SUPPLY CHAIN MANAGEMENT WITH BIM

TOWARDS BETTER CONTROL OF CONSTRUCTION LOGISTICS
REFLECTION
1. SUMMARY

Currently the logistics of construction projects are very inefficient. The construction industry is very fragmented and there are a lot of different information and material processes, therefore it is difficult for a main contractor to get control of these all. It is assumed that if the main contractor gets control of the logistics, the logistics will become more efficient. One of the ways to get control is with BIM. Building Information Modelling combines the data of all stakeholders in one model and can help to streamline the logistics. The goal of this research is to show contractors how they can get change their traditional processes into a supply chain that is managed with BIM and get control of their logistics.

Case study research shows that currently the logistic information and BIM are disconnected. The logistic information is send from the subcontractors and suppliers to the main contractor and back, but this happens mainly in 2D. This is partly due to the fact that there is a mismatch between the information processes and the production processes. As a result, information is missing in the BIM-model. This information should be completed, but that does not happen. No one takes responsibility and therefore the current information processes are fragmented and uncoordinated. The main contractor controls the process but does not coordinate the information, neither does anyone else.

Based upon a literature study and case study research several steps have been defined which the main contractor must take in order to manage the logistics with BIM. The first step is that the main contractor must take the responsibility and control the changes in the process. He must actively lead the supply chain and demand collaborative behaviour from the subcontractors and suppliers. The second step is that the main contractor must make sure that the information processes and BIM are connected, and that the logistic information is incorporated in both. This includes, inter alia, linking the planning to the BIM-model. The third step states that the main contractor must make sure that the BIM-model aligns with the logistics on the construction site. All steps are combined to create the final framework, see Figure 1.1.

Next to the information flows, this research also focused on providing more clarity on the processes in BIM. Figure 1.2 summarizes the structure of BIM from the design phase to the execution phase, with the goal to manage the logistics on site with BIM.

The information flows and the BIM-structure should be connected to make supply chain management with BIM feasible. Overall, both the case study research and the theoretical framework state that if the main contractor takes control, actively coordinates and structures the information flow and focusses on connecting the logistic information and BIM, he can get control of the logistics. According to the opinions of experts the process of changing a traditional supply chain to a supply chain management with BIM is both financially, organisationally and socially feasible for the main contractor.
Figure 1.1 Final Framework (own illustration, 2017)
Figure 1.2 Structure BIM-models (own illustration, 2017)
2. RELATIONSHIP BETWEEN THE RESEARCH AND WIDER SOCIAL CONTEXT

2.1 SCIENTIFIC RELEVANCE

This research is based on former research on construction logistics that has been carried out by TKI, a consortium formed by TNO, Dinalog and NWO (van Merrienboer, 2015). This research started in order to find a solution that would make construction logistics more efficient. The goal of the first round of the research was to define several measures that could be taken to improve the logistics. The outcome showed that two measures showed the most potential: making use of a hub and shifting the transport of employees from private transport to public transport (Dogger et al., 2012). These results were used to set up the second round of the research. In this round, several logistic measures were implemented in two pilot projects in order to conduct a case study and research whether the expected results were correct. The result of the research was twofold according to TKI DINALOG and NWO (2016). On the one hand the results showed that the implementation of the logistic measures payed off, both in terms of sustainability and in decreasing the lead time and the costs of the project. On the other hand, there were also some difficulties. Using software for the collection and management of data turned out to be difficult to implement in a project. The building sector is both fragmented and quite conservative, it is difficult to convince all parties of using a different approach. It also showed that due to a lack of data, most parties do not know the exact costs of for instance transport, it is difficult to avoid assumptions. The third round of the research focuses on solving these problems. The main focus points are measuring the performance of logistic measures, researching the use of BIM for the management of logistics and performing research on company transcending supply chain management with for instance 4C Control Towers (TKI DINALOG & NWO, 2016).

