TRANSLATING BUILDING INFORMATION MODELLING: A STUDY OF THE BIM IMPLEMENTATION PROCESS AT A LARGE SWEDISH CLIENT ORGANISATION

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Building Information Modelling (BIM) is currently widely discussed within both the construction industry and the academia. There is a view that it is a new paradigm presenting possibilities to address the slow increase in productivity currently perceived in the construction industry. Around the world many governments and public client organisations are developing their implementation processes for BIM. In this paper the largest infrastructure client in Sweden is studied. Based on a Case study, the BIM implementation process at this actor is described. These results serve as an empirical example of how BIM is being implemented in order to improve both productivity and innovation in the construction industry. These results have been analysed inspired by theory of 'sociology of translation'. This study concludes that the main tool used to enrol actors into BIM use is demanding model based delivery of project information. However, less emphasis is put on how these models will influence work practices for both the client's project organisation and contractors and consultants in the projects.

Keywords: Building Information Modelling, BIM, sociology of translation, implementation

INTRODUCTION

The construction industry has for many years been considered as having problems with low increases in productivity, lagging behind other industries (Egan, 1998 and Gallaher *et al*., 2004). The general perception is that this industry is slow in adopting new and better ways of working and incorporating innovations from other sectors (Harty, 2008). Over the years many different innovations have been presented to address the problems found in the construction industry. Currently BIM, Building Information Modelling, is by many presented as "a new paradigm" and it is argued that, with proper implementation, it can enable substantial benefits to the construction sector (Azhar, 2011). However, the BIM implementation has been perceived as slow within the industry (Gu and London, 2010; Smith 2014). Even though many case studies have shown extraordinary results from BIM implementation there are still voices expressing that BIM have not yet shown its promised benefits (Gustavsson *et al*., 2012; Jung and Joo, 2011; Fox, 2014). To increase implementation rates the role of client organisation have been emphasised in many studies. Client organisations in general and public clients in particular have been described as being a vital player in successful BIM implementation (Wong *et al*., 2010,

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Lindblad, H (2016) Translating Building Information Modelling: A Study of the BIM Implementation Process at a Large Swedish Client Organisation. *In*: P W Chan and C J Neilson (Eds.) *Proceedings of the 32nd Annual ARCOM Conference,* 5-7 September 2016, Manchester, UK, Association of Researchers in Construction Management, 123-132.

Wong *et al*., 2011). There is also a view that the industry has to be convinced of the importance of BIM in order to achieve the sought after benefits. Following this movement many government initiatives for BIM implementation can be found around the world. In the UK, for example, it has been stated that all public contracts awarded from 2014 demands that all project participants will work collaborative through the use of BIM (Cabinet Office, 2011). Similar to this initiative the Swedish Transport Administration, the largest infrastructure client in Sweden, is implementing BIM in its projects.

There is currently much research presenting case studies of BIM implementation on a project level. However, not as much is known of how the large public client organisations, which is presented as the needed driving force for BIM, is implementing BIM in their organisations. In this paper the BIM adoption process at a large public client organisation is studied. These results are analysed taking inspiration from "sociology of translation" described by Callon (1984) in order to explain the change process linked to BIM. The BIM implementation at the Swedish Transport Administration presents an empirical example of the process of BIM implementation at large public client organisations. This study provides insight in how the organisations suggested to drive BIM adoption organises their BIM implementation.

LITERATURE REVIEW

Implementation of BIM

Earlier studies on BIM implementation have mainly focused on how to enable and improve BIM-use in the construction industry. By mapping and presenting solutions so barriers for BIM implementation, such studies aim to support the implementation. The BIM adoption currently perceived as slow within the construction industry (Gu, 2010, Smith 2014) and there is a view that practitioners needs to be convinced in order to increase BIM adoption rates (Khosrowshahi and Arayici, 2012). The role of Client organisations in general and public client organisations in particular is widely discussed in research related to BIM adoption (Wong *et al*., 2010; Wong *et al*., 2011; Smith, 2014). It is argued that these client organisations are both the actors who are the greatest benefactor of BIM implementation and also the actors empowered to demand BIM-use from contractors and consultants (Linderoth, 2010). It is often stated that these organisation should use their power and demand BIM in their projects in order to influence the industry and increase BIM adoption (Eadie *et al*., 2013; Wong *et al*., 2011; Khosrowshahi and Arayici, 2012). In many countries these types of implementation initiatives are taking place. Public actors are involved in supporting BIM implementation in for example: USA, many Scandinavian countries, Singapore and Hong Kong (Wong el al., 2010). During the last years an increase in BIM adoption rates has also been observed and it has been argued that government directives are effective as a driver for BIM (Smith, 2014).

