Western Norway University of Applied Sciences

MASTER'S THESIS

Managing Project Complexity in The Smart Building Environment

"A Proposal of how to overcome the challenges in project management in the Real Estate industry"

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Summary:

This thesis address how landlords and property managers work with smart building technologies by examining the barriers and challenges property managers experience when implementing smart building technologies in commercial real estate (buildings). This study used a qualitative research design and collected data material from 11 interviews. The majority of informants are property managers and similar roles such as operations managers, project managers, and others. In order to better understand the barriers and challenges this research interviewed other parts of the value chain, including a technology vendor (supplier), a system integrator and two international consultants, as well as a proactive researcher in the field of smart building. Information gathered from the interviews provided insight about project management, also a changed and new role of the property manager, and several challenges related to making a building smart. Chapter 1 provides the background of the thesis and an introduction to the next chapter, the theoretical framework in chapter 2. The relevance of the theoretical framework is related to the findings made in this study. Chapter 3 presents the choice of methods and research design. Chapter 4 presents findings made in this study that points to human and technological factors to barriers and challenges of implementing smart building technologies. Chapter 5 discusses key findings with relevant theories and previous studies. Themes such as property managers are given a new role, project management, involvement in projects, and the complexity of projects. Chapter 6 summarizes the thesis and draws a conclusion based on the study's findings and discussion.

Sammendrag (Summery Norwegian):

Denne oppgaven tar for seg hvordan byggeiere og eiendomsledere jobber med smart bygg teknologier ved å undersøke hvilke hindre og utfordringer eiendomsledere erfarer ved implementering av smartbygg teknologier i forretningsbygg. Det har blitt utført med et kvalitativt design og samlet inn datamateriale fra 11 intervjuer. Majoriteten av informantene er eiendomsledere i form av prosjekt ledere, driftsledere og lignende, og for å forstå barrierene og utfordringene bedre har vi intervjuet andre deler av verdikjeden, hvorav en leverandør av teknologi, en system integrator og to internasjonale konsulenter, samt en proaktiv forsker i smartbygg feltet. Informasjonen fra intervjuene har gitt innsikt i prosjektledelses metodikker, en endret og ny rolle hos eiendomsleder, og en rekke utfordringer knyttet til å gjøre et bygg smart. Kapittel 1 gir oppgavens bakgrunn og en introduksjon til neste kapittel, teoridelen. Det teoretiske rammeverkets relevans er knyttet til de funn gjort i denne studien. Kapittel 3 presenterer valg av metoder og forsknings design. Kapittel 4 presenterer funn gjort i denne studien som viser til menneskelige og teknologiske faktorer som barrierer og utfordringer. Kapittel 5 diskuterer sentrale funn opp mot relevante teorier og tidligere studier. Det diskuteres tematikker som: eiendomsledere får en ny rolle, prosjektledelse, involvering i prosjekter og prosjekters kompleksitet. Kapittel 6 trekker sammen oppgaven og drar en konklusjon basert på studiens funn og diskusjon.

Keywords:

Smart buildings, Intelligent buildings, Real Estate, PropTech, Internet of Things, Innovation, Digitalization, Digital transformation, Project management, Traditional project management, Agile project management, User involvement, Multi-project management, Co working office, Open innovation, Ambidexterity, Co-creation, Knowledge management.

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Managing project complexity in the smart building environment

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Abstract

The thesis is an exploratory qualitative study exploring the barriers and challenges property managers experience when working on projects regarding implementation of smart building technologies. The study is completed for the purpose of contribute to the research field of smart building technology, and to give property managers more information before decision-making and investments these projects. This study conducted 11 interviews with the majority of property managers. In order to understand the barriers and challenges presented by the property managers, this study also interviewed two international consultants, one system integrator, a system vendor and a researcher in the field of smart buildings. This thesis present findings of human and technological factors regarding the barriers and challenges of implementing smart building technologies. This study discusses findings with theory relevant to the information presented in findings. The conclusion drawn from findings and the discussion concludes primarily with the property managers new role and the involvement of users in projects.

Preface

This research paper marks the end of a two-year Master in Innovation and Management by Western Norway University of Applied Sciences, Campus Bergen. The research examines what barriers and challenges property managers experience when implementing smart building technologies, and by presenting these we hope to increase knowledge so that property managers can make decisions based on more information. Therefore, we hope that this study will contribute to the research of Real Estate and PropTech industry so we can see more smart buildings and smart cities.

We would like to thank our supervisor, Kjersti Berg Danilova, which has given us great feedback and insight throughout the whole study. We also want to give a very special thanks to SINTEF, which gave a research-scholarship that increased the quality of this study. We also want to thank all the informants that took their time to meet with us. We want to thank you for your openness during the interviews and your contribution to this study.

Norway, Bergen, May 2019.

Christian Bru & Jostein Hella

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1 Introduksjon

Digital innovation has triggered dramatic economic changes (Yoo, 2012), and many sectors are rapidly changing due to digitalization and digital transformation (Hartl & Hess, 2019). Digital technology's rapid progress creates pressure on companies to innovate and transform their businesses. Companies need to consider how to incorporate digital and innovative business principles (Stief et al., 2016). Digitalization is difficult for most companies struggling to understand their business opportunities and implications (Bharadwaj et al., 2013). The role is particularly challenging for small firms due to their general lack of resources (Zach et al., 2014). Cooperation with others is one way to develop innovation and transformation capabilities (Eikebrokk et al., 2018). Businesses are constantly finding multiple partners to make digital solutions and digitalization more successful (Grover & Kohli, 2012). However, developing and maintaining a co-creation strategy is challenging and potentially leading to tensions between companies (Gnyawali & Park, 2011). Project management and the connection between the task and the resources sometimes can become somewhat abstract and difficult to define (Aust et al., 2015). This is also true in projects and development projects across firms (Bosch-Rekveldt et al., 2018). Overall, we see that the digital transformation can create challenges and barriers across several kinds of perspectives (Skjelvan, 2015), and that the management of and leadership of this change or digital transformation can be challenging (Jacobsen, 2012; Stensaker et al., 2002)

