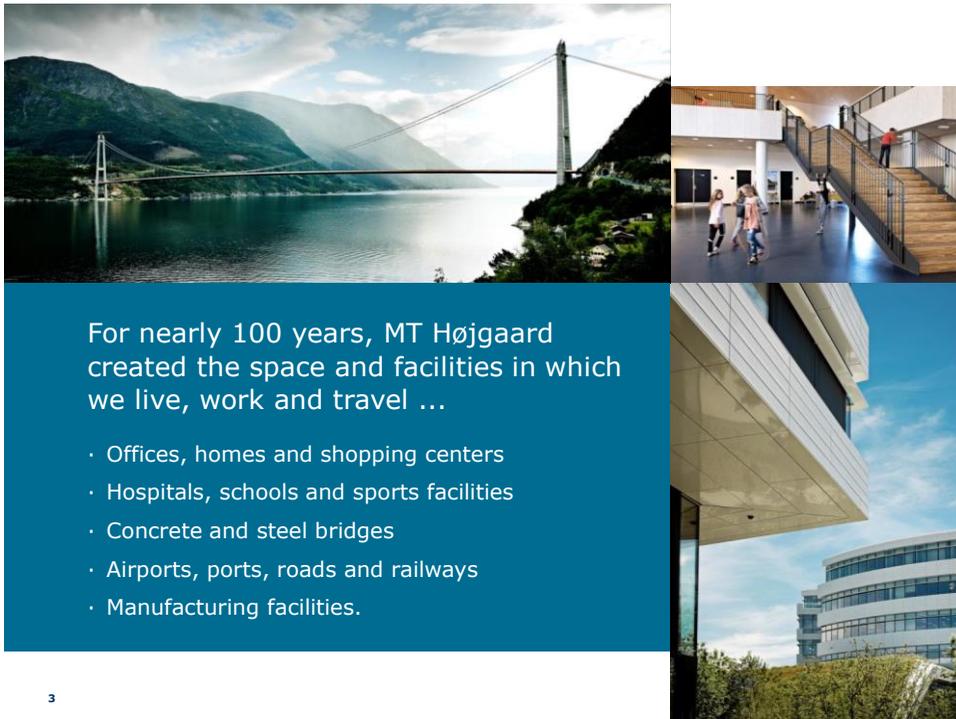


BIM Adoption and Implementation – Lessons from Denmark

Agenda:

- I. MT Højgaard** | The contractor
- II. Lessons from Denmark** | Sharing Best practices from our projects – spring 2016
- III. BIM Adoption and Implementation** | Denmark and Canada
- IV. Best practices as open source** | Sharing tools and best practices from our projects
- V. Next step** | Incorporating international experiences

