <p>"After the commencement of construction, the contractor will control the integration of design changes into the model. The BIM Project Manager should maintain a register to record the latest information incorporated in the model."</p> <p>Six topics: Project Team Interaction, Revision Management, Quality Control, Drawing and Documentation Production, Statutory Submissions, Quantification</p>		<p>Much responsibility on BIM Project Manager</p> <p>"The BIM Project Manager should combine all of the different discipline specific models using a model compiler. The entire BIM model should be provided to all of the project team on a regular or continual basis."</p> <p>"During the construction stage, it is anticipated that the main contractor will manage the BIM models."</p> <p>The BIM Models will be used to determine if there are any clashes, not specified how. Clashes will be identified and documented by BIM Project Manager.</p>
Hong Kong	Yes	BIM Methodologies , Processes		Ch. 3.3, p. 18, Ch. 3.4, p. 21	

New Zealand	Yes	Collaboration, clash detection	<p>"One of the key benefits of the BIM process is the ability to coordinate modelled elements. Significant savings can be made on site by resolving coordination issues in the modelled environment."</p> <p>"Each Discipline BIM Coordinator is responsible for ensuring that the models they are responsible for are coordinated both within themselves and with the other disciplines. Major coordination issues should be resolved prior to models being federated and run through clash detection programmes. Further information on model coordination is provided in Appendix I."</p>	<p>Ch. 4.4, p. 16, Ch. 4.5, p. 17 Ch. 4.7, p. 19. Ch. 5.6, p. 21</p>	Relies heavily on BxP. Collaboration is to be decided and included in the BxP (both Design and Construction).
Norway	Yes	Collaboration, Clash Detection, process		<p>Building Information Modelling spin-off deliverables, p. 81</p>	<p>Informs about BCF (BIM Collaboration Format), no requirement. Also informative on Consistency check (Architectural and Structural), Verifying design area (all projects)(Two ways to do this, it is recommended to always do both, Solibri and spatial program in dRofus), Clash Detection / Coordination. Important to use the same coordinate system and orientation, recommended to test the exchange of discipline models at an early stage to ensure a correct starting situation.</p>
Singapore	Yes	Collaboration, Clash Detection	<p>"Proper search sets and clash rules should be set up before running the respective coordination processes, to:</p> <ul style="list-style-type: none"> · Reduce time and resources spent on detecting false positives. · Hide elements that are unnecessary in the coordination process, for example, known issues that are to be resolved in later project stages; elements that do not impact the cost when changed on site, etc · Group particular elements for a specific type of coordination process, such as forming groups between a ceiling search set and an MEP model only during a clash analysis" 	<p>Ch. 4.2, 4.2.1, 4.6, 4.7</p>	<p>Strongly connected to BxP. Project members to share their models at regular intervals. At certain milestones models from different disciplines should be coordinated to resolve potential conflicts and avoid clashes and expensive abortive works and delays. Recommends common software platform for effective coordination.</p> <p>Collaboration is explained in ch 4.6 and 4.7 (Workflow of projects).</p>
UK	Yes		<p>"Key to the process is the management of moving the data between each of the four phases (see 4.2.2, 4.2.3, 4.2.4 and 4.2.5), it is here that vital checking, approving and issuing processes are executed."</p>	<p>BS 1192:2007+A2 :2016, Ch. 4</p>	<p>Process and CDE. Four phases to the CDE (Work in progress, Shared, Published Documentation and Archive). Short, concise, illustrations. CDE and AIM are also mentioned in PAS 1192-3:2014 Ch. 5.</p>
USA	Yes		<p>"The BIM Collaboration Format (BCF) represents a standard for communication between BIM Models. The BCF format allows for all parties involved transferring critical information and viewpoints between individuals independent of the software being used. The BCF uses an XML schema to carry critical information between software in an improved collaboration workflow."</p>	<p>NatBIM guide for owners, Ch. 2.2.4, p. 7</p>	<p>Should not solely depend on information exchange, but also schedule regular BIM coordination meetings. During such meetings the model should be available as a shared model to all involved. Exactly how the collaboration is to happen should be decided and documented in the BxP.</p>

