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Procedia Economics and Finance 21 (2015) 439 – 445

Procedia Economics and Finance

www.elsevier.com/locate/procedia

8th Nordic Conference on Construction Economics and Organization

Collaboration with BIM - Learning from the front runners in the Norwegian industry

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Abstract

How can findings from qualitative case studies in the AEC industry be generalised and thus contribute to scientific and practical development? In this paper, I argue that such generalisations are possible through so-called analytical generalisation. This is demonstrated by making an ideal typology built on the empirical data and the existing research related to the inter-organisational collaboration with BIM. The typology is based on different levels of technical and organisational interoperability, respectively, and portrays four ideal projects. It is here concluded that the both types of interoperability are important for inter-organisational collaboration and the typology represents a fruitful approach to analytical generalisation.

Selection and/ peer-review under responsibility of Tampere University of Technology, Department of Civil Engineering

Keywords: BIM; case studies; collaboration; generalisation; interoperability; qualitative research

1. Introduction

The architecture, engineering and construction (AEC) industry is one of the largest and most important industries in Norway (Espelien & Reve, 2007). In recent years the industry has, both in Norway and internationally, faced major challenges. Some has characterized the industry as low-productive, low-technology oriented, and generally to be an underperforming industry. There seems to be an agreement among both practitioners and scholars that a large part of the industry's problems stem from poor inter-organisational collaboration in the building process, and that this needs to be strengthened (e.g. Bygg21, 2014). The rapid development of information and communication technology (ICT) has provided some new promising digital tools for collaboration in the AEC industry. In the last

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Selection and/ peer-review under responsibility of Tampere University of Technology, Department of Civil Engineering
doi:10.1016/S2212-5671(15)00197-5

decade we have seen particularly interesting technology in terms of building information modeling (BIM). BIM is a term referring to three-dimensional computer-aided design technologies and processes in the AEC industry. With the use of BIM a network of interdependent actors can collaborate to develop a model of the planned construction works (Taylor & Bernstein, 2009). One of the most striking arguments for using BIM in the AEC industry is that it has the potential to improve the collaboration among the actors involved in the building process which is expected to lead to increased efficiency, productivity and reduce costs.

Investigation of the use of BIM in real-life projects is central in a number of ongoing research projects in Norway and throughout the world. To understand complex issues such as how BIM is implemented and how it affects collaboration and work practices etc., the use of in-depth qualitative case studies are usually necessary. More general, Taylor et al. (2011) also claims that there are an increasing tendency for papers in the field of construction, engineering and management applying case study research methods. Case studies are seen as appropriate to answer 'how' and 'why' questions and allows for the investigation of many variables consequently generating in-depth knowledge. According to Yin (2013), a case study consists of an in-depth inquiry into a specific and complex phenomenon, set within its real-world context. Most often case studies are considered to be qualitative research. This does not have to be the case, survey data may for instance be included in a case study. Still, only qualitative case studies will be discussed in this paper.

How findings from qualitative case studies can be generalised and contribute to scientific and practical development is rarely discussed within research in the AEC industry. Related to this methodological question, how can other researchers as well as practitioners learn from the experiences of the numerous research projects that try out BIM worldwide? Findings from qualitative case studies will not provide a basis for statistical generalisation, as the numbers of cases studied are relatively few. However, the use of case studies allows for other ways to accumulate knowledge. This is an everlasting topic within the social sciences as well as for research in the AEC industry. In this paper, the possibility of generalizing findings from qualitative case study research is discussed. The main purpose is to show how this could be done by constructing a typology based on empirical data and previous research. The following research question will thus be examined: How can findings from qualitative case studies on BIM and collaboration be generalised?

This paper is structured as follows. I outline aspects related to generalisation issues in qualitative methods and analytic generalisation through typology-making. Next, I make a typology based on the empirical data and the existing research related to inter-organisational collaboration in design phases in BIM enabled projects.