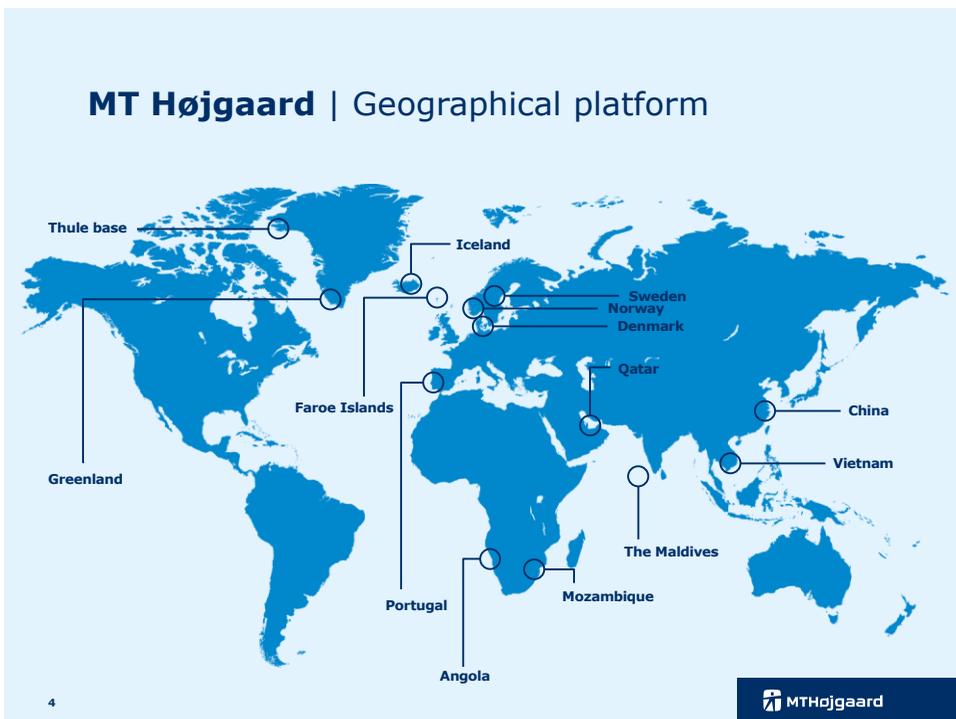


For nearly 100 years, MT Højgaard created the space and facilities in which we live, work and travel ...

- Offices, homes and shopping centers
- Hospitals, schools and sports facilities
- Concrete and steel bridges
- Airports, ports, roads and railways
- Manufacturing facilities.

3

MT Højgaard | Geographical platform



Thule base

Greenland

Faroe Islands

Iceland

Sweden
Norway
Denmark

Portugal

Angola

Mozambique

Qatar

The Maldives

China

Vietnam

4

 MT Højgaard

MT Højgaard | The collaboration with BIM

**We execute the project virtually -
before we build in real life**



5

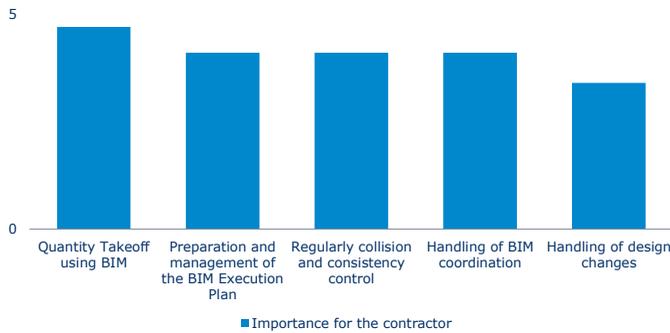


Lessons from Denmark



Lessons from Denmark | Sharing Best practices from our projects – spring 2016

The BIM initiatives that give the contractor the greatest value



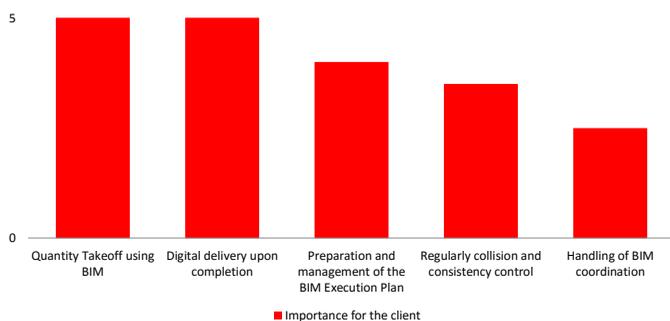
Source: white paper: The strength of the local BIM efforts in a larger perspectiv – May 2016

7



Lessons from Denmark | Sharing Best practices from our projects – spring 2016

The BIM initiatives that give the greatest value to the client



Source: white paper: The strength of the local BIM efforts in a larger perspectiv – May 2016