Many studies present suggestions for how these client actors should design their implementation process. Wong *et al*., (2011) presents six steps for BIM implementation which they argue must be taken by the government to promote BIM. Mainly the government should establish a policy of BIM use in all new projects (Wong *et al*., 2011). But it is also important to regulate the information, specifying open formats and promoting collaborative use of project related information, enabling the collaborative benefits with BIM (Wong *et al*., 2011). Interoperability between software and formats is identified as a major issue and governments have been shown to be able to drive the development towards more open standards thereby increase interoperability (Porwal and Hewage, 2013). Khosrowshahi and Arayici (2012) argue the importance of education and

awareness about BIM as a critical way of addressing resistance to change. It is also argued that there is a need for a certain degree of involvement of researchers before higher levels of BIM maturity can be reached (Khosrowshahi and Arayici, 2012).

Innovation in construction

Even though not often referred to in BIM related research the subject of innovation in construction is a well discussed topic. In a study of implementation of virtual reality (VR) Whyte (2002) makes comparisons to the previous innovations such as CAD and how it often took longer than expected to introduce such systems. This implementation was often lead by technical staff at mid management level and generally at newly created departments (Currie, 1989). In order to achieve successful adoption of IT Whyte (2002) argues for the need for both strategic decision-making by top management and input from technical managers to coordinate both on project and business level. Harty (2008) describes the concept of relative boundedness for innovations which effects extend beyond the control of a single implementer. In construction many actors different are involved which are influenced by the innovation. Innovation that is aimed towards changing the ways actors in construction operate must therefore be implemented across this inter-organisational landscape (Harty, 2008). Therefore, when studying implementation of innovation in construction it is relevant to trace networks of association, the actors included (and excluded) in shaping the implementation process and study how they influence this process (Harty, 2008).

Sociology of translation

Actor-Network theory (ANT) is not unheard as tools of describing the implementation of information systems or other situations concerning technical innovation. By analysing both human and non-human elements (actors) ANT can address the social-technical divide in the implementation process (Tatnall and Gilding, 2005).This approach to studying the adoption of BIM makes it possible to map the actors needs and motives for being enrolled in the networks where BIM is being implemented (Linderoth, 2010). Within the field of BIM related research, it is commonly argued that BIM adoption will require substantial changes to both business and work practices, together with many other changes in the culture of how projects are conducted (Mihindu and Arayici, 2008; Succar, 2009; Tylor, 2007). How the technology influences, changes and defines roles among the actors in the network is made possible by an actor network perspective (Linderoth, 2010). Callon (1984) identifies four moments of translation in the process of a driving actor to impose themselves and their definition of the situation on others. These steps are:

- Problematisation - The process of identifying the actors related to the sought after change process. In order to enrol these actors there is a need to understand their goals and needs. The problematisation stage also enables the definition of an obligatory passage point, a set of issues that is needed to be resolved in order to succeed.
- Interessement - This is the process by which the actors identified are linked together and given roles which the driving actors propose.
- Enrolment - a set of strategies orchestrated by the driving actor to make the other actors take and accept the roles proposed.
- Mobilisation - The methods used to ensure that the spokes persons for the different actors are able to represent their respective actors and that they are not later betrayed by these groups.

This models works as a method for mapping the process in which the driving actor imposes themselves on others. By analysing the interplay between the different actors

identified it can be revealed how they are linked to this network and which influence they all have on the process where BIM is being implemented.

METHOD

This paper builds upon a case study of the BIM implementation process at the Swedish Transport Administration. In the case study analysis of documents produced throughout the implementation process has been done. The case study is supplemented with a series of semi-structured interviews. A total of 11 interviews have been made, 6 with participants and managers driving the BIM implementation and 3 with project managers in projects currently using BIM together with 2 interviews with the project manager for one of the two BIM implementation projects. The results have been analysed by the theory of sociology of Translation by Callon (1984). The results have also been related to earlier research on BIM implementation with the focus of client organisations and their role in supporting BIM implementation.

