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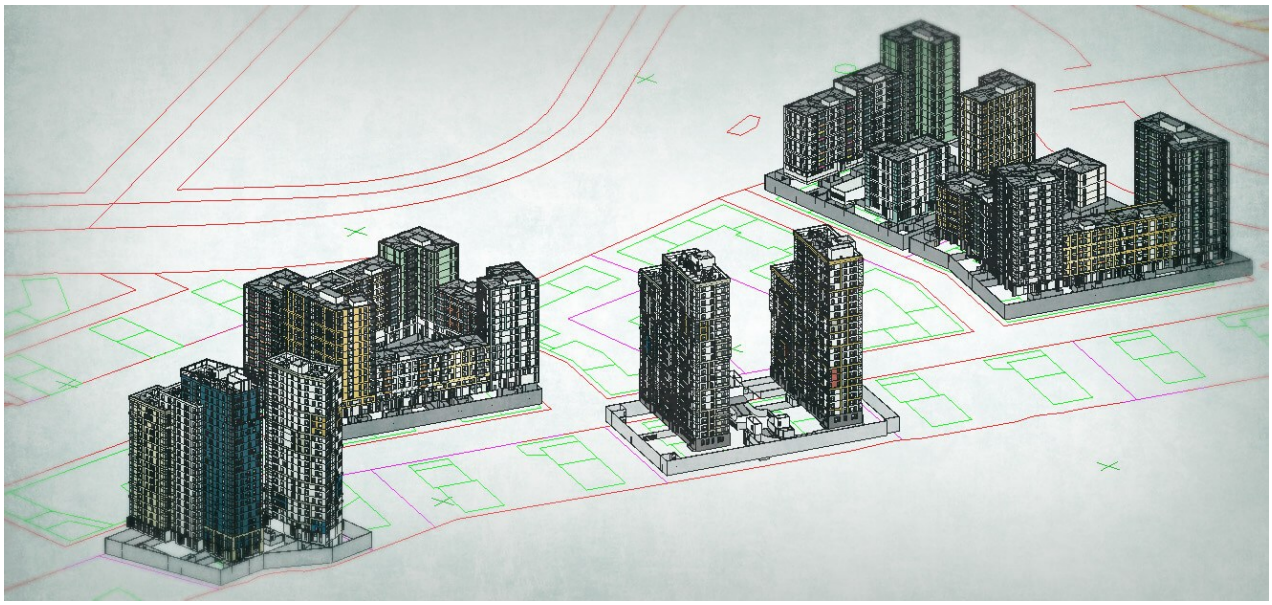

Building Information Modelling: Perceived value and opportunities

An investigation of real estate owners and appraisal firms

Master's thesis in Architecture and Civil Engineering

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Division of Division Construction Management
CHALMERS UNIVERSITY OF TECHNOLOGY
Master's Thesis ACEX30-18-76
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ABSTRACT

The real estate sector is under digitalization where traditional replacements of paper to digital equivalents are heading towards more intelligent and interoperable solutions. Building Information Modelling, also known as BIM, has developed as a tool to be used in the industry, having seen the benefits in construction and architecture. The advantages with BIM have been research to a higher extent within these branches and the possibilities for development in the real estate sector should be examined further. The cost of operating and managing a building could be many times higher than the actual construction, which gives a reason to focus more on facilities management.

The report is embracing a qualitative method and has been developed from six semi-structured interviews from actors who are located in the city of Gothenburg. A literature review has been conducted in order to create a theoretical framework, which later on has been analysed together with the empirical material. The report investigates if there are any incentives for the property owners in Gothenburg to implement BIM. To analyse BIM´s possibilities in operations and compare it with how property owners work today. To examine if BIM can affect the real estate value in a positive manner, which was the report main research question, could it increase the interest in implementing BIM. Furthermore, there has mainly been two professions in focus in this report, property owners and appraisers.

This thesis could not support that a property would be valued higher by having BIM implemented. Other economic factors could neither be found, however there is a potential for BIM in the real estate sector since the model could be used to save time and costs. This can be made due to the rich information base that BIM can entail and thereby have a large amount of information available. The information must be relevant to several professions in an organization to benefit to whole company. BIM could also be used in visualisation of buildings without having to visit the actual site and also for refurbishments.

Key words: BIM, Facility management, Property owners, Real estate value

Byggnadsinformationsmodellering: Upplevt värde och möjligheter

En utredning av fastighetsägare och värderingsfirmor

Examensarbete inom masterprogrammet Internationell Projektledning

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SAMMANFATTNING

Fastighetsbranschen genomgår en digitaliseringsprocess där tidigare utbyten av fysiska papper mot digitala motsvarigheter, riktas mot mer intelligenta och interoperativa lösningar. Byggnadsinformationsmodellen, även kallad BIM, har växt fram som ett verktyg som kan användas i branschen från att det används i allt högre grad inom konstruktion och arkitektur. Fördelarna som BIM medför har undersökt i större utsträckning inom dessa branscher och utvecklingsmöjligheterna för BIM inom förvaltning bör studeras ytterligare. Kostnader för en byggnad kan vara flera gånger större efter konstruktion än under konstruktionen, vilket ger en anledning till att rikta mer fokus mot förvaltningsfasen.

Rapporten anammar en metod av kvalitativ karaktär och är utvecklad utifrån sex stycken semi-strukturerade intervjuer från aktörer etablerade i Göteborg. En litteraturstudie har genomförts för att skapa ett teoretiskt ramverk som sedan analyserats med det empiriska materialet. Rapporten utreder om det finns incitament för fastighetsägare i Göteborg att implementera BIM. Detta genom att studera möjligheterna som BIM kan medföra till förvaltning samt jämföra dessa med hur fastighetsägare arbetar idag. Genom att undersöka ifall BIM kan påverka fastighetsvärdet positivt, vilket var rapportens huvudfrågeställning, skulle detta kunna öka intresset för implementeringen av BIM i branschen. Huvudsakligen har två yrkesroller varit i fokus i rapporten, fastighetsägare och fastighetsvärderare.

Rapporten kunde ej ge ett stöd för att ett fastighetsvärde skulle bli högre med hjälp av att ha BIM implementerat. Andra ekonomiska faktorer kunde inte heller styrkas, dock bör det finnas en potential för BIM inom fastighetsbranschen på grund av att modellen kan användas för att spara tid och kostnader. Dels på grund av den stora informationsdatabas som BIM kan möjliggöra och på så sätt ha en mängd relevant information tillgänglig. Det måste göras i förhållande till flera olika roller för att stötta hela förvaltningsorganisationen. BIM kan även användas till fördel vid visualisering av byggnader utan att ej behöva besöka fastigheten eller vid en ombyggnation.

Nyckelord: BIM, Fastighetsvärde, Fastighetsägare, Förvaltning

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Preface

This Master of Science thesis was conducted during the spring of 2018 at Chalmers University of Technology. The thesis is the final assignment included in the master programme International Project Management. The project has been carried out for a company named Zynka BIM, which is located in the city of Gothenburg.

Firstly, we would like to thank all interviewees who shared their knowledge, insights and helped us to complete this thesis. Special thanks Mattias Roupé, our supervisor, who has contributed with important input but also who has supported and direct us throughout the process. We would also like to thank Zynka BIM for the opportunity to work with them especially Daniel Månsson who was our contact at the company.

Gothenburg, June 2018

Per Almquist, Niklas Gustafsson

Notations

Table 1 List of interviews

Table 2 Information requirements

Roman upper case letters

CF_N	Future Cash Flow
PV	Present Value
r	Discount rate
t	Time variable

Roman lower case letters

CF_N	Holding Period

List of abbreviations

AEC	Architecture, Engineering and Construction sector
BIM	Building Information Modelling
CAD	Computer-Aided Design
DCF	Discounted Cash Flow
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certifications
ID	Identification
NOI	Net Operating Income
PDF	Portable Document Format
2D	Two Dimensional
3D	Three Dimensional
4D	Four Dimensional
5D	Five Dimensional
6D	Six Dimensional
7D	Seven Dimensional

1 Introduction

In the following chapter there will be a introduction to the master thesis and its subject areas. A background will discuss and introduce the reader to the digitalization branch and its impact. Furthermore, the master thesis purpose, research questions and limitation are also presented.

1.1 Background

Building Information Modelling, or simply BIM, have emerged in the construction and architecture sector over the past years. The opportunities that it counts for in design, cost savings and time planning have been a factor the make more contractors and architects to benefit from the tool. While BIM in construction and design are well adopted and are no longer in the research stage, there is still a need to study the application of BIM in facilities management since this is at an early stage (Pishdad-Bozorgi et al., 2018). The design, construction and handover of a building are traditionally considered to be the regular project life cycle in the industry. However, the extended project life cycle, where the facility management face is included, can be many times longer and this phase (Becerik-Gerber et al., 2012). It is estimated to constitute of circa 60% of the total life cycle cost of a building by Guillen et al. (2016) and Parsanezhad and Dimyadi (2014) refers to Jordani (2010) stating that 85% of life cycle cost of a building is after the construction. This phase is also referred to as the operation and maintenance phase and information management is a main reason for an argued over cost that has been realized in the sector in recent years. To have an accurate hand over process from construction and an integrated life-cycle approach is a necessity in order to achieve an automated facilities management practice (Parsanezhad and Tarandi, 2013).