8



Lessons from Denmark | Sharing BIM Adoption in Denmark – Spring 2016



Weighting on a scale of 1 -10, where 1 is least important for the client (Regarding Value)	The contractors BIM proces	The ICT regulations requirements	The text of the ICT regulation 118
10	Quantity Takeoff using BIM	Handling of digital construction objects (classification, bill of quantities .)	9. To the extent that the tender includes bill of quantities, the Client must ensure: 3) that models are made available to the bidder in IFC format.
10		Digital delivery upon completion (IFC objects and properties, "as built")	10.-(2) The Client must ensure: 3) that object-based construction models are provided in IFC format.
8	Preparation and management of the BIM Execution Plan	ICT agreement	7.-(1) During project design and execution the Client must require that object-based construction modelling be used.
7	Regularly collision and consistency control	Use of digital construction models (IFC, collision control)	6.-(2) The Client must ensure: 3) that object-based construction models are provided in IFC format. 7.-(2) The Client must ensure: 4) that the models are made available in IFC format.
5	Handling of BIM coordination	ICT coordination	3. The Client must ensure that throughout the construction project there is coordination of the overall use of ICT between all of the parties involved.

Source: white paper: The strength of the local BIM efforts in a larger perspective – May 2016

11



Lessons from Denmark | Sharing BIM Adoption in Denmark – Spring 2016



Weighting on a scale of 1 -10, where 1 is least important for the client (Regarding Value)	The contractors BIM proces	The ICT regulations requirements	The text of the ICT regulation 118
10	Quantity Takeoff using BIM	Handling of digital construction objects (classification, bill of quantities .)	9. To the extent that the tender includes bill of quantities, the Client must ensure: 3) that models are made available to the bidder in IFC format.
10		Digital delivery upon completion (IFC objects and properties, "as built")	10.-(2) The Client must ensure: 3) that object-based construction models are provided in IFC format.
8	Preparation and management of the BIM Execution Plan	ICT agreement	7.-(1) During project design and execution the Client must require that object-based construction modelling be used.
7	Regularly collision and consistency control	Use of digital construction models (IFC, collision control)	6.-(2) The Client must ensure: 3) that object-based construction models are provided in IFC format. 7.-(2) The Client must ensure: 4) that the models are made available in IFC format.
5	Handling of BIM coordination	ICT coordination	3. The Client must ensure that throughout the construction project there is coordination of the overall use of ICT between all of the parties involved.

Source: white paper: The strength of the local BIM efforts in a larger perspective – May 2016

12



Lessons from Denmark | Sharing Best practices from BIM Adoption in Denmark – Spring 2016

White paper regarding the Danish BIM framework and BIM adoption

The BIM initiatives that give the greatest value to the construction project

Initiative	Value
Collaboration	High
Information exchange	Medium-High
Integration of disciplines	Medium
Use of BIM	Low

Appendix A. BIM Regulation 116

Appendix B. BIM Regulation 116

MTHojgaard logo

Lessons from Denmark | Sharing Best practices from BIM Adoption in Denmark – Spring 2016

International BIM Report 2016

Roadmap to Lifecycle Building Information Modeling in the Canadian AECOD Community

The Roadmap to Lifecycle BIM in the Canadian AECOD Community is turning ONE

Open standards for BIM

Benefits and barriers to BIM

BIM in Canada: where are we headed?