Not unlike the finance and banking industry, the construction and real estate industry is also now facing the digital age coming upon them (Armstrong et al., 2019; Byggeindustrien, 2019; Størkson, 2018; Weir et al., 2019). According to (Rakneberg & Bardalen, 2016) buildings in Norway account for 35% of energy consumption, 3% of climate emissions, consume 50% of materials and generate 25% of waste, which pose a huge potential for improvement through innovation and change in business models. Not only is consumption a big part of it, but the increasing urbanization and population growth also emphasize the importance of utilizing our buildings and urban spaces better. With an urban increase of 50% of the population in 2007 to an estimated 70% in 2050 (Ritchie et al., 2018), with the combination of the increase in population, means an overall increase of 2,6 billion people living in the worlds cities (Roser, 2019). That means 1/3 of today’s world population are filling our cities the next 30 years. Therefore, the importance of how we work, travel and utilize our building masses become more

important than ever (Rakneberg & Bardalen, 2016). According to (Rakneberg & Bardalen, 2016) buildings in Norway account for 35% of energy consumption, 3% of climate emissions, consume 50% of materials and generate 25% of waste, which pose a huge potential for improvement through innovation and change in business models. Not only is consumption a big part of it, but the increasing urbanization and population growth also emphasize the importance of utilizing our buildings and urban spaces better. With an urban increase of 50% of the population in 2007 to an estimated 70% in 2050 (Ritchie et al., 2018), with the combination of the increase in population, means an overall increase of 2,6 billion people living in the worlds cities (Roser, 2019). That means 1/3 of today's world population are filling our cities the next 30 years. Therefore, the importance of how we work, travel and utilize our building masses become more important than ever (Rakneberg & Bardalen, 2016)

Long has the construction industry tried to cope with more digital tools to work more effective(Armstrong et al., 2019; Weir et al., 2019). Emerging PropTech and Smart building technology within the real estate industry and building management is still a new concept for many (Green, 2014), and with many challenges remaining to achieve full-scale adoption of digital technology (Weir et al., 2019). This is true on both a global (Weir & Pyle, 2018; Weir et al., 2019) and national scale of Norway where this research is conducted (DigitalNorway, 2019; Walløe, 2017). BNL (2017) (The Federation of Norwegian Construction Industries) has presented that the real estate industry and construction industry in Norway are facing the digital age and that it will radically change the way they work, interact, and communicate.

The digital age brings with it many digital tools and new concepts like smart building, digital platforms and Internet of Things (IoT). The term *smart building* is defined in many different ways and meanings (Buckman et al., 2014; Ghaffarianhoseini et al., 2016; Walløe, 2017; Weerts & Kennedy, 2019). The scale of the smart building industry and the use of IoT technology is increasing, the global industry of IoT and Smart Building has an growth of 15% and is estimated to reach the 1000 billion USD mark within 2022 (IDC, 2019). Not only is it a market in growth, but also a complex market with many challenges ahead (Weir et al., 2019).

This study has been endorsed and financially sponsored by SINTEF (Letter in chapter 10.2), which have enabled us to visit the Smart Building Conference 2020 and conduct high quality interviews and observations throughout the whole study process. The Smart Building Conference enables this study to be recognized on an international level by engaging informants and being active in the Smart Building Community throughout the writing of this thesis.

Without the financial sponsorship by SINTEF, we would not had the ground foundation of information we gathered at the Smart Building Conference and would not be able to engage the international informants that we have in this study, thereby making this study also valuable for international researchers and businesses, and raise the overall quality of the study by thoroughly pre educating the researchers in the smart building concept.

1.1 Research aim and structure

This research aims to explore and uncover the main barriers and challenges that the real estate industry (mainly property managers) are facing when implementing smart building technologies based on a sample of the Norwegian real estate firms, coworking space, Scandinavian system integrator, one international system developer/vendor and three international consulting firms. Moreover, this study will give information on how to work with projects when implementing smart building technology and what kind of complexities they face during this process. The goal of this study is to give valuable information to the real estate industry firms that can make the implementation process less challenging. This is done by gathering experience from individuals that have been involved in projects of implementing smart building technologies. The paper finds challenges and barriers property managers and landlords have experienced when implementing smart building technology. The findings and relevant theoretical literature will then be discussed in the *chapter 5*. A conclusion will then be drawn based on the findings and the discussion. This paper also found information about challenges and contextual situations which can be used for further research.

From this, two research questions have been created as follows:

Research question 1: "*What barriers property managers experience as challenging when implementing smart building technologies?"*

Research question 2: *"How property managers and real estate firms can manage challenges in projects regarding implementation of smart building technologies?"*

The research has an explorative, inductive, and practical design of the methodology to unravel situational issues the informants have experienced. To find real experienced barriers and challenges the researchers has been inspired to use a Design Thinking Mindset, by not making any assumptions that might lead the researchers down a narrow and predetermined path.

Therefore, the researchers of this study have not made any presumptions of what kind of challenges they might face or laid out any predefined questions that could lead them into certain theoretical fields or earlier discovered challenges. By using this mindset can the researchers potentially get a deeper understanding and identifications of the challenges that the informants are facing in the digital transformation in the real estate industry.

The thesis is organized as follows. The next section presents a theoretical framework that is relevant to the findings of this study. Then there will be presented the research method, followed by this study´s findings. Furthermore, the discussion will discuss the overall pattern of the findings. Lastly, the conclusion will be drawn based on the barriers and challenges presented in the findings and the discussion that followed.

2 Theoretical fundament

This chapter will present literature relevant to this study. The paper will first present the main theory of "Smart Buildings and IoT" and "Digital transformation". Thereafter it will present supporting theory on "Project Management" and "Co-creation and Ambidexterity".

2.1 Smart buildings and Internet of Things (IoT)

The term *smart building* has many different meanings and definitions (Walløe, 2017). In studies that has defined the term *smart building* do not agree to one or a few definitions, and reasons for this seems to be that there are many other terms similar to smart buildings that may cause confusion to what a smart building is (Brech et al., 2011; Walløe, 2017). Other terms as: autonomous, cognitive, and intelligent buildings are important interconnected terms are all terms that are used to describe smart and intelligent buildings. Whereas smart building and intelligent buildings have long been used interchangeably. Ghaffarianhoseini et al. (2016) have made models and a complete overview of the term smart building and intelligent building and their related terms to define the relations. Recent studies, however, mean that smart building is more or less the modern term for the same thing (Buckman et al., 2014).