In a time where digitalization keeps on accelerating and poses different opportunities and challenges for business, it is not feasible to stick to old habits. In an investigation from Fastighetsägarna (2018), the union on property owners, in Stockholm, it is argued that the real estate sector has to face the challenges and opportunities that a digitalization of the sector will include. A digitalization of the branch will propose opportunities to evolve the core business of the company and also develop solution for tomorrow. The investigation of how property owners see the digitalization process gave approximately 45 % positive responses where companies see this phase as an opportunity, 40% were neutral and the rest, 15%, perceived this as a challenge. When the City of Stockholm did an investigation of digitalization and innovation for sustainable facilities, they argue for a common dialogue and solution for the sector (2017). The problem of high investments cost is discussed and the insecurity of what type of technology that will bring value to the organization.

Facility managers have been facing the challenge of replacing traditional paper documents with digital formats for recent years but are now heading towards more intelligent and interoperable instruments (Parsanezhad and Tarandi, 2013). BIM has emerged as a solution to this in recent decades, providing a common data base of a portfolio or singular facilities and the information to support the operation and maintenance of the buildings (Cavka et al., 2017). The proposal of common databases as a tool for effective facilities management was presented as far back as in the 1980's.

If BIM could be used in order to get a higher real estate property value, it could be an incentive for property owners to implement the technology to a higher extent. This study area has not been found in previous research, which is a reason to examine the topic in order to find new benefits. BIM might have an impact on lower operational costs, bring higher rents or lower the risk, which could bring a higher real estate property value.

1.2 Purpose

The purpose of the report is to examine the connection between a real estate property value and Building Information Modelling. Since the real estate sector is developing in terms of digitalization, Building Information Modelling could have a higher usage rate in the industry. The areas of applications will be evaluated together with its potential of implementation. If Building Information Modelling could entail a positive effect on the market value, or pose other economic effects for property owners, it would be an incentive to further implementation.

1.2.1 Research questions

- Is it possible to prove a higher real estate value with BIM implemented?
- How digitalized are property professionals today?
- What is the most crucial information that property professionals are looking for within a BIM model?
- How can BIM support property professionals?
- How may economic benefits be drawn from implementing a BIM model in property management?

1.3 Delimitations

The study is focusing on the commercial real estate market in Gothenburg, which includes office spaces, retail and similar markets. Housing has been a small inclusion although the main aspects have been concerning the previously stated areas. This means that no public institutions, such as hospitals and schools, have been a part of this research. Another exclusion are residential family villas. The interviews have been conducted on an organizational level, meaning that personal that are involved in

the day-to-day operation and maintenance have not been a part of it. Technical aspects have not been investigated in the companies and comparing a BIM-solution and the systems of today more than how the interviews explained how they are structured today. The thesis is therefore in a more theoretical approach to seek application areas rather than actual case studies of specific systems. Calculations are also in a theoretical approach since no numbers have been investigated from the interviews.

2 Theoretical framework

The following section will include theory and previous research to the fields of BIM and valuation theory. The first section includes BIM application for property owners. Starting by explaining the basic concepts of BIM, the framework is more narrowed down to focus on operation and maintenance with application areas for facilities management and challenges for implementation and usage.

The second section is about market value and valuation theory for real estate in order to establish connection to a higher valuation. Furthermore, a small section of building certifications is also included in the theoretical framework to discuss its connection and effect on valuation and market value.

2.1 Building Information Modelling

Building Information Modelling, many times referred to as BIM, is a field that stretches through the different sectors that are a part of a buildings lifecycle. The definition of BIM may therefore vary, depending on where it used. BIM Alliance Sweden (2018) proposes the ability to create and use digital models of the built environment. It may be bridges, railroads and buildings together with systems that might be included in the structures. Both Building Information Modelling and Building Information Model may be shortened to the same abbreviation BIM. Objects in the digital model are made to represent object in the reality. Autodesk (2018), which is a company that creates BIM systems, describes that BIM can be used in as an intelligent tool in the architecture, engineering and construction sector (AEC), in order to plan, design, construct and manage building in a more effective manner. BIM is a digital software that visualize a building in a three-dimensional format (Sabol, 2013). Along with the digital representation of the physical building, there are information tied to the model and about its components. Building components in BIM exists as objects, for instance a door is created and stored in the model as a door and not as lines giving the shape of a door as it would in a traditional CAD visualization. The object-environment entails attributes to be connected to each object; they may be quantified and also visualized. Object will also detect one other, a door object will relate to a wall object, and it is possible to see the relationships among several components in the model. Eastman et al. (2011) emphasizes that parametric objects are central for the understanding of BIM and that it is different from a traditional 3D object. BIM-objects consists of geometric boundaries and have data and rules connected to them. The rules will also be determined for related objects, as if it will indicate if options are feasible or not. The geometric aspects are shown redundantly, which means that objects cannot collide or overlap one another as it could to in a multiple two-dimensional drawing. Furthermore, objects have the ability to extract, link or receive data to other sources, starring for instance its attributes.

BIM may be described in a number of dimensions to explain application areas of the technology (Guillen et al., 2016). 2D models are traditional vector-based drawings, 3D models involve three-dimensional representation with parametric and object-based components. 4D extends to scheduling and planning, captured information is used for project and construction performance. BIM in 5D is related to cost estimation and control of the project in the construction phase. 6D models connect to sustainability and the impact of the construction and operations and lastly 7D BIM models relates to facilities management. This includes planning for operation and maintenance and performing the rest of the project/building life cycle.

BIM enables a number of features to encompass a more effective process and reduce costs over a project life cycle (Sabol, 2013). The author makes the following examples of how to benefit from using BIM technology:

- Early decision-making; it is possible to display the building performance at an early stage of the project which makes it possible to evaluate changes and their potential impact on time and cost
- Improved accuracy; due to the accuracy of the BIM model, a more effective communication will take place between different parties of the process. The model provides an understanding, which may lower the risk of errors during the construction phase.
- Rapid quantification; the number of components can be measured which facilitates estimates and may enforce an efficient workflow
- Robust analytics; analyses including energy and scheduling can improve decision making
- Improved coordination; BIM technology makes it possible to conduct analyses in order to be proactive rather than reactive. For instance, components that might interfere on each other may be detected before an eventual error occurs which may reduce a costly delay in order to re-build. Contracts and subcontractors will have the ability to work in a common virtual environment, which enhances communication.
- Improved project delivery; by using a BIM model, more reliable and well-structured information may be handed over after completed construction to use in the operation and maintenance phase

BIM enables collaborative information sharing which allows all stakeholders to access the same information at the same time (Bosch et al., 2014). BIM functions as a shared collaborative platform that may help decision-making. This may be achievable from three objectives according to the authors; object-based modelling, shared model collaboration and network-based integration while all these are included in one common environment. Interoperability is an important factor the achieve this, where the same vocabulary has to be in place, information requirements has to be established and all relevant data has to be captured.

2.1.1 Building Information Modelling and Owners

Owners are in many cases the initiator of a project and will thus set the requirements of a facility, select the procurement method and also the service providers of the project (Eastman et al., 2011). It is possible for owners to benefit from BIM during the different phases of a project lifecycle, including design, cost and scheduling, which could lead to a higher return on investment. Owners will have a different role depending on the where the project is in the lifecycle and is an actor that could be present during the whole extended life cycle o the building (Cavka et al., 2017). During the pre-constructional phase, owners will determine requirements of the project, which have been highlights as one of the most important aspects of having a successful implementation of BIM. It might be troublesome to generalize requirements due to a contextual aspect of each project; however, the project delivery supported by BIM has to facilitate the hand over process in order to support the coming operation and maintenance. The role of the owners will shift to a consuming role of information during the design and construction phase followed by the last phase, operation and maintenance, where a role of information generation and management will be presented. Operation and maintenance can be many times more costly than the initial construction cost (Becerik-Gerber et al., 2012) and have been accounted for 60% - 85% of the total life cycle cost of a building (Guillen et al., 2016; Jordani (2010) in Parsanezhad and Dimyadi (2014), which puts emphasis on the importance of this phase in the life cycle. It is argued that this phase has been accountable for an over cost in the sector where a main reason is poor information management. Building Information Modelling could act as a solution for this problem by arranging information into a common database (Cavka et al., 2017). Previous years of replacing paper documents into digital formats, such as PDF's, are now exploring further into more intelligent and interoperable technology (Parsanezhad & Tarandi, 2013).

2.1.2 Requirements

Properly owners may have a large organization including a variety of roles within it, which indicates that different personal need different information (Cavka et al., 2017). Studies have shown that floor plans and design specifications are the most important needs for some whereas other studies have pointed to be able to locate components and room specifics or non-geometric attributes with examples of ID-name, type and service. Digital spread sheets of component attributes have traditionally been seen as the most crucial requirements from owners needs from the model. Required information could be used in order to extend the service life cycle of equipment, optimized maintenance activities, to achieve energy efficiency and minimize labor time and equipment downtime.

