

ANALYSIS AND MEASURES TO IMPROVE THE EFFICIENCY OF BUILDING INFORMATION MODELLING IN COST ESTIMATES

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Abstract

Building Information Models (BIM) and information in these models have been responsible for an "industrial revolution" in the construction industry, but there has not been the same focus on BIM in the early stages of planning, such as using it in cost estimation and calculations, also called 5D-BIM. Our research question is: "What are the advantages and disadvantages of using BIM in the estimation phase, and which measures can make this more efficient and user friendly." Information was first obtained by examining cost estimation programs used in a larger construction company in Norway. Secondly a survey was sent out to employees in the construction industry, where the respondents were asked to assess and explain their relationship with BIM and cost estimation. The results revealed that there is a lack of competence and training for those who use BIM-models for cost estimation. Secondly It has been identified that BIM-models used to calculations is not detailed enough. Integration of cost estimation earlier in the project development would have more influence on choices and solutions. The conclusion is that cost estimation has to be more efficient in the interaction with BIM, including implementation of stricter requirements for BIM-models used for dynamic calculations, skills need to be raised, calculations should be involved earlier in the projects, and the public sector should be involved more to propose measures.

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1. Introduction

Norway is among the pioneers in the use of BIM tools. Attention is drawn to the fact that Norway also has its challenges with the use of BIM tools. It is pointed out that contractors have a lot to gain by working smarter and in close cooperation with other players in the industry [1]. In Norway, BIM-implementation has been in progress for many years, much due to Statsbygg, one of the largest construction developers in Norway, demanding BIM since 2010 [2]. Therefore, many of the large architecture, engineering and construction (AEC) firms operating in Norway have hands-on experience in working with BIM [3]. In Norway there is a national standard, NS 8360:2015 for BIM-objects [4], that has been important for the implementation of BIM in new buildings. Models and information in these models have been responsible for an "industrial revolution" in the construction industry, but there has not been a focus on BIM in the early planning phase to the same extent as the use of BIM models on construction sites. Although the use of BIM in calculations of buildings has lagged behind, there has also been an evolution there. This paper examines and identifies the current challenges, disadvantages and advantages of using BIM in the early phase of a project, mainly cost estimation, and then identifies measures that can be taken based on feedback from a survey. This paper has, thereby, chosen to take a step further and look at digitization with the help of the transfer of data from the BIM-model to calculation programs, to see how it is expected to affect work in the cost estimation of buildings in Norway. The research question is: *What are the advantages and disadvantages of using BIM in the estimation phase, and what measures can make this more efficient and user friendly.* The purpose is to see to what extent today's BIM technology is expected to have an impact on productivity in a calculation process, and whether this might simplify or complicate the work.

2. Theory

McKinsey & Company published a report in 2020 that described the future of the construction industry from a technological perspective. We are in the middle of a divide where many software solutions have been implemented, which gained momentum during the Covid pandemic [5]; however, many people still use Excel and software that is not explicitly intended for calculation for civil engineering projects. In this transition phase where you slowly but surely move to dedicated calculation programs, it is natural that there will be a period of adaptation for both end user and developer. The developers must work to make their software user-friendly, while users must be trained and accustomed to new methods. For the interests of this paper it is necessary to describe some of the programs used in the case study.

2.1. *Solibri*

With Solibri you can collect, check and quality-assure your BIM projects. The tool helps you maintain the required quality in models from different disciplines, so that all parties involved can work together effectively [6]. Solibri could also be used to quantity take-offs.

2.2. *Naviate Simple BIM*

Naviate Simple BIM is a BIM editing program that is used to create models that contain the exact information needed. The model is trimmed and edited to contain information that is relevant. It is then exported as an IFC file that is used as needed. Another advantage that comes with this is that the file size becomes smaller when unnecessary information is eliminated from the file. This can be anything from aesthetic illustrations such as furniture to entire buildings that are not to be included. You can, for example, trim away everything and be left with the building structure and information relevant to this only [7].

