The digital construction site

Content

1. Introduction

1.1 Background

The implementation of digital tools and BIM related work methods on the construction sites is still related to very challenging tasks in correlation to the workers' will and ability to put the new tools to use. Furthermore, the contracting companies as organizations are not necessarily geared to meet the demands and wishes of the workers in relation to access to BIM technology. The main focus of this report is to explore the existing barriers to an optimal use of the digital tools. The report will outline the barriers blocking the digitalized work methods reaching the workers on the construction site. Thereby we will be enabled to improve and focus the training available optimally. During the project period we were made aware of some unanticipated difficulties concerning the different professions' expectations of both training in and need for digital solutions. It is these circumstances that the project will shed light on.

1.2 Focus points of the project

The three main questions answered in the report are:

- What barriers and potentials do the workers of the individual professions experience in relation to the implementation of new technology?
- What communicative barriers are there vertically between the different professions represented within each of the participating companies?
- What cultural differences vertically between the different professions represented within each of the participating companies must be taken into account, when the use of new technology is to be implemented among the workers?

This being said, the skills and needs of the users have changed during the project. Accordingly, the workers have begun using screen dumps of BIM models, and by the end of the project, the technical skills of both workers and companies as a whole have evolved so much, that the introduction of BIM models appear to be realistic. However, the lack of tablets in the market that would allow the 3D models to be manipulated on the construction sites still make up a very tangible barrier. Furthermore this requires a powerful internet connection in order to get the necessary data without causing a disproportionate waste of time, which can turn out to be a difficult problem to solve in practice.

1.3 Facts about the project

The project is being carried out at The New University Hospital in Aarhus (DNU), and involves to participating companies; Jakon and MT Højgaard.

Jakon has a number of different hardware units, although all are produced by Apple. By the end of the project three gang leaders and one foreman each had a tablet computer. Jakon has chosen a license based software system that is primarily used for QA and registration of errors and defects in the construction process.

The workers at MT Højgaard use iPads and iPad minis. By the end of the project, MT Højgaard had 7 iPads on the construction site, and one worker also used hos his private smartphone as well. Furthermore, a monitor has been placed at the gang leaders' office, where several workers can meet and go through the building plans together. MT Højgaard uses a simple, free file sharing service, where the digital construction plans can be uploaded and shared. From this service the workers can download the plans and information they need, and go through them on their tablets.

Both companies need internet connection for the software to work, and although there has been set up a Wi-Fi network on the construction site, it has not been sufficiently reliable to accommodate the needs of the workers, and accordingly all units have been equipped with a SIM card.

2. Methodological approach

The inquiry itself has been conducted in several stages, partly through anthropological fieldwork in the form of participant observation, and partly through a total of 18 semi-structured interviews with persons in the project.

Fieldwork is basically just what it seems, namely working in the field of analytical interest. For the researcher, engaging in participant observation means both participating in the ingoing activities, i.e. working alongside the construction workers, while at the same time observing the object of interest, in this case the workers' use of soft- and hard ware. In practice that means that the researcher participates in the daily routines on equal terms, i.e. having the

same work hours and as doing the same job, as much as practically possible, as the workers. Self-evidently, the extent of the participation is in some situations limited by the researchers lack of experience within the particular field of expertise.

In most cases the role of the researcher is similar to that of an apprentice. As a researcher, one has to accept the place that you are given, which is usually – and also in this case – at the bottom of the professional hierarchy. From this position, the workers' use of the tablets they have been given can be tracked, and it is possible to see in which situations the tablets are used – and in which they are not. Furthermore, short informal interviews can be conducted continuously, and this allows for the researcher to ask questions in relation to a specific situation, for example "I noticed you chose to use a printed construction plan instead of the iPad just now. How can that be?" In this way it is possible to ask about a specific problematic as it occurs, which increases the level of details in the overall research project.

The 18 semi-structured interviews have been conducted during the course of the fieldwork and cover all levels of workers on the construction site as well as their foremen.

3. Outcomes of the project

3.1 Challenges in the project

Although the tying machine and the iPad are both tools, that have changed the working conditions on the construction site, there are aspects that make them entirely different. The primary difference is, that where the tying machine was designed to optimize a specific part of the building process, the iPad can be looked upon as a tool that affects the construction site in several different ways. The tying machine streamlined one particular function, whereas the digitalization, in this case in the form of iPads, will change not only working procedures, but also hierarchical structures, communication, and work culture throughout the entire construction industry. It is a tool with enormous efficiency improvement potential, but it is also a tool, that you cannot simply "put in the wheelbarrow" overnight, the way it was done with the tying machine. The fieldwork at the construction site has shown quite a few successes, but undoubtedly focus on the barriers identified during the project is needed in

order to realize the full potential of the digital construction site. Overall the identified barriers can be put into three different categories:

1. Basic skills in the handling of both hard- and software
2. Communicative barriers
3. Culturally based barriers

The basic skills have to do with the use of as well as knowledge about hard- and software; how does one use an iPad, and how does the software work? Also, it has a great effect on the implementation process, whether the workers are intimidated by the new technology or not. All barriers in this category are relatively easy to address, as they "only" require practical training and some getting used to through daily use of the technology. Naturally, full attention from the companies is required, but it will be just as much dependent on the individual how much follow-up is needed, just as the choice of software will have an impact.