The concept of smart building is to use gathered data to make autonomous and smart decisions without human interaction, where IoT and sensors are an important part of the data gathering source and the core concept of smart buildings (Jia et al., 2019). Buckman et al. (2014) define smart building as:

*"Smart Buildings are buildings which integrate and account for intelligence, enterprise, control, and materials and construction as an entire building system, with adaptability, not reactivity, at its core, in order to meet the drivers for building progression: energy and efficiency, longevity, and comfort and satisfaction. The increased amount of information available from this wider range of sources will allow these systems to become adaptable and enable a Smart Building to prepare itself for context and change over all timescales." (*p. 104*)*

IoT is a concept that refers to the use of new technologies and sensors to incorporate and strictly connect the virtual world of IT with the real world of things (Scuotto et al., 2016). Haughian (2018) define IoT as *"The Internet of Things is the network of physical devices embedded with*

software, sensors, actuators, and network connectivity that enables these objects to collect and exchange data." (p. 5).

Where important components like sensors and IoT is important for data gathering. IMB have illustrated the different layers and important components that comprise in a smart building concept in *Figure 1* that illustrate how a smart building "becomes smart".

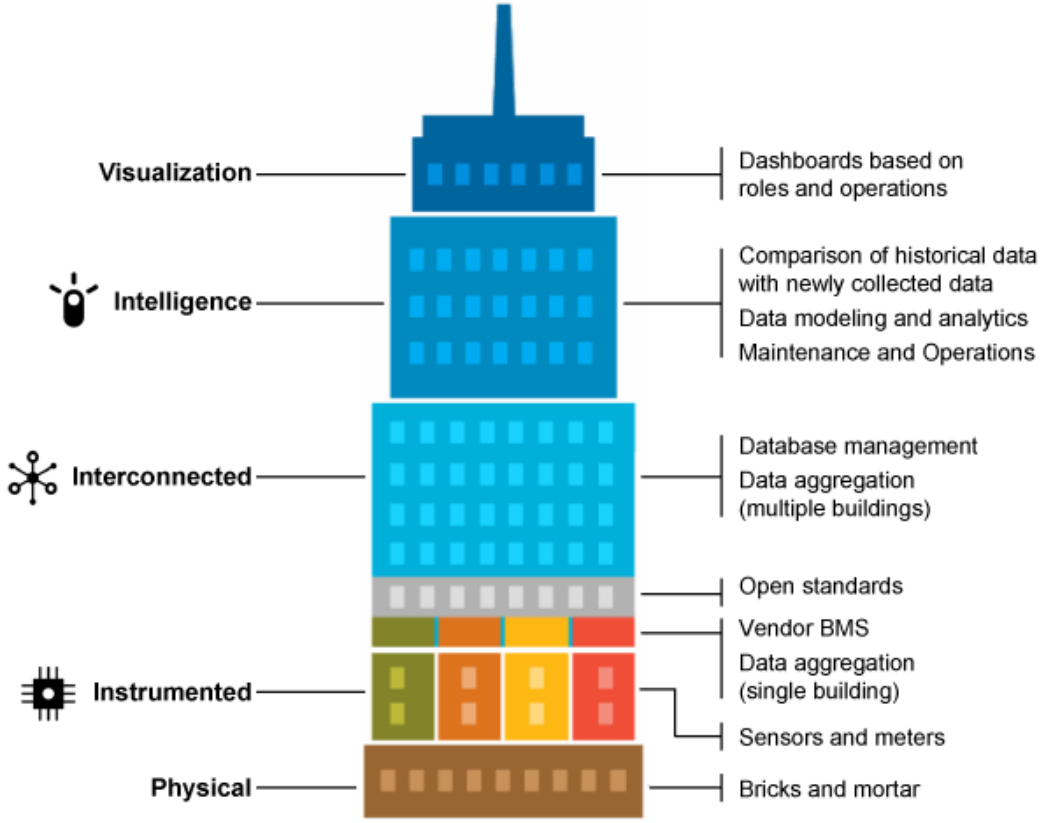


Figure 1: The structure of a smart building, as IBM sees it (Brech et al., 2011; Tsarchopoulos, 2011)

Jia present an overview of how IoT and Smart building systems are connected. He defines the IoT technology for smart buildings within a 3-layer IoT architecture: ***(1) Perception layer, (2) Network layer and (3) Application layer***. Where the (1) *perception layer* deal with data and information collection in the physical world and is usually represented by sensing and actuating technologies; (2) the *network layer* is the technical core of IoT systems, also referred as transportation layer, is responsible for processing and transmitting the raw data obtained from the perception layer; and (3) application layer serves as the front-end interface to provide analysis and decision-making results for users in related business or industry domain. Furthermore Jia et al. (2019) present 5 major opportunities of IoT in smart buildings: Localization, Energy Management, Facility Management, Indoor Comfort and Safety &

Security. An overview of the connection between the layers and the major application areas of IoT in smart buildings are illustrated in *Figure 2*.