2.3. *ISY ByggOffice*

ISY ByggOffice from Norconsult Information Systems is an online program used in the estimation phase to calculate all types of projects. On its website, the calculator tab is described as a program that is organized and efficient and has ease of use in focus [8]. It also has the ability to store empirical values in the form of unit times and resource consumption. This makes cost estimation more accurate, and you can update these figures as often as you like. ISY ByggOffice also has the option of importing BIM models for taking off quantities and objects. This of course assumes that the model is accurate and tidy. When the model is in the required condition and imported, you then get a complete calculation description.

3. Method

Information was first obtained by examining cost estimation programs used in a large construction company in Norway. A case study was done using the BIM-architect model of an apartment building in Oslo, Norway. The BIM model, made by the architect, was transferred to Solibri and Simple BIM. After some revision and simplifying of the BIM model, it was transferred to ISY ByggOffice which was the calculation program used.

Secondly a survey was sent out to 30 employees in the construction industry. 17 people in the construction industry answered these questions, this group consisted of 9 project leaders/ project engineers, 3 BIM-designers, 1 building designer and 4 calculation specialists. The respondents were asked to assess and explain their relationship with BIM and cost estimation. The questions were divided into three parts. First they focused on the use of BIM-tools, next they focused on calculation tools, and finally they focused on the correlation between BIM and calculation tools. The analysis of the results follows the questions asked and the results are discussed. The responses were obtained and analysed

from a qualitative perspective and assessed against the use of these programs through participatory observation and experiences.

4. Results

The results are divided into two parts. Firstly they focus on examining cost estimation programs used in a larger construction company in Norway using a case study. Secondly they focus on the survey that was sent out to employees in the construction industry.

4.1. Examining of cost estimation programs used in an apartment building case in a larger construction company in Norway.

The examination of cost estimation in a construction company in Norway revealed that BIM-models have been used in all newer projects. There is a varying degree of information and accuracy in these models, some lack important information necessary for the calculations. There have been projects with, for example, doors that lack requirements for fire resistance. Also duplicates of objects occur, which increases the cost of the project and can lead to double orders if not discovered in the final design phase.



Fig. 1. The case study using one of these apartment buildings in Oslo, Norway [9].

The case study using an apartment building, revealed that there are great advantages of using a model trimmer such as Simple BIM to simplify the BIM-model before the calculation process. The model is trimmed so that it takes up less space and smaller elements, which leads to less storage space being used and thus also less RAM memory to run the model on a PC. The disadvantage with this is that it is time-consuming. In addition to this, training, skills development and familiarization are required to make it effective. One must also be aware that such software licenses cost a great deal of money for companies, and when you have to use several different softwares, the expenses also increase both in the form of license fees and courses/training of the designers.

It seems that a recurring problem is the fact that a model is not fully developed and all solutions are not fully designed by the time the calculation is made. Often, documents received have been changed during a tender. An example that repeats itself is to replace site-built bathrooms with cabin solutions that are installed in the building with taps and connected to the water and electricity network.

With the extraction of information from a window in the program Solibri, the ID numbers of the windows was missing, then the window form could not be taken out and sent to contractors and providers. No sound and fire requirements had been entered either. This had to be implemented manually from the reports from the sound and fire engineering consultants. Lots of time was used to put the right information into the BIM-model before transferring it to ISY Byggofice.

4.2. Results of the survey sent out to the employees in the construction industry in Norway.

There were 17 responses on the survey, 16 (94,1 %) of them had experience with the use of BIM tools and 14 (82,4 %) had experience with the use of cost calculation programs.

Of the 16 with experience of BIM-tools, 16 had experience with the use of Solibri, 7 had experience with the use of Archicad, 7 had the experience with the use of Revit, and 4 had experience with the use of SimpleBIM, (see figure 1a). Other programs used were Autocad, Tekla Structure, Interaxo fields, StreamBIM and Allplan.