Accurate as-built documentation of all building components, including architectural, structural, mechanical, electrical, plumbing and fire protection systems are other requirements. The building information has to be integrated or compatible with current facilities management systems to support the management (Becerik-Gerber et al., 2012).

Commercial property managers need information not only about the facility, but also about the surrounding environment and the market (Wilkinson and Jupp, 2016). The value of BIM for property connects to the assessment of the risk, growth and depreciation of a property with information that can support these factors of a property. A display of the performance during the lifecycle is desirable which include original commissioning, project execution, operations and maintenance and re-commissioning.

BIM requirement areas from Lützkendorf and Lorentz (2011) in Wilkinson and Jupp (2016) show more requirements that are not traditionally connected to the BIM objects. Market and location (national market, micro/macro location and recent sales) data, property data describing plot of land (surrounding context), property data describing economic information (Payments in and out, vacancy, tenant info) are examples of this. Building information (environmental quality, technical quality – 3D objects) and process qualities (planning, construction and management descriptors) are other aspects. Real estate data such as property value attributes is the last example from the authors.

2.1.3 Application areas in Facilities Management

Facilities Management is a part of the maintenance and operational phase. BIM have a number of application areas to owners concerning facilities management developed by Becerik-Gerber et al. (2012). The following application areas have been based from these authors:

Locating building components
On-site personal do traditionally rely on blueprints, their own knowledge or intuition in order to find a locate building components during operative maintenance. Examples are systems connected to electricity and water, which many times are not directly seen since they may be located in the ceiling, behind walls or in the floor. This can be a time-consuming process, for instance with new employees or when tasks are outsourced to external companies. Being able to precisely find these components with a 3D BIM model would save time and having a navigation system incorporated would facilitate the process even more. Integrating FM-systems could also help to detect errors by having information of maintenance history and specifications of the equipment.

Visualization and marketing
The 3D graphic can be used to display the inside of a building without having the actually visiting it. It can be used for marketing purposes in order to show images and animations of spaces and possible refurbishment. It is explained to have significant value in high-density spaces since these areas can be visualized with required construction equipment and how these would fit.

Space management
Space management can have positive aspect both to the physical utilization of spaces within facilities and also for the people that are working in the facilities in order to have more attractive workplaces. Numbering and labelling the spaces in a building can facilitate the operations to keep track of rooms. This is beneficial for maintenance schedules.

Emergency management
Emergencies can happen in any facility and it is important to handle a situation if it occurs. By having a BIM model implemented, it is possible to enhance decision making based on the real-time data. It is possible to detect emergency areas through the 3D graphics and also provide data if an emergency occurs and a team arrives. For instance, during a fire, hazardous material can be detected, closest fire exits, closest hydrants, electric panels and floor plans. It is also possible to train personal in case of an emergency with the model.

Energy management
Most energy-efficient solution can be found using BIM with the behavioral model of the building to see how energy system will work under different scenarios. The energy consumption can be monitored with integration of sensors and BIM based visualization environment. Examples are shown where it is possible to detect energy consumption in unoccupied rooms and also to track the energy consumption in rooms that have a permanent resident and recommend them to lower the consumption in it is high. Displaying historical energy consumption of the building, located to different areas, can also be made to support future consumption and budgeting.

BIM should not replace existing data management systems but act as a central model, pulling information from the other systems according to Lazar and McArthur (2016). Difficulties of having to switch between multiple systems and text-based data from FM-systems and physical drawings or the actual building can be facilitated with BIM. BIM may be an answer to this problem due to its rich information base and its virtual environment with 3D graphical interface. BIM could also be constructed to a more simplified model to support operation and maintenance including possibilities to view historical complaints and external documentation, such as manuals and service reports, can be available by hyperlinks. It may also be used to perform environmental analyses, illustrate heating and cooling loads.

2.1.4 Challenges for implementation and usage

The implementation process is complex for owners and is one of the most important barriers for using BIM (Cavka et al., 2017). One part of the complexity could be that several different departments are included in the FM practice and they have different needs. Another important factor is the way of having a project approach, with a distinctive start and finish, compared to a longer life cycle approach, which is more suitable for owners. The authors found in their study that there is a problem from the owner side in setting the premises for the BIM necessities. It is summarized in three points where the first one is related to an own insecurity about their needs in order to support asset management. This is followed by a lack of experience of knowing how this information may be supported by the usage of BIM and finally; there is a uncertainty of how to access information in a BIM model. Giel and Issa (2016) are supporting the explaining that owners may see great use of BIM and its data, however they are unsure what to require from the model and lacks the experience and resources required to implement the model in the operation and maintenance. There is low number of qualified users in the own staff and the cost of training the personal is an obstacle for implementing BIM. This causes a need for a framework on how to educate the staff about BIM technology and the benefits that it implies for the operations of the facility. Additionally, the information needs of the FM personal must be evaluated before the information requirements of the BIM models are set. The "BIM community" has a language, which can be difficult to understand for those who are not familiar with the technology (Wilkinson and Jupp, 2016). A challenge arises therefor to gain knowledge about the vocabulary for property professionals in order to facilitate of the BIM data. The organization may be hindered to implement BIM due to knowledge silos in the company within different business units (Bosch et al., 2014).

The information in the model is another aspect that could pose problems during implementation and usage. The validity of the information is crucial for the potential usage, connecting to BIM models that are called "as-built", meaning that they are a digital copy of the constructed facility as it is completed and not a digital representation based on the original drawings. Bosch et al. (2014) presents that the input of the information may cause problems with the validity and also that there is a need for updating the model in order to have the right information in the model. The as-built models are not verified to be as-built in real life, which is problematic. Creation of as-built models have been a problem and barrier for implementing BIM due to its initial cost, especially for already existing buildings, and the continual need of updating the model (Lazar and McArthur, 2016). Cavka et al. (2017) argues that owner's staff do not know what type of information they will receive after the handover and do often have to manually input the information into FM systems after the building is under the management. Relevant information might be missing if relevant requirements are not set from the beginning. A diversity of formats and a limited use of open standards are other aspects to this challenge.

Wilkinson and Jupp (2016) support many of the challenges described above from their study, mentioning interoperability and data standards, data quality and fidelity, context, security and privacy, digital skills and knowledge competencies. Respondents in the study were asked to rank challenges and the ones that had the highest score among the surveyed respondents were:

- Ensuring data to be compatible and usable over longer period of time, updated, organized and exploited¨
- Accuracy and reliability of data
- Degree of interpretation and manipulation
- Number of data sources
- Intellectual property and information ownership
- Lack of digital skills

The importance of the challenges differs among different types of professions since they require diverse types of data. It is also depending on the stage of the life cycle where examples of property managers need information during a longer period of time compared to a building surveyor that are in a more limited time frame demanding specific data for instance for conducting a due diligence (Wilkinson and Jupp 2016). To have an accurate hand over process from construction and an integrated life-cycle approach is a necessity in order to achieve an automated facilities management practice (Parsanezhad & Tarandi, 2013). Too much information can also be a difficulty since and overload of information causes a lack of purpose and disorientation (Cavka et al., 2017).

2.2 Valuation theory

There are several different methods that could be used to valuate a real estate property. In the US there are three types of methods which is, sales comparison, income method and cost method while British influenced countries have two more, profits method and residual method. In this chapter the cost method, sales comparison and income methods will be discussed. The last-named method, income method, will have the focus where especially the discounted cash flow method will be reviewed which is one version of an income method (Mooya, 2016).

The cost approach unlike other valuation methods is based on cost estimations of a theoretical breakdown of a property´s all components, elements and land. The value is therefore estimated on how the construction cost would be including labour, material and depreciation on the day of the valuation. Furthermore, the value of land, which the property stands on, is measured ideally by comparable objects, which later will be added to the depreciation (Mooya, 2016).

The cost method is best suited and the most relevant in objects where it is very little reliable market information available. Furthermore, properties such as hospitals, schools and churches are among these objects that are not often traded in the daily market which makes the previously information not as reliable (Mooya, 2016).

The sale comparison method is based on that the appraised property is closely related to similar properties in the same market that have been sold. Since all properties are unique due to location, layout and standards the appraiser should seek to find several different comparable objects that must be adjusted the differences to the appraised property. The adjustments involve, age, size, locations, quality, date of transaction etc. Furthermore, a fundamental ingredient is that there are actual comparable assets available (Pagourtzi et al., 2003).

According to Mooya (2016) displays the sale comparison the most valid market value hence it is based on actual transactions within the market. Furthermore, method is solid on its own but is also a supportive factor in other well-established valuation methods.

2.2.1 Market value

The market value for a real estate could be seen as the transaction price with an arm's length of negotiating for the specific property. However, the market value will change under time and under specific circumstances and is never something constant. A change in the environment and other circumstances has an also an impact on the market value. According to Stephen (2008) are there three specific inefficiencies that are essential and could be decisive for the market value. First, there are limited properties available on the market at a specific period of time, which do not cover the full spectra of characteristics for a property. This will result in giving the property a sort of monopoly in its characteristics over the buyer. Furthermore, due to lack of technical systems and instruments buyers have incomplete information of each property. Full information of the standard in each component in a property is missing which can affect the buyer from making an investment. This factor also gives consequences, if a trade will be negotiating, that the buyer and the seller could accept an offer of a property which has been listed wrong. Furthermore, if a broker is hired for the listening a conflict could occur when a seller wants the highest possible price for the property while the broker wants to sell it as fast as possible. The third aspect is the bargain power, an experience seller could in fact negotiate a higher price from a less experienced buyer and vice versa (Stephen, 2008). However, due to the given circumstances could the price be defined as a stochastic variable due to the uncertainness of the different attributes, persons involved and information available. Furthermore, the price could be illustrated by a normal distribution diagram where the most common transaction sum is defined as the most probably value for the property (Lantmännen & Mäklarsamfundet, 2010).

