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Customer Need Assessment for Differentiation in Building Information Modeling

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ABSTRACT

Author: Heikki Hämäläinen **Title**: Customer Need Assessment for Differentiation in Building Information Modeling	
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Building Information Modeling – BIM is widely spreading in the Architecture, Engineering, and Construction (AEC) industries. Manufacturers of building elements are also starting to provide more and more objects of their products. The ideal availability and distribution for these models is not yet stabilized. Usual goal of a manufacturer is to get their model into design as early as possible. Finding the ways to satisfy customer needs with a superior service would help to achieve this goal.

This study aims to seek what case company's customers want out of the model and what they think is the ideal way to obtain these models and what are the desired functionalities for this service. This master's thesis uses a modified version of lead user method to gain understanding of what the needs are in a longer term. In this framework also benchmarking of current solutions and their common model functions is done. Empirical data is collected with survey and interviews.

As a result this thesis provides understanding that what is the information customer uses when obtaining a model, what kind of model is expected to be achieved and how is should the process optimally function. Based on these results ideal service is pointed out.

TIIVISTELMÄ

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Rakennustietomallintaminen (eng. Building Information Modeling – BIM) on vahvasti kasvava trendi arkkitehtuurin, insinöörityön ja rakentamisen piirissä. Lisäksi myös rakennuksen elementtien valmistajat ovat heränneet tarjoamaan yhä enemmän mallinnettuja objekteja tuotteistaan. Näiden mallien saatavuus ja jakelu ei ole vielä vakiintunutta. Tyypillinen tavoite tuotteen valmistajalle on saada mallinsa suunnitelmaan mahdollisimman aikaisesti. Tämän tavoitteen saavuttamista auttaa asikkaiden tarpeiden tyydyttäminen ensiluokkaisella palvelulla.

Tämän työn tavoitteena on ymmärtää mitä case yrityksen asiakkaat odottavat malleilta ja kuinka he ideaalitilanteessa saavat nämä mallit sekä mitkä ovat halutut ominaisuudet tälle palvelulle. Tämä diplomityö käyttää päätutkimusmenetelmänään muokattua lead user metodia hahmottaakseen näitä tarpeita pitkällä aikavälillä. Tämä viitekehys sisältää myös nykyisten ratkaisujen niiden toiminnallisuuden benchmarkin.

Työn tuloksena on ymmärrys siitä, mihin tietoon perustuen asiakas hankkii mallin, mitä mallilta odotetaan ja kuinka hankintaprosessi optimitilanteessa toimii. Näihin tuloksiin perustuen esitetään ideaali palvelukonsepti.

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Kiitos kuuluu myös perheelle. Kiitos äidille jatkuvasta hukassa olevien asioiden löytämisestä ja asettamisesta tärkeysjärjestykseen – tuesta opiskelujen ja elämän vaikeina hetkinä.

I would also like to thank all the fine young people I got to spend my time with in Skinnarila and get to know different sides of our student culture. Thanks Kaplaaki and LTKY for teaching me outside the classroom. And of course a big thank you for the ones that I am lucky to continue now after Skinnarila has been left behind.

Järvenpää, October 19, 2015
Heikki Hämäläinen

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LIST OF SYMBOLS AND ABBREVIATIONS

4D	3D and time information
5D	3D and cost information
6D	3D and lifecycle information
7D	3D and maintenance information
AEC	Architecture, Engineering and Construction
AIA	American Institute of Architects
BIM	Building Information Model
CAD	Computer Aided Design
DB	Design-Build
DBB	Design-Bid-Build
DMU	Decision Making Unit
IFC	Industry Foundation Classes
LOD	Level of Detail (Level of Development)
QFD	Quality Function Deployment
UK	United Kingdom
US	United States

1. INTRODUCTION

Information technology has changed the way we do business. This also applies on the architecture, engineering and construction (AEC) industry. For this industry Building Information Modeling (BIM) has been one of the most promising developments in the 21st century (Eastman, Teicholz, Sacks & Liston 2008). As a digital, accurate 3D model it enables savings on build time, more accurate calculations and fewer mistakes, which again turn in to savings of money. This way it is no wonder BIM is gaining more and more attention. Although the buzz around BIM has been big, the maturation and adaptation of technologies and the philosophy has been slower than estimated (RIBA 2010, RIBA 2011, RIBA 2012, RIBA 2013, RIBA 2014). This creates a need for manufacturers and suppliers to start thinking new ways to satisfy customer needs regarding BIM and BIM models, as building designers begin to demand BIM models instead of the more traditional CAD drawings. Furthermore, differentiation in this field could open new opportunities to gain competitive advantage.

Finland is one of the leading countries in BIM research. Tekes – the Finnish Funding Agency for Innovation – has funded several research programs for BIM, such as PRE program on 2010 – 2014 which is an abbreviation for Built Environment Process Re-engineering. This program was further divided into six schematic work packages that focused on different areas of BIM and was granted a fund of 21.8 million euros. (RYM Oy 2015) Another program that started as a follow-up for one of these work packages in 2015 is called DRUMBEAT. This program is focuses on collaborative development of ICT solutions that enable distributed publication and utilization of BIM models on the web. Budget for this program is 6.8 million euros and will run until 2017. (DRUMBEAT 2015) Both of these programs have strong ties in the industry and academy, as the programs are led by companies working with the issues researched. (RYM Oy 2015, DRUMBEAT 2015)

One of the key elements for BIM is interoperability, by which professionals in the AEC industry to work simultaneously with different “layers” of the design, such as plumbing or electrical design (Eastman et al. 2008). Furthermore, as all parts of the design are modeled into one design, suppliers of certain parts of the building can benefit from offering their products as BIM models. This has led to the situation where more and more suppliers model their own products as objects to the design finding new ways to attract their customers and to engage them with the firm. This is also the focus of this study.

KONE Corporation is one of the biggest elevator and escalator companies in the world. For over 100 years of history, KONE has had a focus on the technological development and innovations strategies (Michelsen 2013, Kone Oyj 2015b). Even though elevators and escalators are nowadays done for the needs of BIM systems, the competition within these services is rough. If KONE wants to utilize the technological leadership strategy, the company has to act and improve its current offering in this area. As the usage and the ways of using BIM are not yet stabilized, there is plenty of room to improve the current offering and this way to obtain the abovementioned advantages of superior experience in this area.

Another master’s thesis by Kallio (2014) was conducted for the case company in 2014 related to this subject. This study was focusing on customers’ views on how they use BIM in wider context and whether putting efforts on BIM development would be profitable in that sense. The results one year ago and especially the suggestions for future research in that study were taken into account when planning this research. Customers who took part on that previous thesis clearly saw that BIM is this future way of working in the construction industry (Kallio 2014). Most of them further stated that they are expected to expand their BIM operations in the near future. One interviewee in this previous thesis highlighted the process and human side of BIM, stating that BIM should be an abbreviation of Building Information Management which would point out better how important it is how information is processed. In addition, Kallio (2014) stated that customers should be always taken into account when clarifying BIM related issues.

1.1 Research objectives and questions

As was found out by Kallio (2014), KONE’s customers see that BIM is the future way of working. This is why their needs related to KONE’s services play a crucial role on how these services should be arranged. As that study found out that BIM indeed is a concept that KONE should put great efforts in order to compete with rivalry in the business, a research gap of how that can be achieved is formed. This thesis focuses in that problem. One of the keys to this is issue is to understand what are the needs towards BIM. Which are the important factors that customers use as the basis of their decision making and what do they expect to get as an output.

Furthermore, the process of handling building information was highlighted in the previous thesis by Kallio (2014). This thesis aims to understand this process better and how customers want to attain information about KONE BIM models and how this information is managed during the design process. This way, deeper understanding of how KONE could better react to these information management requirements is clarified.

To achieve these results KONE’s customers from four countries are surveyed to gain general understanding of what is desired by KONE’s customers. Later this attained understanding is observed in more detail, as BIM experts from KONE’s native country Finland are interviewed to understand what is happening in the marketplace. In addition to this, two follow-up interviews with respondents of the survey are interviewed, in order to understand the issues that are faced during the design process.

One aspect is also to understand the existing solutions for the purpose. For this purpose, these solutions are briefly introduced and later a comparison between solutions is displayed as benchmarking. This provides a basis to understand the context and later to understand the obtained results and how differentiation can be achieved in this context.

As an outcome of this study a solid understanding of these issues is made. Another goal is to understand how customer engagement can be achieved within this context and how to differentiate from the competition in order to achieve that. For these goals, suggestions are made based on the results of the study. This research creates a good basis for implementation planning and design of the technical functionalities.

Previous study from this approach in this context was not found. This subject is very case-specific and results from other need assessments in BIM context cannot be directly adapted, since the product – an elevator – is very specific for each design.

To achieve the goal, the following research questions are formulated:

1. *Which are the most important customer needs regarding BIM elevator models and their availability?*

2. *What are the current competing solutions?*

3. *Which of the existing types of availability solutions are ideal to satisfy these needs?*

1.2 Limitations

The study takes into account two geographical areas: North America and Europe. KONE has a strong presence especially in Asian markets, but as BIM development and interest inside the company lies strongly in these two areas, this was use as basis for this selection. This selection was partly done because customers from these markets were easily contacted compared to Asian markets. This was important due to relatively short time span for the execution.

Thesis takes a marketing point of view on building information models and their availability. Customer needs are reviewed in this sense and focus is solely on the availability and design process. The reality is not as black and white, as modeling and design are not separate from company's other functions. Decisions are not made only in basis of these services, but as the goal is to clarify what is desired design process-wise, the connection to this bigger picture is not made in a broader manner. This study takes into account the current situation rather than taking a longitudinal (long-term) aspect; sole focus is on current solutions and how they can be improved and how customer satisfaction may be achieved in this context. Furthermore, as the research focuses on finding the customer needs and thus is not interested on the different views inside the company. A whole another thesis could be written about how different parties inside such large company use this kind of concept.

As the main goal is finding the needs and thinking of how they could be satisfied, technical issues or how the findings could be implemented in action in different parts of the organization are not discussed. This is seen as a following stage for this study, and in a large corporation there are many things to take into account in that stage as well. In addition, different offerings and elevator types and their needs modeling-wise are not taken into account. In this thesis KONE and competitors are discussed as what they offer in general without further specification by elevator model.

1.3 Structure of the study

Structure of this study is illustrated in figure 1. First chapter explains the reasoning and research problem behind this thesis. Based on this background and starting situation, objectives, limitations structure are presented as an outcome of the chapter. Chapter 2 introduces the theoretical framework for this study. In that chapter, some characteristics for this for this study and case context are explained and previously applied methods for similar issues are reviewed and evaluated in the light of these characteristics. As an output a framework for this thesis is presented. In chapter 3 this framework is discussed research-wise. Output of that chapter provides the selected research path, classification and chosen data collection methods for this framework. In addition reliability and validity of the results is discussed. Chapter 4 explains the context of the study. It provides an overview on the case company and the most important background information regarding the building information modeling concept and software. In chapter 5 the framework and the methodology are applied into this context and as an outcome existing solutions and customer needs are identified. In chapter 6 these results are further discussed, and as an output the key findings are given. These findings are concluded in chapter 7 as conclusions are presented as answers to research questions and managerial implications. Also limitations, reliability of the study and contribution to research are evaluated and suggestions to future research are given in chapter 7.

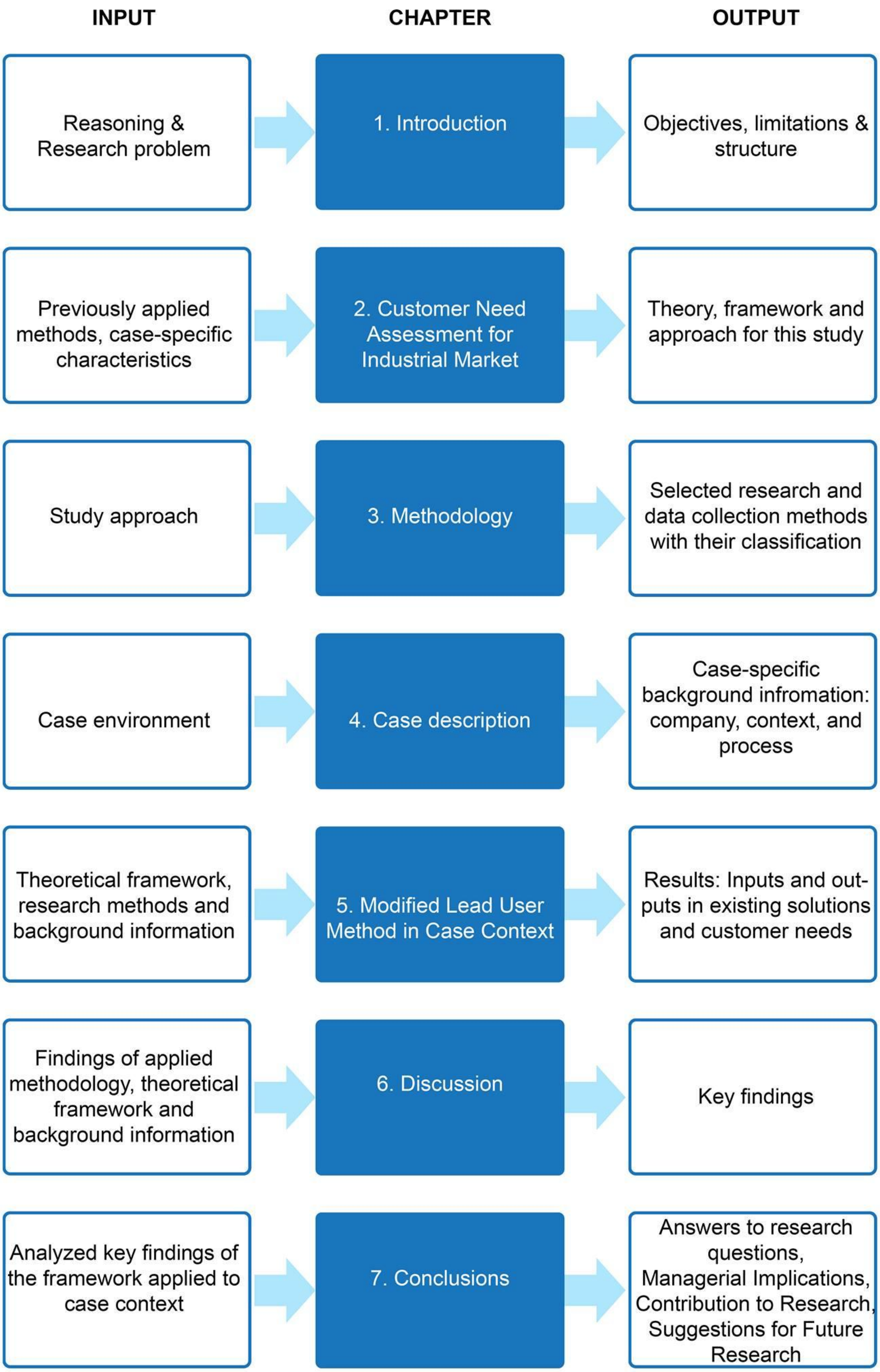

Figure 1. Structure of the thesis

2. CUSTOMER NEED ASSESSMENT FOR INDUSTRIAL MARKETING

Studies show that need assessment is a highly successful factor in new product development (Elfvengren, Kärkkäinen, Torkkeli & Tuominen 2004). But call for further empirical evidence and measures for this success, has been made (Fang 2008). In order to develop competitive products customer needs must be understood. (Kärkkäinen, Piippo & Tuominen 2001) In this light it seems reasonable that the methods to conduct a need assessment in these two contexts are different. Still, according to Kärkkäinen et al. (2001) it is not unusual that the industrial companies use the consumer side methods for their need assessments, even though they are not a good fit. To identify the suitable methods for industrial marketing, the characteristics of industrial markets should be established.

First, an understanding of who is the customer has to be made. In industrial markets, the buying process tends to vary and is influenced by more people, than in the consumer goods market. Webster and Wind (1972) were some of the early ones to define a so called buying center or decision making unit (DMU) that describes the people taking part on the buying process and their roles in this process. Their first definition of the DMU included five roles: user, influencer, buyer, decider and gatekeeper. Webster (1991) later modified DMU in some cases to include approvers and initiators as additional ones. These have been argued to create overlap in as approvers and deciders are seen too similar to each other, and the same problem is included between initiators and gatekeepers (West & Paliwoda 1996). In this thesis, the original five roles are used to understand the roles in this context.

Users are the ones that use the product or service. In the buying process they can be the ones that make the initiative and are influencing the requirements of the purchase. *Influencers* are working with the requirements and evaluating the alternatives. People working in technical positions are especially important influencers. (Kotler & Armstrong 2009) They can also provide further information for the process. *Buyers* are the ones that have the formal power to make the decision about the supplier and to agree on terms of the purchase. They also may have a role on shaping the product specifications as well as having a significant role in negotiating. They are commonly the major actors on decisions about the supplier and may also be high-level managers. *Deciders* make the final decision and approve or disapprove the purchase, product requirements and the suppliers. (Kotler & Pfoertsch 2006, Kotler 2003) West and Paliwoda (1996) further remind that decider may also have role of a buyer. Finally, *gatekeepers* are the people who can prevent the information flow between the seller and the most important pieces of the DMU. Gatekeepers include people such as purchasing agents or receptionists that within their role might prevent the interaction from happening. (Kotler & Pfoertsch 2006, Kotler 2003)

In organizational buying when there are many different people playing various part in the buying process, marketers will most likely not have time or resources to contact all of the people included. This is why it is important to reach the *key buying influencers*, the people who affect on the buying process the most.(Kotler 2003)

It has also been stated the DMU tends to change in terms of size and composition, depending on the type of buying situation (Woodside, Doyle & Michell 1979). This framework and has been sometimes called as buyclass framework (Anderson et al. 1987). The concept was introduced in 1967 by Robinson, Faris and Wind, and 20 years later was one of the most used theories for organizational behavior, according to Anderson et al. (1987). The types of buying situation in this theory have often been divided into three: straight re-buy, modified re-buy, and new task (Luffman 1993, Woodside 1979). To understand these categories, table 1 summarizes them according to four different variables and their importance to the buying type.

Table 1. Buying decision grid (Woodside et al. 1979, Robinson et al. 1967).

Type of buying situation	**Newness of the problem**	**Information requirements**	**Consideration of new alternatives**	**Number in DMU**
New task	High	Maximum	Important	3 to 5 people*
Modified rebuy	Medium	Moderate	Limited	3 to 5 people*
Straight rebuy	Low	Minimal	None	2 to 3 people

*New task and modified rebuy were evaluated together (Woodside et al.l 1979).