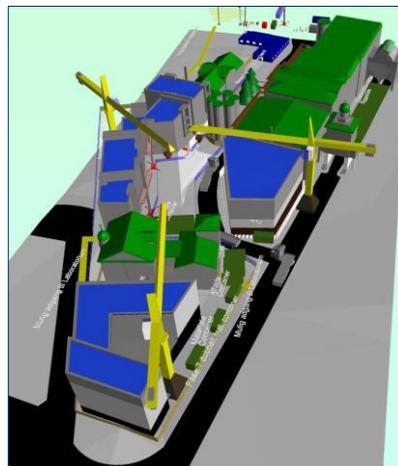
Canadian Construction Association logo

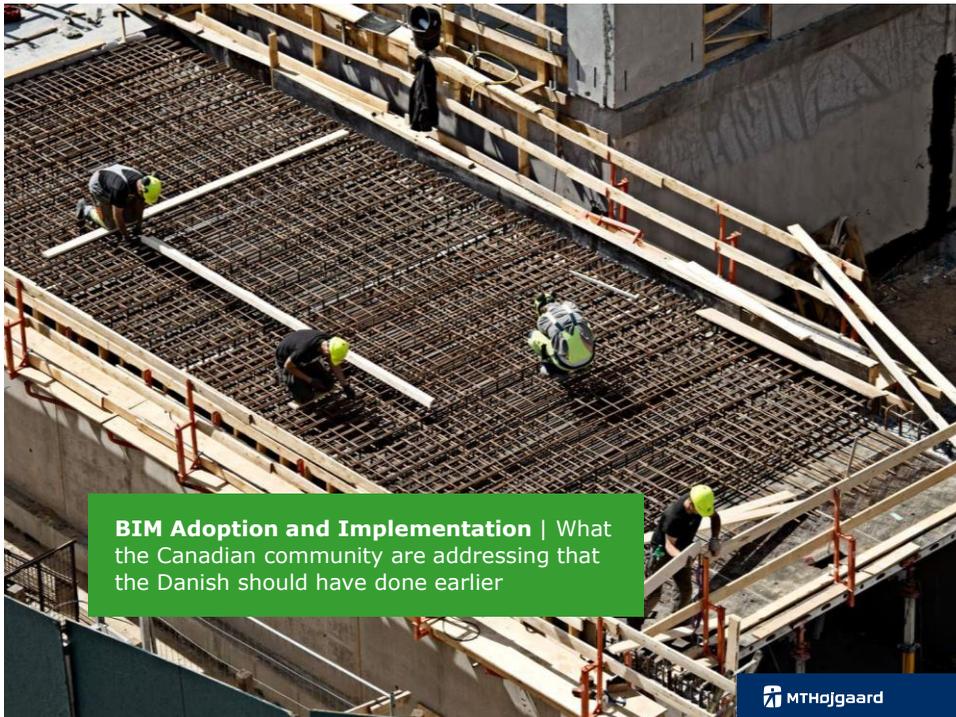




BIM Adoption and Implementation | What the Canadian and Danish community are doing similarly

- I. BIM implementation is hard and take a long time – but worth the effort
- II. Developing BIM training packages with educational institutions
- III. Openness to look at BIM in an international context.





BIM Adoption and Implementation | What the Canadian community are addressing that the Danish should have done earlier

- I. Openness about a number of national issues involving BIM is included in the BIM development
- II. A BIM Roadmap for the National BIM development
- III. Openness about the national BIM implementation.





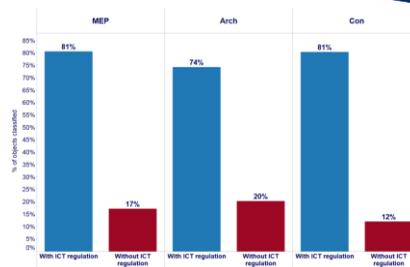
BIM Adoption and Implementation | What the Danish community have done differently that we can recommend to others

I. The current **framework for digital collaboration using BIM in public construction projects** in Denmark came into effect in April 2013 in the form of ICT Regulation 118

II. Denmark leads the way in **IFC use**

III. **Systematic analysis of the digital deliveries (BIM) on construction projects.**

Applying our open source approach by sharing the value of the digital collaboration across our projects using BIM and open standards (IFC) and relevant requirements in the form of the Danish ICT Regulation 118



Source: white paper: Addressing classification in the Danish AEC industry – June 2015

Best practices as open source | BIM educational materials

BIM assignments and problems for educational institutions

This document contains both a number of BIM tasks which is based on information around BIM in the Danish construction industry, as well as a number of BIM cases from the same practices that can be used as inspiration for design assignments and issues.

BIM assignments

The below assignments have been prepared by MTH Højgaard. The project used in the case study is the assignment to a CEO for students for the BIM 93 project at the Benckert Research Center (BRC) for Aarhus University. Below are a list of questions that have been assigned to the students. The cases are based on the BIM 93 project. The BIM 93 project is a public-private partnership between MTH Højgaard and Aarhus University. The BIM 93 project is a public-private partnership between MTH Højgaard and Aarhus University. The BIM 93 project is a public-private partnership between MTH Højgaard and Aarhus University.