Of the 14 with experience of calculation programs, 10 had experience with the use of ISY ByggOffice, 12 had experience with the use of Excel, and 4 had experience with the use of Geometra, (see figure 1b). Other programs used was Holte SmartKalk, ISY Linker, ISY Beskrivelse, Bluebeam, Revit MEP, ISY G-prog and Focus Anbud. The answers that came back were not surprising; Solibri, ISY ByggOffice and Excel still run the show.

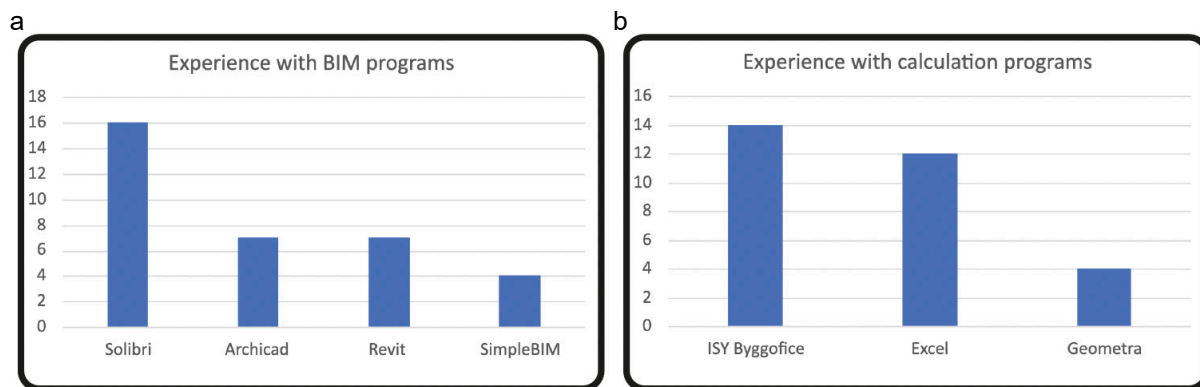


Fig. 1. (a) Respondents experience with BIM-programs; (b) Respondents experience with calculation programs.

After identifying users of BIM and calculation tools, the next step was to find out how satisfied these users were with the interaction between BIM and calculation programs. A majority of 41% stated a satisfaction level of 6 on a scale between 0 and 10, where 10 was the best. There were also some users who stated higher and lower, but no one had stated a degree of satisfaction higher than 8. There were some users who were quite unhappy as well. Taken together, the average was 5.53 and the median was 6.

An answer often repeated among the respondents, is that the models in the early phase are not detailed or complete enough to perform accurate calculations and cost estimates. As one of the participants in the survey points out: *"Models this early in the phase are not good enough to provide a full basis for calculations. But it visualizes the building and you get a better understanding of what is to be built."* Another answer gives a similar picture: *"The BIM model is often not complete enough to be used as a calculation tool, but can be used as a visual understanding"*.

The respondents then answered what advantages there were with the use of BIM tools in the early calculation/ planning phase. An answer repeated often, was that it makes the project visual and holistic. This in turn makes it easier to identify pitfalls and often forgotten elements. Other arguments are that it is time-saving and easier to identify collisions using a BIM model.

The respondents were also asked about the disadvantages of using BIM tools in the calculation/planning phase. The results show that BIM models from architects and consultant engineers are not detailed enough and contain errors, and models used for calculations do not necessarily represent what is being built. It is also a recurring theme that competence is inadequate and that this needs to be addressed. One respondent summed it up like this: *"Too much trust in models often leads to tunnel vision. It must be used correctly, and one must have the competence to see the details that do not appear in the model."*

Then the respondents were asked what they actually needed to use from the BIM-models in calculations or preliminary projects. The answers were slightly more varied. One of the answers was that ISY ByggOffice was too messy to use, with a desire to switch to a setup on Excel, another answer was that you should create a standard for the model before you switch to a calculation phase. An interesting response that was obtained was as follows: *“Want more use of dynamic calculation. That we get to the point where calculation is more of a natural part of the preliminary, sketch, detail and execution project phases. More of a natural part of the planning in these phases (and operations administration in the latter)”*.