In *straight re-buy*, the products are bought without changing their requirements. Low risk is characteristic for this situation. (Kotler & Pfoertsch 2006) Many low-cost items are bought as straight re-buy and it remains as the most common buying situation (Anderson, Chu & Weitz 1987). On the other hand on *modified re-buy*, the need is satisfied in modified way (Kotler & Pfoertsch 2006). The company sees that re-evaluation of the alternatives can be beneficial for the process (Luffman 1993). This can occur as change in price, quality or as improvement in service. In this situation, the companies who the buyer has previously worked with try to convince the buyer to slide back to straight re-buy. Previously unknown companies try to hold the buyers in this stage long enough for the buyer to fully evaluate their options. (Kotler & Armstrong 2009) Third option is *new task*, in which a company faces a new purchase situation for a certain product or service, that it has no previous experience (Luffman 1993). In new task situations the risk and uncertainty are usually increased due to the lack of experience. (Kotler & Pfoertsch 2006) Since there is very little experience and assumptions of the features of the final product bought, the supplier should be highly involved during the buying process. (Kotler & Armstrong 2009) Due to these reasons, new task is relatively rare and the DMU relatively large. It was further suggested that the economic terms are secondary because of the risen uncertainty. (Anderson et al. 1987)

Another way to view buying process is to analyze the type of purchasing. Kraljic (1983) defined four different categories for this depending on the type of a product. These product types are: routine (also sometimes noncritical) products, leverage products, strategic products and bottleneck products. Categorization uses two factors to determine the categories: value and cost for the customer and risk. Due to the popularity of this categorization, different iterations and tests (Cani 2007, Olsen 1997) have occurred since the original concept was introduced. In this thesis, the adaptation by Kotler (2003) is used to define these categories due to its simple and clear representation. Supplementation from the original article by Kraljic (1983) will also be presented.

Figure 2 illustrates a matrix of these categories. *Routine products* have a low value and cost and also include a low risk (Kraljic 1983). This commonly leads to seeking the lowest price and routine ordering, hence the name of the category (Kotler 2003). Kotler (2003) brought up office supplies as an example for routine products. *Leverage products* are the second category. They again include high value and cost, which come with a little risk of supply (Kraljic 1983). Suppliers tend to know well that customers compare the products and prices. Engine pistons were mentioned as the example for this product type. (Kotler 2003) Third category is *strategic products*, which in include high value and cost and also high risk (Kraljic 1983). Due to the occurrence of both of these at high-level, customers are keen to find a known solution, for which they are more willing to pay premium as well. Mainframe computers were mentioned as an example product for this category. Fourth and a final category are *bottleneck products*. They include low value and cost while involving high risk. Spare parts are a good example of this type of products. (Kotler 2003)

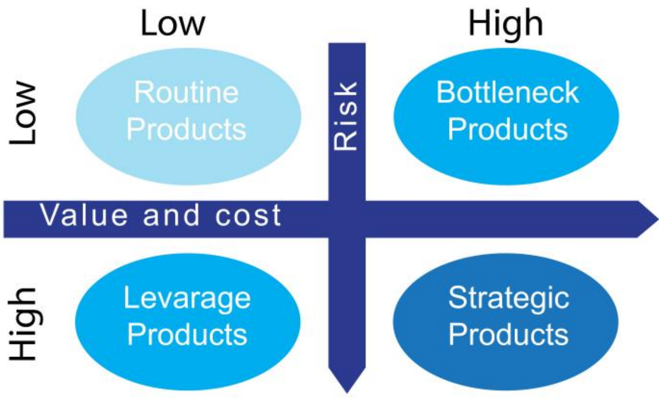

Figure 2. Matrix of product types. Adapted from Kotler (2003) and Kraljic (1983)

Although the process might be more complex, industrial markets usually have well-established and close relationships and direct personal contacts with the key customers. These are beneficial for a successful need assessment. (Elfvengren et al. 2004, Kärkkäinen et al. 2001) This tends to make the amount of buyers fairly small, which again makes qualitative methods more suitable over quantitative ones. Qualitative method usage is also supported by the more complex nature of product details in industrial markets. (Elfvengren et al. 2004, Kärkkäinen et al. 2001) One factor is also that trends in the industrial market have the tendency to be well known by the professionals. (von Hippel 1986) This is one thing that should be taken in to account when deciding the approach for the research.

2.1 Customer Involvement in Design Process

The goal of all development processes is to provide users with a well thought-out and designed product with maximal utility and value-addition (Veryzer & Borja de Mozota 2005). Successful innovations that manage to provide the aforementioned are based on accurate perceptions of customer needs. The economic success of a new product or service depends on the ability to interact with customers in the design process understand and utilize their needs, and turn them quickly into products, while maintaining low costs in the process. (Elfvengren et al. 2004, Gruner, Homburg 2000) This customer perspective should be taken into account all the way from the early stages of the development until the very end of the process. (Kärkkäinen et al. 2001, Laage-Hellman, Lind & Perna 2014). In business markets customers are often involved in the early phases to provide ideas and later in testing phases, which has created a gap in between (Gruner, Homburg 2000, Olson, Bakke 2001). Laage-Hellman et al. (2014) also stated that different types of users should be taken as part of the process and also more than is common in this day and age.

Innovations have been traditionally associated with tangible products (de Bretani 1995). Some scholars, such as de Bretani (1995) have found the customer involvement as an important success factor for intangible products as well. But still there is a call for more empirical evidence of performance implications in customer involvement in new service development. (Alam 2002, Carbonell, Rodriguez-Escudero & Pujari 2012)

Next, different forms of customer involvement are introduced. In addition to marketing theories, a substantial part of literature sources for the following subjects are related to innovations and customer involvement in new product development. This is because the framework focuses on finding best ways to involve customer into the design process and to understand different ways of developing services instead of purely improving current offering and marketing of this offering to satisfy customer needs. Similar approach of combining marketing and innovation management theories has been recently taken at least by Laage-Hellman et al. (2014).

Need assessment is a systematic series of procedures and methods with which customers' needs are gathered, structured, estimated and analyzed to determine product characteristics and to ensure that the whole company is working to satisfy the identified needs (Elfvengren et al. 2004, Kärkkäinen et al. 2001, Muramatsu, Ichimura & Ishii 1990). Need assessment is also a way to ensure that the development activities are accurate. (Elfvengren et al. 2004) The goals that companies set for the need assessment process must be in line with company objectives and strategies (Kärkkäinen et al. 2001). To ensure that the needs are taken into account in the product development, this should be done interactively between supplier and customer (Lagrosen 2005). To understand how this can be achieved in action, different levels and different methods for customer involvement in product design process are introduced next.

Alam (2002) identified six different goals for customer involvement in new service development. To evaluate different theories and concepts for customer involvement, especially the first of these matches the goal of the thesis rather well. Also the sixth has similar attributes that align with the goals of this study. The six are goals for customer involvement in service design are (Alam 2002):

- *"Development of a better and more differentiated new service to match the customer needs and wants"*
- *"reduce the overall service development time"*
- *"user education about the use and attributes of a new service"*
- *"users – as innovators for the rapid diffusion of innovations"*
- *"strengthen public relations"*
- *"assist a firm in maintaining a long-term relationship with the users"*

Blazevik and Lievens (2008) categorized customer involvement according to the level of involvement the customer has in the process. These categories are named passive users, active informers and bidirectional creators. In comparison to the above-mentioned categorization, Fang (2008) conducted a research that examined two different categories that are similar to Blazevic and Lievens' (2008) as he defined that customers can be used as an information source or as co-developers. For the purpose of this thesis, categories by Blazevic and Lievens (2008) are introduced next. *Passive users* give out a low level of knowledge into the co-development process. Companies track customer behavior to understand their needs and to further find solutions to customers' problems. Usually customers do not know that their behavior is being tracked. This information can be useful, but it does not help companies to understand the perceptions about their services. *Active informers* instead are more self-initiative about providing this information. They give information about problems with companies' products or services. This can be done in such forums that further inform other customers as well about the flaws. Companies can further encourage their customers to give this information to improve their current offering. Active informers hope that the company reacts to their feedback, but do not necessarily give solutions to these problems. *Bidirectional creators* on the other hand do make suggestions and solutions for a problem. Customers who act as bidirectional creators have experiences with the product, so their information is valuable for the company. Learning about the problems in advance helps companies to be well prepared and save on assistance costs that otherwise might occur. (Blazevic & Lievens 2008)

In addition to the previous, other categorizations have been suggested. Kaulio's (1998) framework is used to discover different theories within this context. Also other scholars have explored the stages of customer involvement (Alam 2002). Kaulio's (1998) provides a good overview on different theories which is why it is further explained. According to Kaulio (1998), customer involvement can be sorted into two dimensions: longitudinal and lateral. Longitudinal refers to the point or points when the customer is interacting the process. Lateral aspect is focused on the depth of the engagement. To describe longitudinal dimension, the process is divided into five phases: specification, concept development, detailed design, prototyping and final product. Lateral dimensions require more specific explanation. They are divided into three "depths", according to how deep is the influence of the customer. These are design for customers, design with customers and design by customers. The first of these, *design for*, emphasizes the information gathering from the customer and the product development based on that. It does not engage the customer in the development process further than that. *Design with* approach has similar intentions, but in addition displays different solutions or concepts for the customer who then gives valuable feedback based on them. *Design by* takes it further and actively engages the customer in the product development process. (Lagrosen 2005, Kaulio 1998)

In his article Kaulio (1998) selected suitable applications for customer involvement process and described them in this longitudinal/lateral dimensions framework. The framework and the seven methods selected in his study are represented in figure 3. (Kaulio 1998) These methods are now briefly introduced with further detail, and an evaluation of the suitability for this study then follows.

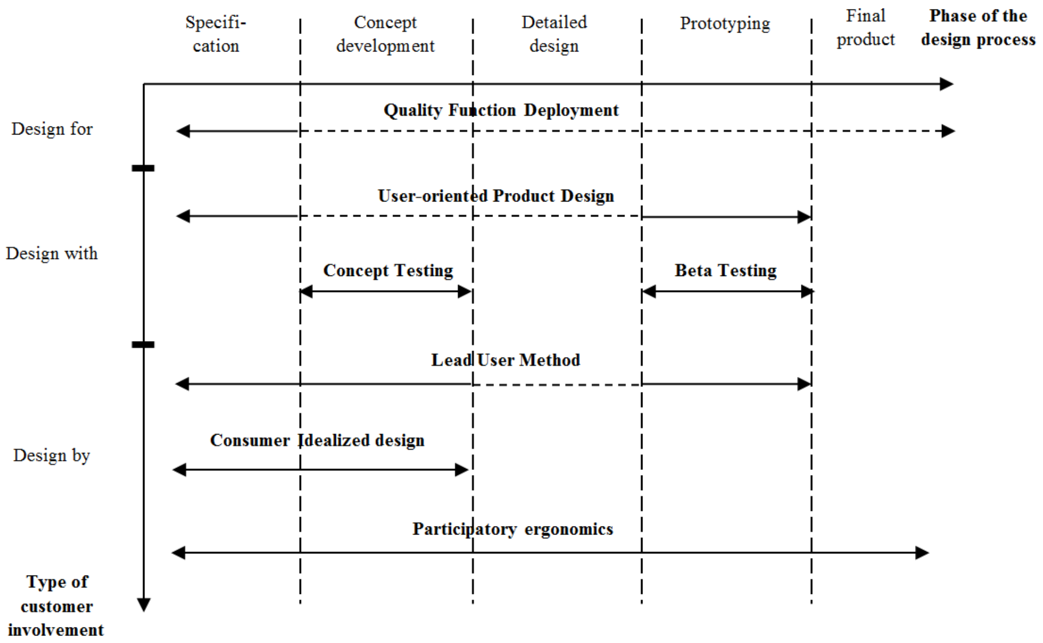

Figure 3. Customer involvement methods in design process phases (Kaulio 1998)

Quality Function Deployment (QFD) is a popular approach especially for those companies that use total quality management. The method collects customer's needs and translates them into engineering and designer characteristics for product development (Kaulio 1998). Matrices are used for the translation, which the simplest way to use such method is by asking customers to weight the importance of certain factors and then to turn these into engineering features, as well as to find correlations between the two groups. This method can also be used as a waterfall model can help to evaluate the needs all the way to manufacturing characteristics. (Bahill & Chapman 1993)

User-oriented product development can be described as an iterative process of engineers and designers producing different prototypes and users testing them and providing feedback to improve it. The process starts with collecting user requirements or user needs, which are then translated into engineering characteristics. After the critical role of designers begins where they design multiple prototypes based on these requirements. This method has been used for many different markets, for example in interior design and hand tools and public systems such as public transportation. (Kaulio 1998)

Concept testing involves customers in evaluating different concepts that the company has developed. This does not initially involve customer into specifying the features that should be included in the concept. Instead the customer is introduced to the concepts via stimulus materials, such as sketches, models, mock-ups and prototypes in addition to verbal communication. Realistic description of the concept should be provided to customer to secure as accurate feedback as possible. (Kaulio 1998)

Beta testing is a method that has been frequently used in software development. It is usually done in latter phases of product development, aiming to test the effects of environmental factors to the usability of the product and overall customer satisfaction of the product. Testing is usually done with selected customers who are given access to the product before its commercial launch. This method should not be the only method used, since the feedback arrives usually late for major changes. Instead it is at its best in correcting minor flaws and “bugs”, in software before launching the product to the main audience. (Kaulio 1998)

Lead user method is an approach that aims to collect information from the industry experts in order to refine the upcoming trends in the market. Von Hippel (1986) defined lead users to be the ones whose problems will become general in the marketplace in near future and who will benefit greatly in finding solutions to these problems (von Hippel 1986). The method for this approach includes four phases: Goal Generation and Team Formation, Trend and Need Research, Identification of Lead Users, and Concept design (Lilien, Morrison, Searls, Sonnack & von Hippel 2002, Lüthje & Herstatt 2004, Churchill, von Hippel & Sonnack 2009).

Consumer idealized design engages customers in the early phases of the product development. They are asked to forget the existing products and the feasibility of the new designs. The goal is to conceptualize new designs, articulate what are the requirements for them and record the reasoning for these designs. The process is done in a practice that resamples a focus group, with participants who are carefully selected from the target market. A facilitator's role is to guide participants away from the obstacle, whereas customers actively find solutions to their own problems and requirements. (Kaulio 1998)

Idea of *participatory ergonomics* is that workers/users actively engage themselves in designing and improving their own working environment or living space and generating ideas for them. The facilitation is the key for the method and is usually done in small group activities. According to Kaulio (1998) the studies conducting this method have been applications related to improving of workplaces and he reminds that by that time (1998), no studies of mass product development were carried out. (Kaulio 1998)

To answer the research questions, this study aims to involve customers as active informers. Data about the passive users is not available in such quantities in that it would provide information to address the questions about the needs. On the other hand, within the timeframe of this study, possible bidirectional creators are hard to identify and utilize as the information source and so the scope of the study would have had to have be broaden. In this sense, the level of customer involvement is taking its place somewhere between active users and bidirectional creators. Wish is that after this study these participants may become bidirectional creators for the company to help them further with the product development in this area of business. What comes to lateral dimensions, design with customer is closest to the scope of this thesis. The defined methods are evaluated in this light as follows, taking into account the time limitations of the study.

QFD could be a great solution for this setting. QFD is a very suitable tool for the initial stages of the need assessment and to help conceptualizing these needs. However, it has limitations in involving the customer after this has been done. (Kaulio 1998) The resources that QFD would require to be fully used were not found in the case company, which is why this method was not used even when its suitability would be great for this kind of study.

Concept testing could be used to test the concept. The desired outcome of this study however is not several concepts, and which of these would be successful and which ones not. Instead the goal is to provide customer requirements and how they can be answered. This is why they are one of the primary targets to find out. Concept testing is not meant for this first specification stage meant by Kaulio (1998). This could be a good concept that comes to follow up for this study.

As mentioned, in the timeframe of this thesis, involving customers as bidirectional creators is too much to arrange. User-oriented design would be beneficial for this study indeed, but it ties the customer too much in the design process. This is why this method cannot be utilized in this study.

Participatory ergonomics is the only method mentioned by Kaulio (1998) that is used for all of the stages of product development. The problem with this method is that participatory ergonomics have not really been used for other purposes other than to improve their own workplaces and living space. The wanted outcome of the study is slightly related to that, since the service is something that customers use, but the main focus is outside of customers’ everyday lives. In overall, this could be interesting approach to this study. However there are limitations to attract customer to such involvement. This method would be more suitable for internal studies within the company.

Also beta testing is one possible solution that could be conducted after this study and the concept has been developed. Beta testing is mainly used for testing the products and services before their actual public launch, which is not the case just yet. In the timeframe of this study, beta testing cannot be done, but it is most certainly a method to be utilized once the solution is created, either based on the results of this study or not.

The core method chosen for this study is lead user method. Characteristics from QFD, concept testing and will be used in the research framework as well. Applications from these approaches will be discussed in chapter 2.5 as the framework is introduced.

Lead user method will be used as the main theory for this study. The approach for attracting the customers for the study is highly similar to the one discussed with the case company in the initial stages and also this way can be seen as the ideal method for this type of study. Lead user method and how to utilize it will be described subsequently. Also, as requested by the case company a competitive situation analysis is conducted within this study. Benchmarking is used for this and will be introduced after the lead used method chapter. In the chapter 2.5 the framework created for this study will be explained as a whole.

2.2 Lead user method

Two literature reviews with customer involvement and lead user contexts were found. One was written by Lehnen, Els and Herstatt (2014), the other one by Finnish researcher Oinonen (2014). The review by Lehnen et al (2014) was conducted as a review in German business press and was strictly focused on the lead user method and its implementation into managerial practice. On the other hand Oinonen's (2014) review was done for a bachelor's thesis and was more focused on customer involvement in business practice. Both of these gave great insight to literature on the subject and acted as a good source for articles to review. In the business-to-business context lead user method has not been as much as in consumer markets context.

In 1986 Eric von Hippel introduced a concept of lead users as innovators for novel product concepts. The idea is that manufacturing firms that are developing new products should do it in cooperation with their lead users. Von Hippel (1986) defined a lead user as a one whose "present strong needs will become general in a market-place months or years in the future". (von Hippel 1986) Especially in high technology industries, as the new product needs are evolving quickly, the customers who know the market trends are most likely to be the best ones to tell what are going to be the need of the majority of the market in the future. (Urban & von Hippel 1988) Von Hippel (1986) further proposes that in these industries, the lead users do already have real-life experience of these innovations. (von Hippel 1986)

Another determining factor that has to be fulfilled is that lead users also need to benefit greatly if they can obtain solution to these needs (von Hippel 1986). Sometimes users may start to think solutions for these needs by themselves, while they know that the trend they are solving is going to be faced by majority in the future. By realizing a solution, they can indeed benefit greatly, once they have it before the bulk. (Lüthje, Herstatt 2004). This indicator offers possibilities for manufacturers to collaborate with the users. Lüthje and Herstatt (2004) also stated that in lead user processes the benefit might be bigger for the user than for the manufacturer, while the costs tend to be vice versa. Greater the benefits that can be obtained from the novel product or process solution, the more willingly people are to invest on its development (Mansfield 1968). This applies also for the development process and the engagement of the users to the process.