Assignment 1 - BIM assignments

When BIM is used on a project, it is important to establish the right rules for the use of BIM and to establish communication technology (ICT) standards. You will receive a list of BIM project use cases and assignments on building the new rules. The project is a public-private partnership and is consequently subject to the Danish ICT Standard (SIS 1.0). The rules are based on the following:

- 1) You make a plan for the BIM activities to be taken on the project during the planning phase of the construction project.
- 2) You make a plan for the BIM activities to be taken on the project during the planning phase of the construction project.
- 3) You make a plan for the BIM activities to be taken on the project during the planning phase of the construction project.

Assignment 2 - BIM assignments

When BIM is used on a project, it is important to establish the right rules for the use of BIM and to establish communication technology (ICT) standards. You will receive a list of BIM project use cases and assignments on building the new rules. The project is a public-private partnership and is consequently subject to the Danish ICT Standard (SIS 1.0). The rules are based on the following:

- 1) You make a plan for the BIM activities to be taken on the project during the planning phase of the construction project.
- 2) You make a plan for the BIM activities to be taken on the project during the planning phase of the construction project.
- 3) You make a plan for the BIM activities to be taken on the project during the planning phase of the construction project.

Assignment 3 - BIM assignments

When BIM is used on a project, it is important to establish the right rules for the use of BIM and to establish communication technology (ICT) standards. You will receive a list of BIM project use cases and assignments on building the new rules. The project is a public-private partnership and is consequently subject to the Danish ICT Standard (SIS 1.0). The rules are based on the following:

- 1) You make a plan for the BIM activities to be taken on the project during the planning phase of the construction project.
- 2) You make a plan for the BIM activities to be taken on the project during the planning phase of the construction project.
- 3) You make a plan for the BIM activities to be taken on the project during the planning phase of the construction project.

Developing BIM training packages with educational institutions

23



Best practices as open source | BIM educational materials

Establish partnerships between academia and industry to encourage knowledge creation and innovation, e.g. PhD students

Cooperating with the educational institutions, so trainees and students can work with BIM on our construction sites

24



Best practices as open source | PhD research

The research at MT Højgaard is also based on practices in Canada:

2009-2010: Senior Project Manager and Office Project Coordinator with Integrated Designs Inc., Saskatoon, SK, Canada

(<http://www.i-designs.ca/>)

2007-2010: Employed as graduate architect and project administrator with Genesis Network part of SNC Lavalin Inc.

(<http://www.snclavalin.com/>)

Lea Ursup
 Industrial Ph.D. Student at MT Højgaard (DK) & Chalmers University of Technology, Department of Civil & Environmental Engineering (SE)
 E-mail address: lea@mh.dk
 Sub-theme: 60 Rethinking Responses to Institutional Complexity

Navigating an octopus by the stars: leading a design-build project organization by complex constellations of institutional logics

Design-build projects in the construction industry typically involve establishing a temporary inter-organizational project organization (IOPO). The IOPO consists of a number of people typically representing an owner, architect, various engineers, a contractor, suppliers and the workmen. When all these people team up to collaborate a number of institutional logics meet. The purpose of this paper is to discuss how symbolic and material practices of the IOPO result in a complex constellation of institutional logics; indicate how this constellation affects coordination of the organization's daily work; and indicate why and how organizations within the IOPO may struggle to or benefit from managing the constellation. The research is based on a qualitative study of the design and build of a large bank in Denmark. The study shows that the organizations in the IOPO share the same five field level logics; however, their respective collective symbolic and material practices vary. Further, the logics can be competing, conflicting and complementary, all at once. In some situations, the constellation results in successful coordination between the organizations and the design process progresses; at other times the constellation prevents coordination and the design process stalls. The conclusion is that the logics can be complementary, competing and conflicting all at once and that coordination is affected by the constellations development over time. Furthermore, the complexity of the constellation and the pressure from the IOPO's own coordination mechanisms makes it difficult for the IOPO to harness the benefits of the conflicting and competing logics. In fact, the development of the constellation over time causes the IOPO to disintegrate.