Operation and Maintenance Requirements

Country	Mentioned	Search terms	Comment	Source	Note
Australia	Yes	Operation, Maintenance, facility management, facility	<p>"Final BIM Deliverables requires that as-built BIM Model(s) be submitted at the end of construction for this purpose."</p> <p>"Facility Management: Portions of this life-cycle oriented data format may be required for a variety of different building information deliverables that will replace paper deliverables. The deliverables for the FM Handover MVD in a COBie format include but are not limited to:</p> <ul style="list-style-type: none"> o Verification of the design solution against the Program for Design (PFD). o Scheduled building and equipment lists. o Construction submittal register requirements. o Identification of installed equipment and all tagged building products. o Facility handover deliverables." 	Ch. 2.5, p. 3, Ch. 3.2, 3.3, 4.2, 7.7	<p>Provide portable documents in PDF (documents that normally provided in traditional paper-based format).</p> <p>"Strategy for integration of Facility Management information" is a part of the BMP (Both Design and Construction BMPs).</p> <p>Design Team Manager has requirements on FM deliveries.</p> <p>"As a minimum, facility management information should be provided in a digital form and organised and indexed in a clear, logical manner that allows the information to be easily retrieved by anyone with basic computer skills using readily accessible software."</p> <p>Facility managements requirements should be defined, typically "Space management and tracking, Asset management, Maintenance Scheduling, Building Performance Analysis".</p>
Belgium	Yes	Operation, Maintenance, facility management, facility	Deliver as-built models in highest LOD, namely LOD500. In addition, a human-readable file is delivered (CSV, IFC, XML) that contains as much as possible of the BIM data. Ideally, this data file can be imported automatically into existing Facility Management Information Systems (FMIS). This second process is similar to the COBie procedure used in the US.	Ch. Maintenance Phase, p. 38	<p>The owner, helped by the BIM process manager defines the aim and expected use of the Building Information Model:</p> <ul style="list-style-type: none"> -- Determine the use of BIM and thus, define to what extend the model will be developed: -Support collaboration including operation (maintenance, facility management, demolition).
Canada	No	Operation, Maintenance, facility management, facility			
Finland		Operation, Maintenance, facility management, facility			
Hong Kong	Yes	Operation, Maintenance, facility management, facility		Ch. 3.3.1, p. 19	"On completion of the construction works and handover to the client, the facility management team may use the BIM model and databases for facilities management."

New Zealand	Yes	Operation, Maintenance, facility management, facility	<p>"the analysis of the design information/model can improve the construction and operational safety of a facility by using it during the safety in design review process"</p> <p>"Outputs from the BIM process can feed into the FM/AM Plan, for example, the migration of asset data into the Computer Aided FM System (CAFM) system. Alternatively, the FM/AM Plan can feed directly into the Project BIM Brief, for example, the asset data and record model requirements."</p>	Ch. 1.4, p. 7, Ch. 4.8 p. 19, Ch. 7, p. 23-24	<p>Facilities Management/Asset Management Plan is the client's strategy for the ongoing operation of the built asset. The plan can include items such as:</p> <ul style="list-style-type: none"> • asset data hierarchy • asset data requirements • asset information strategy • preventative maintenance strategy • As Built model/documentation requirements. <p>The end of chapter 7 describes a recommended approach. Connected to Project BIM Brief and BxP.</p>
Norway	Yes	Operation, Maintenance, facility management, facility	"The "as built" BIM does not necessarily contain the relevant information required for Facility Management and Operations (FM&O) purposes. Some parts of the BIM information may be relevant for design and construction purposes only. Other parts are in a sense relevant but may not be within the scope of what FM&O is designed to update and maintain over time. For these reasons the "as built" BIM will typically need to be transformed into a "FM&O BIM" – i.e. create a partial extract model for relevant FM&O use. This will typically be carried out on a model server."	C11, #132 p. 60, C.12 p. 60	<p>No requirements stated by Statsbygg at the moment about FM&O utilisation due to little knowledge. Amendments are anticipated as knowledge increases.</p> <p>"The General Services Administration (GSA) in the U.S. is formulating the BIM Guide Series "Series 08 - Facility Management"5 – this document is expected to provide good guidance when issued."</p>
Singapore	Mentioned, not covered	Operation, Maintenance, facility management, facility	"BIM element is modelled as an actual constructed building component or system and is an as-built representation of the actual completed building."	Ch. 3.2.2, p. 10. Appendix C, p. 41	Modelling guidelines for Facility Management will be addressed in the future version of the Guide.
UK		Operation, Maintenance, facility management, facility		PAS 1192-3:2014, Ch. 4, 5	A 30-page document describing the purpose, process and strategy for the operational phase and asset management. Lots of illustrations. AIM (Asset Information Model) should be used.
USA		Operation, Maintenance, facility management, facility			