In 1988 Urban and von Hippel conducted a first study using lead user method. The research was about PC-CAD systems, then rapidly evolving industry. The study was highly successful, creating a product that gained 78.6 % first choice rate over commercial options and company specific applications in an after development survey. (Urban & von Hippel 1988) Since then firms like 3M and HILTI have used the method successfully in their R&D processes (Lilien et al. 2002, Herstatt, von Hippel 1992).

3M focused on idea-generation with lead user method. The results were encouraging: average idea was estimated to bring $146 million dollars in five years, which is more than eight times higher than with more traditional methods. A total yield of five ideas that were funded was $730 million in incremental annual sales. In their study of 3M, Lilien et al. (2002) decided to use lead users from target market and advanced analog market related to 3M's industry. (Lilien et al. 2002)

Studies that have utilized lead user method have also shown some mixed and negative results (Olson, Bakke 2001, Carbonell, Rodriguez-Escudero & Pujari 2012). One example is from Olson and Bakke's study (2001) where it failed to prove the benefits of method in longitudinal usage, when the method is systematically used for new product development. Due to the characteristics of the method, more bureaucracy was brought to the process, which was hard to implement in a smaller firm such as Cinet, the case company in their study. Even though their initial results from the first implementation of lead user method were positive, their conclusion was that method is likely to need effective disciplines and incentives for lasting changes in the new product development process. (Olson, Bakke 2001) This is an indication that lead user method is best used in a cross-sectional studies, meaning that it should focus on a certain time and place, not continuous product development.

Carbonell et al. (2012) used lead user method in new service development and focused on examining the relationship between customer lead-userness and different indicators of new service performance. One of their findings stated that lead-userness might cause a negative impact on market performance. As a reason they referred to Enkel, Kausch and Gassmann's (2005) thought that lead users might think radically different to rest of the market, which could cause negative impact on service development that is aimed for the general market, though their results otherwise succeeded to find positive effects of involving lead users to the development process.

According to Churchill, von Hippel and Sonnack (2009), lead user approach differs from traditional concept development methods in three ways. First of all, in a traditional approach the average customers are asked what they think they need in the future, whereas lead users can provide richer and more accurate information. They are already dealing with the needs that the common customer is going to face in the near future. Secondly, only customer need data is usually collected by the marketing researcher, but lead users can also be involved in prototype conceptualizing. This may lead to more attractive, market-ready products. This also decreases the amount of work the engineers inside the company have to put in development, another great benefit of the method (Urban & von Hippel 1988, Herstatt & von Hippel 1992). And finally, utilizing lead users in the process may speed up the process. (Churchill et al. 2009) A study by Herstatt and von Hippel (1992) suggests that compared to traditional methods, the complete concept development may be completed twice as fast by using lead user study. (Herstatt & von Hippel 1992)

It is beneficial to seek customers from the same industry and also customers external to the industry. (Churchill, von Hippel & Sonnack 2009)Churchill, von Hippel and Sonnack (2009) further found three types of lead users. The three types are:

1. “Lead users in the target application and market;
2. Lead users of similar applications in “advanced analog” market;
3. Lead users with respect to important attributes of problems faced by users in the target market.” (Churchill, von Hippel & Sonnack 2009)

The first type refers to a professional who is working with similar applications that are being developed. The second lead users could work in different, usually more demanding markets, but is working with an application that is related to the research. The third type of professionals is the ones that work with similar issues, but in an unrelated application. (Churchill, von Hippel & Sonnack 2009)

Urban and von Hippel (1988), based on von Hippel's original article (1986) stated that the potential benefit that lead users are looking for can be observed in three measures. The first one is the *evidence of user development*. Once a user is investing in related innovation, a benefit can be expected in the relationship. Secondly *dissatisfaction to the current solutions* is a trigger for innovations and expected benefit. And finally, *speed of adopting innovations* is a certain sign of expected benefits. (Urban & von Hippel 1988)

Von Hippel (1986) further introduced widely referred 4-phase Lead User Idea-Generation Process which has later been refined by Lilien et al. (2002) and Lüthje and Herstatt (2004). As the process is described in this thesis, these two are used to complete the original for the most suitable and accurate terms and definitions of the concept. Later the same four steps were described in a handbook co-authored by the von Hippel himself (Churchill et al. 2009). Originally von Hippel did not have the first step of this model as its own phase, since the concept was just introduced and not stable, but as the method developed the team and goal generation phase was added (Churchill et al. 2009). In their guidebook, Churchill et al. (2009) remind that the actual process is not always strictly separated as it might seem as describe here. Some activities might occur in earlier phases and some might be repeated in the following ones. In their handbook, the phase three in this thesis is part of the second phase. (Churchill et al. 2009) The phases of process go as follows and are described in figure 4.

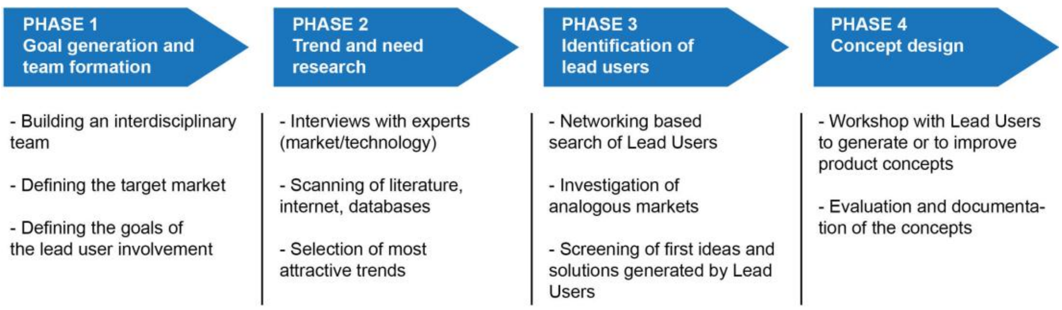

Figure 4. Phases of lead user method, according to Lüthje et al. (2004)

2.2.1 Phase 1: Goal Generation and Team Formation

The first phase of lead user approach can be seen as kind of a homework phase for the rest of the method. It has two main goals: defining the focus and overall goals for the study and forming a team to conduct it. (Churchill et al. 2009)

The first planning task is to define the objectives for the research. Usually it begins by accurate description of the search field, which could mean a target market, product or service category or an application that the company would develop the innovations for. This is followed by requirements for the outcome. (Lüthje & Herstatt 2004, Churchill et al. 2009). Outcome includes the key elements that the study should provide and the business goals of the project in both short- and long-term (Churchill et al. 2009).

The team is commonly composed of three to five experienced people with knowledge from different departments, such as marketing and technology and one member is selected as a project leader. (Lilien et al. 2002) Due to the experience required for the study, team members are usually selected via careful assessment. Churchill et al. (2009) points out in one example that teams were formed around different profile. It includes technical, manufacturing and marketing experts and a team leader. (Churchill et al. 2009) Each member generally devotes 12 to 20 hours per week for the study and the study usually lasts four to six months. (Lilien et al. 2002) The expected commitment brings two main advantages: it will enable the developed products to be brought to the market quicker and secondly, it is essential for creating a climate for creative thinking. In addition to people and time, the resources should be considered wisely economically (Churchill et al. 2009).

2.2.2 Phase 2: Trend and Need Research

After goals have been set and the team is formed, trends and needs for the study have to be identified. The identified lead users are most probably familiar with the trends in the industry. In order to find the lead users, it is highly important to find the trends. (Herstatt & von Hippel 1992) Trends can be a technological development and a market change related to the given search field, which is defined in the first phase. Furthermore also economic, legal or social developments impacting the market or industry can be seen as trends to be researched. (Lüthje & Herstatt 2004) These trends are the also the ones that the study will focus on until the end of phase four. (Churchill et al. 2009)

The analysis of secondary source information is a highly valuable way to find the information. Academic publications, databanks and the internet provide a great source of information for to define the market trends. (Lüthje & Herstatt 2004) Systematically identified and interviewed experts are another great source that has been successfully used to find the underlying trends (Lilien et al. 2002). Experts are the top authorities in this field. They have special knowledge and a broad view of the field and technical trends and the leading-edge applications to these trends. (Lilien et al. 2002, Churchill et al. 2009)

This phase is concluded in framing the customer need, which is one of the most important tasks of the whole method. This means that the trends identified previously in this phase are evaluated and the specific needs are selected. These needs will be the ones that are addressed in the later phases. In order to decide the needs that are the ones to address, business opportunities of the needs are preliminary assessed. This is done informally, and the needs that have the best commercial potential are selected. (Churchill et al. 2009)

2.2.3 Phase 3: Identification of Lead Users

As mentioned the bigger the benefit from the solution, the more customers are ready to invest on development (Mansfield 1968). To find the lead users who are most willing to participate, the ones that can gain the most benefit from the solution have to be found. If one is happy with the current solution, the need for change tends to be smaller, which again leads to that the ones who are dissatisfied with the current offering as the ones who need to be searched for (Lüthje & Herstatt 2004).

Lüthje and Herstatt (2004) defined in their article two approaches to find the lead users. The first of these is the screening approach. In this approach a substantial amount of users are screened and tested to see if they show the indicators that Lüthje and Herstatt identified for the lead users: that they are actually leading the trends and they are dissatisfied with the current offering. Data for this approach is usually easily available in customer databases, which allows the manufacturer to conduct these surveys. This approach is best suitable for situations when the number of customer is sufficiently small to be screened. (Lüthje & Herstatt 2004)

Another way to find possible lead users is networking and searching for the ones that are innovating themselves. (von Hippel 1986) This requires some "pre-screening" to find the relevant users in the target market, by interviewing. In the interview people are asked whether they know any other users who would have new needs or are actively developing their own solutions. This way the lead users can be identified. (Lüthje & Herstatt 2004) For example, Urban and von Hippel (1988) surprisingly found out, that most of their interviewees were developing systems of their own. Lilien et al. (2002) further describe the networking approach as a pyramid process. In this approach, they find people who have strong interest on the trend in the field and expect that those people have found people who know more. These more knowledgeable people are the lead users. (Lilien et al. 2002) While both of these two are found successful, the theoretical foundation for networking approach is not solid (Lüthje & Herstatt 2004).

2.2.4 Phase 4: Concept design

In most cases, a workshop with lead users and experts is organized. Workshop usually lasts two or three days (Churchill et al. 2009). Usually 10 to 15 people participate to these workshops (Lilien et al. 2002). The goal of the workshop is to improve the concept solutions that have been identified and add new ones (Churchill et al. 2009). One pattern that Lilien et al. (2002) recognize for the workshops is that first the attendees work in small groups, then as a whole in order to finalize the concept to fit the company's need. Together the group analyses the technical feasibility, marketability, and functions regarding management. (Lilien et al. 2002)

In this phase there are a couple of issues to address; Intellectual Property Rights are an important topic, since the lead users might not be willing to reveal their own inventions to the manufacturers. It is normal that they feel they should prevent the rival users to gain access to their secrets without appropriate compensation. Another risk may be that they are afraid to invest time and financial resources in such process. Due to this the need for a workshop has to been discussed, and other ways of conducting this phase is also possible. (Lüthje & Herstatt 2004)

2.3 Benchmarking

Benchmarking is one of the most used management tools in the world (Vorhies & Morgan 2005). It is a structured process to measure companies own practices to compare them to the best practices in the same or another industry (e.g. Camp 1995, Zairi 1998). Benchmarking is learning from others, by using their knowledge and information to improve organization. This requires the understanding of the internal strengths and weaknesses and how they compare to identified best practices. (Lankford 2000) According to Shamma & Hassan (2013), the most common benchmarking methods use financial operational indicators as these comparison units. They further suggest that these are not suitable for every situation and thus propose another, customer-driven approach (Shamma, Hassan 2013). Some scholars also claim that benchmarking focuses on identifying and replicating the best practice (Vorhies & Morgan 2005, Camp 1995, Zairi 1998). Kyrö (2003) calls this the first generation benchmarking and uses the term reverse engineering for it. One of the main goals of benchmarking is to utilize the existing knowledge in the best possible rate. This should not be done as a primary reason for change making; the reason should be the value that the tool adds. (Lankford 2000) In this thesis the focus is differentiation in terms of customer needs and the purpose is not to replicate the existing, but to know what is available in order to know how to differentiate and understand the market.

Next, different approaches to benchmarking are introduced to understand the ways and discover the ideal way to utilize benchmarking in this thesis.

Benchmarking can be categorized according to different variables. Also Kyrö (2003) has referred to benchmarking depending on their generation. Five categories were used as the basis for these generations, in context they are referred to Kyrö's (2003) article. As most of them are similar to the ones that are explained as follows, a side note is made each time to note what generation that benchmarking practice represents. This was done already once above.

One is to categorize it by the nature of benchmarking. These categories are competitive benchmarking, cooperative benchmarking, collaborative benchmarking and internal benchmarking (Kyrö 2003). According to Lankford (2000) it is the most difficult form of benchmarking due to the companies that the comparison is done with, not being willing to give out information. In Kyrö's (2003) terminology this is the second generation of benchmarking.

Cooperative and collaborative benchmarking are the most used types of benchmarking (Boxwell 1994). But they differ from each other by the flow of information. In *cooperative benchmarking* companies invites the best in class organization to share information about their actions. On the other hand, in *collaborative benchmarking* the information flows both ways, which companies are trying to improve their actions together. (Lankford 2000) *Internal benchmarking* is important to know as well. It refers to actions taken inside a company. In internal benchmarking the information and best practices are exchanged between different organizational parts or divisions. (Lankford 2000)

Another categorization is used to define the type of benchmarking action. This includes three primary types: process benchmarking, performance benchmarking and strategic benchmarking. *Process benchmarking* relates to daily operations of the organization. This could be for example improving customer service processes or recruitment processes, actions that tend to be in the lower levels of the organization and that could be improved quickly. (Lankford 2000) Process performance is commonly done collaboratively between companies from different industries. This is known as the third generation benchmarking (Kyrö 2003). *Performance benchmarking* focuses on comparing companies products or services to competitors' ones, and assessing competitive position via this analysis. This can be done for example, on the basis of quality, speed or reliability among other characteristics specific to the product or service. (Lankford 2000) *Strategic benchmarking* is interested in how companies compete and what kinds of strategies are applied by the competitors. It is about long term results and is top management's interest. This is the fourth generation of benchmarking. (Kyrö 2003) In addition to the already mentioned four generations by Kyrö (2003) expressed them in her article, the fifth generation is *global benchmarking.* It takes into account the global dimension in competitor, functional and generic benchmarking. (Kyrö 2003)

2.4 Framework for the thesis

Lead user is the core method for the thesis. A major driver for this is the company's close relationship with their customers. This would further support the data collection in such a tight schedule. Saunders et al. (2009), mention expert interviews as one of the most commonly used data collection method for exploratory studies. Lead user method has similar elements to expert interviews, and in fact a blurred line can be seen in the actual findings chapter.

Elements from QFD, customer idealized design, and concept testing are included in the research design. None of them fully serves the research purpose in themselves, and for this reason some parts of each are then taken to support this research. Valuing different functionalities, an element typical to QFD, is done to understand customers' expectation towards the subject and to understand inputs and outputs in the case context. In the original approach, this would be followed by the comparison between these and engineering characteristics and relationships would be searched. This was found too heavy to conduct inside the company within this timeframe. Some characteristics from customer idealized design are also added to the framework. There are anyway some major differences on the data collection methods and mindset that is achieved in the original customer oriented design process. As a result, the customer needs are used to design a concept, which is later further developed in a concept testing-like circumstances. A major difference is that there is only one concept that is developed and is not tested as it is in the last phases of the study. Instead, benchmarking is used to evaluate the developed concept. Phases of the research are introduced as follows.

This study combines phases used in lead user method (Lilien et al. 2002, Lüthje & Herstatt 2004, Urban & von Hippel 1988) jointly with those introduced by Kaulio (1998), Kärkkäinen et al. (2001) and Veryzer and Borja de Mozota (2005). Phases of the study are displayed in figure 5. Combining lead user method's four phases and the six phases used by Kärkkäinen et al. (2001), definition of the starting situation is added as first phase to the framework. This is due to the assignment that already included pre-identification of the current trends on the market done by the company. In this part the underlying trends are identified and existing solutions for the purpose are introduced. This is done due to the nature of describing the current trends and what is already discovered about BIM. The current situation is evaluated with informal internal interviews and by reviewing literature related to the topic.

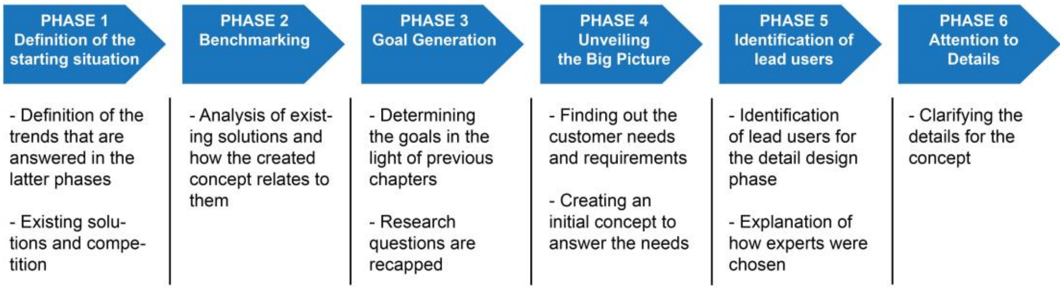

Figure 5. The framework for the study

The second phase of the study is benchmarking. This phase was introduced by Kärkkäinen et al. (2001). The case company's goal is to understand the current market situation in order to develop a service that would bring a competitive advantage. In the first phase the existing solutions and approaches in the market are introduced. In this part a comparison between the existing alternatives is made in three dimensions: inputs, outputs and other. This way the most commonly used alternatives for each of them are found. These are compared to customer needs in the findings chapter. In addition, internal benchmarking is also done, once different existing options inside the company are compared with the developed concept in the findings chapter. Benchmarking in this study can be defined as competitive and process benchmarking. It does not go as deep as would be ideal for fully balanced benchmarking, but a comparison that is characteristic for competitive benchmarking is carried out. This limitation is done due to the resources and time allocated to this thesis; this part could be a thesis of its own once fully executed.

The original first phase is the third phase of this study. This is due to the team forming part of the original not being, as the study is conducted by the author of this thesis. Experts from the case company naturally give their support and expertize during the process and can be seen as a part of the research team. Also, to form goals for the empirical parts of the framework, results from the first two phases were desired. In this part goals for the latter parts are created. The research questions are also recapped in this section.

The pre-identification of the trends in the phase one has an effect on the phase four, which in this study focuses on defining the needs and requirements, rather than the underlying trends on the market, as in the original lead user framework. This phase is named as *unveiling the big picture,* which refers to the purpose of the chapter: unveiling the underlying needs of the customer. This name is more descriptive to this phase compared to the ones used in lead user method, since this phase is not identical to the meaning of the phase '*identification of needs and trends'* by Lüthje et al. (2004). In this phase the survey results are introduced and processed to guide for the questions in the phase six.

The fifth phase is dedicated to identify the lead users and lead experts and to rationalize why the selected people from the respondents were selected. In the phase six the results of the interviews described in phase five are introduced in the same logic used for benchmarking: input, output and other. This way the survey results and results from the interview give their clarification for the subject. This chapter is thus called *attention to detail*.