2. Generalisation in qualitative research

Payne and Williams (2005) defines generalisation as "[…] to claim that what is the case in one place or time, will be so elsewhere or in another time". In the daily life we generalise almost all the time, more or less consciously. Based on experiences with a particular situation, we form expectations about what will happen in similar situations. Generalisation is also something most researchers have to deal with. If results of a study seem reasonable, the question whether the findings can be valid for other situations are being raised (Kvale & Brinkmann, 2009). Within a quantitative research tradition questions related to generalisation is normally dealt with by pursuing a sample-to-population logic. Within a qualitative research tradition generalisation must be treated in a different manner. The discussion on how generalisation should be treated in qualitative research has been going on for years. This debate is often fragmented and characterized by very different approaches: from those who believe that generalisation is neither desirable nor possible, to those who believe generalisation is both possible and necessary (Williams, 2000).

2.1. Analytical generalisation

Authors such as Yin (2003, 2013) and Kvale and Brinkmann (2009) have argued for the value of analytic or conceptual generalisation (Tjora, 2012). According to Yin (2013), this type of generalisation implies "[…] the extraction of a more abstract level of ideas from a set of case study findings − ideas that nevertheless can pertain to newer situations other than the case(s) in the original case study". For case studies on organizational development, evaluations, etc. the analytic generalisation should also aim to apply to other concrete situations and not just to contribute to theory building. Tjora (2012) states that with this kind of generalisation the researcher develops concepts, typologies and theories that will have relevance beyond the cases studied. To ensure relevance beyond the specific study, researchers need to support their conclusions with existing literature and theories from research beyond their cases. The literature tends to discuss analytical or conceptual generalisations on an abstract level, and processes and procedures for constructing such forms of generalisation are unclear. Yin (2013) refers to Halkier (2011) and argues that "[…] the creation of some typology of analytic generalisations, along with the operational procedures for deriving each type, would represent a greater advance than has been experienced during the past couple of decades".

2.2. Typology making as analytical generalisation

In her article "Methodological Practicalities in Analytical Generalisation" Halkier (2011) suggests different forms of analytic generalisation and offers some procedures for developing them in empirical studies. One of these forms is construction of what is labeled "ideal typologies". Halkier mentions one of the founding fathers of sociology, Max Weber, and his work on ideal types and refers to his definition of an ideal type as "[...] a one-sidedly focused synthesis of diffuse and discrete empirical phenomena into a unified abstract analytical construct which will never be discovered in this specific form" (Halkier, 2011). To construct ideal types involves forming a limited number of categories that one-sidedly emphasizes some parts of the empirical material at the expense of other parts. These categories are then labelled and each represents one ideal type. The labelled categories should express "[…] inferences central to the knowledge interest of the research and valid for the inquiry of the study" (Halkier, 2011). Such labelling illustrates and emphasizes the central findings.

An obvious challenge to construct typologies is that it requires a significant reduction of complexity in the data. This means that some aspects of the empirical data will not be covered by the typology, as Halkier (2011) states "[…] many other patterns and the overlaps, grey zones, shifts, and multiplicities run a risk of not getting represented through ideal typologizing […]". The purpose of such a generalisation form is not that the researcher should summarize all the empirical material, but rather take some parts that seem particularly interesting both empirically and theoretically. Said differently, the researcher must decide which details that should be emphasized and which should be toned down. In the next section I will use my own empirical material and previous research to illustrate how an analytical generalisation can be a fruitful type of generalisation for research in the AEC industry.

3. Collaboration with BIM

This paper's empirical material is derived from a large, ongoing Norwegian research project called SamBIM (Collaboration with BIM as a catalyst). In this research project several actors from the AEC industry want to try out new forms of organization and building information models in order to achieve better collaboration in real-life projects. By collaboration I mean the process where different organizations work together to reach a common goal.