PRE-QUALIFICATIONS

Country's	mentioned	Search terms (skill- Experience- proficiency- knowledge)	Source
Australia	yes	<p>Bim manager - "the individual shall have sufficient BIM experience for the size and complexity of the project and shall have relevant proficiency in the proposed authoring and coordination software." followed by responsibilities</p> <p>Technical or trade BIM Coordinators - "these individuals shall have the relevant experience required for the complexity of the project" followed by minimum responsibilities</p> <p>Construction BIM manager - "this individual shall have the appropriate level of relevant bim experience required for the project complexity and procurement delivery strategy." followed by responsibilities</p>	NATSPEC_National_BIM_Guide_v1.0_Sep_2011 4 BIM ROLES AND RESPONSEILITIES
Belgium	no	(empty)	BIM FUNCTIONS BIM RESPONSIBILITIES AND ADJUSTEMENTS
Canada	yes	"Clearly communicate the required LOD deliverables at various project stages in a collaborative environment and identify any possible impediments that may occur due to a lack of proficiency among modelling participants/disciplines. Identifying these potential deficiencies allows the BIM team to develop mitigation strategies to successfully overcome these challenges."	3.4 Information Exchanges & Software Proficiency
Finland	yes	<p>"the Coordinator's tasks are often related to technical issues and therefore require a profound knowledge of BIM software and processes."</p> <p>"The task of the BIM coordinator should be given to an experienced project individual who has adequate expertise in building information modelling and project management."</p>	3.9 role of the BIM Coordinator
Hong Kong	yes	<p>"The client should appoint a professional BIM Project Manager to lead and support the BIM process. This BIM PM could be an architect, engineer or contractor or an independent BIM Professional with relevant practical construction knowledge and design coordination experience."</p> <p>Written in section 4 - BIM PM will hold" regular training"</p> <p>"The BIM Modellers (technicians and operators) will have particular discipline experience (ARC, STR or MEP) with a minimum of 3 years of 3D CAD modelling knowledge."</p>	1.0 Introduction 4.0 BIM Management & Staff Resources
New Zealand	yes	"Reviewing the BIM Evaluation and Response Template will allow the client to select a team with skills matched to the complexity of the specific project and who have aligned BIM delivery methodologies."	3— Legal implications of BIM