Finally, the main findings from the framework are discussed in chapter 6. In this part of the analysis, the benchmarking results and results from the empirical data in phases 4 and 6 are discussed together to find what is the concept that would satisfy the customer needs best while being feasible to execute.

3. METHODOLOGY

In this chapter the methodology for the study is introduced. First the selected research framework is explained. The part explains the nature and approach of the study and justifies the choices for this research. After this, the phases that the study includes are introduced. This is followed by the data collection techniques for the study and the discussion of the reliability and validity of the findings.

3.1 Research design

A model by Saunders, Lewis & Thornhill (2009) is used to find the suitable framework for the study and to classify it. This is includes five layers of research, which are displayed in the figure 6. These are further described in this chapter.

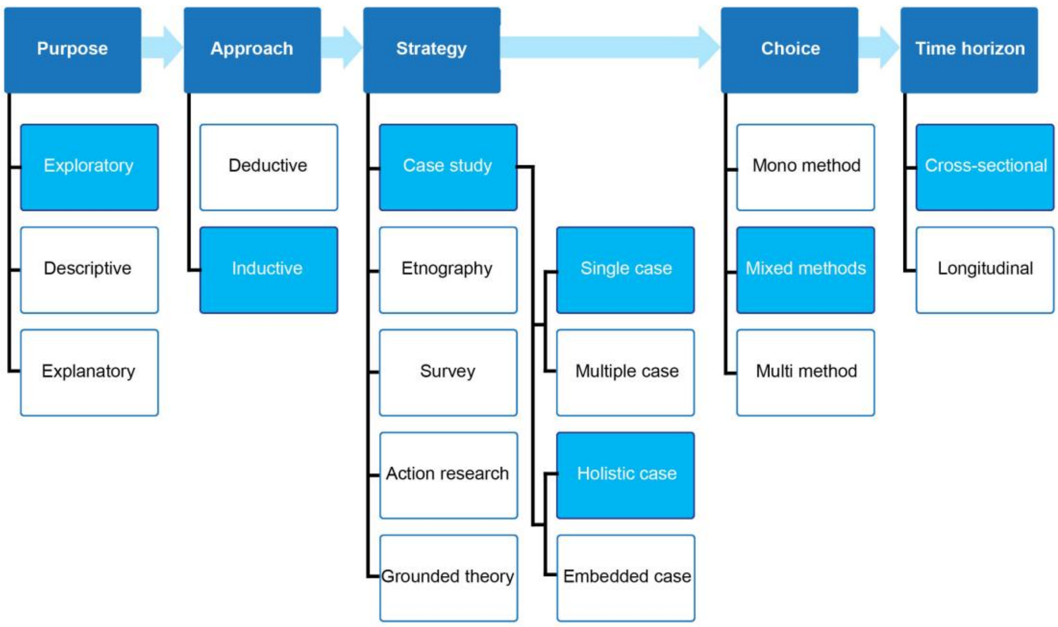

Figure 6. Summary of selected layers of research design for this study. Adapted from Saunders et al. 2009.

This study has an exploratory nature. Exploratory studies are researches that seek to find new insights on certain subject, to see phenomena in a new light, or simply to ask what is happening (Robson 2002). That is the setting for this study as well and it also effects on the research approach of this study, which is inductive one. Rather than testing an existing theory, as that is typical to deductive studies, this study aims to build a theory based on the results of the study, which is again typical for inductive studies. (Saunders et al. 2009)

The research is conducted with a case study research strategy, and furthermore with a holistic single-case. According to Robson (2002) a case study is *"a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence"*. According to Yin (1981) these sources may include e.g. "*fieldwork, archival records, verbal reports observations, or any combination of these"*. On the other hand Eisenhardt (1989) defined case study as one that *"focuses on understanding the dynamics present within single settings".* This makes this strategy suitable for the purpose of this thesis. It is commonly used strategy for exploratory and explanatory studies (Saunders et al. 2009) and also for both qualitative and quantitative studies (Yin 1981). In this study the real life context is introduced in chapter 4. Furthermore the information sources are explained in the following data collection section. Case study strategy has been found useful especially in industrial marketing. This is especially due to the substantial portion of research that studies *"the decisions and behaviors by individuals and groups within and between organizations".* (Woodside & Wilson 2003) In this study, similar goals are intended.

As mentioned the study has a single-case. This derives from the fact that it was assigned by one company that wanted to know the answers to their own - case specific - situation. This kind of study could be conducted also as a multiple case study. If the generalizable results were desired, mirroring the results to other cases would improve this (Saunders et al. 2009). Call for greater justification for a usage of single-case has been made (Yin 2003), but in this study the choice was made for aforementioned reason of company assignment. Cross-industry case study could be an option to take multiple cases into this study, but in the scope of this thesis this was seen unnecessary.

In addition to single case vs. multiple-case, Yin (2003) described another dimension as holistic case vs. embedded case. As mentioned earlier, this study is a holistic case, which means that it is no further classification of the investigated group is done, although some responses are analyzed separately according to their respondent group (Saunders et al. 2009). Otherwise company’s operations within the case context are treated as one entity, rather than separating them to different units.

Mixed methods were the obvious research choice, deriving from the utilization of multiple information sources, which is common to case studies (Yin 1981). Some qualitative survey answers are quantized which would refer also into usage of mixed-model research, but the study as a whole can be rather presumed as a case study. This is part of triangulation of the study, factor that is important part of case studies. Triangulation is term used to describe the use of two or more independent sources of information to help to ensure the reliability of the data. (Saunders et al. 2009) Data collection techniques that ensure sufficient triangulation are explained in the next part of this chapter.

The study was done from the beginning until the end in five months. Previous longitudinal data was not available, so the choice was to conduct the research as cross-sectional study. This means that the study is a description of the subject in a certain point of time, which in this case is the aforementioned five months. (Saunders et al. 2009)

3.2 Data Collection

In this research setting and in the planned schedule for the study it was decided with the case company that the customer needs can be best collected by using the connections inside the company and further their knowledge of their local customers. To gain the most expertized review on the subject and based on the knowledge in the company the Netherlands, the United States, United Kingdom and Finland were selected as the most matured markets for this setting and also the markets that the possible lead users could be found.

According to Saunders et al (2009) exploratory studies tend to have three popular ways to conduct the research: literature review, expert interviews and focus group interviews. All three of these are used in data collection for different phases of the empirical part. Different data collection methods and their relation to different phases of the study are described in figure 7. Of these three data collection methods, literature review was the starting point for this study during which the methods introduced in its own chapter were found. Literature is also scanned regarding in the three first phases of applying the framework to case context in chapter 5. It is important to mention couple of especially important sources. National BIM Reports are a valuable source of information to define the current situation at phase 1. Furthermore observations of different download services and plugins are put under literature sources and they are extremely important source of information for the two first phases. Internet sources other than these are the main source of information for goal generation at phase 3.

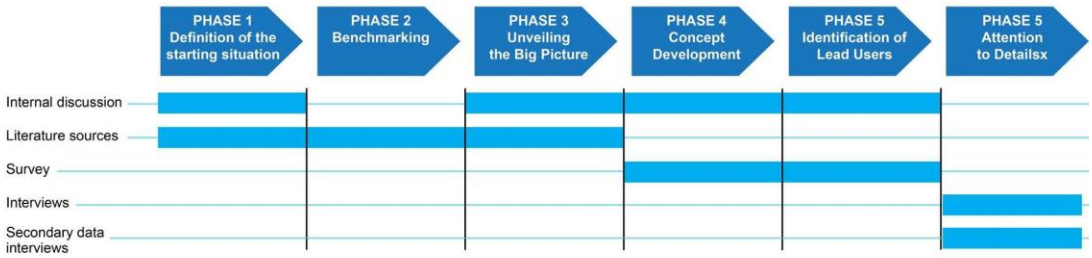

Figure 7. Summary of data collection in different phases of this study

Phases 1, 3, 4 and 5 are supported by conversations with the company. This is done to utilize the information that already exists inside the company in order to make sure that the direction of the study is right. Other way the internal information is useful is the networking approach for phases 4 and 6, as the customers are contacted. This lifeblood for the study to be successful: if no customers are found, the reliability of the study suffers, and if the customers are not actually lead users, the validity of the method - especially the one of the phase 6 - is threatened. This might further influence on the validity of the study as a whole. Reliability and validity will be further discussed after data collection methods and in the end of the study.

As mentioned in the theoretical framework chapter, data collection for lead user method very often utilizes literature review, expert interviews and focus group interviews as well. After literature review, there are three steps to collect empirical data for the thesis: A survey, follow-up interviews and group interview with lead experts. Survey is meant to gain an overall look on what the customers of the company need and require, whereas follow-up interview is used to clarify what is found on survey and the group interview to further understand the trends in the markets and to provide an expert view on the subject.

Survey was sent to 40 people in total - the Netherlands (15 invitations), the United States (14), United Kingdom (5) and Finland (4). It was done as an online-questionnaire including open-end questions, multiple choice questions and section to measure relative importance of different functions in building information modeling (BIM) plugin for which ordinal scales were used. Total amount of answers was 12, which creates a response rate of 30 %. Most active respondents were from the US, as 14 invitations were sent and out of these 8 were answered. In other countries the response rate was clearly poorer. The holiday season in European countries can be seen as the main reason for the smaller response rate. Purpose of the survey was to understand the big picture, but also to identify the lead users from the respondents and to weight the importance of different functionalities related to BIM plugin. The survey was done together with another thesis worker with a different approach to BIM at the company. In the results part the questions for the other thesis are not noted due their irrelativeness to the subject.

Networking approach was selected as the dominant method for identifying the lead users for both the survey and interviews. It was the easiest, most reliable, and fastest way to get the customer’s point of view for the study. This was done by contacting the departments of the company that act in the customer interface and asking for their suggestions of the customers who know the most and use BIM in their projects. All of these contacts might not be lead users by definition. This is something to take into account when discussing the reliability of the method.

Another important part for the sixth phase was the group interview with the lead experts. Group interview with experts was done as an unstructured interview while the follow-up interviews utilized semi-structured technique. According to Saunders et al. (2009), unstructured interviews are the most frequent for exploratory studies. To get comparable results for this thesis, semi-structured interviews were found to be the most suitable for the phone interviews. It allows the respondents to answer openly, while maintaining the focus on the desired causes. The nature of the group interview anyhow demanded unstructured approach.

Besides survey, interviews and group interview also secondary data from interviews conducted by KONE unit in United States (KONE US) was used in the last phase of the framework. This aligns well with the goals of case study strategy and provides more information from case company’s customers for the clarification of the topic.

3.3 Reliability and validity

Creditability of this work is discussed based on reliability and validity of the study. Reliability and validity are important signs of confidence on the data collected, trust in application of the method and on the managerial usage of the results. Riege (2003) argues that reliability and validity of case study research is a key issue for both marketing practitioners and academics and despite the advantages of the method, they are in doubt. (Riege 2003) In this part both of these are introduced with key threats and later solutions of how their effects are being avoided or decreased. Later, in chapter 7 the outcome and how the reliability of the study turned out, is discussed.

Reliability of results can be discussed in three terms. Firstly whether the measures will yield same results on other occasions or not, secondly if the same observations will be reached by other observers, and thirdly is there transparency in how sense was made from raw data. (Saunders et al. 2009)

Findings from studies that were conducted with non-standardized methods - such as in this case - are not necessary intended to be repeatable. This is due to that they reflect the reality in a certain time in a situation that might be changing. (Marshall & Rossman 1999) This study is meant to observe this particular setting, not to be repeated and verified as a method. In this kind of complex and dynamic circumstances, the repetition would not be realistic or feasible without impairing the research (Saunders et al. 2009). This is why the repeatability is not taken into account as a concern regarding the reliability of the findings.

To measure the reliability, Saunders et al. (2009) classified the threats to reliability into subject or participant-, and observer-based bias and error. By subject or participant error they mean situations, when the participant might be affected by external conditions, such as time of the week, and might give different answer than they otherwise would. Subject or participant bias on the other hand could mean a situation that the company (that the respondent works for) limits respondent’s answers in some direction and this way the answer is biased. These are mainly related to the repeatability, which again is no goal for this study. Observer-based bias refers to a situation where the researcher would be threat to reliability. Observer error occurs for example when in the interviews, the questions are asked in a different manner, which might cause difference in the answer. When this occurs, it might cause a situation that cannot be reached by anyone else but that observer. Observer bias again simply means that the answers are interpreted differently. (Saunders et al. 2009) This again is addressed to the transparency of the results.

One of the reasons to utilize semi-structured interviews in the individual interviews instead of unstructured ones (that are more frequently used in exploratory studies) was that this is a way to decrease the observer error of the study. (Saunders et al. 2009) If the questions have certain structure or backbone, there is not as much room for observer error. On the other hand, structured interview might limit the answers too much, which would also affect the reliability of the study. This way semi-structure was seen as the ideal solution. Also once the respondent feels comfortable and open about the subject it can prevent the participant bias of the study. Although in the online-survey it is impossible to control the possibility of bias, since one cannot be certain if the requested person is responding. This is threat with survey is not seen realistic in this context. In addition to these comparison tables were used to draw lines of how the sense was made out of the data. Similar framework is used in different phases to ensure that the data is interpreted in a similar way.

Validity is a question of whether the findings actually are what they appear to be and if the relationship between two variables is a causal one. Once again Saunders et al. (2009) point out threats to validity: history, testing, instrumentation, mortality and ambiguity of causal direction. Of these, two of the most relevant are history and mortality. Ways to answer to these threats are introduced next.

History refers to the timing of the research and whether the conditions change the answers of a certain respondent. (Saunders et al. 2009) In this study, summer holidays are affecting the response rate, but not necessarily the history aspect of the validity of the thesis. If the respondent has just returned from summer holidays, it might have an effect on the answers due to the long break from being involved to the subject, but on the other hand the questions are such that they are not locked on a specific date nor affected by quick chances on the environment.

Mortality is a problem that occurs more on longitudinal studies (Saunders et al. 2009). It refers to a situation when a respondent is dropping out of studies. This way it is not a main concern to this study, but could occur if the people who left their contact information for clarifying questions, are not taking part in the interview phase after all.

In order to ensure the validity of the study, two stage empirical data collection that was mentioned above is arranged. By this, the possible validity problems that arise in the survey can be further tested in the interviews in the phase 6 of the framework. This way the concept that is created in the fourth phase is tested and verified by some of the participants and lead experts that know the scheme very well. This way results should present what they appear to be. If the validity of the results in the phase 4 is under threat, they will not be so after the sixth phase.

4. CASE DESCRIPTION

In this chapter, the most important details about the topic are provided. First, an overview of the case company, KONE, is given and this is followed by the fundamental knowledge about building information modeling and insight on the current competitive situation in this field. Building information modeling is also discussed in terms of the current status and fundamental variables that are important for this study.

4.1 KONE

KONE was established on 1910. The company first imported and installed elevators from Sweden, before starting their own production in 1918. In the beginning the operations were focused on the Finnish market, but nowadays KONE is known as one of the biggest elevator and escalator companies in the world. (Michelsen 2013) KONE has a large and extensive order base, with over 130,000 elevators and escalators designed, manufactured and installed annually. KONE also offers maintenance services and modernization solutions for existing elevators and escalators. In 2014, there is 1 million equipment have KONE maintenance service. This forms a 45 % of KONE’s total business. KONE is truly international company, as it employs over 47,000 employees in more than 50 countries worldwide. In 2014, KONE’s net sales reached 7.3 billion euros. (Kone Oyj 2015a)

KONE has been devoted to superior quality on their products since the early days when they started producing elevators (Michelsen 2013). Company’s history knows multiple industry changing innovations. One of the greatest being machine-roomless elevator, which was introduced commercially in 1996. Instead of using own room for the machine, the newly designed motor is placed outside of the hoistway. This causes multiple advantages, such as reductions in the construction cost of the building, savings in energy consumption and maintenance costs, and low noise level. (Janovský 2004) KONE took the technological leadership position with the machine-roomless elevator, and the concept was imitated by the closest competitors in the following years (Michelsen 2013). Another, more recent, innovation to mention is KONE UltraRope that was introduced in 2013. It is a new hoisting technology which reduces the weight of the overall elevator systems. It is primarily focused on the high-rise buildings where the hoisting system usually cost the biggest part of the cumulative weight of the system. With this technology, the travel height can be doubled to 1 kilometer compared to traditional used technologies that most commonly utilize steel ropes. In addition KONE states (2013) that the lifetime of the UltraRope is also twice as long. (Kone Oyj 2015d)

KONE has been listed by Forbes as one of the top 100 innovative companies in the world in five consecutive years. The latest rank in 2015 is 48th, which also means that KONE is the 5th innovative company in Europe. (Kone Oyj 2015b) Today, one of KONE’s key strategic areas is to be “first in customer loyalty” by improving the customer service and communication (Kone Oyj 2015f). In this light, new emerging technologies - such as building information modeling (BIM) - can be seen as an important way to achieve these goals. Even though they are not the core business of the company, having a top notch services in BIM would be a sign of the dedication to the superior technological solutions, customer service and communication experience.

4.2 Building Information Modeling

Building information modeling (BIM) has been emerging and is the most promising new way to manage projects in architecture, engineering and construction (AEC) industries (Eastman et al. 2008, Azhar, Hein & Sketo 2011). In this chapter, BIM is defined, the key elements of the concept are introduced, and after that the benefits and challenges are evaluated. Current situation of the concept are covered the first part of the next chapter.

Different definitions for BIM have been made. According to Azhar et al. (2011) building information modeling is *"n-dimensional (n-D) models to simulate the planning, design, construction and operation of a facility"* (Azhar et al. 2011)

M.A. Mortenson Company on the other hand defines BIM simply as *"An intelligent simulation of architecture"* (Eastman et al. 2008).

Maybe the most comprehensive definition is by Bryde, Broquetas and Volm (2013). They claim that BIM is *"A set of interacting policies, processes and technologies generating a methodology to manage the essential building design and project data in digital format throughout the building's life-cycle"* (Bryde et al. 2013)

To look behind these definitions their core variables are now explained briefly. Two key elements to BIM are that it is done in digitally and in 3D. The final virtual models are accurate and include precise geometry and relevant data to aid the construction, fabrication and procurement in the realization of the building. (Eastman et al. 2008). Aforementioned relevant data can be shown in the model as the n-dimensions that were mentioned by Azhar et al. (2011). All of these dimensions are formed on the basis of 3D design. 4D refers to time-programming or schedule of the process, 5D refers to a model with cost variables and 6D to sustainability measurements. (Redmond et al. 2012) Even 7D has been introduced, even though there is no software capable of supporting it. The seventh dimension is maintenance of the building. (Kacprzyk, Kępa 2014)

Furthermore, scholars often emphasize the importance of interoperability of BIM. It refers to the need to pass data between different applications due to the fact that no single system can currently answer to all the requirements set by the design process, this way interoperability seeks to give the professionals more freedom to use specialized applications. It eliminates unnecessary replication of data that has already been generated and thus allows smooth workflows. (Eastman et al. 2008). Sometimes the idea of the interoperability does not turn into reality as gloriously as it was supposed to. The problems naturally occur when the heterogeneous applications do not communicate in the required level (Bryde et al. 2013, Grilo & Jardim-Goncalves 2010) Standardization is usually the key solution to this kind of problems. The format that the exchange is done between different systems has a significant on the success of the exchange. If this format can be standardized the issue is less likely to occur. (Eastman et al. 2008)

To enable successful exchange between different systems various exchange formats have been created. There are plenty of different solutions for this, but for this thesis Industry Foundation Classes (IFC) is an important one. IFC is an open-standard option for the purpose. Eastman et al. (2008) recognized it as most probable to become the international standard for data exchange and integration. This was because it is open-standard, which makes it easier to communicate between different systems and also because the public sector tends to avoid the possibility to give monopoly to one software platform. (Eastman et al. 2008) Software vendors and developers are usually willing to add these kind of international standards are into their software and pushing the features to their clients (Tulenheimo 2015).