Finally, the respondents were asked about their point of view on the industry's relationship with BIM in calculations / preliminary projects. There were many answers, but a common denominator in the answers was that further development and adoption of BIM-tools to a greater extent early in a project is the way to go. One respondent summed up the other responses quite well by saying: *“I am of the opinion that there is a desire to use BIM. It's not completely painless yet, but we're well on our way. We must raise the quality of models at an earlier stage and make more demands on how a model for the tender stage should look and what it should contain. It is difficult to get these requirements through, since we as contractors are not involved early enough.”*

Overall, the results of the survey have provided a clue to where the problems lie and how it is perceived by individuals. Some of the answers may seem obvious, but when carrying out the survey, many of the hypotheses have been confirmed independently and can be used to further discuss and find solutions to problems related to BIM and calculation/pre-project. *“Quick overview of what is to be built. If it is a good model, some quantities can easily be extracted for a quick calculation.”*

5. Discussion

When it comes to the survey directly linked to this paper, the feedback has been a good mix. A regular occurrence is that models early in the calculation phase are not complete enough to have an accurate price estimate of a building. Among other things, it is mentioned that the architect and designer have a limited preliminary project which is difficult to calculate accurately with the correct quantities. It can be anything from forgotten elements such as windows or walls to information in the various elements that is not included. can be forgotten. unclear and simply unfinished. Missing information about objects

Another aspect is competence. Although Norway is far ahead, there have been responses in the survey that indicate that there may be some lack of competence, as those who use BIM and calculation tools have more software and methods to stick to. The investigation has revealed that courses/training are in short supply. This can be explained by the fact that there is a greater proportion of older people (55-66 years) in construction who work full-time, compared to other industries. The report to which reference is made covers everyone in construction, including migrant workers and those who work outside on a construction site with a journeyman's certificate [10].

Some of the answers from the respondents is making a proof of this.

“Too much trust in models often leads to tunnel vision. It must be used correctly, and one must have the experience to see the details that do not appear in the model.”

“Want more use of dynamic calculation. That we get to the point where calculation is more of a natural part of the preliminary, sketch, detail and execution project phase. More of a natural part of the planning in these phases (and operations administration in the latter)”.

“If you raise IT competence, influence the industry to have a standard template for BIM files and create calculation templates from this in ISY Byggoffice, you can quickly save a lot of time on automatic quantity withdrawal in ISY Byggoffice Office.”

It is also important to mention the benefits of having a representative or official from competing contractors involved early on, to give them the opportunity to collaborate with the architect and create a compatible BIM file with the contractors' wishes and specifications included.

6. Conclusion

This paper aims to give an answer to the research question: *What are the advantages and disadvantages of using BIM in the estimation phase, and what measures can make this more efficient and user friendly.* The answer is that some measures must be initiated to make cost estimation more efficient in interaction with BIM tools: It is proposed to raise skills, implement requirements for models, implementation of dynamic calculation, involve calculation earlier in a project and involve the public sector to propose measures. The results show that there is a lack of competence and training for those who do not directly work with the development of models, for example people who use models for cost estimation. It has been identified that models have major shortcomings in such an early phase of a project. Secondly It has been identified that BIM-models used to calculations is not detailed enough. Integration of cost estimation earlier in the project development would have more influence on choices and solutions. The conclusion is that cost estimation has to be more efficient in the interaction with BIM, which includes implementation of stricter requirements for BIM-models used for dynamic calculations, skills has to be raised, and calculations should be involved earlier in the projects, and the public sector should be involved more to propose measures. It is also proposed that calculus becomes a dynamic subject that follows from the early phase to the final phase of a project, and integration of cost estimation earlier in the project development to have influence on choices and solutions.

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