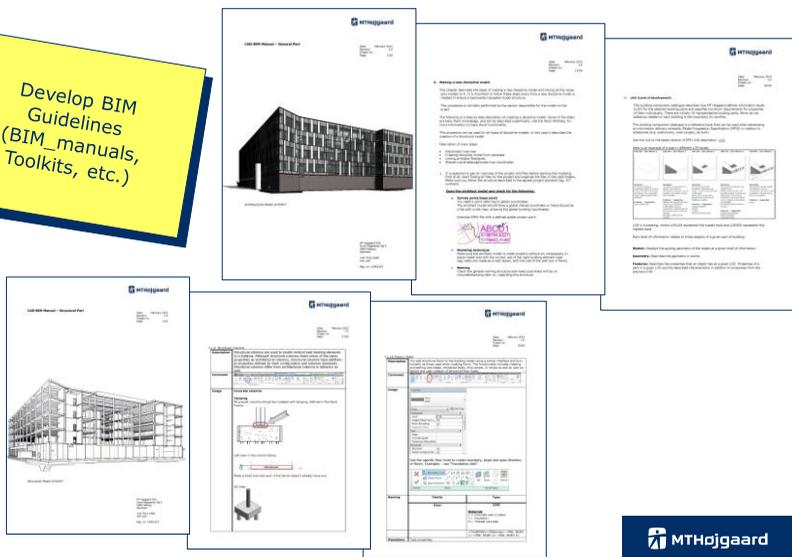
Keywords: Inter-organizational project organization; institutional logics; institutional complexity; constellation of institutional logic; design-build.

25



Best practices as open source | Sharing the tools from our projects

Develop BIM Guidelines (BIM_manuals, Toolkits, etc.)



Best practices as open source | Sharing our insights

Maintain and communicate best practices and BIM body of knowledge

Build the Future Today
Tobias Billmann
A guide for new practitioners
LIMBIO 2015

Appendix 2: BIM Coordination - Guide

EPILUGUE TOGETHER WE CREATE A HIGH-PRODUCTIVITY CONSTRUCTION INDUSTRY

Create a movement to BIM and engage public owners & push for strong leadership at national and municipal levels

MTHøjgaard

Best practices as open source | Sharing Best practices from our projects in white papers

Develop metrics and Key Performance Indicators (KPI) for consistent performance and capability assessment

Quality of Design Documentation in Denmark

Quality Level	Percentage
Low	14%
Medium	49%
High	37%

Quality of Design Material for Projects Covered by the ICT-regulation

Quality Level	Percentage
Low	7%
Average	16%
High	77%

MTHøjgaard

Best practices as open source | Sharing Best practices from our projects in white papers

The results show a 33% increase in the quality of the design material when projects include IFC as a part of the design material – August 2014

IFC - A driver for design quality in the AEC industry

Results and outcomes

Well-structured design material is essential for reducing the total construction time...

Non-IFC vs IFC

MTHojgaard

The use of IFC within the frame of a national ICT regulation contributes with 45% higher design quality compared with non-IFC projects

31

Best practices as open source | Sharing Best practices from our projects in white papers

Projects covered by the current ICT regulation 118 has a 205% increase in BIM value compared to projects covered by other BIM-frameworks – December 2014

Value drivers in the Danish national ICT regulations

ICT regulations value value construction projects

The following table illustrates which aspects are covered by the respective regulations