Delimitations

This study does currently not present results of how this change process has been accepted in actual projects. That is to say, the question of how successful the translation process has been is not currently included.

RESULTS

The BIM interest at the Swedish Transport Administration was initialised by individual project managers around 2010. These project managers got inspired by the buzz around BIM and tested it to various degrees in their projects. The project managers grouped themselves in a 'BIM network' to share experiences and develop their use of BIM. This network was not managed centrally but was rather an unstructured forum where these project managers could exchange BIM knowledge. In this network were several of the largest infrastructure projects in Sweden. At that time, the Swedish Transport Administration went through a lot of turmoil. The organisation was established in 2010 and was the result of a combination of two predeceasing organisations: the Swedish Road Administration and the Swedish Railway administration. During this reorganisation the leadership was unclear. According to one of the more influential project managers in the early BIM projects, this lack of guidance enabled the BIM developments as resourceful project managers had a large degree of freedom to take action and start new initiatives.

The Swedish government authorised a committee to analyse the public client organisations measures to increase productivity and innovation in the infrastructure branch of the construction industry. This committee started their work in 2009 and resulted in a Swedish Government Official Report in 2012 (SOU, 2012:39). This report suggested that the Swedish Transport Administration should drive implementation of BIM in the industry. Some of the project managers connected to the 'BIM network' were directly involved in the writing of this report and thereby had an impact on it. Based on this Report, the General Director for the Swedish Transport Administration decided that BIM should be implemented in this organisation.

The problematisation stage of BIM implementation

The initial step in the BIM adoption process was taken in the loosely connected ‘BIM network’. The focus in this network was to find ways of taking advantage of the new possibilities with the technology. After the decision by the general director the BIM initiative gained legitimacy and the 'BIM network' was reorganised into a 'BIM Initiation project'. This project was obliged to pave way for the BIM implementation at this

organisation. Many of the project managers linked to the 'BIM network' continued working with this project, either directly with the project or as project managers in pilot projects linked to the 'BIM Initiation project'. The 'BIM Initiation project' was initiated in late 2013. Within the boundary of this project a BIM strategy for this client actor was developed. This document describes BIM as: "the use of information models in a continuous flow through the main processes connected with a constructed facility". Further it is expressed that the object oriented information could be used for multiple purposes, such as: clash control, analysis of different design alternatives, cost calculations and time scheduling. Combined these benefits is expected to result in a more efficient project process.

In order to achieve the benefits presented in the BIM strategy the 'BIM Initiation project' formulated question in relation to how BIM should be implemented, addressing implementation barriers like interoperability and other technical aspects of adoption. Apart from those issues, the main question was how to influence projects to use BIM, influencing them to adopt the new possibilities.

Identification of actors

The actors related to the BIM adoption process is brought in by the stated questions. These actors are not expressly defined in the 'BIM Initiation project'; however it is these actors that are addressed in the implementation process. The actors have been identified as: Projects at the Swedish Transport Administration, Third party users and the BIM technology.

- The projects at the Swedish Transport Administration – It is in the projects that the actual changes are made. If BIM is going to be used, it is going to be used in construction projects. The projects are however not a perfectly homogenous group. Most prominent is the difference between projects conducted in the different branches of the Swedish Transport Administration, 'investment' and 'large projects'. The projects all have their own possibilities with different project goals. However, the projects and their project managers are addressed as a united group in the BIM adoption process.
- Third party users – These are the contractors, designers and consultants in the projects. In order to adopt BIM it is these actors that need to deliver project related information in new ways. It is also the ambition that the BIM implementation will influence these actors to change and thereby change the Swedish construction industry.
- The BIM technology – The BIM technology was tested in several pilot projects, however it can be used very differently. Depending on how it is used it has different requirements. More advanced collaborative uses of BIM requires more advanced models and higher levels of interoperability. The level to which BIM should be used in projects will have to be addressed in the implementation process. Infrastructure has not been in focus in the development of BIM tools and currently there are problems in expressing drawn out objects, like roads and railways. Standardisation has also not been taken as far as in house construction and especially the issue of road alignment have been identified as a problem in relation to developing models based on open formats.