Autodesk's Revit Architecture is the best known and current market leader for the use of BIM in architectural design (Eastman et al. 2008). It is also the main software that KONE uses for BIM modeling. Other popular software are Bentley Systems, ArchiCAD and Tekla Structures. Each of these software have their own, native software format, which is reported in the New Zealand BIM report as an issue for the interoperability of BIM, since they do not commonly work too well with each other (Masterspec 2013). It is important to understand what software the customers use in order to determine which formats should be available.

According to Azhar et al. (2011) lifecycle data in this context refers to planning, design, and construction and operation phases of the building. In more traditional sense it refers to all stages from inception to demolition (Grilo & Jardim-Goncalves 2010). The important factor is that BIM allows more accurate predictions of environmental performance in earlier phases and the lifecycle costs - and this way the total costs of the building - are understood better. In addition, the data stored in the model can be used for the maintenance purposes during building’s lifetime. (Azhar et al. 2011) As mentioned, 6D refers to lifecycle and 7D to maintenance of the building (Kacprzyk & Kępa 2014).

Key benefits of using BIM over different, more traditional methods like 2D CAD are usually based on the effective and more accurate, but also savings. By including many different designs like design structures, piping and plumbing in the same model, the design process is more effective and can provide substantial savings by reductions in design time and by decreased rate of error (Azhar et al. 2011). Also in some cases, initial phases of construction can already be started while the design is not yet finished. Azhar et al. (2011) stated that this reduction was up to 7 % in project time. Time savings most probably later on turn into savings in costs. Furthermore, one application of BIM is the inspection of these different design layers and interfaces and recognizing possible overlays in early stages. This allows the corrections to be made before any damage is done and this way avoiding further costs. This function is commonly known as clash detection. In study by Azhar et al. (2011), this was shown as savings up to 10 % of the contract value. Compared to 2D CAD, the need to validate every change made in one part of a design in different independent plans is avoided. This makes BIM less error-prone. (Azhar et al. 2011).

One of the key terms when discussing about BIM models is LOD, which stands for level of detail or level of development depending on the context. The more suitable for this study is the level of detail. LOD refers to a level of which the model element in BIM has details on it, in other words how developed it is. The main difference within these two is that level of detail usually refers to the input, how much detail there are in the model, whereas level of development describes in what degree the model has been thought through geometric- and information-wise, which refers to the output that can be gained from the model. (Bimforum.org 2013)

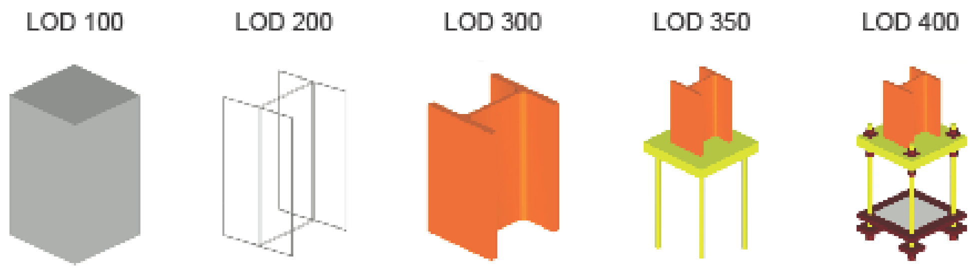

Figure 8. Example objects of different LODs (Bimforum.org 2013)

Each number is used for different LOD. The greater the number, the more developed the model. For example, LOD 100 provides the generic information in order to conceptualize the element, whereas LOD 350 has already enough information for the model element to be installed (Bedrick 2013). Bimforum.org (2013) has collected a guide for LODs and their specifications overall and for major industries in their guide. In the appendix I LODs are defined, and also Bimforum.org's description of what this definition means for elevator industry is delivered. These levels of development originate from The American Institute of Architects (AIA). Definitions for elevators are quotations; while the overall definitions are slightly shorten. In addition, AIA also has a LOD 500 definition which is a field verified model, although there are differences, as Bimforum uses LOD400 as the highest level. (Bimforum.org 2013)

The term LOD is not flawless. Still while there are LODs with number description, the design phases usually need a model with elements from multiple levels. That is what makes the request of certain LOD model hard to request. Since there is no strict correspondence between the design phase and the LODs, it is more usable to describe the functionalities of the model needed and the stage the project is to find out the most suitable BIM model for the purpose. (Bimforum.org 2013)

In this study, terms that are used are "space reservation model", "low-detail model" and "high-detail model". These do not refer to any exact LOD, but instead are used to understand the need without limiting the customer to any LOD, since as mentioned, the term is not totally flawless.

4.3 Building Design Process

Two different processes for building design have been widely recognized: Design-Bid-Build and Design-Build. These two are now briefly discussed in terms of participants and work flow.

Design-Bid-Build (DBB) process is a traditional way to design a building, which is the most widely used and best understood one (Koppinen & Lahdenperä 2004). First, the *owner* hires an *architect*, who gathers a list of requirement for the building and develops building program and a schematic design. To fulfill these requirements, the architect hires employees or contracts *consultants* to assist on different areas of expertise. Usually these contracts are based on low bid (Koppinen & Lahdenperä 2004). These designs may be recorded in different drawings, which must be coordinated to reflect the changes between different versions. (Eastman et al. 2008)

Second stage is to place *constructor* bid based upon these drawings, which have to be sufficiently detailed in order for the constructors to place their bids. The owner and the architect can choose which constructors may place their bids. Based on the drawings and specifications, these bidders choose their *subcontractors* and determine the cost estimate for the construction phase. (Eastman et al. 2008) Usually the winning contractor is the one with the overall lowest bid, which includes general contractor's costs and subcontractors' costs (Koppinen & Lahdenperä 2004).

When the winning general contractor is chosen, it is often needed to review and redraw some of the drawings for the building to reflect the construction process and to phase the work. Also subcontractors need to do more detailed shop drawing of their own part of the building process. If these drawings have failures, or if they have errors from the previous stages, it causes time and money in the construction site. These also make it difficult to fabricate components offsite, which may subject the component to errors due to the worse conditions onsite. These errors and uncertainties that occur at the construction phase often require changes to be made to the designs. The previous unknown changes may cause problems as the contractor to might have bid below the estimated cost in order to win the job. (Eastman et al. 2008)

Design-Build (DB) process has a different approach. It was developed to consolidate the responsibility for design and construction into one form and to simplify the owner’s administration tasks. Instead of contracting an architect, the owner contracts a single contractor, or a design-team that develops a building program and a schematic design (Koppinen & Lahdenperä 2004). The DB contractor estimates the cost and the time needed for the building. The owner requests changes and after this approves the plan, after which the final estimate cost is set up. After this the DB contractor contracts specialists and subcontractors for different requirements of the building. (Eastman et al. 2008) Koppinen and Lahdenperä (2004) further discussed about different variations of DB process, but for the sake of this study, they are not necessary background information.

It has been shown that DB process saves time significantly on the construction phase (Ibbs, Kwak & Odabasi 2003, Hale, Shrestha, Gibson & Migliaccio 2009). Furthermore advantages in costs and cost growth may occur (Hale et al. 2009). Once the core of the plan is established, the construction of the foundation of the building can start, as it does not require the fully detailed model to be ready. On the other hand after the initial design is approved, it is difficult for the owner to makes changes to it. The advantages of BIM usage are usually well achieved via DB process, since single entity is responsible for the design and construction and since both of these are covered in the design phase. The key of BIM is collaboration, and only part of the advantages may be achieved in other approaches. (Eastman et al. 2008)

5. MODIFIED LEAD USER METHOD IN CASE CONTEXT

In this chapter, the framework that was created for this study is applied to case context. As mentioned in the data collection chapter, the first three chapters are primarily based on literature sources and observations, whereas the last three present the empirical results of the study. The chapter is divided into six parts that follow the name of the phases of the framework. These parts are displayed in figure 9 as a funnel. As the phases go further, the funnel narrows down, just as the focus of the study.

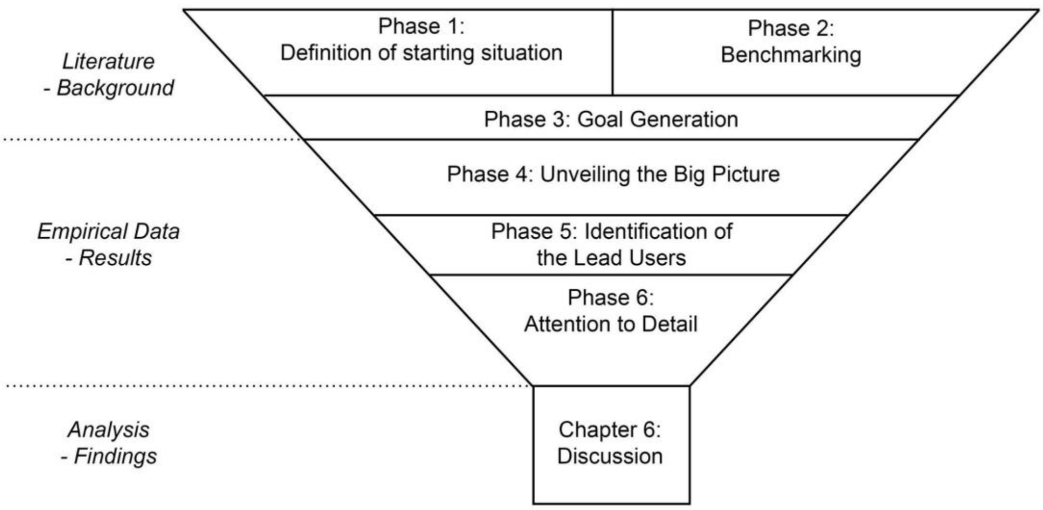

Figure 9. Funnel of parts of the chapter

5.1 Phase 1: Definition of the starting situation

In the first phase of the study, the starting situation is defined. This means that the trends – in this case the current situation and adaptation of BIM – are introduced. In addition, this part will introduce the current solutions for BIM model distribution. This forms a solid basis for phase 2 and 3, as they focus on analyzing the starting situation and creating goals for the rest of the study.

5.1.1 Maturation of Building Information Modeling

BIM has been a topic already for many years and especially architects, engineers and big contractors have been demanding the implementation. (Tulenheimo 2015) Even though there has been a lot of buzz about BIM, the reality is that even the ones who are working within the field do not have clear picture of what BIM is. (RIBA 2012)

To get a better picture of BIM usage, several surveys have been conducted within the professionals of the industry. These National BIM Surveys, as the name proposes, are conducted nation-wide, providing comparable information of the trends in the industry. The spectrum of the attendants varies a bit from country to country; for example, in Finland 23 % of the attendants were architects, whereas in Canada the number was 12 %. This might explain the variation in the answers. In Finland, the survey was conducted for the first time in 2013. Similar surveys have been done in United Kingdom (UK), Canada and New Zealand. (RIBA 2012, Masterspec 2013, Finne, Hakkarainen & Malleson 2014, Digicon, IBC 2013)

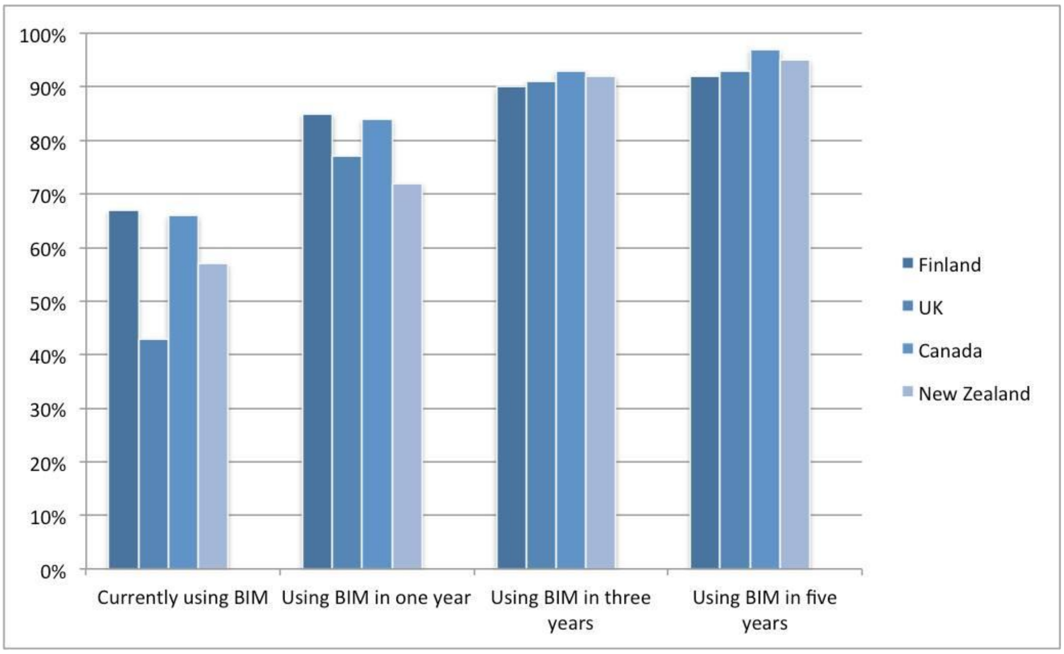

Figure 10.Current and future usage of BIM. {{16 Finne, Christian 2014; 19 RIBA 2012; 20 Masterspec 2013; 21 Digicon 2013;}}

The figure 10 describes the levels at the time of the survey and participants' thoughts of the situation on one, three and five years. Some variation can be observed from country to country on that time, but when considering the three-year and five-year objectives, the differences even out to 90 % or more. This is a significant sign that BIM is going to be highly used concept in the future. (RIBA 2012, Masterspec 2013, Finne et al. 2014)

To explore these expectations and how they have actually turned into reality a longitudinal aspect to the subject was taken. To do this UK surveys were selected as a reference due to the fact that National BIM Survey in UK has been conducted since 2010. To compare these expectations with reality, the current users in percentage and their expectations of their usage in percentage were compared. Percentage indicates that how many of respondents use BIM and what did they think the previous year. In figure 11 each year has a comparison of that year's current users and previous year's expectation of that current year in percentages. (RIBA 2010, RIBA 2011, RIBA 2012, RIBA 2013, RIBA 2014)

As can be seen from figure 11, the actual usage is not purely in line with the expectations of BIM usage in the future. The respondents tend to expect higher BIM usage than actually appears to become reality. On the other hand, in their RIBA (2014) makes an interesting comment about the maturity stage of BIM in UK. In the classical innovation adaptation lifecycle, with the segments of Innovators, Early Adopters, Early Majority, Late Majority and Laggards, BIM has reached the stage that the first three categories have already adopted the method. They expect even more rapid adaptation in the near future. (RIBA 2014)

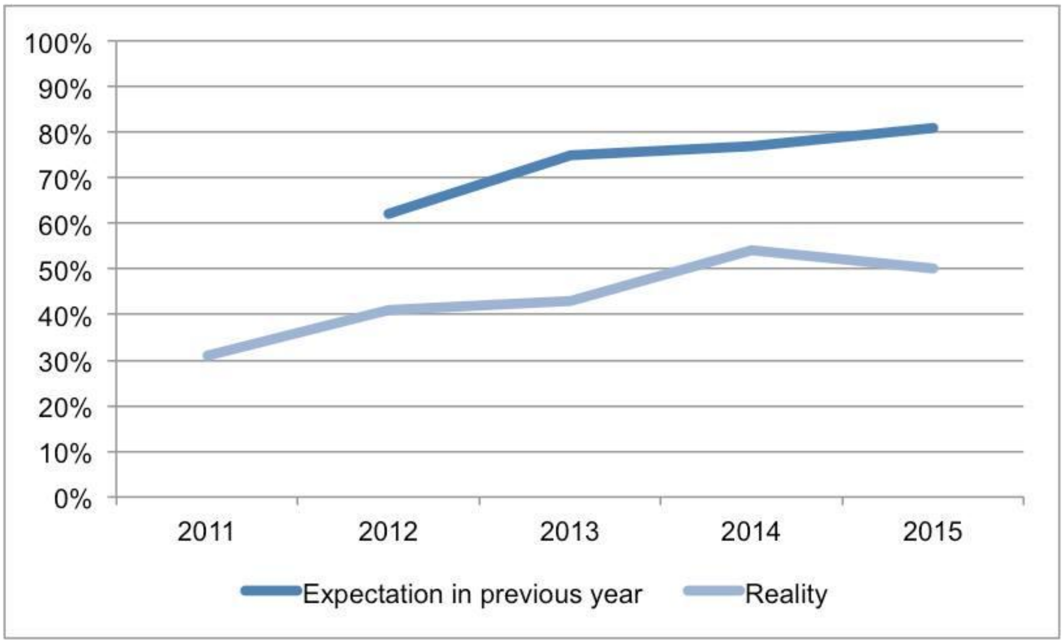

Figure 11. Comparison between expectations and actual BIM usage in UK. (RIBA 2010, RIBA 2011, RIBA 2012, RIBA 2013, RIBA 2014)

At the same time it is worth to point out that the overall awareness of BIM in UK has risen significantly. This easier to discuss in terms of unawareness, which has dropped especially between 2011 and 2012 from 21 % to 6 % after which it has been settled to 5 to 6 % during the last few years. (RIBA 2010, RIBA 2011, RIBA 2012, RIBA 2013, RIBA 2014) In this context it has to be mentioned that UK as a market can be biased with the fact that the local government has been expected to provide its support to BIM-projects over traditional ones (RIBA 2014). This may affect the overall awareness of BIM as well as the expectations that have not been met in reality.

In comparison, according to McGraw Hill Construction’s report (2014) BIM adaptation explodes in United States (US) markets between 2007 and 2012, rising from 28 to 71 % in five years. The change is driven by constructors instead of architects as their BIM adaptation recently exceeded the one of architects’ (McGraw Hill Construction 2014). All in all, the US market can be this way seen to be more matured than the ones described in the figure 10. Similar explosion with the usage rate could be happening soon as was expected in RIBA's report (2014).