2.2.2 Discounted Cash Flow

A real estate investment is seen as an income generating investment which means the earnings the property generates is determined as the real estate value. The rule of thumb is, the higher the revenue, the higher property value (Fetibegovic and Nilsson, 2011). The Discounted Cash Flow method (DCF) is based on the principle that the earnings of what the asset, mainly rents, will create a function of the income and the discount rate. The DCF is therefore essentially based on a series of future Net Operating Income (NOI) projections for an asset, which will be discounted to a present value.

According to Damodaran (2002) is the DCF considered by modern researcher to be the most appropriate technique for valuing real estate. Furthermore, it is the most used analysis method by real estate valuation companies. One of the reasons could be that the simplest models is constructed in Excel and requires relatively simple mathematical ability in order to execute a valuation. However, the DCF analysis could differ a lot in accuracy due to many factors which could be experience, data input and knowledge (Damodaran, 2002).

In order to provide a DCF valuation several factors must be taken in consideration, it is not just the cash flows and the discount rate that matters. Vacancies and exit yield is also vital factors, the vacancies describe how the occupancy of the property look like. The exit yield could be the component which is one of the most difficult to forecast hence, the exit yield will mirror the market situation during the year of the of the salvage (Appraisal Institute, 2001). The forecasting of the cash flows also referred as the holding period which is often around 5-20 years. Shorter holding period than 5 years makes the DCF analysis meaningless, the analysis then befits the purpose of a direct capitalization model hence the exit yield will have an enormous impact and become almost the only decisive factor (Andersson et al., 2006). The holding period decides for how many years the cash flows will be evaluated. If the holding period is longer (20 years) the assumptions will be more difficult to get accurate and the DCF method could therefore be argued to be investor-specific and in some cases unrealistic (Mooya, 2016). Furthermore, due to the fact that many of the data going in the valuation is based on assumptions of how the future market will evolve but also the fact that every component in the asset is not visible it is important to argue for the made decisions. These uncertainties make the DFC method problematic in two aspects. How to do estimations rents, expenses and revenues when the market information is insufficient, and the second aspect is the forecasting of the cash flows and how the market will be (Mooya, 2016). The formula for the DCF will be illustrated below and is adopted from Fetibegovic and Nilsson (2011):

$$PV = \sum_{t=1}^{N} \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \ldots + \frac{CF_N}{(1+r)^N}$$

- PV = Present Value
- CF = Future Cash Flows
- r = Discount rate
- N = Holding period
- t = Time variable

Due to that DCF is based on cash flows it gives a great insight on how the liquidity of what the property generates. Level of feedback could easily be managed depending on the owner, form a year basis but could also be monthly or daily. Furthermore, if changes in the market occur the DCF method can easily be adopted to the new surroundings (Persson, 2008).

2.2.3 Energy Performance Certifications

Sustainable developments in the real estate sector have for the past years been growing in terms of environmental building certifications. Especially energy efficiency has become more and more important for the battle against the emerging global carbon emissions. Energy Performance of Buildings Directive (EPBD) has led the initiative in implementing a wide range of energy performance certifications. It includes both commercial and residential properties in Europe (Kok and Jennen, 2012). Since 2008, the EPBD has required that all new constructions should have certifications regarding information about energy consumption and that the level of energy consumptions requires minimum level. However, it has been forwarded to each country's authority to determine what the exact levels should be (Bonde and Song, 2013).

Several investigations regarding how Energy Performance Certifications (EPC) has an impact on the real estate's value has been conducted. Furthermore, the results have been divided; according to Bonde and Song (2013), the electricity usage has no impact on the real estate´s market value. The main variables are still rent, vacancies, and location and the reason are that the price for electricity is too low and the correlation between the usage of energy and the costs of energy is too low. Another explanation could be that the appraisers uses stencil or approximations of the operating costs and are unaware of the EPCs factual impact when valuing a property. In doing the approximations of operating costs the appraisers do not properly evaluate the exact energy performance. Bonde and Song (2013) goes in line with Fuerst et al. (2015) where no evidence supports that EPC have an impact on either the market value or the marker rents. However, Kok and Jennen (2012) have lead an investigation in the Netherland to analyse the financial implications of real estate

energy labels. In their study they found out that “non-green” buildings had an average of 6,5 percentage lower rent income.

The difference in the results could in fact have to do with different markets. Kok and Jennen (2012) portrayed the situation when the investigation was made that it was high vacancies and it was recently after the financial crash of 2008. However, the main objective is that there could be an impact on market rents and an increased value due to EPC.

3 Method

The following chapter will present how the report has been conducted. It will be revealed how the data has been gathered and how the interviews have been composed in order to extract as legitimate information as possible. Furthermore, a discussion of ethical considerations, how the method was selected and the research approach will be evaluated.

3.1 Research strategy

The strategy used to deliver this report is of a qualitative approach. The strategy has been adopted to get an understanding of any underlying motivators for the thesis research purpose. The qualitative research strategy is undertaking a social approach and is constructed in such way that individuals interact by words (Merriam, 2002). The other option could have been a quantitative approach, which is a more statistic and numerical. The quantitative research approach is based on distance between researcher and participants and capture data through standardize instruments while a qualitative research approach emphasizes a collecting data through interactions and words. Therefore, in order to analyse, understand the market and establish a solid view of today's situation the qualitative approach is better suited for collecting opinions, thoughts and ideas (Bryman, 2012). The course of action to gather the qualitative data has been via interviewing different people with different positions from the industry. The interviews were executed in a semi-structured technique with some change in the openness of questions. The purpose was to have a dynamic dialogue with the interviewee in order to extract as much legitimate information as possible and not influence the industry representative. However, the qualitative approach is argued of being more subjective than the quantitative approach due to the interaction and in some cases are there a premade relationship which could affect the outcome (Bryman, 2012). Furthermore, data gathered via a qualitative approach could be seen as "open" and could therefore be generalized and own interpretations could influence the outcome.

To avoid these pitfalls linked to the qualitative approach did the authors, prior each interview, have a dialogue where the importance of the interview strategy where discussed. These discussions resulted in a layout for each interview where the authors believed it would be as objective and non-influential as possible. However, the consequences of the author's actions are discussed later in the report together with thoughts of the research validity.

3.2 Literature review

In order to generate a theoretical foundation to the thesis and to facilitate the authors understanding in the subject a literature review has been conducted. The literature was overall two parted, where Building Information Modelling (BIM) was the first part

and real estate valuation was the second. The review of literature was conducted through both books and articles but due to that the topic is relatively new and untested, information was also conducted through YouTube, blogs, and branch magazines. The reason to conduct information from relatively unorthodox sources was to be get updates and consume knowledge from some of the most recent materials and publications. The main sources were either academic or a more unorthodox sources, the more unorthodox sources was evaluated in the initial phase of the thesis to gather a relatively fast and solid knowledge base to continue the process. Furthermore, to find relevant information Chalmers library was the foundation and the base for most of the academic literature, some key word was used in the search engine to filter and narrow the exploration. These key words were depending on which part of the thesis that was in focus, when BIM was in focus key words like "BIM", "Property management", "Facility management", "Value" and "BIM requirements" was in center. When focusing on real estate valuation these key words was "real estate valuation" and "BIM impact real estate value".

3.3 Empirical data

The thesis' empirical part was conducted through six semi-structured interviews with business actors from the industry. The interviewees were chosen to receive a broad view of the subject since it is fairly un-researched. The semi-structure approach was decided to achieve a genuine, wide and fair picture of the situation of the topic, which the thesis discusses. Before the interview started the interviewers introduced themselves, the topic and the purpose of the master thesis to give the interviewees an insight of the report. Furthermore, the interviews were divided into three main areas, which were *Today's situation, Future potential* and *Valuation*. Moreover, the interviewees where diverse in their profession. There were mainly two types of professions which was either working with appraisals or with property management. The interview questions were organized in two sections because of this; one for the appraisals and one for property management. The interviewees talked freely regarding the topic that was discussed, and the interviewers could intervene and ask questions, which was not premade. The interviews were dynamic and in order to achieve the goal with the interviews the semi-structured layout was believed to be the best alternative. A quantitative approach would not mirror the markets situation or give depth of the understanding of the thesis research aim and it was therefore decided to adopt the qualitative approach. Table 1 below illustrates the interviewees' titles and the date when the interview took place.