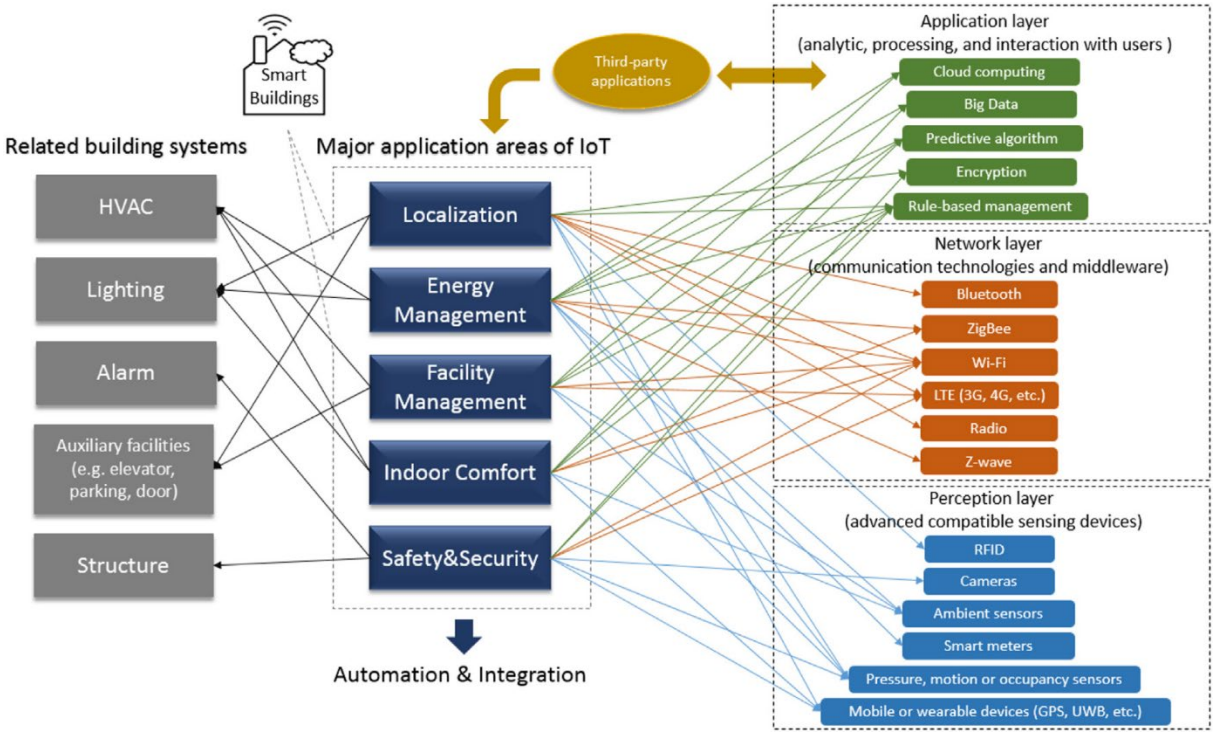


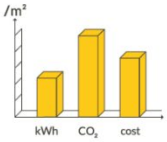
Figure 2: Overview of applications of IoT on smart buildings (goals, technologies, and related building systems) gathered from Jia et al. (2019)

Overall, we see that IoT is an essential part of the smart building concept and that the opportunities and possibilities to utilize the technology is major when it comes to increase management efficiency.

2.1.1 Creating a common understanding of smart building

Walløe (2017) argue that the concept and definition of smart building is not unanimous, explaining that the concept of smart building and digitalization is somewhat overwhelming and new to many in the real estate industry. Some of the large companies have therefore gone together to create guidelines and step-by-step approaches to become "*smarter*" and be able to create a "*good dialogue and discussion about the need for an anticipated effect of smart technology*" (Powerhouse.no, 2019) and be able to realize buildings where the total lifecycle greenhouse gas emissions comply with the requirements set out in the UN climate report (IPCC, 2020). This guide is structured to give the real estate firms (1) definitions within the smart building concept, (2) define the development process, (3) define common ambition levels for smart buildings, and lastly (4) describe the requirement for desired functions without describing specific supplier-dependent solutions.

The first part is to define a common understanding of the smart building concept. Specifically, creating an overview of and a understanding between users, tenants, owners and society on the four dimensions of user satisfaction, environment, efficient floor space and robustness (as illustrated in *Figure 3*.



	User satisfaction	Environment	Efficient floor space	Robustness
User	Well-being, health and satisfaction	Making a positive contribution to the environment	Smart solutions and functional spaces	Simpler everyday life
Tenant	Increased employee productivity	Wise user behaviour and smaller climate footprint in operation. Good reputation.	Reduced rent costs (more for the money)	Flexibility when needs change
Owner	More attractive in the market	Smaller environmental impact, reduced risk and good reputation	Higher rental income per square meter	Future-proof, flexible buildings and increased property value
Society	Better public health	Reduced use of resources and environmental impact	Increased value creation	Equipped for changes in climate and environment

Figure 3: Smart by Powerhouse definitions, gathered from Powerhouse.no (2019)

The second part is simply how and what one should aim for throughout the development process. The third part is defining the levels, or ambitions, for a smart building project. These definitions and levels are borrowed from conceptual ideas from the autonomous vehicle literature (SAE International, 2014), and are relatively consistent with smart building studies defining the levels of smart buildings (Buckman et al., 2014) (illustrated in *Figure 4*).

Figure 4: Ambition levels of smart buildings adopted by (Powerhouse.no, 2019).
The current building standard comprise the basic level (Level 0)

Lastly, it is what kind of requirements in terms of functional requirements, systems, etc. to meet the different ambition levels which can be used as guidelines to configure and reach the desired level of automation in your smart building.

2.2 Innovation and innovation systems

Innovation in its modern meaning is “a new idea, method or device” (Merriam-Webster): Though the Austrian economist Joseph Schumpeter is one of the most central names in the innovation world and formed the modern innovation discipline (Njøs & Sjøtun, 2016), but the roots of the term innovation go all the way back to the 15th century (Godin & Vinck, 2017)

Schumpeter referred to innovation as a social phenomenon (Fagerberg, 2003) and pointed to new ways of combining knowledge and resources as the driver of innovation and development. Schumpeter's original definition of innovation, from the book *"The theory of economic development"* (Schumpeter, 1934) (as reproduced in (Nordbakken, 2019)) deals with five different elements:

1. Introducing a new - or significantly improved - version of an existing product or service.
2. Introduction of a new production method.
3. Establishment or introduction to a new market, whether the market has existed before or not.
4. Provision of a new raw material source or supply source for semi-finished products and product components.
5. Introducing new ways of organizing a business or industry, developing a monopoly position

This study focusses on more recent research and studies within the innovation discipline whereas the Schumpeterian has been further developed from the idea of a social structure, to a more entrepreneurial central driving force of the economy. Which is explained by integrating knowledge and resources in new ways (Spilling & Alsos, 2006), into regional, national and global innovation systems where innovations arise in the interaction between different actors. The focus on individual companies and individuals as innovators is waning, and instead the literature focuses on relationships and interactions between different actors to explain innovation activity (Njøs & Sjøtun, 2016). We will elaborate the importance of innovational systems and collaboration in *chapter 2.5* and *chapter 2.4.3*.