Another perspective to BIM usage is to observe for how long customers have been using it, in other words, how standardized their ways of working with BIM are. McGraw Hill Construction's (2014) report states that in United States, contractors are getting more experienced with BIM, as 86 % of contractors have used BIM for over two years. For major European markets (UK, France and Germany) the number is significantly lower, 53 %. As the survey and the interviews in the latter phases are done in multiple countries, this is something to take into account.

All in all**,** BIM has been proved to stabilize its role in building design and the signs are clear that the expansion of the adoption will continue. This again creates a need for companies to find ways for their business to adapt to the change from traditional design process towards BIM-oriented design.

5.1.2 Competitive situation and competing solutions

In this part the existing solutions by the KONE and its closest competitors are briefly discussed. Also other substitutive solutions that might threat the solutions by the case company are described. First the download services that are offered by the manufacturers themselves are discussed, followed by introduction to one of the fundamental BIM object libraries and software built-in plugins are presented. This part forms a basis for the next phase.

First, the closest competitors in the elevator industry and KONE's current offering are observed. This study is especially interested to find out the competition within the availability of BIM models and is not focusing on the competition between these companies in broader scale. In addition, other provided solutions - plugin and object libraries are introduced after the discussion of the company-based solutions.

KONE has three major rivals in the industry: Thyssen-Krupp (Germany), Schindler (Switzerland), and Otis (USA). All of these four companies offer similar download services for their BIM models. Small differences occur between the variables based on which the model is determined. This is one of the key questions for the usability of the all the services from download services to plugins.

The service by Thyssen-Krupp is called Elevator Finder. It allows one to search for most suitable elevator for the purpose. By providing the website with few variables, such as desired net travel, speed and capacity, it shows the user the suitable elevators and provides BIM models. Thyssen-Krupp states that the models provided are meant for illustration purposes only and this way demand the customer to contact the company for the actual models. This way Thyssen-Krupp may have their models illustrated in the building design in an early stage. The solution also provides access to different documents of the elevator than BIM. The difference to all the other download services is that Elevator Finder does not generate specifications for the elevator and this way does not create a custom BIM model. Instead it is used only to find the most suitable elevator on basis of the aforementioned variables. Thyssen-Krupp has another tool for the purpose of generating specifications for the models. (Thyssen-Krupp 2015)

Schindler has a solution is called Schindler Plan. Major difference to Elevator Finder is that the Plan allows user to customize the elevator step all the way to fine details such as door finishes and handrail mounting. Compared to any other service, Schindler requires more details about the elevator. Plan also requires one to first select the elevator rather than selecting the most suitable to the specifications. Also via this service, one can download different documents in addition to BIM. (Schindler 2015)

Otis' implementation uses the travel distance, number of stops and the number of elevators to calculate the most suitable one. After this multiple other optional choices can be made to further specify the model to become more accurate for the purpose. Otis' service differs greatly in the sense that it does not provide elevator models, but specifications and 2D drawings instead. (Otis 2015b)

KONE's current approach is called Toolbox and it is highly similar to Schindler Plan. Starting from choosing an elevator model that has three different models to choose from, there are many specifications to modify, some of which are required and some optional and specifying ones. Many of the features that can be chosen are code names, which might cause confusion within designers not dedicated to the subject. Furthermore, KONE is no exception; it also has the opportunity to download different document types. (Kone Oyj 2015c) KONE currently has two tools to guide with the selections that have to be made for the Toolbox approach. One to guide customers to choose the right size of elevator shaft, which is called Planulator and another called Quicktraffic that is used to help with elevator traffic calculations. (Kone Oyj 2015e)

Arayici, Hein and Sketo (2011) suggest that having a BIM object library tremendously increases the experience and enables leaner process. These kinds of libraries require sufficient guidance to achieve the aforementioned benefits. (Arayici et al. 2011) This suggests that providing objects to architects and designers is desired. In this context especially one existing library, Autodesk Seek, is high-lighted as an example of a competitive option of an object library. Autodesk Seek is naturally made by the same manufacturer as the Revit software itself, but also other options, such as RevitCity, an online community for Revit users that offers library as well as information about other resources (RevitCity 2015). Autodesk promotes Seek as a quick way to discover, preview and download BIM models and other files in a very similar basis as what is offered by elevator companies themselves (Autodesk 2015).

Currently Seek has a product library of 66 000 products from more than 400 hundred manufacturers. The quick search lets the user to search by keyword which is further defined by the file type and location (Autodesk 2015). Of the four closest competitors, only Schindler’s models are available in Seek, as of September 9th 2015. (Autodesk 2015)

As was stated by the interviews conducted by KONE US, that customers do not want to return to web service to update a model and give new specifications every time. In this sense Autodesk Seek’s adaption of preview and exploration of the models before downloading seems like a great option. Naturally, it is not flawless either, but this application is useful to react to obvious mistakes that need actions and a new model download.

Plugin is a software module that adds a specific feature or service to a larger system, in this case to Autodesk Revit software. (Webopedia 2015) One of the companies to provide an elevator plugin is DigiPara. It is a German company that is specialized in elevator BIM design. (DigiPara 2015b) DigiPara’s ElevatorArchitect is a plugin that offers BIM models from the main elevator companies. Models are made by DigiPara, which means the models might not be up-to-date by definition. The main functional difference between Elevatorarchitect and the other aforementioned tools is that Elevatorarchitect is that it is integrated into Revit. The plugin is free for users and according to DigiPara’s website has 15,000 users. DigiPara offers an opportunity for the companies to certify them and at the moment Schindler and Thyssen-Krupp have certified some of their models. In case of certified elevators plugin is connected to different elevator providers’ online servers and that way has the up-to-date information for the BIM models. It also provides the correct contact information for each certified manufacturer. (DigiPara 2015a)

At the moment, Otis is the only big elevator manufacturer who to provide such a plugin. Otis BIMcreate is relatively new plugin that was released for the public in the summer of 2015. According to their website functionalities included are ability to configure models, to make structural decisions, and help to ensure the integration of the elevator system and building design. (Otis 2015a)

5.2 Phase 2: Benchmarking

To do a benchmarking with the current solutions, a comparison chart was created. In this chart, the most important factors related to the functionality were listed to gain a more comparative look of what kind of models are offered via these services and based on which attributes. For this thesis the names of each tool are left out, since the interest is solely on what is available, not who is behind these tools. Download services and plugins, in addition to KONE’s own services are included in this comparison. In the findings chapter, these results are analyzed in the light of what was gained in the empirical data of this study. Libraries are left out of this comparison due to functional difference, but are anyway discussed in latter phases with respondents and again in the findings.

Comparison is divided into three segments. First is the input, which refers to the attributes that the downloaded model is based on. These are divided in to three categories: required, optional or not applicable to choose as the basis for the model.

By comparing inputs, and what is required or optional, an overview of what companies need to provide models is provided. Later in the findings these factors are compared to what customers define in phases 4 and 6 that are the factors that they are using to make the decisions. This is done to find out the ideal set of factors to require forming the basis for the model, and also what factors to give the option to specify the model.

In this part the observations and notions of different variables are done.. Most of the services require this information and additional 2 to 6 variables for their model. The single most requested variable is travel distance, which is required by 5 out of 6 services. After travel distance there is plenty of variation of what these additional inputs are. Most commonly required variables include capacity, speed, number of elevators, number of stops, rear opening and selection of elevator model, which are all required by 3 out of 6 services. In the findings part these 6 variables are special attention when prioritizing which inputs customers are most likely to base their elevator selections on.

When analyzing the inputs that most of the services require in order to provide the model, it is important to understand the interrelationships between different inputs with the outputs. To understand these interrelationships between inputs and outputs, a discussion with engineer from the case company was held. Travel distance is one of the key to define the height of the elevator. The other elements on the elevator shaft height are pit and head room, which are the parts below the lower most served floor and above the top most served floor. This is crucial for the model and this can be seen in the comparison as well: only one of the services had this as an optional factor, whereas all the others required the information. Capacity is another basic function to define the size of the elevator. It is directly related to the floor area of the elevator car and this way also the size of the whole elevator system. Services such as KONE Quicktraffic are used to define the capacity.

Elevator choice and rear opening choice are different are basically selections between two or more options instead of playing a key role on defining some dimensions, although rear opening has a role on specifying the depth of the shaft. On the other hand, to customer these might show up differently. The existence of rear openings in different floors should be easy to answer if the design of the building is clear, but this again may differ depending on the design phase. Speed affects the size of the pit and the head room. Naturally speed affects the motor selection, which further has an effect on the size of the machine room. All of these are elements in the model and also affect on the dimensions. Number of stops and number of elevators are quantitative dimensions, which should be easy to define. Quicktraffic may also answer to the question of how many elevators are needed in that specific project and give recommendations of the speed for these elevators.

Some clear differences can be found out between download services and plugins. First of all, the opportunities that can be offered via plugins can be seen in this comparison. Due to the fact that plugin is built into the software, information can be obtained from the design and this why the inputs can be lighter and the floor levels can be derived from the design, which again will help customer with factors such as travel distance, which was the most common one to request.

This difference can also be seen in the comparison of the outputs. Similar comparison chart was done in this category. Without a plugin, the observed models do not have interface to change the input factors or to choose options like what is shown in the model. Via some functionalities of the Revit software some of these factors can be changed, but this is commonly limited to changing the number of floors and floor heights and is not very simple to use as is. Plugin offers a chance to return change this functions in the same interface. Only one of the services has a low-detail model whereas others rely on high-detail one. Also only one of the services has the opportunity to change the level of detail and also what is visible in the model. Important note is that no 4D, 5D, 6D nor libraries of most used elevators were observed in any of these services.

Third segment for the comparison is other. The attributes selected for this segment are other notions of what affect the process of downloading, but not necessarily the output, the actual model and its functions. On the other hand they might have an effect on the usability of the service or details that are not visible in the actual model but might affect the actual product on site or provide additional information. There were five factors observed and two of them were seen more important than the other three.

The two ones that were seen as more important factors were observed qualitatively on how well-executed these functions are. Most commonly these services have some kind of tool for design variables that affect the interior of the elevator or in other ways the final product. In the BIM model they are not visible. They might anyway have an influence on elevator choice and this why they might make a difference to some designers. 3 out of 6 of the services have them and 2 are defined as good ones, having great variety of options to choose. Another of these ones is area support. Different areas have different standards and units and support systems. In 3 out of six of 6 had this functionality and two of them have a good support, which means that one can choose very specific area for which the support is given and the local units for example are set.

5.3 Phase 3: Goal generation

This phase focuses on creating the goals for the following phases and what is wanted as an outcome. To create goals who are the ideal people to survey and interview in the following phases, it is important to understand especially the DMU in order to understand “the right” customer needs. Especially important is to recognize the key buying influencers in elevator business.

Concepts of DMU, buying situations and product types were introduced in chapter 2.1. Next, different actors in DMU will be briefly discussed within elevator buying process and in DB process that was introduced in chapter 4.3. This observation is limited to BIM model distribution and the models in design process, not on the actual buying process of the physical elevators. It is anyway important to know that the buying process has a major impact on the elevator choices, since the contracts are not often negotiated in the BIM model exchange. Following is based on conversations with the case company.

The role of a building owner is clearly the decider as the owner is responsible of the project. Owner has the formal power to approve the choices made by the contractor chosen to manage the overall process. Contractor again plays a role of a buyer and also influencer. Many major contractors make big deals with elevator companies of certain elevator offering that is used in different projects and this way the price is cut. Architects are the main influencer for elevator choice. They play a big role in the early design stages, and once they have placed a certain elevator BIM models into their early design, it might be hard to change afterwards. Gatekeepers for the elevator buying process are related to the causes that may prevent BIM models from being distributed. These might include certain services that do not have support in certain area, or absence on certain service. No actor itself can be defined as a gatekeeper for this process.

There are two key buying influencers in the process: architects and contractors. As architects make the initial designs, which can be later difficult to change, they are the most important key influencers for the process. Also, they are the most possible users for the services offered by manufacturers. Contractors or project managers are the possible ones to later change these selections so their needs are also to be defined. Also as mentioned, contractors may have deals with manufacturers about these objects so their needs are especially interesting. This is why these two are the ones that are observed in the study.

As a single object elevators tend to be rather expensive in the overall building process. Thus, what comes to product type, they are a high-cost and high-value product. As what comes to the risk, they hold a high as an object, but making decision between the major manufacturers does not include such risk. Anyway, this way the product type of an elevator can be defined as a strategic product. Also, elevator is usually a unique product due to its configurability and differences in building processes. Thus straight rebuys hardly ever occur. Exception to this might be contractor deals which include certain elevator types, but also then some variation may occur from product to another. Most common buying type this way is modified rebuy or new task, with the moderate to high level of information requirements and medium to high level of problem newness.

In the introduction, three research questions were formed:

1. *Which are the most important customer needs regarding BIM elevator models and their availability?*

2. *What are the current competing solutions?*

3. *Which of the existing types of availability solutions are ideal to satisfy these needs?*

Of these three, the second one was already discussed in the first two phases. The last one again will be analyzed in the findings chapter, which leaves the first one, which again will act as a predecessor for the third, to be pointed out for the following phases. As a prerequisite for this work was that the case company is primarily interested about plugins and what is currently available within the industry and what other possibilities to distribute BIM models are available and what are the ones that satisfy the customers the most. This is one of the main goals, alongside with understanding the inputs that customers want to use for obtaining models and furthermore what are the outputs, the functionalities that the model should include in order to satisfy the customer needs. Last part, as was mentioned in the phase 2, is other factors that influence customer satisfactory in BIM model availability. These are the 4 main goals for the following phases. As the name of the chapter suggests, chapter 5.4 is focusing the problem in a broader aspect, which includes also additional ones to the aforementioned goals. These are then narrowed in chapter 5.6. As was discovered in earlier in this chapter, architects and project management are the groups, of whose opinion this study is most interested about.

5.4 Phase 4: Unveiling the big picture

In this part the survey results are introduced. As mentioned, this was done in order understand the underlying trends, the general needs of the customers and on the other hand to identify the lead users for lead user interviews in the last part of the study framework.

To scan the most promising lead users from the customers, local experts inside the company were contacted to provide insight to their own customers to find the most promising lead user prospects. These experts inside the company were chosen based on the development of that country’s BIM scheme and their personal experience on the subject. After this the local experts contacted the prospects and the online survey form was sent either by the contact person in the country or by the author of this thesis.

Most of the responses were gained from USA. Even though the answers are clearly biased towards the United States, it is not seen as a problem for this study. As was described in the phase 1, the US market is already quite matured, as 71 % of the professionals had adapted BIM in 2012 (McGraw Hill Construction 2014). To compare this to responses gained from Finland and United Kingdom in 2013, the BIM is more widely adapted in the US (RIBA 2012, Finne et al. 2014, McGraw Hill Construction 2014). This again would make the US a sort of a lead user market, which again aligns with the goals of the study. Differences between markets naturally occur and it was pointed out in the group interview, that in the US market Revit has stronger position than in Europe, which can be clearly seen in the answers as well. Due to this reason, and the small amount of responses, all the results are treated as one group.

As the survey was conducted together with another thesis worker, the invitation was sent to people on in different roles. This allows the results to be analyzed within different roles in DMU as well and see the thoughts that different decision makers have on BIM. Respondent profiles can be divided into three categories: architects (7 responses), BIM coordinators (3) and project managers (2). “BIM coordinator” is a generalized title for these respondents, and their actual role may vary from one to another. Answers of these three categories are analyzed and compared in case their responses greatly differ from each other.

This thesis is most of all interested about the responses gained from architects, who were identified inside the company as the main users of the BIM models of the company. This way architects can be seen as more interested about different functions related to these models and their availability.

5.4.1 Insights to general issues

Software-native project format (RFA) is the one used by all the architects, but project managers and BIM coordinators tend to prefer IFC format. This is most probably because architects do not have use the interoperability functions in the same level as the other professionals.

It is interesting to notice that most of the respondents see online download via KONE website as ideal way to receive the elevator and escalator BIM models. This is also the choice of them who are the least satisfied with the current delivery solutions. Within architects, plugin and online download from a public element library are seen as popular solutions. Keeping this in mind, if new solutions for the BIM model availability are developed, online download should be kept as part of the offering since current KONE online toolbox is seen as satisfying option. Otherwise current availability has an average satisfaction rate, leaving room to benefit from new ideas.

When it comes to KONE plugin, a small majority (7 out of 12) would use KONE plugin in their building model. One concern to point out was that one architect does not want to have a 100 plugins at some point from 100 different manufacturers. This further creates a need for other solutions for the same purpose.

Architects seem to be less aware of the 3rd party plugin than other respondents. In overall, 7 out of 12 are aware of them, but only 3 of them are architects. This means that of the unaware people, four are architects and only one is not. On the other hand 2 out of 3 architects aware currently use such plugins, indicating that if architect is aware, plugin might be seen useful. Plugins are used in all phases of the design.

Respondents have varying answers to question about the control they wish to have on their elevator specifications. Most respondents are willing to trust KONE with the specifications and do not want to worry about the elevators too much. In the early phases of the design, some want to have more control than in the latter phases of the process.

5.4.2 Customers' needs toward elevator BIM models

Initial elevator information is added in very early stage of design, in which space for the elevator is commonly reserved. This reserved space for elevator is usually based on the shaft size. The results show that there are two main ways to do this. The first is to create an empty elevator shaft for the design and the second is to use a generic elevator model. The shaft size again is most commonly based on previous experiences. As a single factor number of floors stand out as the most common one. Another to point out is the level of service and amount of traffic for the elevator. If some kind of elevator model is used, it is usually got from a manufacturer, but also different libraries and other web sources are used. In this sense previous projects are also used and the model can be from there as well. The generic elevator model is very low-detailed, and is expected to contain car, doors, shaft and pit of the elevator. Some respondents wanted a more specified model in the early phases, but also a space-filler was requested without any additional information. The ability to change the number of floors and other factors was seen important.

One of the most interesting findings from the survey was that the library of most used elevators and escalators was found useful by great majority of respondents. As stated earlier, models from previous projects are commonly used again in a new one. By allowing customer to save their previous projects in a formal way and by providing service to enhance the experience of using previous project models would offer benefit for KONE as a supplier. 9 out of 12 respondents (and average of 4.67 out of 5) saw that library with most used elevators would be useful.

During the design process, most of the respondents use 1 to 2 different elevator models, with different levels of details. On the other hand, couple of answers also required multiple different and varying models. When specifying the differences between these models, there was no clear view on what they actually are.

5.4.3 Weighting the importance of variables

In the last part of the survey respondents were asked to weight requirements according to how important they see them. Of these 17 factors, 6 scored above average and were selected as important. IFC model has been requested in earlier study as a format that the customer want to use (Kallio 2014). In this survey, it was recognized important mainly by BIM coordinators, who are most likely the group that benefit the most of the interoperability functions of BIM. Also presumably the knowledge of IFC in America is not as great as in Europe. This might have caused lot of average values. If no certain option is available, the opinion is most probably neutral. This is why further discussion about IFC was desired. See the list below. Average is 3.46.