Table 1: List of interviews

Interviewee	**Role**	**Date of interview**
Interviewee A	Facility Manager	2018-04-11
Interviewee B	Facility Manager	2018-04-17
Interviewee C	Facility Manager	2018-04-18
Interviewee D	Facility Manager	2018-04-19
Interviewee E	Appraiser	2018-04-19
Interviewee F	Appraiser	2018-04-20
Interviewee G	Appraiser	2018-04-20
Interviewee H	Facility Manager	2018-05-04

The validity of the received information is believed to mirror the situation of BIM and its value. Furthermore, due to the relatively low amount of interview participants it could be difficult to generalize the results to a much broader context outside of Gothenburg. The aim was to have more participants to interview but unfortunately it could not be arranged since several actors declined to be a part of the study.

3.4 Ethical considerations

Throughout this master thesis an ethical aspect has been under consideration. The ethical considerations have had a great amount of attention for the writers especially during the interview phase. Also, during the thesis findings which is based on the interviews. According to Bryman (2012), there are four areas that ethical principles seem to revolve around. These four principles are:

- Harm to participants
- Lack of informed consent
- Invasion of privacy
- Deception

In order to address these four principles, the authors have informed the interviewees about the purpose of the thesis and have had an introduction of the thesis. Furthermore, to guarantee satisfaction from the interviewees and to stress their anonymity, their names have been change and entitled to interviewee A-H. Moreover, interview objects received the interview questions in advance if the they wanted so. Also, the material that was included in the thesis was sent in advance to the interviewees and asked if something needed to be changed.

4 Findings

The following chapter and subsections will display the findings from the six semi-structured interviews. There are five subsections starting with a description of the interviewed companies' operations today. The second subchapter displays BIM requirements and the third subchapter handles application areas for BIM. The fourth subsection includes valuation parameters and information and the last one is about Energy Performance Certification.

4.1 Operations of the companies

How the responsibilities are arranged and the organization regarding the operation and maintenance phase for a building may impact how the company determines their business model and manage their costs and income. The respondents were asked to describe this within the own company and there were many similarities but also differences.

Most of the companies manages their facilities on their own with different people involved at different stages of the project life cycle, according to Interviewee A, B, C and H. The organizations have several divisions of business and constitutes of people with different titles. Property managers have an economic responsibility and aims to create value for the properties. They have a customer-oriented approach, working with client agreements, negotiations and so forth. On the more technical aspects, there are technical property managers, who manage the properties' future in terms of technological development. Another title called operating technician has a responsibility for the day-today operation of the properties. Furthermore, it is said that another part of the organization handles leasing and renting of commercial property. The facility management could be outsourced to an external actor, leaving some operation and services on a contract. This was also typical for special tasks where the own competence is lacking, such as electricity work.

4.1.1 Information handling in the companies

In general, there seems to be an extensive use of digital platforms in which the companies handle the information through. Furthermore, the workplaces are in general quite paperless but have important documents such as agreements and contracts in the original version. However, the process is still analogue in many parts where the documentation is done on paper and must be transferred manually into the different databases.

Interviewee A, D and H describes the situation to be very digitalized but is not necessary a digitalized process when employees are out on the field and take notes. Nor when papers must be scanned to a PDF and transferred in to the database. Interviewee A and H have one database to manage for the whole organization and is

structured in maps and the database is search friendly. Apart from some of the analogue processes the organization is fully digitalized. Interviewee A and Interviewee H has the same structure, all the information is available online, essential information regarding the organization is published via their intern network. Through the intern network do they have a database containing drawings and other important documentation, which is linked and related to any of their properties.

Interviewee H have had a project to develop a phone and pad-based solution where the employees can get access to both the internal network and their information database away from the office. However, Interviewee H, describe that the database is 3D compatible and editable for the specific person looking at it. Furthermore, the original file can't be updated by anyone except a specific department in the organization. If some changes are made in a drawing that person must contact the department who updates it, but a copy of the changes is saved if it's only a hypothetical change in a meeting or so.

Interviewee B says that they have a various number of platforms, which is structured and visualized in a large map tree. The platforms lack a common thread and vital information regarding a certain building could not be found in the same platform or database. As a result, countless of hours are spent to search and find the information especially for new employees. However, after a while when you get more familiar with the different systems it gets easier.

Interviewee C describes the situation as both digital and analogue where they are in a period of transition. They have had a big development project two years ago to digitalize their current database from papers to digital documents and also establish a new information handling platform. The establish of the information handling system supports digital information transfer when doing inventories, inspections and examinations out on the field. However, it has been problematic and have resulted in analogue processes which must be transferred later on to the database.

4.1.2 Time spent tracking information

According to Interviewee A their database has helped to minimize time waste on searching relevant data. Everything is searchable in the database, which is a key function to the now low time-consuming rate. It is categorized in maps where all the necessary documentation is located, everything from drawings, technical documentation to economic estimation and sheets. Furthermore, Interviewee A had led an internal investigation on how much time were spent on searching information regarding properties and other important documents. This investigation supported and helped to establish their own database which now have helped decrease the actual time being spend on searching to almost zero. Interviewee A goes in line with Interviewee D in regard to very little time spent on searching information. However, Interviewee A says the only task that takes time is to do background checks to

previously project while Interviewee D says that if the information is not in the database it could much longer time.

Interviewee B describes their situation as quite crucial and a massive amount of time is used to find relevant information for specific projects. The reason for the substantial time waste is the unstructured databases they use. Interviewee B´s company uses several databases for different properties which handles the different processes and work. As mentioned earlier, the databases lack a common thread, which makes it difficult to understand.

Interviewee C is similar to Interviewee A and D and said that they are in general quite time efficient but different objects is more easily to find information about, especially objects that are close to the tenants. Interviewee C continues, due to their previously digitization project, the company have seen a big improvement compared to a couple of years ago. However, information regarding older properties which has been renovated by the tenants and not by the firm itself takes longer time to find the information about. Furthermore, if some drawings where badly done and something had to be changed on site and has not been transferred to the digital system it could take more time than necessary to track it down.

4.1.3 Handling of error reports

Interviewee A, C, D and H are very flexible on how their handling of error reports is managed, it depends solely on how the tenants want to do it. However, Interviewee A describe that most frequent channels are by phone to the company's support team, second is mail and last is via their website. Interviewee A and H has apart from taking error reports via the named channels also developed an app with a portal to each property where tenants could report problems but also find the necessary information regarding cleaning, waste disposals and more. Interviewee A and H keeps track of objects that are reported and could do statistical analysis of which objects are reported the most. Interviewee A does also have service history, which they analyse in a preventive purpose. The warranties of each component in a project are connected to the database for a more efficient handling. Furthermore, Interviewee A, B and H has a system when an object is reported the tenants gets a notification through mail or in Interviewee A's case through a specialized app. Through the app, the property manager can follow the progress, also communicate with further staff member if its needed. Interviewee A and B describes that if something can´t be handled by their company itself and must hire an entrepreneur there is no other communication than phones and mails.

The contact between Interviewee B and the tenants is digital through an external firm who handles their error reports via a bridged system and their website. The property representative gets an email and can appoint it further.

Interviewee C tells the majority of the error report is delivered through phone and the customer service. Furthermore, Interviewee C´s firm has developed a system for service and error reports, but it is not launched yet.

In Interviewee H's firm, the system who collects the data of error reports arrange statistically analysis of the components that are more often reported which easier the process of making maintenance plans. Interviewee H does have, as mentioned earlier, a web-based error report channel but the proportion using it is still small compared to mail and calls. However, the accountable must log it manually into the system to secure that the reports are made correctly.

4.2 BIM requirements from owners

The respondents were asked to speak about information requirements in property management in order to tie this to a BIM-model. BIM was not expressed in all interviews since the intention was not to focus on, nor to have any preconceptions about what a BIM-model might, or should, contain. The questions did not have immediate answers and the impression was that it was hard to give a answer right away if this was not something that had been reflected over before. Table 2 below summarizes the answers. Furthermore, speaking about required type of information, some examples were already brought before the interview, which were mentioned as good. Examples were manufacturer and the company responsible for the installation, warranty, capacity and previous repairs. The maintenance interval was an additional thing.

Table 2, Information requirements

Drawings/Systems	*Tenant information*
Structures	"Type" of tenant
Ventilation	Length of contract
Electric	Area leased
Emergency & Fire	*Other requirements*
Wet areas	3D visualization
Transportation	Total system capacity in a room Guarantees Detecting errors

The most common answer were structural drawings of the building, mentioned by four interviewees: B, C, D and H. Structural drawings are in many times important for their value in doing business on short notice, it gives the opportunity to send and received tenders in a fast and easy way. Other reasons mentioned were to facilitate the work for operating technicians when on site. Ventilation was mentioned by three interviewees; A, B and C. Ventilation is crucial to give fast answers on air-flow, to ensure that renovations are feasible for a certain number of people and to evaluate potential new construction projects.

Interviewee A expressed that it is hard to set the requirements, however the systems of the facility were later brought up. The transportation systems, wet areas and the parts of the building that receives the most number of fault reports are all interesting objects. It also depends from facility to facility or usage, further supported by Interviewee C. If the BIM model was seen as a maintenance tool, it would have been useful to have maintenance systems connected in a 3D-model. Moreover, Interviewee A said that the relationship among systems is something that is very interesting, in order to discover how things are connected. This is something that is lacking from the construction handover. Examples such as how ventilation devices are connected and to see the total capacity in a room, followed by how the supply is set up inside the room were mentioned. Other aspects were connected to safety issues, with the fire protection and the possibility to see the structuring inside the building, where the protection zones end and also the distance to the closest fire exit. It was also stressed here that the total relationship among the components is very important and not element-by-element itself.