The data consist of interviews with projects members (informants) in various building projects and observational studies of different kinds of project meetings. The informants have different roles such as architects, engineers and project leaders. In the interviews, the informants were asked about collaboration across organizational boundaries in the design phase. This phase is in focus because a good design process is critically important for a successful building project. More precisely, they were asked to tell how the collaboration in real projects had taken place and what factors they considered to be important for collaboration. In the observational studies, I was particularly interested to see how the collaboration took place in practice. More specifically, I was keen to see with my own eyes what seemed to work well and what appeared to be difficult as well as which consequences this have for inter-organisational collaboration.

The informants told about the difficulties they had encountered in projects where collaboration of various reasons did not work well. They also emphasized the confusing situations that could arise if actors from various companies talked past each other. The data reveals that the informants are particularly concerned with what we might call conditions for collaboration. More specifically there is talk of foundations for collaboration across organizational boundaries in the design phase.

Many of the informants emphasized the importance of what could be referred to as technical aspects of collaboration. These issues are important due the projects heavy reliance on ICT, and in particular with the emergence of BIM. Several informants stressed that if BIM should be valuable for collaboration across organizational boarders it will require some form of standardization and a common understanding of what kind of data tools and file format that should be used. Two informants put it this way (all quotes are translated from Norwegian to English by the author):

> “In the construction industry, there has been and still is a lot of talk about getting the technical things related to BIM to work together and run smoothly across companies”.

> “We have often experienced quite many problems when we are trying compiling models across different disciplines and companies. This is actually something that appears in most projects”.

These situations arise due to a lack of standards or the proprietary nature of software, and are an obstacle for seamless exchange of data and information across organizations. Further, it was pointed out that the low technical compatibility across organizational boundaries will cause extra work because of the need for re-entering of already existing data, as well as the possibility of loss of data and information. This is often referred to in the literature as the degree of technical interoperability (Poirier et al., 2014). IEEE (1990) defines interoperability as follows: “The ability of two or more systems or components to exchange information and to use the information that has been exchanged”. The challenge of getting different ICT tools to communicate adequately has characterised much of the research on BIM.

The quotes below are also taken from some of the interviews and illustrates that several of my informants are partly concerned about getting the technical interoperability accurate. However, first and foremost the quotes illustrate how different informants point to the importance of getting the more “social aspects” of inter-organisational collaboration in order to work well:

> “There is much focus on how to work across different companies. [...] To get different disciplines to collaborate is quite difficult. This goes for both the technical stuff with BIM, and the things related to ‘procedures’. The work procedures and the social interaction is the hardest part; to get people from different companies to be coordinated”.

> “This [collaboration with BIM] is partly about things related to the BIM-tools. But more important than a BIM-strategy is to have a strategy for how we should work together across disciplines and companies in the project”.

> “There are several things that need to be in order. It is of course partly about file formats and all that, but also about understanding each other, how we work in different companies and how this can be utilized in the best way possible in the project”.

> “I think the important thing is that we adapt our processes so that we can work together in the project”.

As the quotes illustrates, it appears that also a set of other factors than those related to technical interoperability is perceived as important for successful inter-organisational collaboration. More specifically, the analysis shows that there also exist a number of organizational and social factors that may prevent collaboration despite high degree of technical interoperability. Factors such as different corporate culture and understandings of roles and responsibilities, understandings of contracts and more or less established project delivery systems as well as different project execution models are all elements which may stifle inter-organisational collaboration. Based on the data it can be concluded that successful collaboration requires a significant degree of mutual adjustment of the inter-organisational processes. This could be labelled as organizational interoperability and is largely in accordance with previous research such as Taylor and Bernstein (2009) and Grilo and Jardim-Goncalves (2010). For instance, Taylor and Bernstein (2009) claims that "Addressing technological interoperability is not sufficient to unleash the benefits of integrated technologies. When technological change spans inter-organisational boundaries in project networks, inter-organisational business practices must also evolve and adapt to these changes". Dossic and Neff (2011) found that BIM-enabled projects are often tightly coupled technologically, but divided organizationally. This means that the use of BIM not necessarily leads to closer collaboration across different companies, and the authors point out different obligations to scope, project, and company as one cause for this division.