- IFC (3.40)
- Space reservation model (4.27)
- Low-detail model (3.58)
- High-detail model (3.80)
- Simplicity in use (4.83)
- BIM model is parametric (4.64)
- Communication via BIM software (3.82)

To compare importance of these factors with what architects have answered, there are two differences to point out. First, architects put a higher value on the schematic design phase, as they give even higher importance to space reservation model (4.67) and low-detail model (3.71), and lower importance to high-detail model (3.6). This could be explained by their involvement on the design, as they are not too interested about the technical details that are in the high-detail model, whereas other respondents are involved in the construction stage, or at least communicate the technicalities with the construction staff. On the other hand, BIM coordinator group is opposite to architects, as they are generally more involved in the latter phases of the project, and are this way more interested about the technicalities as well. Other difference to point out is that architects tend to see communication via BIM software more important. This could be because they need to update and verify the model in different stages.

5.5 Phase 5: Identification of Lead Users

Interviews in the phase 6 were conducted with two goals in mind. Firstly, to understand more what is happening in the Finnish BIM scheme, whether the results from the survey were in line of what is the current trend about BIM in Finland or not and to understand plugins better. Second goal was to understand the usability and the experience of the availability better and what the architects value the most. As mentioned earlier both expert interviews and lead user interviews were chosen as methods for this data collection.

To reach the first goal a group interview was arranged. As mentioned in chapter 2, group interviews and workshops are also commonly used in the interview phase of the lead user method (Lilien et al. 2002). Difference is though that in the lead user workshops, the number of participants is usually 10 to 15, while in this study the number is significantly smaller (Lilien et al. 2002). Despite this, the group interview was seen as a good way to gain insights. Experts to contact for this interview were chosen from Finland and discovered via networking approach inside the company. They are people that in were defined as BIM experts at KONE either by previous collaboration of by their overall status in the scheme as they have been active in Finnish nationwide BIM scheme in addition to their profession. Suggested by Kallio (2014), expert from a high-status Finnish non-profit forum for BIM was contacted. The status of this person in Finnish BIM forerunner is undoubted. Other four experts were due to their previous cooperation with KONE, during which their status has been verified. Of these four experts only one was able to schedule the group interview to expert’s busy week. This interview was conducted as a workshop with these professionals and two experts from the case company.

To address the second goal respondents from the survey were contacted for follow-up interview. Although the survey respondents were all presumably identified as trusted customers, whose expertise is close to lead user level, some scanning had to be done before the follow-up interviews in order to gain as much valuable information as possible about how the developed concept addresses the future needs of the market. In the survey the respondents were asked how satisfied they are with the current offering. As mentioned in chapter 2.3, dissatisfaction is a sign of a lead user. The case company also requested that also the group who showed interest on the KONE plugin idea of the company were taken in the follow-up interviews. This way the interviewees were selected for the interviews utilizing the screening approach as well (Urban & von Hippel 1988). Another factor that is used as a sign of lead user was the speed of adapting innovations. This way interest about KONE plugin concept, knowledge and former usage of such plugins can be seen as determining factors as well. The success of the framework reliability-wise and other notions of the suitability are discussed in chapter 7.

Bearing in mind that giving the permission for the clarifying interview was optional, the interviewees could not be selected from the whole pool of respondents of the survey. From the whole 12 respondents 9 left their contact information and of these 9 respondents 6 were contacted. Of these 6, finally two interviews were scheduled. Interviewee in the second one was the most dissatisfied of all the respondents, and in this sense this person is clearly a lead user. When asked about plugins, no interest was stated by the respondent. Interviewee was aware of them, but was not keen to use them. Despite this, the dissatisfaction indicated a lead user status.

The third interviewee cannot be described as a lead user based on the satisfaction on current elevator model availability and distribution, as the indicated level was 4 out of 5, five being the highest level of satisfaction. This respondent however has previous experience with plugins and is interested about KONE’s plugin concept. This way this person was seen as a lead user as well.

Churchill discovered three different types of lead users: target application and market, similar applications in “analog” market and ones that have important attributes of problems faced in the target market (Churchill et al. 2009). People interviewed for the next phase include lead users from the market, who were identified in the survey, consultant who is seen as part of the last group mentioned by Churchill et al. (2009) and the above mentioned expert from BuildingSmart. This way all of the categories mentioned by Churchill et al. (2009) were represented.

5.6 Phase 6: Attention to details

When discussing the answers it is important to emphasize the different roles that the interviewees act in their professions. As mentioned, the first interview was done with two lead experts of the industry, whereas the second had a project manager attending and the third one was done with an architect. As was discussed earlier, the goal was to achieve an opinion of different key influencers. Results of the interviews are introduced by merging the answers from each individual interview together by topic. The individual interviews had a group of questions as a structure. Interview data is displayed in the appendix V. When presenting the results also some reflections to survey are made. This is due to that most of the topics derive from the survey. Also some comments from the interviews done by KONE US are brought up. Results are introduced as follows: first, topics that belong into input group, second the output, and finally plugin and other general aspects of BIM model availability.

5.6.1 Input variables and early design process

After asking about the early elevator choices and what lead to them in the survey, they were brought up in the interviews as well. Interviewee 3 uses online sources to download models. Usually they define some variables such as size, weight and passenger calculations and after that find an elevator that fits the specifications. This is done roughly: the size of the shaft and the car is defined and the locations for the doors are fixed. After these are defined, they move on with the design.

Similar observations can be made out of the KONE US interviews and the survey for this study. Lead experts' agree with this: logistic planner creates a design and finds a product to fit that. It would be ideal to have a model that reflects to an actual product that can be installed based on the design. Looking for such products is something that designers spend time with, especially in the case of a building that is highly unusual. The options are roughly known by any architect how has worked with residential buildings.

Stated in the second interview, in the early phases of the building design process, the designer is often wrong with the elevator choices, which causes changes to be made and sometimes the pit for the elevator requires changes even three times during the process. This is partly because the construction companies tend the make big part of the investment decisions, as was stated in the group interview. They further said that the owner is also interested about the elevator choices, since it is an expensive as a singular building element. The third interviewee gave architect perspective to this, as it was said that they tend to lock into one manufacturer in their design and if the elevator changes later in the process, it is most commonly because the contractor found a cheaper option. Changing between elevators was stated as the only big problem regarding elevators in BIM. It usually requires changes in the elevator shaft as the new elevator is not probable to fit into the old one. According to the second interview these changes are something that the interviewee wants to be made by the manufacturer, as the changes can be relied on after that.

5.6.2 Model functionalities and usability

In the survey, 5D (cost) was the other dimension besides 3D information that was seen important by over half of the respondents. Cost details were also commonly requested in interviews that were conducted by KONE US with some requests of having the ability to compare costs of different selections. When this was discussed in the group interview, the problem about the subject was that it is difficult to facilitate within the elevator business due to the fact that there are plenty of different variables that determine the price of the elevator or escalator. In the latter phases term used for this is configurability or configurable product.

One of the interviews conducted by KONE US reveals that there are some manufacturers who offer such price calculation tools with a relatively broad price range. This was something that the respondent in those interviews found as a good starting point. In the interview 3 for this thesis, the respondent stated that ASSA Abloy plugin for Revit also has a cost tool that offers similar options and a cost analysis tool that sends the selected equipment to the manufacturer who then analyses the cost for the designer.

According to the group interview, architects' knowledge of product prices is not in high level, and this is a reason that tools like this would be useful. The lack of their experience knowledge of the prices is partly due to the lack of information available, and usually project has a person who calculates the costs and gives hints to an architect about certain parts being too expensive and so on, but sharing very detailed price information is rare. As the cost all in all is sensitive information, indexed prices to help compare different selections were suggested by the interviewees as an option to avoid undesirable information from spreading. A suggestion was also that these indexed prices would further take into account the whole life cycle (6D) of the building, as the elevator investment cost do not stack up to cover great part of the overall costs that include energy consumption and maintenance as well. They stated that 30 to 50 years' usage usually covers the investments of a residential or office building, but in hospitals the same number is 1 to 2 years. This way, the role of the investment cost is reduced and the focus is on traffic efficiency and decreasing the walking distances inside a hospital.

One of the key questions to answer regarding BIM models is LOD of the model. The survey indicated that low-detail models in the early design phases were emphasized more than the higher detail models that are more commonly used in the latter phases. To understand better what LOD to offer, this was discussed in the interviews as well.

The interviewed lead experts made an interesting point that the information that the models is based on is same during the whole process. It is about what is shown in the model, and ability change this can be useful in some projects, which was pointed out in the group interview. The second interview follows the same thought as it was stated that during interviewee's process a model with a graphical level of a LOD100 model is needed, but with very specific information such as in LOD400 model. The model does not show every nut and bolt that there is, but their locations and information about them has to be available. In the same interview request for a higher, LOD300 or LOD400, model was given for the construction phases of the process. This could be run on tablets on site. This was confirmed in the third interview as the respondent stated that when a tablet is used on site, the model should be as realistic as it appears in the actual building. The constructor needs to know where structural support, brackets, rails and beams are located. Lead experts stated that this might cause a technical problem, since such complex products as elevators might cause big files that can be slow or almost impossible to run on handheld devices of the day. Furthermore they continued that the importance of a high-detail model tends to increase in some projects, such as in very high-rise buildings as the mistakes are likely to cost much more. In the case of elevators, an example could be when the shaft is built out of steel instead of the more common concrete shafts. Used solutions to cover the big file sizes have been partial models, though these days they have been more commonly represented in 2D.

Interviewee 2 requested for a higher detail on elevator lobby and machine rooms, which do not commonly get too much attention. It was said that the current models for machine rooms are not indicating too much information about the machine location inside the machine room. This was also pointed out in the group interview along with the pit. It was said that the component at the shaft is only one part of the design. Also the firm of interviewee 2 does fairly lot of detailed design for the high-traffic areas such as elevator lobbies and this way, the information about the details visible to their customers are important to be shown. This would refer to signalization of the elevator.

In overall, the participants of the group interview requested a solution that allows user to create design-wise accurate elevator and to review costs related to the selected configuration and to request an offer for that setting. This would be sent to KONE servers via whom the frontline personnel at KONE could attain the model and communicate the cost information towards the customer. This concept described in the group interview is highly similar to ASSA Abloy’s existing service, which was pointed out by interviewee 3.

On the other hand, in the group interview and the third one it was pointed out that in the early phases the models and their dimensions are not very specific. Third interviewee said that this is because they want to just reserve space in the design with a model that is approximately right size. Same was repeated in the group interview, with an addition that some margin should be left. Lead experts said that the car that was often requested from the initial models was there just for illustration reasons.

5.6.3 Obtaining a model and overall aspects

It was stated in the group interview that the plugin is the ideal way to search elevator and escalator models, but current download services are fine to use too. They saw that the challenge is to get the customers to find and to use the plugin instead of the systems used at the moment. As the product is published and marketed any problems cannot occur, or otherwise it is likely to be uninstalled and never reinstalled though there would be revisions and updated. Very similar review was gained from KONE US, as one of the interviewees mentioned that they have a 5-minute rule during which they need to find what they are looking for. If it cannot be found they close the tool and move on. Lead experts noted though that the attitude towards online services is not as harsh, and they are often used as “it is not ideal, but it is the best option we got”-basis. As the attitude is not as critical, users are more likely to return next time to use the service and possibly to realize the updated version. In case of uninstalled plugin, even though there would be an update, it is possible that the user is not going to even realize that due to the unpleasant previous experiences. Interviewee 2 pointed out that plugin could be useful to change LOD between different design phases, as they tend to have different needs for different phases.

There are two technical problems that can occur. Interviewee 2 mentioned that if he would have multiple plugins he would have to reinstall all of them when he updates to a new version of Autodesk Revit. As new version is published every year, this can be seen as a big problem. Other problem that was discussed in the group interview was that plugins that are designed for older versions of Revit might not function in the new ones. This again can be solved with a new version of the plugin, but it has to be downloaded online and thus might be a barrier for the customer to not use the plugin at all.

In overall the plugin divided the respondents already in the survey into two groups as some of the respondents use plugins whereas another, a bit greater half does not. When asked in these interviews the reasoning for this was clear: it is a question of preference. Interviewees 2 and 3 both recognized this as an answer to this question. Especially interviewee 2 stated clearly that no plugins are used due to a personal preference. In the survey, the same respondent didn't see it reasonable at some point having 100 different plugins from different manufacturers. It was clear that the opinion was that plugins in general could be a great solution for the people who prefer using them. Interviewee 3 uses some plugins to help speed up the process and brought up ASSA Abloy as a suitable reference of a well-functioning plugin.

It was mentioned in the interview 2 that interviewee's firm has their own object library with a search function. Respondent has also used common object libraries Autodesk Seek and RevitCity. First of them was commented as follows: " Autodesk Seek has done a reasonably good job of finding manufacturer product information and giving Revit file for all of it, and the search feature is okay, but there is so little there overall.”. RevitCity again had an opposite problem in interviewee’s mind: “there are tons and tons of stuff, but most of it is junk”. Finding good content was the key that was pointed about these libraries in this interview. One of the key elements mentioned multiple times was search feature that allows the user to scan according to the product line or model to point a few. Interviewee 3 highlighted similar things. Autodesk Seek is commonly used in their firm. They see it has easy to follow rules and that Autodesk is really pushing to make it user friendly. This service is used for objects that are generic and if it cannot be found in Seek the interviewee is likely to use a download service by a manufacturer, like KONE. Manufacturers’ models enjoy trust among their firm: “KONE will not offer me something really bad, because they want my business”.

Libraries also came up in the group interview. Lead experts noted that they are useful in the schematic design phases as the design does not have to be extremely accurate by definition. What comes to the idea of having a KONE library of the most used elevators, this was seen as a good idea by the lead experts. They noted that designers and architects have a habit to expertize on certain type of projects, and so have similar need for the elevators. Same type of project tends to have a similar floor height and as so called bulk design is made the elevator is usually the same. Again it was emphasized how in the residential markets the constructors usually minimize the offering they use to gain economies of scale and this way the options for the architects are limited. This way a readymade selection of this offering would be a handy tool.

It is also important to understand that according to interview 3, firms tend to use a manufacturer multiple times if they find their site comfortable to go to and getting what they need. If there is a supplier that has proven to make their life easier, this one inclines to be recommended to colleagues as well. It was further stated that if a manufacturer has a library, this manufacturer tends to be chosen over the one who does not.

One of the participants in the group interview was very well aware of the current situation of IFC via participant's position in the non-profit organization. He stated that IFC are European invention and this why they might have been overlooked by American respondents in the survey. Currently IFC is on its way to become a binding standard, which would mean that it would gain a monopoly status and no other standard could be designed in EU. According to the interviewee the difference between software-native formats and IFC is that IFC does not change between different Revit-version and is interoperable between different software and is used for this purpose a lot for the same reason. Other of the KONE experts confirmed that in the Netherlands the format is the most frequently used one.

6. DISCUSSION

In this chapter the results of the previous chapter are analyzed and key findings are presented. First, a view on similarities of manufacturer required inputs and customers’ view on what they use as the basis for decisions (customer inputs) are presented. After this the desired outputs presented in the previous chapter are discussed. In the same time they are analyzed based on how they can be arranged and these inputs relate to them.

6.1 Ideal Inputs to Obtain a Building Information Model

In the results of the survey and interviews it was clarified that designers want to make the process of obtaining the elevator model as easy and simple as possible and are not necessarily interested about elevators in very deep level. Basically this would mean that the less information given the better, but at the same time getting as much as an output as possible. Thus, it is important to know as well the minimum requirements that have to be known in order to create a model.

Inputs that most of the manufacturers require and the inputs that customers are most comfortable giving are displayed in table 2. Columns are named after their phase in the previous chapter. First column shows the manufacturer requirements and second and third the ones that were discovered as “customer inputs” in phases 4 and 6. Currently all the services require at least three different inputs for to provide a model as an output. Most of these differ from the ones that customers use as a basis for their decisions. As can be seen in table 2, there is one of attribute that came up repeatedly in benchmarking, survey and interviews, which is capacity of the elevator. Also number of floors can be seen as a common input for both the customers and manufacturers. It would be reasonable to let the customer to design a model based on these factors.

Table 2. Required inputs and customer inputs

Phase 2	Phase 4	Phase 6
Travel distance	Previous projects	Size of the shaft
Capacity	Number of floors	Weight (capacity)
Speed	Level of service (capacity)	Passenger calculations
Number of floors	Amount of traffic	
Rear opening	Building type	
Elevator model		

Furthermore, two factors in table 2 serve more or less the same purpose: elevator model and building type. Interesting is that they are seen important by both, the manufacturers and by customer, but from a different angle. Building type is a factor that could define the elevator model choice or at least narrow it down. If customers are more comfortable giving this information rather than elevator type, the building type should be used with an option to select the elevator type. Elevator model is something that customer does not want to think about based on the answers. As mentioned in chapter 5.6, elevator models tend to change multiple times during the process and for this reason customers do not necessarily know how to provide the correct information. Ideal situation would be that the given specifications limit the options down so that the elevator model is selected as the optimal one automatically by the system itself, instead of that customer – who does not care too much about elevators – chooses one blindfolded. Although it was also stated that the information in the initial steps of the design process has to be only approximately correct.

6.2 Desired Outputs of a Building Information Model

Based on the results of this study, it is clear that two LOD models are demanded: one that is used in the very early phases of the design to mark the space for the elevator and another, highly detailed model, which can be used in the construction phases. Also ability to select what elements are shown in the model is a great addition that is supported by the results. This would be possible to do as the variables that the model is based on remain unchanged for the whole process.

Both of these abilities can already be found in one plugin as was mentioned in benchmarking chapter of the framework. Plugin seems to be the only way to provide these functions at the moment, as download services are not connected to the design software and the model in that design.

It was clearly shown in the results that of the suggested model options especially space reservation model was highly requested. Space reservation model can be seen as referring to the correct dimensions of an elevator, or more accurately the correct height, width and depth of the elevator shaft. These dimensions require information of the travel distance, which more or less defines the overall height of the system, and the elevator car size, the latter of which defines the car size and thus the width and depth of the model. These values can be defined by the capacity. A conclusion from the results was made that customers want to use the minimum amount of factors to define the elevator; this is the optimal way of achieving the goal in the light of the results. Current plugins already use intelligent functions that automatically take the travel distance, number of floors and floor heights from the building project. If this a plugin service is developed, one option is that the customers only need to give one factor, an estimation of the number of people travelling in the elevator, to gain this kind of space reservation model. Nowadays it is common that this value is requested as a load or weight of that the elevator is supposed to carry. Number of travelers is anyhow easier to understand and it is defined by standards, which is why this value should be used in case of an elevator designated for people. Achieving the model with only one factor would directly address to simplicity in use, which was the highest valued factor in the survey. This scenario only occurs in a case of single door elevator, since rear opening is the other factor that affects the depth of the elevator, but as mentioned in the last chapter, this selection is usually easy to make as well.