Interviewee B described the requirements in relation to a digital model. It was not believed that this kind of system or model would bring value in a maintenance matter, this was due to the reality that plans for a building and its tenants can change so fast. When it comes to technical solutions in the building, they might not suit the next tenant and there is no way to simply replace a failure in the system. Everything is very complex and a consequence of that is that it would be very costly to keep everything up to date, even though it would have been positive to have such a model. Moreover, it was hard to see that keeping all contracts, drawings and the own employees updated on a regular basis would pay back at the end. A property owner where apartments are the main source of income might be more suitable for a model where changes do not occur as often.

Interviewee C spoke about the intention of usage; it could either be as a maintenance system or a BIM model as a marketing tool. This was exemplified in commercial areas where it would be possible to visualize for a tenant how an area would look, to monitor the place in a computer and ensure that everyone fits. That case would be more suitable in a client-aspect rather than looking at the ventilation systems. The visualization was also expressed to bring value for the own company for example with re-building. That would result in a more “click-able” format but is not prioritized

today. Furthermore, Interviewee C said that it also depends on where the facilities are located. Perhaps if a property stock at in a different city would be up for an eventual purchase and be managed from distance, where the history of the stock is not well known (for them) or the shape and condition are not totally clear, it would have been great. In that type of situation, information about the maintenance requirements are needed, for instance if major restorations have to be done in the next coming years and that would also affect the price in an affair. Without thinking about BIM, it is necessary to have information about the ventilation, the condition of the structure of the building, plumbing and all that is connected to property management basics. It would be a positive aspect to have all information in one database. Furthermore, discussing what type of information that is needed, the impression was that it is best to focus on "big things". Examples such as manufacturer on a faucet are not really important compared to the ventilation system and other objects that might cause a problem for the tenants. Those things might change and is not considered to be of high importance. If a heating problem would occur in the apartments, it would be beneficial to find it in a trouble shooting to find where the problem is located. Other interesting aspects would be elements that would be expensive to replace or restore, for instance the history of the roof, windows, and façade; objects that would impact the budget of the firm long term.

Information concerning the tenants were another requirement expressed by Interviewee H. Examples are the length of contracts, type of tenant and the leased area. The next step would be to be able to detect when components are broken and to show guarantees in order to make decisions for future replacements.

4.3 Application areas

In order to examine the impact of BIM or digital information handling, the respondents were asked to discuss their view on this topic. BIM was not expressed in all cases and it was referred to digital information handling instead. Questions were asked if a digital building is more attractive compared to one that does not have digital information and if they would be willing to pay more for a building with digital information available. The opinions were similar among the interviews.

4.3.1 Digital solutions

According to Interviewee A, C, D and E, digitalization is something that has been evolving in the real estate sector. BIM is a possible platform to work from, but the purpose of the usage has to be analysed. To make more information available has to support a business-oriented process and BIM could be perceived to be complex sometimes. A question to think of is if it necessarily has to be BIM. Comparing a building that has BIM implemented with one that does not, a higher price could be achieved but it depends on the viability of the information that is available.

Interviewee B did not explicitly speak about BIM but about having digital material of the building, compared to having analogue information handling. It was said that it is hard to connect a digital information handling to the property value or higher willingness to pay, which was also supported by Interviewee C, D, E and H. It is more likely that it is possible to expect a certain standard of the building by having well established documentation. Well-structured information is highly valued, expressed by Interviewee B, and it is more likely to claim a reduction of the price due to a cost of time and money to find the information. According to B and C, gathering digital information is a low cost in the total transaction so it would not make an impact on the price in the end. That is followed by that it will not impact the yield, hence not driving the risk premium lower stated by Interviewee D and E. A real estate transaction could be time intensive and it is positive if all information could be available. Income from rents and the cost of operating the facility can be seen at a precision but hidden errors might not come to attention before a new tenant finds it.

A major factor is the reliability of the information, according to Interviewee A and C, not specifically depended on a digital format, also supported by Interviewee D and E. A well-established digital documentation might indicate that the property is well managed, but it would not stand and fall with the transaction. Parameters such as location and the yield are more determined said Interviewee H. However, it might facilitate the valuation process since the biggest cost in the process is to gather all relevant information and a due diligence process for a sell and buying occasion could be handled in a more time effective way, but it would have a minor effect on the risk of transaction, stated by Interviewee D and E.

Interviewee H expressed that a facility with digital information would not impact the valuation but if two properties on the same location with the exact same attributes were to choose from, digital information might be a factor to concern.

4.3.2 Effective operations

Respondents were asked about more effective operations with digital information handling and the possibility to receive higher rents as a cause of this. Answers varied, and the Interviewees spoke freely on their own perception. The most vital answers are stated below.

BIM could have more potential in the future. Interviewee D, E and H were optimistic that BIM could offer a value in operational cost savings and savings for finding information due to the detailed information that it is capable of. Although that cause for many updates and that is a question of cost and responsibility. Interviewee H continues, having to convince other employees of the benefits of a digital software is another challenge that has to be concerned, younger professionals are more up to date with digital solutions and it could be perceived as a generational matter speaking to Interviewee F and G. Investments has to be taken into relationship with the cost and to

be profitable in a longer time perspective according to Interviewee D and E. There is a need for standardization and to open up the interface to other sources in order to work effectively, expressed by Interviewee A. The maturity of BIM in the sector is a factor and the process is slow. Much is focused around low operational costs and high rents and if BIM may lower the operational costs it can be useful, stated by Interviewee H. If it is possible to detect issues and optimize complex solutions for heating, ventilation etcetera and thereby save a few kronor on each square meter of a building, then it would have consequence. Another possible future aspect discussed by Interviewee A was to support tenants with information to endorse their businesses. However, it would be difficult to claim higher rents due to a more efficient management of the operations or technological improvements in the building according to Interviewee B, D and E. An explanation is that the most people are aware of the rent-levels in the city and that is more determined from the location.

A different aspect came up from Interviewee B. Depending on how the leasing contract is arranged regarding the operational costs for the tenant, the savings that could be made may in some cases only benefit the tenant. If the tenant is paying for the operational costs precisely adjusted every month, they will be the ones that have a positive outcome. The other example is when the tenant pays a monthly fixed fee and that gives the property owner incentives to drive costs down and thereby achieve savings. If the arrangement is as in the first example, lower costs could actually result in lower rents in a re-negotiation since they can claim that they have become more energy efficient.

Housing poses other difficulties according to Interviewee C. Due to a regulated renting market in Sweden, there is no possibility to negotiate a higher price between the tenant and the property owner directly. All thought, keeping a high standard regarding the indoor climate with heating, ventilation and so on should result in a high customer satisfaction. That would in theory be a reason to have a higher rent, also including energy optimizations and the possibility to monitor the climate in the apartments before it perhaps would be too cold. It is a problematic business sometimes since property owners that are not taking responsibility for those kinds of things may still achieve the same rent levels. Discussing the possibilities for lowering the energy consumption and other operational or administrative costs, Interviewee C explains that they are already working with these aspects. Knowing their properties close to the details, they can be on step ahead and are also keen on selecting contractors that have the same approach if they are forces to outsource tasks. An example could be to bring all necessary things to a site right from the start without having to inspect the site first and gathering the right equipment after that. It would be different if it is a bought property stock where they would not have the same knowledge about, a digital model would have more value there in order to find detailed information. But having BIM implemented does not automatically result in a higher property value according to Interviewee H.

4.4 Valuation parameters and information

Interviewee F and G says that in a real estate valuation there are several elements that are decisive. Basically, there are three parameters that are the most common, and these are, payments in, payments out and the geographic location. However, in a more detailed perspective, each parameter contains several components especially in the operating expenses and income but also leasing lengths. Furthermore, vacancies and yield are also very important factors and according to Interviewee E it is important to estimate future vacancies and follow the transactions market and its actors, in order to get accurate information from comparable objects. Moreover, these parameters are placed and managed through Excel and if information is exchanged in a digital version such as PDF's or in papers have no directly impact. In order to do an accurate valuation, the information must be solid. Most of the information is already available like the property's location and therefore it can easily be compared to other objects nearby and estimated to what rent could be. If the comparable property or the valuation objects is missing some rental agreements will the valuation be based on market value with a combination of experience from the valuator. Operating expenses is harder to analyse due to different properties, it could however be managed through template assumptions and it could differ due to diverse agreements between the property owner and the tenants which could be if the owner or tenants pays for example electricity, water and waste. These template assumptions exclude media, insurance and other expenses that are specific for the object. However, the best way is to get actual information regarding NOI and other expenses directly from the property owner.