We consider the communicative barriers pivotal to the success of the digitalization process. The determining factors are clear communication about the purpose of the digitalization, identification of organizational gains, and communication about the progress made in the digitalization process. A close dialogue between the users and those who run the process will undoubtedly have a positive effect on the process. The project shows that dialogue both qualifies the development and speeds up the process, but it is also exemplified how insufficient or misleading communication affect the digitalization process negatively. In order to make such a digitalization process a success, it is important that the involved parties are aware of where and how the communication processes will be affected and transformed.

The culturally caused barriers can be divided into two different forms; the personal routine based barriers (the this-is-how-I-have-always-done-it-attitude), and the group based barriers that have to do with attempting to optimize the conditions of the group one is part of. It is mainly an issue of shifting focus from what one thinks "the others" can or should, and thus what needs they have in a digitalization process, to knowing for certain, by asking them directly through targeted communication in the form of user involvement.

It is possible to avoid or resolve the issues related to the abovementioned barriers through conscious, clear and targeted communication and dialogue about the digitalization process, as well as a culturally intelligent approach with as much employee involvement as possible. All of the above will affect both the degree and speed of the implementations process positively. Section 5 of this report gives a more elaborate explanation of how this can be done in practice.

3.2 Successes in the project

There have been many successes in the project. The workers themselves explain that they experience:

- that access to information has been made easier
- less inquiries about problem solving for the foreman
- fewer and shorter unwanted stops in the building process
- fewer misunderstandings about the execution of the work
- the flexible access to construction plans allows the workers to plan different stages of the building process, when it is most convenient for them and/or their professional group
- fewer mistakes during the process as well as in the finished building
- active employee involvement, resulting in increased job satisfaction and higher productivity

The actual financial gains from the above listed successes can be difficult to calculate, and while one task disappears, another task might take its place.

4. The worker as resource in the digitalization process

As a rule of thumb all individuals are entrepreneurial. That can be an advantage in the digitalization process when securing maximum effect. In this particular project we have seen that the more the workers have been involved in solving concrete problems, the better results have been. Through user involvement the digitalization process can more easily support the gang's existing work culture, which means that the introduction of digital tools can improve and strengthen the ways in which the gang works. If a company insists on using a static system it forces the workers to change their working methods and routines. At all times this

will result in structural resistance from the workers. Consequently it is recommended that the workers are always involved to the largest possible extent during the digitalization process. In other words it is important to take all stakeholders' perspectives into account, as well as identify the incentives to begin using the digital tools for each user group. The digitalization project has shown that when this is not done, the workers quickly stop using the digital systems and return to their old tools.

5. Outline of a 'road map'

In order to make a gang use the digital tools, it is important to consider the following in collaboration with the gang leader:

Before initiating the digitalization process, it is worth considering:

- What type of tablet, and what size do you need? It is necessary to be aware, that some sizes are well suited for certain parts of the building process, while different sizes are better for different parts of the process.
- What type of internet connection is necessary – and available? SIM card or Wi-Fi?
- Who should get a tablet, and where will each tablet create the biggest value? Both personal relations and work functions should be taken into consideration.
- How do you want your file sharing system to be structured? What will create the biggest value for the gang and the company as a whole?
- How much training is needed, before the gang can begin using the system (both hardware and software)?
- How much drawing material should the gang be able to access? Does it make sense to give access to everything at the same time?
- How are you going to name the files, so it will make sense to the gang?
- Who is going to be responsible for updating the drawing material on the different tablets as well as in the file sharing system?
- Can the gang bring home their tablets after work, or should they stay at the site? On the one hand, if you choose to let them take home the tablets, they can prepare for the following day. On the other hand, leaving the tablets on the site gives equal access to everyone, also in the case of illness.

During the implementation phase the company and the gang should continuingly discuss the following (preferably on a weekly basis):

- What problems occur to the gang as well as the company as a whole, and how can they be solved?

- How are the new ways of communicating working in practice, and should there be made adjustments?

- Is the structure of the system beneficial for the gang, or is there a need for adjustments?

- Are the tablets distributed in the best possible way, or should they be redistributed in order to create the biggest value possible? In some cases is it enough to redistribute the existing tablets, and in other cases extra tablets are needed. You should pay attention to what processes are most important at the given time.

- Find out what suggestions for improvement the gang has. Listen to the primary users!