Regulation	IFC	BIM	Building Information Modelling
Regulation 118 (ICT)	+	+	+
Regulation 119 (BIM)	-	+	+
Regulation 120 (Building Information Modelling)	-	-	+
Regulation 121 (Building Information Modelling)	-	-	+
Regulation 122 (Building Information Modelling)	-	-	+
Regulation 123 (Building Information Modelling)	-	-	+
Regulation 124 (Building Information Modelling)	-	-	+
Regulation 125 (Building Information Modelling)	-	-	+
Regulation 126 (Building Information Modelling)	-	-	+
Regulation 127 (Building Information Modelling)	-	-	+
Regulation 128 (Building Information Modelling)	-	-	+
Regulation 129 (Building Information Modelling)	-	-	+
Regulation 130 (Building Information Modelling)	-	-	+
Regulation 131 (Building Information Modelling)	-	-	+
Regulation 132 (Building Information Modelling)	-	-	+
Regulation 133 (Building Information Modelling)	-	-	+
Regulation 134 (Building Information Modelling)	-	-	+
Regulation 135 (Building Information Modelling)	-	-	+
Regulation 136 (Building Information Modelling)	-	-	+
Regulation 137 (Building Information Modelling)	-	-	+
Regulation 138 (Building Information Modelling)	-	-	+
Regulation 139 (Building Information Modelling)	-	-	+
Regulation 140 (Building Information Modelling)	-	-	+
Regulation 141 (Building Information Modelling)	-	-	+
Regulation 142 (Building Information Modelling)	-	-	+
Regulation 143 (Building Information Modelling)	-	-	+
Regulation 144 (Building Information Modelling)	-	-	+
Regulation 145 (Building Information Modelling)	-	-	+
Regulation 146 (Building Information Modelling)	-	-	+
Regulation 147 (Building Information Modelling)	-	-	+
Regulation 148 (Building Information Modelling)	-	-	+
Regulation 149 (Building Information Modelling)	-	-	+
Regulation 150 (Building Information Modelling)	-	-	+

Establish a national performance assessment and benchmarking framework

MTHojgaard

32

Best practices as open source | Sharing Best practices from our projects in white papers

The client must require that:

- I. The overall framework for digital collaboration requires that all parties must ensure that their digital production can be used by and together with other stakeholders in the project.
- II. The collaboration shall at a minimum take place around an open industry standard as IFC (Industry Foundation Classes). The goal is that the project's BIM shall provide the client with a good basis for decision-making in terms of execution time, total cost of ownership and subsequent operation and maintenance.
- III. The contractor must be involved as early as possible in order to realize the project. The first focus must be on the choice of solutions and 4D production planning that enhances project efficiency and reduces execution time by up to several weeks. The early involvement of the contractor will also contribute to more effective production and the client will have high-quality buildings and infrastructure assets, among other things because project documents based on BIM results in less rework.

The client that translates these recommendations to the requirements contained by the project's BIM Execution Plan must ensure a framework for collaboration where the projects profitability is increasing and the stakeholder's exposure to risks and conflicts is reduced – March 2016