This research focuses on one of those focus points, namely the use of BIM for supply chain management. Several research subjects are combined such as supply chain management, building information modelling and sustainability. There has been a lot of research on all of these subjects, however most literature focusses on one or two aspects instead of on the whole supply chain. Peltokorpi and Seppanen (2016) examined several papers on construction logistics and concluded that some subjects, such as delivery reliability, have been extensively studied while other subjects, such as labour productivity, are still underexposed. This is also the case in research on using BIM for supply chain management. Research such as that of Cheng and Kumar (2015) and Bortolini, Formoso, and Shigaki (2015) shows how BIM can be used for site logistics and material logistics, but they both give little attention to labour productivity. Bryde, Broquetas, and Volm (2013) are one of the few to mention the human aspects of implementing BIM. This research aims at closing the gaps of the current research by focusing on all aspects of the supply chain. Next to that it focusses on retrieving the necessary additional data for the overall NWO-project.

2.2 SOCIETAL RELEVANCE

Global warming currently is an important topic worldwide. In December 2015, 195 countries agreed on a climate deal at the Paris Climate Conference. They agreed on keeping the increasing temperature below the 2 degrees Celsius, by decreasing greenhouse gas emissions (“Paris Agreement,” 2016). Many research has shown that global warming is caused by too large concentrations of CO2 and other emissions in the atmosphere (Anderson, Hawkins, & Jones, 2016; Snyder, 2016; Vitousek, 1994). This greenhouse effect causes the earth to warm up, which has disastrous effects on the environment. Nature, both animals and plants, suffer from the increase in temperature (Prasad & Thomas, 2003; Root et al., 2003). The Netherlands also signed the Paris agreement and therefore must limit her greenhouse gases. The three chemicals that have the largest effect on the reduction of the air quality are nitrogen oxides, carbon dioxides and particulate matter (Centraal Bureau voor de Statistiek, 2015a).
Road traffic makes up for approximately 15% of the total emissions of the Netherlands, so decreasing traffic emissions could benefit the reduction of emissions a lot (Centraal Bureau voor de Statistiek, 2016). With road freight traffic being accounted for 22.9% of the total traffic-related nitrogen dioxide emission, 25.4% of the total traffic-related carbon dioxide emission and 20% of the total traffic-related particulate matter emission in 2014, it is evident that reducing the amount of construction related traffic would largely contribute to improving the environment (Centraal Bureau voor de Statistiek, 2015b). This research aims at improving construction logistics and therewith decreasing the amount of traffic. This will have a positive effect on the environment and therefore also on society.

2.3 UTILISATION POTENTIAL
As explained earlier this research is part of a large research carried out by NWO. The NWO-project makes use of pilot projects. Several large construction projects that are dealing with logistic issues are testing new logistic measures to see how the logistics can be improved. This research will focus on one of these pilot projects in order to carry out a case study. This project, Bètatoren, consists of the construction of a large apartment building in Leiden that is carried out by Waal, the main contractor. Part of the research includes an internship at Waal in order to conduct the case study. The utilisation potential of this research is twofold. The final product of the research will be a framework that main contractors can use to setup their supply chain with BIM in such a way that they get more control of their logistics. This framework can be used by main contractors, which will save them a lot of expenses. They can implement it directly during their procurement phase and see the results during the construction phase. It can also be used by NWO as new input for their research. Next to the more general outcome of the research there will also be a more personal outcome. Specified to the case of Bètatoren several recommendations will be made on how Waal can change their supply chain in order to get control of their logistics. These recommendations and the framework are of direct use to Waal because it can save them a lot of money.

3. THE RELATIONSHIP BETWEEN THE THEME OF THE GRADUATION LAB AND THE CASE STUDY
The official theme of the lab is ‘Robotics and Logistics’, which is a very broad theme that focusses on both the use of robots and 3D-printing in construction as on construction logistics. The original focus was only on robotics, however due to the start of the NWO-project the subject of logistics was added. The researches in the lab have a clear focus, they either focus on robotics or on logistics. This research focuses on construction logistics and therefore does not have much of a link with robotics. The case study was also selected based on this. The selection criteria for this case were based upon the previous research of TKI and the criteria of TU Delft regarding a graduation project. Based upon the timespan of the research the case needed to entail a construction project of which the construction phase took place in the first half of 2017. This construction project needed to have an urban nature and needed to deal with some logistic difficulties. Because the research focusses on supply chain management with BIM, the main contractor needed to be willing to use BIM. It also would be an advantage if BIM was already used in the design phase of the project. Another criterion is that the construction project needed to be large enough to involve several subcontractors and suppliers that could be researched. Some of them need to have BIM-experience and others do not. Because this research is part of the overall NWO-project, the case also needed to be part of it. This would ensure the case matches the other involved cases and can therefore contribute better to the overall conclusion. Also by being part of the NWO-project the research can benefit from the knowledge and funding that is available from NWO. Project Bètatoren meets all the requirements and therefore was chosen as the case study for this research.
4. PROCESS

This chapter describes the lessons learned within the graduation process, divided in the period before the P2 and the period from P2 to P4.