2.3 Digitalization and digital transformasjon

Digitalization has been a driving force for business development the last 50 years (Porter & Heppelmann, 2014) and the digital technology have become more accessible and more rapidly developed in recent years (Yoo, 2012). Digital transformation affects the real estate industry (Waters-Lynch & Potts, 2017) as we see a large growth in smart building technology and its utilization (yoo). The concept of digitalization and digital technologies can be connected to the concept of digital transformation. Osmundsen et al. (2018b) define digital transformation as:

*"When digitalization and digital innovation are used over time to enable significant changes in the way one works and that leads to significant transformation of an organization or an entire industry."- (*p. 9*)*

More broadly, digital transformation can be defined BY how digital technology create a major change in how businesses operate (Bilgeri et al., 2017; Hartl & Hess, 2019; Olsen et al., 2020; Osmundsen et al., 2018a).

Furthermore, Osmundsen (2018) describe the different drivers, objectives, success factors and implications that digital transformation create. These factors are summarized in *Table 1*

Drivers	***Objectives***
• Customer behavior and expectation • Digital shifts in the industry • Changing competitive landscape • Regulative changes	• Ensure digital readiness • Digitally enhance products • Embrace product innovation • Develop new business models • Improve digital channels • Increase customer satisfaction and dialogue
Success factors	***Implications***
• A supportive organizational culture • Well-managed transformation activities • Leverage external and internal knowledge • Engage managers and employees • Grow Information Systems capabilities • Develop dynamic capabilities • Develop a digital business strategy • Align business and information systems	• Reformed Information Systems organization • New business models • Effects on outcome and performance

Table 1:Overview of drivers, objectives, success factors and implications in digital transformation literature, adopted from Osmundsen et al. (2018a)

The factors implicate in which way digital technology drive the transformation of businesses and industries, and what success factors are relevant to successfully utilize digital technologies

through a transformation. Lastly the implications show in what way an industry and an organization are affected by the digital transformation.

Digital transformation deals with the use of digital technology for significant changes to work processes or value creation, and sometimes to create new digital products (Nwankpa & Roumani, 2016). Berghaus and Back (2017) explain how organizational changes affect the organization on several levels, leading to changes in strategy and organizational processes. Piccinini et al. (2015) further emphasize than digital transformation also can transform a whole industry through Radicalization of IT-enabled business transformation, transformation of industry business through digital innovation and emergence of physical-digital paradoxes.

2.3.1 Industrial transformation

As Piccinini et al. (2015) point out an industry can especially through 3 aspects: (1) *Radicalization of IT-enabled business transformation*, meaning that integration of digital technologies into products deliver specific customer experiences or deriving entirely new digital business models to profit from digital options, thus the scope and ecosystem in which the firms operate fundamentally change; (2) *Transformation of industry business through digital innovation*, meaning that digital transformation entails much more than just incrementing the business with digital technologies, it requires a rethinking and restructuring the whole business logics of an organization. i.e. thinking in platforms, ecosystems or agile methodologies (Hylving & Schultze, 2013); (3) *Emergence of Physical-digital paradoxes,* meaning that organizations must explore a new sphere that is dominated by digital rules for doing business, including such aspects as agility, openness, and reliance on ecosystems and platforms. Industries have long been dependent on physical products, as now they need to embrace digital aspects too, to create value for their customer, where becoming more ambidextrous and agile is one of the main means of comping with multiple tensions (Raisch & Birkinshaw, 2008).

The real estate industry has historically been very traditional with incremental change in businesses status quo (Green, 2014; Weir & Pyle, 2018). Studies show that the advancement of digital technology have changed the way people work (Leclercq-Vandelannoitte & Isaac, 2016). Coworking is a result of the changing market and changing customer need for a flexible working space. Although coworking is a niche market for start-ups, small businesses and freelancers, studies have shown that traditional real estate and larger corporations are being

challenged and starting to embrace the flexible working concept by offering flexible offices and memberships (Antoniades et al., 2018). The emerging trend of coworking had a growth rate of 110% from 2015 to 2018 in number of coworking spaces. And, the number of members has grown 203% in the same time period (Foertsch, 2019). Coworking spaces are described as a new phenomenon as they differ from old models of shared office space with coworking spaces offering daily, weekly, or monthly office floor rentals (Merkel (Merkel, 2015), 2015). The term coworking refers to the practice of working side by side in a flexible and shared office landscape. Coworking spaces provide flexible and cost-effective, group-oriented workspaces. This simplifies collaboration, interaction, and networking among members (Fuzi, 2015).

According to HM Government (2013), a fully digital construction and real estate industry can ***Lower costs by 33%, Lower emissions by 50%, facilitate for 50% faster delivery and improve exports by 50%.*** To achieve this fully digital real estate industry BNL (2017) define 4 enablers to achieve a fully digital BAE/BCR (building, construction and real estate) industry:

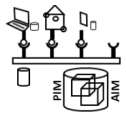
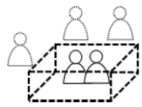
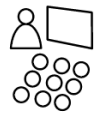
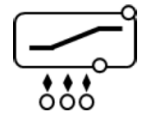
	Enabler 1	Establish a unifying digital platform (digital infrastructure) with common components for construction projects.
	Enabler 2	Establish profit realization arenas where sandboxes and pilot projects for the BAE industry are implemented.
	Enabler 3	Establish plan for competence development in both width and specific.
	Enabler 4	Establish standards for effective information management in project and management, which clarify decision points and how decision information is created, flowed, used, and stored.

Table 2: Enabler to achieve a fully digital real estate industry, adopted from BNL (2017)

Weir et al. (2019) also suggest that a rapid acceleration digital disruption is coming – one that will demand urgent cultural change from real estate companies and that there are much to be done when it comes to system integration, data strategy, and competence and skills gap bridging. This is substantiated by 40% real estate firms see unclear returns on investment, 40% does not prioritize digital strategies, 34% lack a designated person to drive the strategy and 27% lack the appropriate talent at property companies.