Norway	no	<p>"As BIM skills and software tools for this purpose are still immature, Statsbygg has currently opted not to require that the contractor should add this information to the BIM directly.</p> <p>In projects where the contractor and design team do have sufficient skills and tools to add specific system and product info to the BIM, such may be agreed."</p>	C.11 BIM Construction and As Built Requirements
Singapore	no	<p>BIM PROFESSIONALS (BIM MANAGER AND BIM COORDINATOR)</p> <p>"These new roles can be undertaken by existing members in the project team, such as CAD managers, project managers, consultants, contractors, etc." suggesting skill and experience but not outright stated</p>	5 BIM Professionals
United Kingdom	yes	<p>"The owner, or the owner's representative, should determine the composition of the design and construction team. Consideration should be given to the breadth and depth of competences, skills and experience needed in the project through each successive work stage from Strategy through to Operation and End of life"</p>	<p>BS 8536-1:2015 - Briefing for design and construction – Part 1: Code of practice for facilities management (Buildings infrastructure)</p> <p>4.6.2 Owner</p>
USA	yes	<p>"This interface's mission is to turn the tabular chart, which is successful in showing all the information at once in a matrix format, into an interface that users can interact with to self-evaluate their own processes or BIMs."</p>	5.2.5.2.1 Interactive Capability Maturity Model

Simulations

countries	mentioned	Search terms (simulation-analysis)	source
Australia	yes	several simulations mentioned. For example, energy, lightning, virtual testing	7.4 MEP Modelling and Analysis
Belgium	yes	as part of the lod descriptions, energy analysis economic analysis	4.4 Model content and levels of development 7. EXCHANGE B2.0i
Canada	yes	<ul style="list-style-type: none"> • Site Analysis • Energy Analysis • Lighting Analysis • Building System Analysis 	3.3 Satisfying BIM Uses
Finland	yes	whole documents list from Management of a BIM project Energy analyses: Energy consumption simulations x Energy analyses: Condition simulations Computational fluid dynamics (CFD) and simulations Lighting simulations Fire simulations Simulations of rescue and safety situations	series 11 Management of a BIM project 4.3 Design preparation
Hong Kong	yes	"Link the BIM models to the construction programme to produce 4D Virtual Construction simulations" "Implement clash analysis systems to detect and identify conflicts and interferences between different model elements." " "Link the BIM models to environmental analysis software for solar, heating and cooling and life cycle analysis to support building design accreditation and building performance assessment."	2.0 BIM Project Objective
New Zealand	yes	<ul style="list-style-type: none"> • quantity take-off and costing • simulation of various aspects of the proposed building's behaviour such as structural, thermal, acoustic, lighting and fire performance • more effective option analysis during the early stages of a project, allowing for better informed decision making by stakeholders prior to committing to capital cost • the analysis of the design information/model can improve the construction and operational safety of a facility by using it during the safety in design review process • allowing owners/operators/constructors to interact with the facility in a virtual environment prior to it being built. 	1.4 Benefits of adopting the BIM process - ANALYSIS AND SIMULATION

Appendices

Norway	yes	acoustic simulation Quantity take-off for Cost Estimating Energy Analysis Facilities Management Work Package Estimating a lot of analysis are mentioned in G. Project Specific Contract Addendum like fire simulation 5d simulation.	C.1 Architecture Modelling - 55. Space boundaries G. Project Specific Contract Addendum
Singapore	Yes	Environmental simulation and analysis (for Concept Design Purpose only) · Energy validation to estimate energy usage requirements · Lighting design validation & visualization · 4D construction scheduling and sequencing (applicable for Design & Build projects) · Green Mark, RETV, Buildability and Constructability Scores based on BIM model(s) · BIM model of existing building(s) for master plan site study and feasibility analysis (A&A) · Providing Structural and MEP system alternatives based on conceptual massing models · Project cost estimates based on conceptual massing models · MEP cost estimates based on MEP BIM model	3.5 OTHER ADDITIONAL VALUE-ADDED BIM SERVICES
United Kingdom	Yes	Enabling tools, Discipline-based production/analysis software.	Table 1 – Information modelling maturity Level 2
USA	Yes	a whole document on energy analysis	NBIMS-US_V3_4.4_Design_to_Building_Energy_Analysis_BE