Definition of obligatory passage points

In order to achieve BIM adoption and thereby succeed in the implementation a few steps was identified in the work of the 'BIM network' and later the 'BIM Initiation project'.

- To know the extent to which BIM should be used. In other words know how the technology should be used in the projects and thereby how it should influence work practices.
- Ensure that the actors are convinced and they realise the benefits with allying around the BIM implementation process.

Interessement stage of BIM implementation

The projects previously connected to the 'BIM network' were after the start of the 'BIM Initiation project' used as pilot projects. Many of these projects were still running and delivered experiences and results from their projects to the 'initiation project'. Several new pilot projects were also connected to the 'initiation project'; these however used BIM to a very limited degree, if at all. Especially one of the pilot projects, currently the largest infrastructure project in Sweden, had a major influence on the outcomes of the 'initiation project'. This project developed the first draft of the demand document later implemented in the whole organisation. In this process the understanding of BIM present in the BIM networks were formalised and accepted as the general BIM view by the 'BIM Initiation project'. In this way the issue of BIM was not only relevant for a small group in the 'BIM network' but rather something relevant for the whole organisation. The BIM issue was also presented to the different branches of the organisation on several occasions on so called 'BIM days'. In this process the BIM strategy was presented to other parts of the organisation together with possibilities with the new technology.

Enrolment of the actors

At its conclusion in late 2014 the ‘BIM Initiation project’ delivered a total of 32 documents. These documents contained proposed changes to then current guidance documents and new documents setting up guidelines and demands for BIM usage in projects. The documents went through a referral process and got a lot of internal critique. After major rework all these documents had been implemented in the mid-2015. Among these documents is the demands on Object Oriented Information Model (OIM) which describes the demands on how object oriented information should be produced and shared within projects. This document was implemented 2015-06-01 and is referred to by guidance documents describing how projects should be procured. As the main deliverable, the documents makes up the central part in the enrolment of the actors found the problematisation stage. These documents address all these actors and the barriers linked to them that were found as a result of BIM pilot projects.

- The projects at the Swedish Transport Administration – By making changes to guidance documents and procurement templates, object oriented models (BIM models) is introduced as an alternative or the preferred choice of medium for project related information. When accepted, these documents demands that the deliverables from contractors and consultants in projects should be done in coordinated models. It is also these documents that describe how the models should be produced and managed in the projects. The majority of the changes to existing documents contained the change from "drawing" to "model". These documents do however not describe how the internal project organisations at the Swedish Transport Administration should make use of the models and change their work practices.
- Third party users – This actor is enrolled by the demands for BIM described in the new procurement templates. The details of how these actors should use BIM are not defined, as that would be in conflict with other initiatives by the organisation. Rather, it is only demanded that coordinated models should be delivered back to

the Swedish Transport Administration by the main contractor. That is to say that the models should contain information from all disciplines together. This is thought to incentivise the main contractor to demand collaborative BIM use in the project as that would simplify the creation of these coordinated models.

- The BIM technology – How the models should be produced and managed was identified as a major issue in the implementation process. Problems with interoperability and software were identified as problematic in the pilot projects. To address this the guidance documents relates to .dwg/.dgn file formats which is far from the object oriented information initially aimed for but that cannot currently be done in the infrastructure sector.

Other development initiatives

Simultaneous to the development and implementation of BIM, the Swedish Transport Administration worked with another development process, a change towards an 'unmitigated client organisation'. This initiative strives to establish the Swedish Transport Administration as a client organisation, procuring contractors and consultants to conduct the design and construction of projects. Following this initiative the Swedish Transport Administration should avoid putting demands on the work practices of other actors. Instead demands should be specified on the function of produced facility, not on the facility itself. The purpose of this initiative is to increase innovation and lowering costs by giving contractors and consultant's larger degrees of freedom. The work with an 'unmitigated client organisation' and the BIM implementation is somewhat contradictory. BIM-usage is generally relating to new work practices, focusing on collaboration around the joint development and use of models. Because of this possible contradiction the general director's decision to adopt BIM specifically states that the BIM-usage should be in line with 'unmitigated client organisation' concept. As a result the 'BIM Initiation project' could not demand BIM centred work practices. Instead, incitements for BIM supported collaboration was presented in the demands for coordinated models.