2.3.2 Challenges faced during digitalization and digital transformation

Digitalization has created a large landscape of opportunities, but also created numerus challenges that business face when it comes to digital systems and smart building development

projects (Nilsen, 2017). Skjelvan (2015) present a wide set of challenges businesses face while digitalization their operations. These are grouped into four types of challenges:

1. Lack of standardization, further grouped into organizational and technological
2. Lack of competence
3. Cultural barriers
4. Economical barriers

2.3.2.1 Lack of standardization

Skjelvan (2015) explain that lack of standardization is the most important barrier to overcome for successfully digitally transform your organization. This is because the lack of standardization entails challenges related to interaction (interoperability) in technical interconnection of systems, definitions that enable information exchange (semantics) and functional interaction (processes).

In the former challenge of interaction, involves both tasks within the organizations and in relation to the ability to collaborate between actors in a value chain, towards the public sector and their own systems. Another challenge is how standardization makes it more difficult to integrate communication between systems. Which means more work and increased costs of digitization. The last-mentioned challenge is about companies that experience the digitalization process itself as a major obstacle, which also increases the challenges with more complexity in systems and processes. Skjelvan (2015) further explains, the bigger the business, the higher the probability of meeting digitalization challenges.

2.3.2.2 Lack of competence

Lack of expertise is since current employees do not have expertise in use, appropriate solutions and / or procurement, implementation, and operation. Digitization requires new roles that the company may not have today and that one must recruit. This is important because it affects the entire digitization process, work, and implementation of digitization. This shortage results in companies not discovering, seeing or being able to introduce digital solutions that the organization needs. The company thus risks missing out on gains such as increased customer satisfaction, networking, and other gains that digital solutions bring. Lack of expertise is seen as a bigger problem in large companies than in small businesses (Skjelvan, 2015).

2.3.2.3 Cultural barriers

Resistance to or lack of prioritization of digitization work is because digital restructuring is not well enough rooted in management. If management does not prioritize digital restructuring or show this to their employees, this will be reflected to employees who can detect that digitalization is not being prioritized (Skjelvan, 2015). Therefore, management plays an important role in both leadership and organizational structure to be clear on the priorities and follow-up to its employees. Global surveys conducted by KPMG (Weir & Pyle, 2018; Weir et al., 2019) also show that cultural barriers is a challenge, however, that real estate companies are on a positive path to acceptance of the digital trends.

2.3.2.4 Economic barriers

Few companies in Skjelvan's article considered capital for digitization processes a relevant challenge. Nevertheless, there is uncertainty associated with the benefit or gain a possible digitization will bring (Skjelvan, 2015; Weir & Pyle, 2018; Weir et al., 2019).

2.3.3 Digital transformation on different levels of analysis

Both Skjelvan (2015); Weir et al. (2019) find that the digital transformation and that real estate industry face challenges on different levels of analysis. Levels and related challenges are summarized in *Figure 5*. Lanzolla et al. (2018) further study the challenges that are on the 3 different levels: Macro, meso and micro.

At the macro level, the general uncertainty presented about the development of a dominant design presents the question of which technological paradigm and intellectual property rights will contribute to the future development of digital transformation and the role of standardization in the ecosystem. (Blind et al., 2017).

At the meso level, George and Lin (2016) point out that digital technologies *"rais[e] fundamental questions on the underlying processes, routines, capabilities and structures by which organizations adapt and innovate*" (p. 17). Here, the article discusses how a digital transformation at the meso level opens opportunities for gig work and the creation of new organizational forms that facilitate working away from work.

Fisher and Connelly (2017) refers to the micro level and the challenge of successfully changing from analogue to digital skills and competencies that can largely only be accessed remotely. This is a problem that we are seeing more and more of in the real estate industry, especially in commercial real estate which requires larger and more complex systems which in turn require higher competence. Nevertheless, external labor is still used to a greater extent to perform these tasks when they are clearly changing where it may be advantageous to have this competence internally. BNL (2017) presents, among other things, that "*Establishing a plan for competence development in both breadth and apex" is one of the most important enablers in the real estate industry and that "Digital knowledge and skills have been identified in the mapping work as perhaps the biggest challenge for achieving a digitalization of construction and property industry"* (2017, p. 8). Underlining the importance digital and technical skill also in the construction and real estate industry.

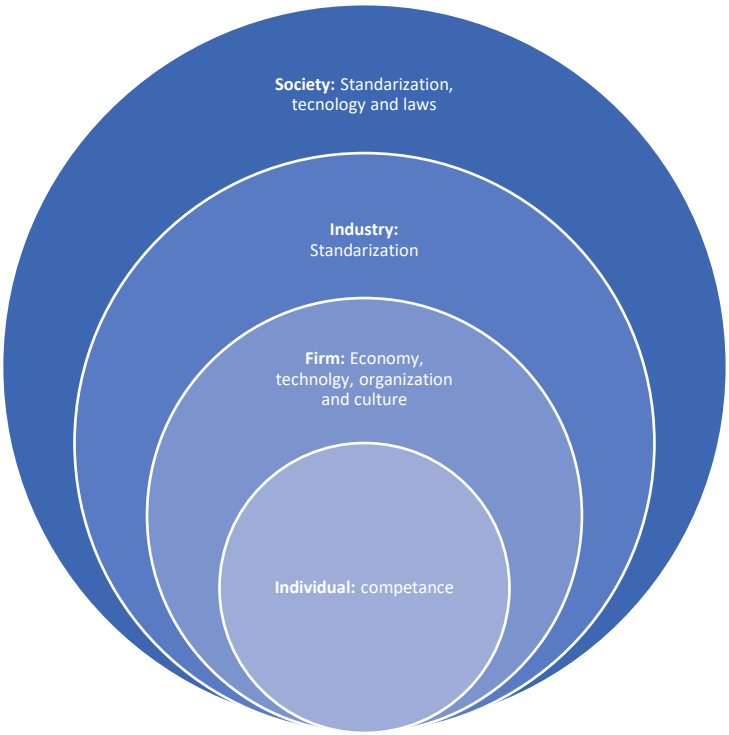


Figure 5: overview of challenges on different levels of analysis. Adopted from (Lanzolla et al., 2018); Skjelvan (2015)

2.4 Project management

The tasks and process of implementing smart building technology is considered as a project, and because the study examine mainly property managers and landlords, the relevance of project management is of importance.

