White paper

Value drivers in the Danish national ICT regulations

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Abstract
This white paper investigated in December 2014 the development of the Danish ICT regulations to determine value drivers for executing BIM on construction projects. MT Højgaard has quantified the value of BIM on projects covered by different ICT regulations and concluded that projects covered by the ICT regulations 118 and 119 in Denmark are experiencing increased value from BIM. ICT regulations 118 and 119 are not augmenting standardisation in general however, they provide a framework with increased focus on BIM compared to the previous regulations and demand use of the IFC format throughout the entire project lifecycle. It is MT Højgaard's understanding that regulatory standardisation is not an organisational constraint but rather an industry opportunity to drive productivity as a joint effort between project participants.

BIM in a regulatory ICT framework
MT Højgaard has initiated an extensive investigation to determine the value of operating within a national ICT framework when applying BIM on construction projects. Previously, it has been documented how the use of IFC within the frame of a national ICT regulation contributes with 45% higher design quality compared with non-IFC projects in Denmark[1]. MT Højgaard experienced general interest from the international building industry to elaborate on the public requirements specified in the Danish ICT regulations.

This white paper aims to clarify what aspects of the Danish ICT regulations that provide favorable circumstances for executing BIM on construction projects in order to harvest the value of BIM during the construction phase. MT Højgaard has quantified the value of BIM activities on its current projects covered by different ICT regulations and concluded that a solid frame for BIM leads to increased productivity gains.

During the past seven years, the Danish Government has set regulations, for using ICT in construction projects, through three national ICT regulations. The first national ICT regulation, ICT regulation 1365, was introduced in 2007 as a modification to the existing regulations covering governmental construction projects from 1971. The second ICT regulation 1381 came into effect from 2011 and the current ICT regulations 118 and 119 came into effect from 2013[2].

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[1] MT Højgaard's white paper: *IFC – A driver for design quality in the AEC* Industry
[2] ICT regulations 118 and 119 are similar but respectively cover public funded projects and public funded housing projects, see *Appendix A, ICT Regulation 118*.

ICT regulations adds value on construction projects

Based on the proven conclusion that IFC and the ICT regulation provides a higher design quality1, MT Højgaard has further investigated, what elements of the ICT regulations that contribute with value, through BIM activities, on MT Højgaard's projects in 2014.

With the aim of benchmarking, MT Højgaard has, through a structured and industrialised approach to BIM, measured the value of BIM activities on projects covered by the ICT regulations. The value is found by evaluating the execution of BIM activities on MT Højgaard's projects and whether the activities create value for the projects. The assessment of value added is done in comparison to our expectations, which are specified in the project BIM execution plan.

The projects in this analysis are divided in three categories where each category is covered by a different ICT regulation, respectively ICT regulation 1365, ICT regulation 1381 and ICT regulations 118 or 119. The current ICT regulations 118 and 119 explicitly require that building models must be available in the IFC-format for all participants throughout the project from concept to operation. This is not a requirement in the previous ICT regulations.

On a scale from 0-5 (with five being the highest value added) and with all projects being executed concurrently, MT Højgaard has found the results, see Figure 1.

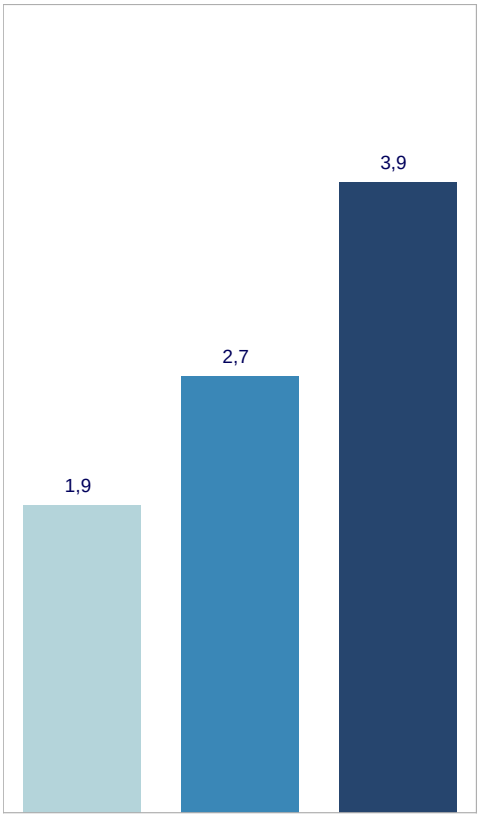

Figure 1 The average score for each category covered by the ICT regulations

Thus projects covered by the current ICT regulations shows a 44% increase in value compared to projects covered by ICT regulation 1381 and a 205% increase in value compared to projects covered by ICT regulation 1365. For projects covered by ICT regulations 118 or 119 the major BIM value contributors are: structured use of quantity take-offs to control the changes of quantities in project material revisions; digital inspections for a better and mutual understanding of the project within the project team and clash detection tests for proactive identification of constructability issues.