Mobilisation of allies

After the completion of the 'BIM Initiation project' in early 2015 the BIM implementation process was continued as two BIM implementation projects. These two projects were initiated in each of the two branches of the Swedish Transport Administration conducting construction projects, 'Investment' and 'Large Projects'. The 'Investment' branch collects the main bulk of projects, everything from small improvement projects to larger road or railway construction. This branch works relatively standardised with projects managers conducting multiple projects simultaneously. 'Large projects' collects the largest and most complicated of the Swedish Transport Administration's projects. These projects are driven more independently from each other and have larger internal support structures.

Following the start of the implementation project at the 'Investment' branch the templates and guidance documents concerning how projects should be conducted was changed. The template for how mission statements should be prepared in the procurement process was changed in 2015-09-09 (UB-mall 7.0). This document refers to the document presenting requirements on how project information should be produced, exchanged and delivered within projects. Thereby the demands on object oriented information were active in all projects following the implementation of this template in September 2015. The impact these changes can have on project are however very limited. The implementation process is not allowed to be an extra cost on projects. That is to say, no new roles are allowed to be added to increase the internal project organisation.

The BIM implementation at ‘Large projects’ have been somewhat different. These projects are driven more independently with larger support structures. This makes the BIM use in these projects more diverse. Some of the projects have acted as BIM pilot projects for the ‘BIM initiation projects’ trying out new possibilities with the technology. In these projects there are larger margins for developing new work practices within the project and this have been done in the pilot projects.

To support these two implementation projects, the ‘BIM initiation project’ was reorganised in the form of a ‘BIM Area of Competence’. In this group, many of the individuals working in the ‘BIM initiation project’ continued and thereby are the link from the original group of project managers in the ‘BIM network’. This Area of Competence continues with the development of the guidance documents and further supporting the BIM implementation at the two branches of the Swedish Transport Administration.

DISCUSSION

The story of BIM implementation at the Swedish Transport Administration is the story of how a group of early adopters translates their understanding of BIM to the whole organisation. It is the 'BIM network' and its descendants that lead the translation process. Even though the general director for the organisation made the formal decisions, this decision was heavily influenced by this group of project managers. The project managers' views of BIM and the hardships relating to successful implementation are well in line with current research on BIM. The confidence that a change towards BIM supported work practices can be achieved by demanding models can be found in both in research and in the 'BIM network'. The extensive focus on technological issues and how to bridge them is also prominent among them both. The sought after benefits described in the BIM strategy is very much in line with how researchers present benefits with BIM. However, most of these benefits correspond to the work of contractors and consultants tied to the projects. Therefore there are direct conflicts with the ‘unmitigated client organisation’ initiative, as it limits the degree to which the client should influence the work practices by these actors. The 'BIM network' has distanced itself from this conflict in their implementation process. This conflict does however come up when the guidance documents starts to get implemented in the organisation. Especially in relation to the Investment branch of organisation these conflicts have arisen. This branch works more standardised with projects and is more tightly governed by other, now conflicting, guidance documents. It should also be noted that the third party users have not been included in the translation process, but are only affected by the new procurement templates.

This implementation process for BIM is similar to how other studies have described the change process in relation to other innovations. Both Currie (1989) and Whyte (2002) found that middle management were responsible for achieving sought after results from technological change. Even when the decision is made by the CEO Whyte (2002) found a lack of direct involvement by board level involvement after this decision. This can lead to implementation problems, bad coordination between different parts of the organisation and a short-sighted focus in relation to the benefits of the technology. Even though these two studies observed CAD and VR respectively, the results are very much reproduced in this study.

CONCLUSION

The Swedish Transport Administration follows the understanding of BIM adoption presented by the main body of BIM related research. Their main way of enrolling actors

is by demanding delivery of models instead of drawings. By the implementation of new guidance documents the obligatory passage point has been past and BIM is now supposedly implemented in the organisation. However, the enrolment of some actors has been problematic. The BIM technology is not as developed for infrastructure as for other construction, which have influenced the demands on the models. The projects supposed to adopt BIM have several conflicting directives to take into consideration making their enrolment more problematic.

Implementation of innovation is not a new phenomenon in construction and it has been studied for decades. This knowledge is however seldom used in relation to implementation of BIM. This case study has found several similarities to the implementation of other innovations. By not using prior knowledge similar problems are bound to present themselves and this is what we can find in relation to the BIM implementation of today.

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