Projects arises out of needs that are not met. These needs have to be met with a solution to a problem. Wysocki (2019) have numerous publications and citations within the project management field of research. Wysocki (2019) define a project as "*a sequence of unique,*

*complex, and connected activities that have one goal or purpose and that must be completed by a specific time, within budget, and according to specification." - (*p. 4*)*

Projects can be complex if one has not done similar projects under similar situations before (Hertogh & Westerveld, 2010). The more complexed the project are, the more uncertainty are in the project. A project has activities that must be finished in a *sequence* and are based on technical requirements. This can be explained as the output of one activity is the input in another, and if this is so, the activities are *connected*. The *uniqueness* of activities in a project are challenging for the project manager, because the activities are always different even though it is a similar project. The activities are also *complex*, not simple repetitive tasks.

Unless the project is complex or large, the project must have a single *goal*. Projects also have a starting point and an end or *completion date*. This date can be given externally or be imposed on oneself. There are also limitations to what available resources that can be given to the project in terms of: machines, money and people. A project managers can find themselves in a resource conflict if they need competence from one key-employee that has a full schedule (Lindland et al., 2018) and therefore managers have to balance between the paradoxes of learning, belonging, performing and organization (Aust et al., 2015).

According to Aust et al. (2015), the balancing of these four concepts is a strategic matter. In short this means that in HR management perspective one face the paradoxes of (1) flexibility/commitment, (2) self-management/human-resource management and (3) sustainability/efficiency paradoxes.

Furthermore, Wysocki (2019) highlight that traditional project management has a clear goal and solution. Yet, data has shown that of all projects around the world, traditional project management approaches are about 20 percent, which is the Traditional Projects quadrant in *Figure 6* (Q1). (Wysocki, 2019) developed this conceptual model which can be used to describe the landscape of a project and provide a solid ground for decision making for project managers.

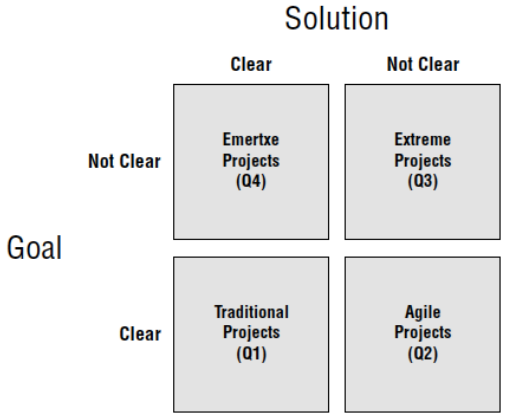


Figure 6: The four quandrants of the project landscape, gathered from Wysocki (2019)

2.4.1 Project management methodologies: Traditional and agile

Unlike traditional project management, agile project management approaches are under the assumption that there will be a change in what the client wants after the client better understand what they need (Wysocki, 2019). Traditional project management (TPM) have a more straightforward approach, in a way that offers a solution to the problem and deliver what was promised. Moreover, what the client wants doesn´t necessarily end up with what they need and are still a major problem in traditional project management (Wysocki, 2019, p. 29).

Agile project management methods allow more effective and more flexible project management. Agile methods are adaptable (Cockburn, 2006), and being agile is described as the ability to deliver fast, change fast and often (Highsmith et al., 2000), Agile methods in itself is not just a new way of working with projects, but a new mindset and way of thinking in project management (Svendsen, 2011). It´s not the practice that´s new, but it´s recognition of people as the most important drivers for a project's success, and the combination of focusing on efficiency and maneuverability (Highsmith & Cockburn, 2001).

The purpose of agile methods in project management is to be more flexible and user-oriented in managing the project. "The Agile Manifesto" describes general principles for effective use of agile methodologies (Fowler (Fowler & Highsmith, 2001)M., et al., 2001). According to Wysocki (2011)these principles apply to all agile methods in software-, product- and service development and are implemented in projects that have a defined goal and an unknown solution to goal attainment (ref *Figure 6*). Projects that carry "agility" are characterized by the following special features (Wysocki, 2019):

- Medium and large projects
- Medium to high uncertainty
- Medium to high risk
- High degree of complexity
- Business opportunity that was not used before
- Meaningful customer engagement
- A small and co-located team
- Two-way communication
- Change-oriented

To adapt to the decreasing fit of TPM and increasing complexity and uncertainty in projects, Wysocki (2019) had developed an Adaptive Project Management Life Cycle (Adaptive PMLC) model that specifically are created to handle complex projects with ever changing and complex

environments. The Adaptive PMLC are cycle based (as illustrated in *Figure 7*) and are characterized by:

- Iterative structure
- Just-in-time planning
- Critical mission projects
- Thrives on change through learning and discovery
- Continuously reviewed and adapted to changing conditions

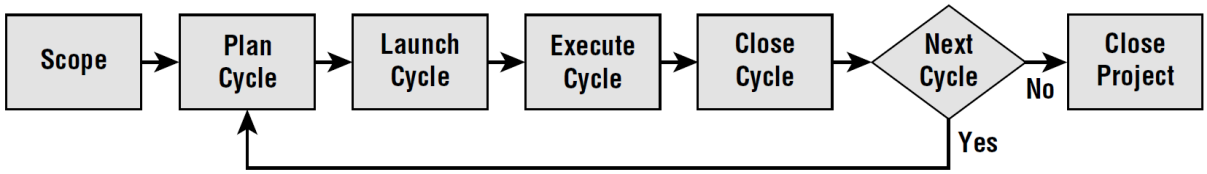


Figure 7: Adaptive PMLC Model, gathered from (Wysocki, 2019)

2.4.2 The end-user

When developing in agile, the end-user has an important role and the whole process are oriented to the end-users wants and needs. When involving the end-user, their competence might come to importance regarding the following attributes (Schuh, 2004):

- Have knowledge of the business
- Understand the objectives of the project
- Have enough time to work on the project
- Is respected by the business, users, and stakeholders
- Willing to make decisions
- Willing to compromise
- Is not a perfectionist

The degree of end-user involvement may also vary from method to method and a variety of factors like users´ experience, task uncertainty, organizational culture etc. (Bano & Zowghi, 2015); across methods, however, the focus on use-case and end-user involvement throughout the whole lifecycle of the project have proven to be an important factor for system development projects (Abelein & Paech, 2015; Bano & Zowghi, 2015; Einhorn et al., 2019). That means the end-user must always be available to perform certain tasks (Schuh, 2004):

- Represent the interests of users, stakeholders, and the business

- Assist in situations where disagreements arise
- Help drive an iterative development process

According to Wysocki (2019), In agile methods, the end-user can be an individual or a group. If the end-user is represented with only one person, then that person will have little decision-making authority but must be more efficient in getting different actors to cooperate and make the most important decisions. When it is a group of individuals, then the group has more authority. Whether it´s one person or more, the end-users must always be able to provide comprehensive and actionable answers. Continuous and substantive participation of end-users improves awareness of the needs of the end-user, leading to a reduction in development time. User-driven planning ensures that the correct technology is selected which is most appropriate for the system being built. Based on the right decisions made by involving end-users, time savings increase the value delivered to them.