A strategic approach to BIM

In MT Højgaard the use of BIM is already addressed early in the tender phase of a project and documented in a project BIM execution plan. The project BIM execution plan specifies which BIM activities a given project is committed to and how the activities should be performed. Based on the project BIM execution plan continuous evaluations are performed on all active projects using BIM in order to identify value drivers and barriers to BIM in the construction phase.

The evaluation is performed by an expert function in close collaboration with the BIM coordinator from the project team. The evaluation is qualitative and based on a close dialog between the BIM coordinator and the expert function in order to clarify which BIM activities that create value for the project. The definition of value generation is in regards to detailed specifications of each BIM activity described in MT Højgaard's project BIM execution plan. Thus, if the BIM activities generate value for the projects according to the project BIM execution plan, it is recorded by the expert function. Examples of added value are better constructability, coordination, less errors etc. facilitated by the BIM activities. MT Højgaard's BIM coordinators go through an extensive BIM education prior to managing BIM on a project. The BIM coordinator is an inherent part of the project team and is responsible for facilitating BIM on the project.

The projects included in this investigation are all currently (2014) being executed by MT Højgaard but are divided in three different groups:

1. Projects covered by ICT regulations 118 or 119
2. Projects covered by ICT regulation 1381
3. Projects covered by ICT regulation 1365

The dataset in the analysis is a part of MT Højgaard's active project portfolio and can therefore not be detailed further. The number of projects in the dataset is limited seen from a data analysis perspective and it is not MT Højgaard's intention to proclaim differently. Thus, the significance of the findings is precipitated by a combination of the results and MT Højgaard's extensive insight to BIM through practical experience and several PhD researches. The results quantify the added value from BIM on MT Højgaard's projects and are unequivocal indicators that support already recognised practices in MT Højgaard.

Given all projects are executed within the same period of time makes a comparison reasonable, as the availability in technology, processes and the level of support from the organisation, can be assumed equal.

How the Danish ICT regulations developed from 2007 – today

The following analysis focuses on how the frame of the ICT regulations and the level of required standardisation have developed. Prior to discussing how the frame and standardisation of the ICT regulation have developed, the two concepts are defined in regards to their application in the regulations. The frame of an ICT regulation is expressed through the level of specific re-

quirements that must be met. An example of a requirement in ICT regulations 118 and 119 prescribes that the project owner must ensure a coordination of the entire usage of ICT between all participating companies. This statement is a clear requirement of what to do.

The level of standardisation in an ICT regulation is expressed through the concise requirements prescribing how things must be done. An example of standardisation in the ICT regulations 118 and 119 is the explicit requirement that building models must be available in the IFC-format, throughout the project, from concept to maintenance. This statement is a clear prescription of how to conform to the requirement.

The following table illustrates which subjects are covered by the respective regulations, see Tabel 1.

Subject/Regulation	**1365**	**1381**	**118/119**
Project web (Projektweb)	X	x	
3D building model (3D bygningsmodel)	X	x	x
Digital tender and bidding (Digitalt udbud)	X	x	x
Digital handover (Digital aflevering)	X	x	x
Classification according to DBK[3]	x (only tender)	x	
ICT coordination (IKT koordinering)			x
Handling of digital building objects (Håndtering af digitale byggeobjekter)			x
Digital communication and project web (Digital kommunikation og projektweb)			x
Digital information on errors and omissions (Digital mangelinformation)			x

Tabel 1 Overview of subjects that are covered by the respective regulations

The first two ICT regulations only address the specific use of building models through one requirement i.e. “3D building models”. In ICT regulations 118 and 119 the granularity is increased and requirements about the building models now include “handling of digital building objects”, “ICT coordination” and “3D building models”. In general the current regulations have introduced more requirements to the work with ICT and BIM.