4.4.1 Risk and yield

Due to the more and more digitalizing branch, most of the information is handled via digital solutions. However, in cases where the information is analogue, the cost of the valuation becomes higher due to information must be traced manually. The work progress is still the same, but the time consumption is drastically more. There is zero increase in the risk due to that all the information and facts must still be seen through and evaluated. Interviewee F and G describes that the impact on having an analogue information source is still very little in the whole transaction cost if the property will be sold. Interviewee E says that it is extremely time consuming but there will not have any effect on the risk premium in the yield. However, if the property has extremely low information it could be a negotiation of discount if problems occur. However, Interviewee F and G believes that a well-documented property will facilitate a real estate transaction. Less time will be spent on inspections and other work that is related to secure that a property is legitimate. Furthermore, the buyer could feel safer if all the documentations from lawyers, accountants and technical reports is gathered. On the other hand, if the seller does not have a proper documentation, a small risk premium could be discussed. Interviewee F and G believes that it also could lead to a lower amount of interested buyer due to the uncertainness.

4.4.2 Future potential of BIM

To be an effective property operator could have an impact on the rent levels. Furthermore, a property owner who have an active management and delivers value to its tenants have the possibility to take higher rents but the geographical location decides how high the rent levels could be at highest according to Interviewee F and G. On the other hand, a bad operations company could result in lower rents and higher vacancies due to the facts that a customer expects a certain level of execution and satisfaction and if those is not meet tenants tend to leave. However, these marginal higher levels of rents are very small compared to the how objects physical shape, standard and also the micro location in the city impact the rent. Interviewee F and G stresses the fact that every company tries to minimize their expenses by their specific methods which could be investing in technology that will reduce costs. Furthermore, to say that better documentation will automatically increase the net operating income could not be proven today. If more documentation is gathered regarding BIM in operations in the future or if BIM becomes a standard, it could possibly change the markets assumptions. Perhaps, if future research could prove that using BIM will have a 20% reduction on different expenses it would become more interesting. Today is it hard to point out that BIM will lead to anything due to that all the maintenance and operations still must be done with or without BIM. As mentioned earlier, in order to get BIM accepted by the branch there must be evidence that is supported by years of statistic data that BIM have an impact on NOI. The evidence must be supported not only by the valuation firms but from the whole branch and investors. However, BIM could facilitate or give an added value for investors and customers if the object could be proper visualized without an actual visit. Today is the situation that Interviewee F and G gets a technical report, which describes the properties, deflects and flaws. These technical reports are one component that decides the property value and gives an indication to the property owner on what needs to be maintained the following years. However, these technical reports are sometimes incomplete and needs to be revised by questioning the property owners. Better documentation and using BIM could therefore facilitate the processes if the technical reports are incomplete. Furthermore, thorough valuations considering technical reports is mainly seen if there will be a real estate transaction and the buyer wants to have a complete picture of the property. Other valuations are basically made without the technical details, only with economical and market parameters due to the high costs of making a complete technical report because a third party is often hired to do them.

4.5 Energy Performance Certificates and value

Building certifications have boosted the last 5-15 years due to the general increase in environmental aspects. All new production today is in some way certified, type of certification depends on the company's culture and which they are most fond of. Many companies who own older properties certificate the older stock. Furthermore, Interviewee F and G stresses that certificated property in this period of time with

today's vacancy rate for commercial properties in the inner city is so low which makes it difficult to find empty objects that satisfy all parameters for a customer. The results are therefore, to have a certificated property is not the most vital aspect. However, if a customer stands with two identical objects where one is certified and the other is not will the customer probably choose the certificated real estate. Furthermore, authorities and larger companies could have policies that say that they must be in a certificated building. However, if there is a rise in vacancies, which leads to higher supply, could the question regarding certification be more significant. There is not a sign today that classifications have a direct impact on the real estate value, it is still the rents, location and the discount rate that are decisive.

4.5.1 Energy Performance Certificates and its effect on willingness to pay

Building certifications regarding energy have been on the market for some years in Sweden and questions about how this affects the transaction price and willingness to pay were presented during the interviews. The common approach was that certifications can be beneficial, but it depends on how it is used stated by Interviewee A, B and C. Usage areas could vary and two alternatives were exemplified. One could be that the building has a higher value due to a lower operating cost said Interviewee C and H, and the other is more in a marketing approach expressed Interviewee C. It could give a possibility to mark the company with a better environmental profile, primarily for the commercial areas of the building, and perhaps receiving tenants that are likely to pay a higher rent to sit in that kind of building. It could also be to profile the company against the city in order to receive building permits. According to Interviewee D and E, building certifications do often have correlation to the type of company that owns or is renting the building. Big companies and public authorities do usually want to have a good reputation or have environmental policies that they have to follow. Small companies do in some cases not care. A possibility could be that people are not certain of what a building certification means or what the difference is between a gold or silver classification. Interviewee H continues, tenants are more focused on location, area, price and are not prioritizing a certification on the building.

A certification can reduce some uncertainties in a transaction and ensures a certain level of the building said Interviewee A and C. The eventual addition on the price that a certification can bring has to be put in relation to the cost of performing the certification since owners are aware of how the process is conducted expressed Interviewee A and D. A new-constructed building that is not, or cannot be, certified is simply not attractive according to Interviewee A.

5 Analysis and Discussion

This following section will explore and connect the theoretical framework with the findings from the interviews. It seems to be an agreement that BIM has the potential to optimize aspects in the industry, both in early stages of the project but also in the operation and maintenance phase. Early analyses to support decision-making and also time and cost are displayed argued by Sabol (2013), however this analysis will put focus on the operational stages of the property life cycle.

It was stated early in the report that authors have argued that BIM have predominantly been used with positive results in the construction sector, whereas facility management, have not received the same attention in previous research (Pishdad-Bozorgi et al., 2018). One of the goals of this report were driven from this argument where more incentives for property owners was to be found for implementing BIM. Property owners usually manages their facilities on their own, based on the conducted interviews, with the exception of cleaning and such services as well as task were certain expertise is required for instance with electrical work. This implies that there are different roles within the companies; from commercial property managers focusing on economic factors such as the value growth of the property, to operational technicians that have a more technical approach solving the daily operational issues. Due to the different approaches from the roles and different character of their work, it is quite evident that they need different type of information on a daily basis. This is also argued as a challenge for implementing BIM, described by Cavka et al. (2017) that the FM practice include several departments and this these departments have different needs. The BIM model can act as a central database (Bosch et al., 2014) that several people can interact with at the same time. If the BIM model is updated with information that can support the variety of task that the different roles require, it can propose benefits for the organization. The existing systems in the organization does not have to be replaced, the BIM technology may pull information from these systems organizing them into one common information environment. The interviews displayed the problem where it sometimes is needed to switch in between systems in order to find the right information which is also something that have been brought up by Lazar and McArthur (2016). Examples were from managing service errands from tenants and also in general searching for information about the facilities. Lazar and McArthur (2016) suggests that BIM can be the solution for this problem, for instance by attaching hyperlinks with information about components which could be appropriate in a service matter to check guarantees. Furthermore, using BIM as a central database might reduce the time that is spent by searching for information, which was a problem discussed during the interviews.

Further supported by Wilkinson and Jupp (2016) is that the information need is different relative to the time-point in the FM-phase. It was found in the interviews that valuation consultants need information during an intensive time in order to evaluate

the property. BIM may have a benefit in a technical due diligence if the information provided from the model is reliable, since it could spare time and thus cost for this process. Since the valuation in many cases is built up on other aspects than technical parameters, other type of information would necessary be connected to the model in order to provide this kind of work with an incentive to use the model. As it was mentioned by Lützkendorf and Lorentz (2011) in Wilkinson and Jupp (2016), parameters related to the location, such as recent sales, and economical factors with payments in and out would bring more significance for valuation experts to extract data for the model for an appropriate valuation formula. This would also be relevant for commercial property managers in order to have a lot of information gathered at one place. It was not described during the interviews how these types of information are displayed today, although it shows a potential to explore. This could make facilitate the process of managing costs, hence lowering the net operating income in order to bring more value to the property. Having a common database could also promote the collaboration between different roles when several people have access to the same information and may therefore make decisions on the same base.

Another topic is the reliability of the information in the model, stated by several authors as a barrier for implementing BIM (Bosch et al., 2015; Lazar and McArthur 2016; Cavka et al., 2017; Wilkinson and Jupp, 2016), which was also shown during the interviews. It could be seen from the interviews that valid information is highly important whereas the information source is not as important whether it is digital or analogue. Some interviewees mentioned the initial cost as a barrier, which Lazar and McArthur (2016) also described, especially for already existing buildings. Also, the maintenance requirement of keeping a model up to date was confirmed from the findings. Models that are not viable to be "as-built" are problematic since they cannot support daily operations if they are not an exact representation of the building. Identified application areas such as locating components suggested by (Becerik-Gerber et al., 2012), would not be possible.