35



Weighting on a scale of 1-10, where 1 is least important for the client (Regarding Value)	The ICT regulations requirements	Criteria for scoring of the creation of value	The text of the ICT regulation 118
10	Handling of digital construction objects (classification, bill of quantities, ...)	If classification is used, may there be granted 1 point, if the project uses the bill of quantities, may be granted 1 point. If there is any relationship between objects in the BIM model, building component descriptions and items in the tender list, there may be granted up to 8 points.	4. (1) The Client must require that throughout the construction project digital construction objects are structured, classified, named, coded and identified on a uniform basis and to a specific degree of detail. In this respect the Client must require that the construction objects are provided with the information and characteristics that are of relevance to the subsequent management, operation and maintenance. (2) The Client must ensure that guidelines are laid down for the handling of digital construction objects throughout the course of the construction project. 6. To the extent that the tender includes bill of quantities, the Client must ensure (1) that the tender documents for each contract include bills of quantities as well as relevant digital, object-based construction models from which quantities can be extracted, (2) that models are made available to the bidder in IFC format, and (3) that the tender documents show the basis on which the quantities are calculated, including the measurement rules and/or measurement methods that are used.
10	Digital delivery upon completion (IFC objects and properties, "as built")	Delivery of "as-built" material gives 1 point. Delivery of "as-built" model provides up to 4 points. Submission of operating and maintenance material gives 1 point. Handover of digital facility management information to FM system provides up to 4 points.	6. (1) In consultation with the Contractor, the Client must set requirements concerning the digital submission of the information that is deemed to be relevant for: (1) documentation of the construction work, (2) documentation of the construction project, (3) operation and maintenance, and (4) the future management of the property. (2) The Client must ensure: (1) that digital delivery on the handover of the construction project is included in the agreements with advisers, contractors and suppliers, and (2) that digital-based construction models are provided in IFC format.
8	ICT agreement	ICT technical communication specification completed 3 points. ICT technical ICD specification completed 3 points. ICT technical delivery specification completed 3 points. Are all of the above specifications completed given 10 points total. A maximum of 8 ICT points can be granted.	7. (1) During project design and execution the Client must require that object based construction modeling be used. (2) The Client must ensure: (1) that agreement is reached concerning which discipline and shared models are to be prepared.
7	Use of digital construction models (IFC, collision control)	Available the IFC models on the project web gives 1 point. If the collision control is performed, may there be granted 1 point. If the required properties are found in the IFC model, may there be granted up to 4 points. Where documentation of collision control, may there be granted up to 4 points.	8. (1) As part of the competitive element of competition-based bidding rounds, the Client must require that the proposals received include digital, object-based construction models, as well as visualizations made on the basis of these models. Construction models and visualizations must document the proposed architectural, functional and technical conditions at a specified information level. (2) The Client must ensure: (1) that the competition programme outlines requirements of the model's structure and information content, of Section 4, based on the size, nature and complexity of the competition, (2) that the number and location of visualizations are determined on the basis of the size, nature and complexity of the competition, and (3) that object-based construction models are provided in IFC format. 7. (2) The Client must ensure: (1) that each of the parties with responsibility for models prepares the necessary digital models, of which the content and use are specified in relation to the service provided by the individual party, (2) that discipline models are coordinated via one or several shared models for the purpose of simulation, clash detection, bill of quantities, drawings and specifications, and (3) that the models are made available in IFC format.
5	ICT coordination	Points are given as an average of the fulfillment of the other sub-criteria.	9. The Client must ensure that throughout the construction project there is coordination of the overall use of ICT between all of the parties involved in the project.
5	Digital communication and	If a project-based system is used may be given 1 point. Consistent file naming gives 1 point.	4. (1) The Client must require that a system be used for digital communication and archiving of all relevant information during the course of a construction project. This is to make which information available in the system, and at which times, plans and drawings to other systems, and that the plan that is drawn up includes specification of which project and on the completion of the construction work, of Section 10, regulations and that: (1) the user, and (2) the content is the subject of the logs. which are used, which documents the registered defects in accordance with the structure determined for the project.
4	Digital invitations to tender and bids	When a digital invitation to tender is used, tender documents give 1 point. If the quantities are part of the supply may be granted up to 3 points.	8. To the extent that the tender includes bill of quantities, the Client must ensure: (1) that bill of quantities are included in the tender documents.

Next step | Incorporating international experiences

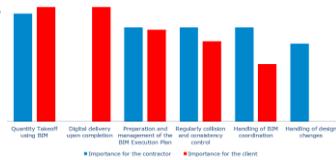


Next step | Incorporating international experiences

The Danish ICT Regulation 118 can be used as a paradigm for a BIM-framework:

- I. The paradigm may be divided and given priority in relation to the resources that industry and organizations in Canada have available
- II. The paradigm has a relationship between requirements and the effect for both the contractor and the client

- III. The paradigm is supported by analysis and measurement tools regarding BIM from the period 2014-2016.



37

Source: white paper: The strength of the local BIM efforts in a larger perspective – May 2016