The analysis of requirements in all versions of the ICT regulations shows that the ratio of content concerning *the frame and standardisation* has changed. Initially the firmness of the frame is considered in the different regulations concerning IFC. The requirements, in regulation 1365 concerning IFC, prescribe that project owners must ensure that the building model is provided

[3] A Danish classification system from 2006. ICT regulations 118 and 119 require the use of classification but without a specific reference to a classification system.

in IFC, but it can be exchanged between the participants in any format. Allowing an exchange in any format makes the frame less firm and may introduce the risk of lacking interoperability in the value chain, if proprietary formats are chosen. Furthermore regulation 1365 prescribes that the building model must be provided to the contractor in, as a minimum, the IFC format. This statement leaves room for flexible interpretation as the alternative to “as a minimum in the IFC format” will depend on the perspective of the reader. The same level of ambiguity is to some extent present in regulation 1381, where the requirement about “3D building model” state, that the building models must be provided to the contractor in the IFC format or another file format. This also introduces the risk of lacking interoperability but on the contrary, regulation 1381 requires that building models in the digital tender must be provided in IFC. Thus, while regulation 1381 provides an overall frame for using IFC which is more firm than regulation 1365 it still contains ambiguity. The current regulations 118 and 119 explicitly require the use of the IFC format throughout the entire project, thus providing a more firm frame for interoperability. Additionally the increased granularity of requirements towards BIM provides a more extensive frame which the participants can operate within. ICT regulations 118 and 119 provide more requirements about what participants must do when using BIM on public construction projects. In order to consider how participants should do it, the level of standardisation must be analysed.

In regulations 1365 and 1381 there are examples of standardisation e.g. the digital tender must contain project and building component descriptions according to bips B100 (national standard developed by the organisation bips). Equally the digital tender must include descriptions according to the principles of the description tool B.1000 developed by bips. All three regulations demand a consistent use of a classification system, but it is only regulation 1365 and 1381 that specifies which particular standard that must be used. The current regulations 118 and 119 include less requirements specifying how things should be done, but applies an increased focus on what aspects of ICT and BIM that must be done.

Analysing the development of the national ICT regulations broadly, it is identified how the focus of ICT regulations are shifting from prescribing specific solutions (how to) towards a focus on activities, processes and roles (what to). Thus with the development of the ICT regulations in Denmark the level of standardisation has decreased while the frame of the ICT regulations has become more firm.

Conclusions

MT Højgaard has experienced how the right standardisation and requirements in the ICT regulations are contributing with a more solid frame for using BIM and ICT as collaborative tools on construction projects. MT Højgaard has even quantified the value from BIM activities on its current projects covered by different ICT regulations and concluded that a solid regulatory frame for BIM leads to increased productivity gains.

From a contractor’s point of view, it is crucial to increase the demand for the right standardisation through legislations in order to share information and data through BIM on projects. Better exchange of information both throughout the entire value chain and the life cycle of construction projects will drive productivity in the construction industry.

Reflections from the Danish construction industry on ICT regulations and standardisation

The introduction of the current national ICT regulations 118 and 119 was accompanied by an industry hearing session, where opinions were expressed. The frame and standardisation for working with BIM, implied by the national ICT regulations, separate the industry in two. There

was one group advocating that standardisation and national regulations constrain the choice of applications and methods for the individual participants, and that the requirement of using IFC ultimately create more work. However, it is argued that fewer requirements towards common standardisation will derive risks, since the digitalisation and possibility for exchanging models and valuable data will deteriorate along with the lack of a standard specification for data exchange formats.

The other group of participants was pro regulations and standardisation arguing that the requirements for using IFC propagate a frame for flexible data exchange within the value chain all the way from design to operations. Within this group some recognise how the ICT regulations provide a more structured application of BIM thus resulting in productivity gains and savings. Additionally some participants are requesting more standardisation from the ICT regulations in order to realise the full potential of process standardisation.

The Danish government has in November 2014 made the construction political strategy for 2014 explicit with a number of strategic goals. With an ambition of increasing efficiency and effectiveness in the Danish construction industry, this paper indicates, that the authorities should align their strategic goals with more standardisation in the ICT regulations. As an example, the authorities have a goal of increasing efficiency in operations and maintenance of public assets. This will require a general standardisation of the digital handover in order to handle the large amounts of data generated from operations and maintenance in a multimillion square meters asset portfolio. It is specifically stated in the strategic goals that a systematic and structured data collection is essential in order to control the operations and maintenance. Thus requirements towards a standardised data model for relevant operations and maintenance data are necessary. There are different standards in the construction industry that provide an application neutral and open source data format, intended for describing data for operations and maintenance of buildings. Furthermore the Danish government has an ambition of using data from public buildings to achieve their goals within construction and energy aspects. Aggregating data across large asset portfolios is challenging without a standardised specification.

It is MT Højgaard's experience that standardisation through governmental legislation is not an organisational constraint but actually an industry opportunity to align interfaces between trade disciplines and drive productivity together.