On the other hand this kind of one factor plugin is supported by an assumption that experiences with the abovementioned plugins with all the possibilities to change everything might cause confusion within the people who are not especially interested about elevators. According to the results many of designers are not so keen knowing everything that is going under the hood. ASSA Abloy has solved this by offering two different versions of plugin. Such option could be a solution for this scheme as well. If customer is satisfied with two different LOD's, a simpler version of the plugin with those two options is a good option. On the other hand, the full version would include the ability to change the LOD or the components that are shown, thus providing more flexible solutions while requesting more knowledge of the subject.

KONE's current solution is to offer a low-detail model via download service. Also high-detailed model is available on request, but that needs to be done by contacting KONE personnel. Communication in switching between these two versions is a problem, and plugin seems to be a good way to enable this. Also this can be chosen as the functionality of a plugin: to update the online downloaded model into a more detailed one inside the software.

One interesting finding was that the early model in the design, such as the previously discussed space reservation model often derives from an earlier project. This is fully aligns with the majority of responses stating a library of most used elevators is a good idea. This can be arranged in two ways: via online database with new interface that requires a login or via software built-in plugin, without the need for logging in. As stated in the results, KONE US interviewees stated that they do not want to log in as it is seen as an extra step. A plugin could simply have a tab that allows the user to save the currently used elevator to be added to the future projects. Online version would be difficult to establish, due to a new interface. Since there are many respondents who see online the optimal way to obtain models, this is anyway something that would be recommended. According to engineer in the case company, if this kind of service is offered, a connection to case company's database has to be established.

6.3 Other Observations of the Results

IFC format was requested in the results part by interviewees and also in the survey. IFC format would be a good option to consider, as it helps with the management between different versions. Also, as stated, IFC is on it's way to become an international standard and this way it would also be beneficial to make the solution IFC-compatible.

Currently only 3D is seen important within elevator BIM context. Also notions of 4D and 5D were made, but at the current development level of BIM, they are not just yet realistic to make as a standard procedure. Comparison between indexed prices and life cycle price assessment is suggested as a secondary goal, but more research on this subject needs to be done before making any actions with the subject.

It is interesting that communication is seen as an important functionality for a plugin. Also communication is something that can be rather easily arranged in a low level, which means that plugin would include a contact button, which lets the user to send an email to a contact person in a firm or on the other hand a button to request an offer for that particular elevator. Problem with the latter part is that it is common to have separate ongoing contracts with certain prices that the designer would not have access to. This might mean that the whole functionality is useless. Ideal level for communication could be that customer can simultaneously show the problem on the screen while getting advice or changes by the manufacturer. This is not currently possible, or at least it is not easy to arrange and calls for more research.

7. CONCLUSIONS

KONE’s has been utilizing the technological leadership strategy since the early days of the company and has been lately honored as one of the most innovative companies in the world. Building Information Modeling (BIM) again has been regarded as the most promising, emerging technology for construction industry. Also KONE’s customers have indicated that BIM is going to be a major concept for them. It is in line with KONE’s technology strategy to be the first mover in the business regarding BIM and to provide solutions that are second to none. In this chapter conclusions are made. First, overall look on the research is provided and followed by the answers on the research questions that explain the most important findings. After this managerial implications are drawn to understand the suggested actions that should be made after this study. Chapter is ended with assessment of reliability, contribution to previous research and suggestions for future research.

This study focused on clarifying KONE’s customers’ needs towards BIM models. As an outcome these needs were categorized to input variables that customers most commonly use to attain a model, desired feature that should be included in the model and functionalities of the process and related systems. Another important part was to discover existing solutions for third-party model availability and what solutions are currently provided in the market and what would be the best option for KONE to provide its customers. In gathering information from customers and also in observation of existing solutions, special focus was given to software built-in plugins that provide access to third party models without the need to leave the BIM software.

A modified version of lead user method was the core approach for the research. Lead users are innovative customers, whose current needs indicate what will be the general needs in the market in following years (von Hippel 1986). This way this method was seen as an interesting approach suitable for this context. In this study, benchmarking was utilized as part of lead user method to understand current solutions. Also certain approaches commonly used in Quality Function

Deployment, Concept Testing and Customer Idealized Design were used to support the framework. For empirical data collection survey and interviews were utilized alongside with plenty of literature and secondary sources.

7.1 Answers to research questions

A conclusion can be drawn that differentiation in BIM model availability can be achieved by understanding customer needs better than competitors. Another option would be that once customer has imported a BIM model by certain manufacturer, changing this model would be made as difficult as possible. This is seen as negative engagement, since in the results it was identified that the model may be changed multiple times during the process and limiting this might cause unwanted perceptions from the customer. To understand the customer needs better and how to respond to them the following three research questions were formed in the beginning of the study to support in this project. In this part these questions are answered. These answers recap the results and key findings of this study.

1. *Which are the most important customer needs regarding BIM elevator models and their availability?*

The most important needs can be categorized to inputs, outputs and others. Inputs actually refer to what customers are willing to base their elevator decisions on. These include desired capacity, building type, number of floors, passenger calculations/amount of traffic and size of the (elevator) shaft. In addition number of floors is an important factor to determine what kind of elevator is optimal for the design. One identified factor is that customers do not often care about elevator choices too much; it is just a small portion of their design process. This means that to change these input factors into outputs, customers want to have much information by giving as little as possible. They also want to use models from earlier projects again in new ones. This aligns with the high request rate for a library of most used elevators.

Most of the customers want to have two different development models as output: one that reserves the space in the design and high-detail model that can be used as the design in overall has higher level of development. Ideal model would also include an opportunity to change the visible elements depending on current need set by the design phase.

Other needs that have been recognize include such functions that influence the usability of the model or the service. Above all, the service should be simple to use. Communication function was also seen important, but no further instructions of how this should be arranged were identified. Customers are more willing to have freedom in the early phases of their design and require more guidance and communication when coming to the more developed models. This calls for greater guidance tools and/or easy to use functions for the early phases of the design.

2. *What are the current competing solutions?*

Current solutions for the needs that customers have are download services, plugins and object libraries. First two of these are commonly elevator specific, whereas the last one is usually arranged as a search engine for all BIM objects. Download services are offered by manufacturers themselves. They require few attributes as inputs for a model and provide a high-detail model without an ability to change the characteristics afterwards without going back to the download service. Manufacturers commonly state that these models should not be used as construction models without consulting the manufacturer. All of case company's closest competitors have similar service. Some differences occur with how many attributes are required as input, but most commonly these services require travel distance and two other inputs to provide a model.

There are currently two major competitive solutions within plugins, one made by a major competitor and the other from a third party software provider. Basic functions of both of these are highly similar. Competitor's plugin uses similar functions to provide the model as the download services, but takes some factors from the design, which is one of the major benefits of plugins. The third party plugin has elevators from multiple manufacturers. From a user point of view this is a great solution, but the problem is that not all of the models in that service are certified by the manufacturer. This may cause problems in latter design phases when the model needs to be buildable. This third party plugin takes better advantage of the fact that it is built in the software by enabling updating and changing the visibility of certain parts of the elevator and LOD of the whole system. This way user can optimize the elevator model to each stage of the design.

Object libraries do not at the moment offer a big threat to these two aforementioned solutions. As elevator is configurable object, which means it is usually a new task or modified rebuy product, it cannot be distributed effectively the same way as some more standard objects such as windows or doors. This way many challenges are faced in this kind of public object libraries.

3. *Which of the existing types of availability solutions are ideal to satisfy these needs?*

There is currently no company that offers both, a proper download service online while having a plugin that works inside software. As a conclusion from the study it can be said that both of these services have their users – it is a question of preference. It was further found out that via plugin, the service can be much more adaptive and versatile, making the process of obtaining an elevator BIM model easier for the customer. This is why a suggestion is made that a plugin should be offered, but as many users prefer online download service; this should be a parallel option.

The key is to make a solution that is really simple to use. As was found out, often customers do not care about elevators too much, and this is why the process should be as light as possible, at least to get started. Also sufficient support via tools and communication should be provided.

Taking into account the previously mentioned needs, a plugin has proven to be the best technical solution to these needs. Plugin further provides opportunities to react to users design to create an accurate model for that specific context and to really make the service simple to use. Also, it enables changes between different LOD's and visibility of elements.

It is important though to understand that not all customers want to use a plugin, as was found out it is a matter of preference. This is when the existing download service steps in. In order to really engage all customers, this service needs to be also well thought out. It should work in a similar way as plugin, but taking into account that some outputs, such as travel distance and number of floors have to be manually inserted as download service is not connected to the design to acquire them automatically.

7.2 Managerial implications

To gain competitive advantage and engage customers via KONE BIM models, following actions are suggested regarding distribution channels, inputs to obtain a model, models themselves and functions during the process:

- KONE adds a Revit plugin to its offering, while maintaining and improving the existing online solutions.
- One factor specification, capacity used to define the space reservation model.
- Two different pre-defined LOD versions are available to change with one click.
- Library of most used elevators is part of these solutions.
- Current online tools should be arrange as a logical path and implemented into plugin as support tools.
- Beta testing should be arranged to get feedback before the actual launch.

KONE should offer two parallel services for BIM availability: plugin and online download service. Functionality of these two services is alike, as they both provide two different levels of detail, but due to technological limitations, customer needs to return to online download service to download a new version of the model. In plugin this is built-in functionality, and customer can update the model by selection inside the software.

Well-functioning plugin is light what come to inputs, and versatile regarding outputs. Plugin has intelligent functions that take information regarding travel distance, number of floors and floors heights from customer's project. In download service these inputs are set manually. In both of these, options capacity is used as a core input. Capacity is defined as number of travelers or weight, depending on building type. By defining capacity, and in online version the other factors, customer will get the first model, which is low-detail space reservation model that includes the outer dimensions of the elevator shaft and standard doors for the elevator on each floor. In plugin the visible elements can be changed one by one in the software or changed into pre-defined high-detail model. Allowing this to happen requires prioritization between what is suggested as standard for the model. Well prioritized offering not only will help customer, but also allows KONE to select what is ideal to sell. In addition, ability to save elevators should be part of the plugin in early stages as a drag-n-drop function. In the online download version usability of this kind of service will be decided based on the feedback gained from the plugin users.

It is important to note that not all customers want to use a plugin, and for this reason current online tools should be provided as an alternative. The existing tools – Toolbox, Planulator and Quicktraffic – should be tied next to each other in a manner that helps the customer to make BIM model decisions. These services supplement each other and if customer is in a doubt with Toolbox, these two other services should support in decision making. Ideally, KONE BIM website would have a seamless path, starting from Planulator, going to Quicktraffic and ending up in Toolbox, via which even a customer, who has no idea about elevators, would end up with the perfect elevator for the current project. These two existing solutions, Planulator and Quicktraffic form a solid basis for developing similar supporting tools for the plugin as well and are should be added to the service as well.

Developing of the online service will be done based on customer feedback. As it was also mentioned in interview that with plugins companies tend to have one shot to engage the customer, the first version should be well-functioning. The barrier to re-download a plugin after being dissatisfied is higher than to return to a website that has somewhat similar service. Beta testing should be used as a development method for the first version of the plugin before launching it to public. Later, depending on feedback in beta testing stage, the plugin is improved and optionally, divided into two different plugins: simplified and full version. First would have basic formats: creating a model and later updating it to a higher detailed version, whereas full version would enable customer more freedom to change the visibility of different parts of the model and thus would demand more knowledge of elevators.

7.3 Limitations and reliability assessment

As discussed in the methodology chapter, certain selections for the methodology were made to improve the reliability. Semi-structured interviews helped to obtain somewhat comparable answers from these two interviews. Some variation between the interview structures occurred due to the different roles and different answers in the survey. One additional interview was also conducted, but as this interview was seen as a threat to validity of this thesis, it was later disqualified from the results. Results and findings are not generalizable, as is typical for case studies. This was a known already in advance.

There are two important notions to be made about the reliability of the study, which are both affected by the outturn of the study. Lead user method was the core element of the study. Threat to the reliability of this method was that the status of the participants. If they would not be lead users, this method is not utilized in the right way. As was discussed before the interviews, all of the respondents are either lead users or lead experts as was the goal of the study. Another related threat is the amount of responses. Lead user method usually includes 10 to 15 people taking part on a workshop. This study had only 4 participants and 2 from inside the case company on the interview stages, which is a threat to the validity of the method. Workshop nature of the original method allows the participants to supplement each other which did occur a bit in the group interview, but not in a large scale. This way the reliability of whether the results are actually lead user opinion or opinion of normal customer is endangered and unsure. The findings can anyway be taken as reliable answers for the research questions despite the fact that lead user method would be threatened.

Furthermore, a notation has to be made that as one limitation for this study was that this process in reality is not an individual process, but includes communication between the buyer and supplier just as any other relationship.

7.4 Contribution to previous research

One aim of the thesis was to test lead user method in new context and how this method could be modified to answer case specific needs. Method should include much more attendants and more time to provide information of whether it is suitable method for such cases. Anyhow, it has a strong potential of engaging customers into the design process and as it has been used in development of analog products, it could be suitable for further investigation within building information modeling scheme.

This research what a continuum for another master’s thesis conducted last year related to the same subject for the case company. Suggestions made in that thesis were taken into account and this way thesis is a contribution to the same vein of studies in the case company. Building information modeling itself is fairly popular research subject at the time and as mentioned in the introduction, multiple research projects in Finland by itself are currently conducted. As a single case study the contribution to this scheme is not significant, and after the publication of this study, similar studies have already been published and the new information, ideas and data has been discovered. After all, this was not the intention of this study by any mean.

7.5 Suggestions for future research

In this context, if the plugin is created, it will open new doors for research. Implementation of these suggestions and how different technical functionalities can be arranged in reality are interesting question. Marketing-wise it would be interesting plan how the knowledge of the plugin is raised. Methodologically thinking the ways of developing new services is a great vein of study to observe. Questions like should beta testing or concept development be used and in what depth customers are activated in this process of refining the actual product sound interesting. Lead user method can be a great way for prototyping purposes as the first development stages of the service have been finished as well (Kaulio 1998).

3D is currently the dominant dimension for all BIM design, and for obvious reasons. Other dimensions are currently emerging and as one of the interviewees stated, one of firm’s customers was really pushing for 6D planning. This is why a suggestion to future research within this context, but also in a broader view is that different dimensions and their practical implications are researched. As 5D (cost) was requested multiple times in the survey and interviews as an interesting factor, it is a good starting point. Especially interesting would be find out how price indexes could be used to compare different sets of specifications and their pricing.

Furthermore, communication has a plenty of studying to do. It came up in the group interview that a format for communication between software and project to project called BCF has been developed. An interesting study to conduct would be one that introduces different way of communication inside BIM software.

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APPENDICES

Appendix I – Levels of details and what they mean for elevators

LOD	Definition	For elevators
100	May be graphically represented with a symbol or other generic representation, but does not satisfy the requirements for LOD 200. Information related to the Model Element (i.e., cost per square foot, tonnage of HVAC, etc.) can be derived from other Model Elements.	Schematic model elements that are not distinguishable by type or material. Component sizes and locations still flexible.
200	Graphically represented as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.	Generic representation of the system envelope, including critical path of travel zones.
300	Graphically represented as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.	Specific system elements modeled by type, including all path of travel zones. Pits and/or control rooms and associated equipment to be modeled if applicable. Major structural support elements modeled. Connections to mechanical or electrical services.
350	Graphically represented as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the Model Element.	Sizing adjusted to the actual manufacturer specifications. Guiding tracks/rails Service/access zones
400	Graphically represented as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the Model Element.	All connections, supports, framing, and other supplementary components.

Appendix II – Benchmarking input factors

INPUT	Service A	Service B	Service C	Service D	Service E	Service F
Travel distance	Required	Optional	Required	Required	Required*	Required*
Capacity	Optional	Required	Required	Required	Optional	Optional
Speed	Optional	Required	Required	Required	Optional	NA
Number of elevators	Optional	Required	NA	Required	Required	Optional
Number of stops	Required	Optional	NA	Required	Required	Optional
Rear opening (y/n)	Required	Required	NA	Optional	Required	NA
Choose elevator model	Optional	Required	NA	Optional	Required	Required
Car dimensions	Optional	Required	NA	Optional	Optional	Optional
Door height	Optional	NA	NA	Optional	Optional	Optional
Door type (center, side..)	Optional	NA	NA	Optional	NA	NA
Door hand	NA	Required	NA	Optional	Optional	NA
Door width	Optional	NA	NA	NA	NA	Optional
Type of usage/type of building	NA	Required	NA	Optional	NA	Required
Machine room type	Optional	Optional	NA	NA	Required	NA
Power supply	NA	Optional	NA	Optional	NA	NA
Specific door infomation	Optional	NA	NA	NA	NA	NA
Floor heights	Optional	NA	NA	Optional	NA	NA
Pit depth	NA	NA	NA	Optional	Optional	Optional
Population in the zone	NA	NA	NA	NA	NA	Required
Shaft dimensions	NA	NA	NA	Optional	NA	Optional

**Automatic from the design*

Meanings of the colors in the table:

- Green = required to obtain the elevator model
- Yellow = optional, can be used to further define the selection
- Red = not applicable, this function is not found in the system

Appendix III – Benchmarking output factors

Output	Service A	Service B	Service C	Service E	Service F
Low-detail model	Yes	No	No	No	Yes
High-detail model	No	Yes	Yes	Yes	Yes
How many different LOD choices	1	1	1	1	2
Ability to change what is visible	No	No	No	No	Yes
Ability to change number of stops	Yes	No	Yes	Yes*	Yes*
Ability to change floor heights	Yes	No	Yes	Yes*	Yes*
Ability to make a group of elevators	No	No	No	Yes	Yes
Communicati on/contact	No	No	No	No	Yes
Library of most used elevators	No	No	No	No	No
4D	No	No	No	No	No
5D	No	No	No	No	No
6D	No	No	No	No	No

*Automatic from the design

Meanings of the colors in the table:

- Green = this function is found in the model
- Red = this function is not found in the model

Appendix IV – Benchmarking other factors

Other	Service A	Service B	Service C	Service D	Service E	Service F
Area support (qualitative)	Good	Poor	Poor	Poor	Medium	Good
Design tools (qualitative)	Good	Good	Poor	Medium	Poor	Poor
Maintenance selections	NA	Optional	NA	Optional	NA	NA
Seismic details	NA	Optional	NA	Optional	Required	NA
User Contact Details	NA	NA	NA	NA	NA	NA

Meanings of the colors in the table:

- Green (good) = the service has a good level of this function
- Orange (medium) = this service has the function, which is neither good nor bad
- Red (poor) = There is not a proper function in this service
- Light green (required) = this value is required to obtain a model
- Yellow (optional) = optional, can be used to further define the selection
- Light red (NA) = not applicable, this function is not found in the system

Appendix V – Interview data

Number	Interviewee	Company	Date	Duration
1	Development Manager	A	3 Sep 2015	150 min
1	BIM Manager	B	3 Sep 2015	150 min
1	BIM Expert	KONE	3 Sep 2015	150 min
1	Project Manager	KONE	3 Sep 2015	150 min
2	Senior Engineer - BIM	C	14 Sep 2015	61 min
3	Architect	D	15 Sep 2015	38 min