The knowledge level of BIM in the companies may be perceived as a reason for why BIM is not used in most of the companies that were represented in the interviews. As mentioned by Wilkinson and Jupp (2016) as knowledge competencies, Giel and Issa (2016) as lack of experience and Cavka et al. (2017) with problems about knowing what to request, how to capture information and a lack of experience of how BIM can support operations. This was supported in the findings since several respondents were insecure about what BIM actually is and what it is capable of. A connection to the question of what type of information that the interviews would request might be possible since the lack of knowledge of the application areas might result in too low expectations. Education of what the BIM model is capable of doing related to the facilities management might be needed to make this visible for the companies that lack this knowledge as of today. The dominant responses to required information were structural drawings and ventilation, drawings were a crucial factor in order to make and receive fast offerings from contractors. From the more knowledgeable

respondent in terms of BIM technology, it would be interesting to display the total effect of the combined components in a room, for instance for ventilation in order to evaluate how many people that could be present in that room at the same time. The geometric objects with information about components that a BIM model is capable of were not mentioned during the interviews except for when interviewees were actively asked about it. It had a positive response, exemplified for a reason that it could be material for decisions regarding purchasing new equipment or repairing them under guarantee. However, another view was that components in the building will change depending on the tenant or the next tenant, which causes an unnecessary of this kind of information since the tenant might move or if there the own company will form new plans for the building. Why this aspect was not expressed before question is not known, either it is considered to not be of high importance or due to a lack of knowledge. It was not clear from the interviews if a person in the companies were responsible for the digital development or having a similar role in order to coordinate possible BIM development, although it can be assumed that the knowledgeable interview had some kind of involvement in this. One other interviewee mentioned that they had one person responsible for their digital systems were other employees could report potential errors to, for example in drawings, which could later be corrected. It could be argued that it is important to have a person or a group of people that are driving the process of implementing BIM and that is aware of how the technology may support the organization. This can be an addition to a proposal from Giel and Issa (2016) of a framework for education the own staff about BIM and its benefits. It is also important to ground the theory of what to include in the model from the own FM-needs, however this implies somewhat a paradox when the people are not aware of the possibilities.

From the theoretical framework, stated by Cavka et al. (2017), it is difficult to generalize requirements that owners seek from BIM because of a contextual aspect of each project. The statement found support from the findings where answers reflected that the most important aspects of information varies from facility to facility from the same owners' perspective and also from owner to owner. The findings in this matter show a first step in what they seek to find within a digital model but could pose more answers if this had been reflected of before. Drawings, mentioned before, were a common answer, which does not require a BIM model per say but they can be attached to one. Components that are often reported with issues is valuable to have information about and also ventilation. Another aspects that was mentioned by one respondent was the ability to visualize the buildings, both for internal intentions and also in order to market facilities to clients. For instance, in refurbishing and to display how additional floors would look on an existing building. It may also be useful if properties are managed from a distance, for example in another city, in order to receive information about the facilities. Additional information requirements are information that can be used to support the operations of the tenants in the building, for instance using real time data.

To establish clear requirements of information needs from the BIM model were expressed by Cavka et al. (2017) for a major reason to benefit from BIM. However, this makes sense in a new construction project where this can be requested from different stakeholder in early processes and is not as applicable for owners that most of the time manages an existing property stock. The question of how owners may implement a BIM model on existing property is still for evaluation and have to be researched further. This problem can be further elaborated to the cost of implementing the model and the complexity of this process. The impression of a costly process was among the findings from the interviews where everything that is implemented has to be evaluated in relation to its initial cost. The cost of establishing a BIM model for an upcoming project is probably considered to be minor in terms of the whole cost of the project, whereas it might be interpreted as a single high expense for an already existing building. The cost of keeping the model up to date is also something considered and there is a need for more evidence of cost savings in order to prove an incentive for owners to implement BIM models on existing buildings.

According to the appraisal firms BIM or a well-documented property have a great effect on the valuing process, which in fact could save both time and money. The interviews gave an insight that many of the appraisal firms are keen on a well-documented property in order to be time effective in many aspects. However, according to the interviewees a BIM property could not directly lead to a higher value but to an added value which as mentioned earlier are supported by the gained time and money for the appraisal process. Furthermore, as Stephen (2008) second inefficiency regarding technical system and the lack of evaluate a precise market value for a property could in fact be eliminated or at least minimized due to BIM. Moreover, in a transaction if both the seller and buyer could get access to the documentation a more detailed analysis of the property could be determine and thereby could the negotiate start from a point where the “actual” value is closer. However, due to the properties uniqueness a “right” market value is subjective and could depend of the investor, but a fairer transaction will be made in terms of information access for both parties.

Looking at the DCF formula, which is inspired by Fetibegovic and Nilsson (2011), is the possibility of BIM to increase the property value in the expenses posts in the Cash flows. A more optimized and time effective operations could in fact as a results of BIM lead to minimize administration and maintenance costs in the DCF model. The interviews delivered a response that matches and confirm the hypothesis that BIM could technically minimize the expenses such as maintenance and administrative costs, which will lead to a higher NOI. As a result, the increased NOI will lead to a higher valuation, which is being described in the theoretical chapter regarding DCF. The interviews did however describe the situation as a very small increase, which could be negligible. Furthermore, the small increase could in fact be significant for smaller companies or with larger companies if BIM is applied throughout their real estate portfolio, which then is added up to larger amounts. However, in the future

when more research regarding BIM has been conducted it could be possible to change the view of BIM's impact in real estate sector. If BIM could be proven to minimize operating expenses, companies could get more interested in implementing BIM. Furthermore, if companies could calculate a short payback time for the BIM investment it could also be a reason for more actors to implement BIM.

The response if a well-documented property could lead to a lower risk the answers was a bit diverse. Most of the interviewees especially the valuation firms were against and did not believe that it would affect the risk premium in the yield. However, some interviews revealed that a small risk would be eliminated which could make a property more interesting in an affair. Furthermore, what speaks against a yield impact is that a buyer can write off specific elements if problems occur after the transactions has been made and when the new occupier has the property in its portfolio.

Looking at the future of BIM there could be an increase in the demand if future research can prove that BIM is in fact more efficient. Efficiency could be in terms of regarding costs, operations and transactions. Furthermore, a BIM certification or a certification that indicates that the building is well documented could be an effect if future research speaks in favor for BIM; an effect that could attract buyers and tenants in investing or occupying the property.

Energy Performance Certifications (EPC) were studied in order to see if property with different EPC's had an impact on the value. According to Bonde and Song (2013) had the certifications no impact on the property value, but Kok and Jennen (2012) showed that it might bring higher rents. The findings from this report shows also divided answers where some interviewees expressed that EPC's are attractive due to the lower energy consumption and that it can be a good for the reputation. Other answers were influenced by the leasing contract of the tenants in the building. When the tenants pay exactly for their energy consumption, although that the property owner was responsible for eventual cost savings, tenants could use this in a re-negotiation of future leasing contracts and thereby argue for a lower rent. As Bonde and Song (2013) discusses is the location and rent levels the most vital factors and value drivers for a real estate. Furthermore, the level of energy consumption a fraction compared to the other value drivers, which makes the EPC's not that prioritized, which is supported by the findings.

6 Conclusion

This thesis has shown that it is problematic to implement BIM among property professionals in Gothenburg today. BIM could have a future potential in the sector, but it seems like it has to become a recognized tool among different types of property professionals and propose actual benefits to support different types of tasks in order to be more attractive to implement. To conclude the study, and reflect on the results, the research questions from the report have been evaluated. These were, as stated before:

- Is it possible to prove a higher real estate value with BIM implemented?
- How digitalized are property professionals today?
- What is the most crucial information that property professionals are looking for within a BIM model?
- How can BIM support property professionals?
- How may economic benefits be drawn from implementing a BIM model in property management?

It was not possible to prove a higher real estate property value with BIM, neither according to the literature nor the interviews. It was more likely to lower the expenses of a building rather than receiving higher rents with BIM implemented. Tenants would not be willing to pay more for renting space in a building where the property owner could offer better solutions according to some interviewees, since the location of the building is more relevant and determine of the rent level. Although, being able to offer information to the tenants that would help to optimize their operations could perhaps pose other opportunities in the future if this would be possible. Digital information handling, which this thesis had one focus area of, had no effect on lowering the risk, which could impact the property value if it had.

Property owners have a high digitalization rate today, based from the answers from the interviews. Documents that previously were in traditional paper form are now replaced to a high extent of digital equivalents. Many actors did not use BIM but other types of digital systems to support property management were exemplified. The most popular information requirement that was expressed in this study were different types of drawings, tenant information and other requirements such as being able to use BIM's visualization possibilities.

BIM could provide benefits that effect parameters that builds up to the value, namely expenses and lower costs of the operation and maintenance of a building. That could lead to a higher net operating income, which could in long-term result in a higher real estate value. There is a need to provide support of how this would be achieved and proof of the economic benefits with BIM, since this thesis could not provide this. Time savings are one aspect that would be possible to achieve, both in operation and maintenance and also in a valuation process. The fact that many owners look at BIM

as a heavy investment is another motive to provide estimates of the actual cost of implementation and also for maintaining a BIM-model in order to calculate the payback time and return on investment.

The most specific problem where BIM could offer a solution from this research was to have the model as a central database, having all information collected at one place or being able to access information from links. Examples of switching and searching for information in different systems could be avoided and thereby save time and money. There are many more application areas suggested from the literature, described in this thesis that might show how BIM could help to become more effective with property management.

A BIM certification could possibly help, giving a proof that the information in the model is reliable but also to ensure that the property is well documented.

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