References:

- White paper entitled *IFC – A driver for design quality in the AEC industry*, August 2014.

Appendix A, ICT Regulation 118

Regulation concerning the use of information and communication technology (ICT) in public construction.

Pursuant to Section 2(1), Section 5(1), Section 8 and Section 8a of the Danish Act on Public Construction Activities, cf. Consolidated Act no. 1712 of 16 December 2010, as amended by Act no. 623 of 14 July 2011, the following is laid down:

Area of application

1.-(1) The Regulation applies to the construction of buildings, the conversion and extension of buildings, the renovation and maintenance of buildings, and facilities related to such buildings with regard to:

1) Construction with the Danish State as the Client for an estimated contract sum of DKK 5 million excluding VAT, or higher.

2) Construction for an estimated contract sum of DKK 5 million excluding VAT, or higher, of which at least 50 per cent is financed in full or in part by State loans or subsidies.

3) Construction for an estimated contract sum of DKK 5 million excluding VAT, or higher, for the use of institutions of which the operation is paid by the State, when the subsidy constitutes at least 50 per cent of the operational expenses.

4) Construction with a region or municipality as the Client for an estimated contract sum of DKK 20 million excluding VAT, or higher.

5) Construction for an estimated contract sum of DKK 20 million excluding VAT, or higher, which is financed in full or in part by loans or subsidies of at least 50 per cent from regions and municipalities.

6) Construction for an estimated contract sum of DKK 20 million excluding VAT, or higher, for the use of institutions of which the operation is paid by regions and municipalities, when the subsidy constitutes at least 50 per cent of the operational expenses.

(2) The Regulation does not apply to construction for which public support is granted pursuant to the Danish Act on Public Housing, etc., the Danish Act on Private Care Dwellings and the Danish Act on Urban Renewal and Urban Development.

2.-(1) In conjunction with construction projects concerning renovation and maintenance, the Client may waive fulfilment of one or more of the Regulation's requirements if the costs of the fulfilment of the requirement(s) in question do not match the benefits.

(2) Nonetheless, the Client may not waive the regulations in Section 8 concerning digital invitations to tender and bids via a digital system.

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.

Handling of digital construction objects

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.

Digital communication and projectweb, etc.

5.-(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.

(2) The Client must ensure:

1) that a plan is drawn up concerning which parties are to make which information available in the system, and at which times;

2) that information can be obtained from the system and transferred to other systems, and that the plan that is drawn up includes specification of which transfers are required during the course of the project and on the completion of the construction work, cf. Section 10;

3) that the system includes access control, notifications and logs;

4) that it is determined which file formats are to be used; and

5) that it is determined which meta data is to be connected to the individual file types.

Use of digital construction models

6.-(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 visualisations made on the basis of these models. Construction models and visualisations must document the proposals' architectural, functional and technical conditions at a specified information level.

(2) The Client must ensure:

1) that the competition programme outlines requirements of the models' structure and information content, cf. Section 4, based on the size, nature and complexity of the competition;

2) that the number and location of visualisations 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.-(1) During project design and execution the Client must require that object-based construction modelling be used.

(2) The Client must ensure:

1) that agreement is reached concerning which discipline and shared models are to be prepared;

2) that each of the parties with responsibility for models prepares the necessary discipline models, of which the content and use are specified in relation to the service provided by the individual party;

3) 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

4) that the models are made available in IFC format.

Digital invitations to tender and bids

8. The Client must require that for invitations to tender for construction works digital invitations to tender and bids are applied, by using a digital system. The tender documents must be drawn up so that, to a relevant extent, the documents can be used digitally by the bidders in conjunction with their submission of bids, and so that bids are structured in accordance with the structure otherwise used in the construction project, cf. Section 4.

9. 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;
2) 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;
3) that models are made available to the bidder in IFC format; and
4) that the tender documents show the basis on which the quantities are calculated, including the measurement rules and/or measurement methods that are used.

Digital delivery on handing over the construction project

10.-(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;

2) that the agreements include the handover's extent, structure, classification, identification and formats; and

3) that object-based construction models are provided in IFC format.

Digital information concerning defects

11. The Client must ensure that digital lists of defects are used, which describe the registered defects in accordance with the structure determined for the project, cf. Section 4.

Entry into force and transitional provisions

12.-(1) The Regulation enters into force on 1 April 2013 and applies to construction projects that are initiated as from and including this date.

(2) Regulation no. 1381 of 13 December 2010 concerning requirements of the use of information and communication technology in construction projects is repealed as of 1 April 2013. However, the Regulation will continue to apply to construction projects that are initiated before 1 April 2013.