3.1. Towards a typology

On the basis of my data and the discussion above, I have constructed a typology of different starting points for BIM enabled projects. This typology does not tell us anything about the collaboration outcome in the projects, but it says something about the collaboration potential. Based on the two types of interoperability, combinations of these types give four different ideal types of projects conditions for collaboration. The typology distinguishes between "low" and "high" technological and organizational interoperability, respectively.

- Projects with both low technical and organizational interoperability
- Projects with low technical but high organizational interoperability
- Projects with high technical but low organizational interoperability
- Projects with both high technical and organizational interoperability

This can be illustrated in a cross tabulation (Fig. 1). The first ideal type (1) illustrates a project with a low value of both types of interoperability. This kind of project can be characterized as a Babylonian confusion, i.e. no one speaks the "same language" neither technical nor organizational. In ideal type (2) and (3), there are also some challenges due to low interoperability related to technical or organizational factors respectively. In other words, it is a matter of technical or organizational confusion. The basis for collaboration in these two ideal types is not as good as it could have been. The fourth ideal type (4) is different, characterized by a high degree of interoperability on both types. This means that in this ideal project it exists a potential were all involved actors speak a "common language" – a project characterized by a lingua franca both technical and organizational.

		Technical interoperability: Low	Technical interoperability: High
Organizational interoperability	Low	"Babylonian confusion" (1)	"Organizational confusion" (3)
	High	"Technical confusion" (2)	"Lingua franca" (4)

Fig. 1. Conditions for inter-organisational collaboration with BIM.

Obviously, the reality is a lot more complex than illustrated by the typology in Fig. 1. In practice, the two types of interoperability are interrelated and will affect each other. Moreover, the typology is relatively coarse. For instance, what is here referred to as organizational interoperability does not distinguish between factors related to day-to-day practices at the operational level and more strategic thinking in the different companies on how such as contract arrangements and project delivery methods should be understood and what they imply. Some of the quotes above revealed that the informants identified several factors associated to the working methods and procedures for the daily work at the operative level. My data also indicates that it exist significant differences on how companies consider what may be referred to as more or less established collaborative concepts or models. Examples of this kind of confusion can be differences in their perception of models or concepts such as Lean and VDC and what this means in practice. To succeed with a high degree of organizational interoperability it is important with a common and unified understanding of various organizational factors across all companies involved in the project.

Nevertheless, in such a typology, it is essential to one-sidedly underline particular characteristics to illustrate some key points. It is necessary to simplify, because the reality is too complex to capture into a typology. It will, as pointed out by Halkier (2011), be overlaps, grey zones and shifts, which cause information to be lost. This implies that the typology cannot be seen as a reconstruction of real projects. Instead it is a generalisation based on experiences from several BIM-enabled projects. The typology could be a useful analytic tool for understanding and discussing important conditions and potentials for inter-organisational collaboration in the design phase of building projects that use BIM.

4. Conclusion

The question initially posed was “How can findings from qualitative case studies on BIM and collaboration be generalised?” The discussion demonstrates that there is significant potential for generalisation in qualitative case studies. Admittedly, this is not a potential which can be taken for granted. In this paper, an ideal typology is constructed on the basis of empirical data and existing research. The typology is based on different degrees of technical and organizational interoperability. Different combinations of these two types of interoperability form a typology of four ideal types of projects. The typology seeks to illustrate the ideal project's conditions and potentials for inter-organisational collaboration. In such a typology, it is essential to one-sidedly underline particular characteristics to illustrate some key points. It is argued that these ideal types are a fruitful approach to understand inter-organisational collaboration in the design phase in AEC industry. The four ideal types and their description will be particularly useful as they name and specify complex situations and thus make them more tangible.

This paper demonstrates that the findings of a very few case studies can form the basis of valuable knowledge for the rest of the industry. An understanding of the factors which underlie inter-organisational collaboration with BIM makes it possible for the industry to set up projects where it can obtain the benefits associated with BIM tools and processes. The typology is still in an early stage and should be tested through further empirical and theoretical analysis.

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