4.1 RESEARCH PERIOD BEFORE P2

- Due to the fact that my research is part of an ongoing research of TNO (the NWO-project), I had a flying start in the P1 period. Within the NWO-project there were already subjects defined that could use extra research, so it was relatively easy for me to define my research subject. Since there were already companies joining the NWO-project, it was also quite easy for me to arrange an internship. Due to this I was able to design a quite complete research proposal very early in the process. This made it possible to get a lot of feedback from my mentors and therefore I had a detailed proposal by the end of the P1 period, which did not change much after that. Even though I am happy for this flying start, there was also a downside. Because I joined an ongoing project, the research subjects were already set. This was helpful, but also kind of forced me into a certain direction. BIM originally was not part of my research ideas, but was quite a big part of the NWO research and therefore it seemed logical that I incorporated it into my research proposal. During the P1 period it became more and more important and eventually became the basis of my research. Even though I do not mind, I think BIM is an interesting subject and I am glad it is part of my research, I did feel a little bit like the subject was forced on me. The same goes for my internship. I am very happy with my internship and would not want to change it, however it was already partly arranged before I could really think about what I wanted. So, even though I am happy the way my research proposal turned out and I am happy I could conduct this research within the NWO-project, I would want to advise future students to really make sure to stay true to yourself. Ideas and proposals change, which is completely normal, but make sure you end up with something you want to do, not something someone else wants you to do.

- During this period I was mainly focusing on designing a perfect research proposal that fully connected to my ideas and the NWO-project. I forgot, however, to take my case into account. I was designing a proposal based on the ideal situation, but forgot to take into account that I was researching a real construction project that had its own planning. This resulted in the fact that my original idea, researching the finishing phase of the construction project, was not possible simply because the finishing phase would not start until after my graduation date. The planning of the project did not match my graduation planning. This was quite a setback because instead of measuring actual effects I could only base my research on assumptions. In the end it turned out well because now I could conduct a research of which the results could already be used by Waal to make changes to their finishing phase. However, I would recommend future students to really take your case into account when setting up a case study. You can have such a perfect idea, but if it does not match with reality you will not be able to make a good research project out of it.

4.2 RESEARCH PERIOD FROM P2 TO P5

- During this period I conducted several interviews with subcontractors and suppliers from the project I was researching. During the former period I made a, quite optimistic, schedule of all the interviews I wanted to conduct and the period in which I wanted to conduct them. This turned out to be much more difficult than I thought beforehand. At first I planned to send out questionnaires which people could fill in in their own time and return them by email. This did not work, because none of the respondents stuck to the deadline. After repeated emails and calls I got all questionnaires after one month. From that moment on I only planned ‘live’ interviews on a fixed date, so I was sure about when I got new data. This thought me that you cannot depend on other people, everyone is busy with their own work and no one,
except for you, has your graduation project as a priority. You have to make sure you get from people what you need, so a hands-on mentality is important.

- The research proposal that I presented during my P2 presentation consisted mainly of interviews as a research method. This made my research a bit too ‘social’, which was also one of the comments of my P2. After that I made the decision to add more in-depth research of the BIM-model to the research. I am very glad I did this because it turned out that the data I collected from the BIM-model was very helpful to support the data collected from the interviews. It was also nice to have a different data collection method because that increased the validation of my research.

5. PRODUCT

This research aims at showing contractors how they can get more control of the logistics of the building project with BIM. This is done by first analyzing the current status of supply chain management and BIM within a selected case. The second step is to research how the current supply chain processes should be changed in order to manage the supply chain with BIM. The final product of the research is a framework that shows contractors how they should organize their supply chain with all the information flows and the BIM-model in order to manage the logistics on site. The literature study and the empirical research together form the direct basis for the final framework. The literature study forms the basis of the framework and shows what the structure should be according to theory. The empirical research adds practical knowledge to this based on extensive case analysis. The relationship between the research and the product is therefore very close.
6. BIBLIOGRAPHY