Communication between the end-user and development-team becomes an important role in the progress of the project, and since crucial information needs to be shared, the face-to-face communication mode is preferred to other communication methods (Boehm & Turner, 2003). Effective end-user-development-team will have a significant effect on the performance of an agile project and system success (Abelein & Paech, 2015; Bano & Zowghi, 2015), however, studies also suggest that user involvement alone has modest effect on performance that other factors play a part too (He & Wong, 2004). Thus, suggesting that:

"*If productivity benefits are the focus, user participation should be designed as a special practice to provide developers the needed domain knowledge; thus, selecting knowledgeable users and helping them communicate more effectively with developers should be of great concern to project managers."* - (p. 325)

Participation of the end-users in agile software development programs enables immediate feedback to be provided and can therefore be adjusted to the end-user's current preferences and needs. Through giving feedback, the end-users enable the development-team to make the necessary adjustments more quickly. It´s therefore of great importance to involve end-users and to make the development process go quicker, more effective and much cheaper (Boehm & Turner, 2003).

2.4.3 Project complexity coping strategies

One of the main problems when it comes to smart building and -city projects is the complexity of a single project and multi-project setting. (Hertogh & Westerveld, 2010) defined a set of complexities that define a single projects, ranging in the dimensions of social-, financial-, organizational-, legal-, technical and time complexities. Li et al. (2015) have furthermore compiled a list of multi-project complexities from (Hertogh & Westerveld, 2010) and (Maylor et al., 2006) listed in *Table 1* alongside with different coping strategies developed by (Aritua et al., 2009).

The complexity of multi-project and multi-project management in the Changchun urbanization.

Multi-project complexity			Multi-project complexity management	
Dimensions	Elements	Main factors	Coping strategies	Coping approaches
Attributes	Detail (including technical)	Large numbers, various types, wide distribution; technical complexity for certain projects	Internal & content focused approach	Project database; project repository; technical demonstration and approval
	Dynamic	Emergent projects or priority adjustments		
Objectives	Social	Top attentions from project stakeholders	Systems management, interactive management	Media communication; change management; multi-layer schedule management; contract management; cost management; process management; health, safety and environment management; integration system and platform support
	Financial	Difficulties in cost and investment management caused by uncertainties from management and multiple levels of organizations		
	Time	Pressures raised by extremely tight schedule and short notice, asynchronous construction periods including new, rebuild, expanded, and renovated projects at the same time		
Organization	Social	Multi-stakeholders; significant impacts on city operations and local citizens' life; possible corruptions in the construction bidding and tendering	Systems management, dynamic management	Multi-dimensional organization innovation; optimization of governance mechanisms; system design; standard contract design; optimization of contractual changes; supplier evaluation and shortlist; improvement of professional's skills; relying on professional team; integrated system supporting
	Financial	Multiple investors, and multiple sources of investment		
	Organizational	Complex relationships between external supervisions; large scale organizations; complex contractual relationships; frequent changes in contractors and suppliers; shortage of skilled professionals; inappropriateness between organizational positions and personnel skills		
Environment	Social	Highly open management systems, intensive interactions and interferences with social and urban operating systems	Dynamic management	Media communication; construction schedule optimization; management system design; risk assessment of new laws and regulations; innovative project financing models, such as Public Private Partnerships
	Legal	legislative inadequacies on Agent Construction Model (ACM); influence of new rules and regulations		
	Financial	Various sources of investment; impact of micro-economic development; impact of private capital involvement		

Table 3: The complexity of multi-project and multi-project management

The vast amount of complexity that a multi-project require also need comping strategies. Aritua et al. (2009) present four strategies to manage the project complexity illustrated in *Table 1*.

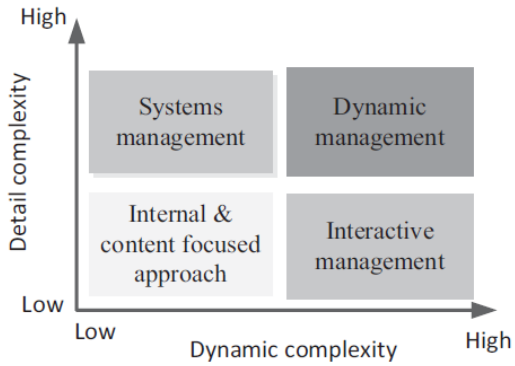


Figure 8: Four strategies to manage the project complexity (adapted form Aritua et al. (2009); Li et al. (2015))

According to Li et al. (2015) the internal and content based approach relies on a sole emphasis on seeking a technological solution to the perceived issue without much attention to strategy and interaction (Hertogh & Westerveld, 2010). Systems management approaches focus on efficiency, including organizational decomposition, time, expense, quality and risk. Project managers working with multiple projects with varying scopes, requirements and deadlines face challenges in a multi-project (Maylor et al., 2006). Interactive management approaches focus on engagement, including integration, redefinition and change in scope, using short-term predictability and variance. In multi-projects, managers struggle with interdependencies and interactions between projects, but have few resources and strategies available to help them track the overall image of all interdependencies and interactions (Patanakul & Milosevic, 2008). Dynamic management approaches combine power and interaction, including integrating the organizational structure, control methods and interactions (Hertogh & Westerveld, 2010).

2.4.4 Success across multiple continuous projects

Increased user involvement and agility in project management also require a change in culture and organizational structures (Almeida, 2017). Almeida (2017) emphasize that the challenges faced when changing from a more traditional waterfall to agile environments are within four dimensions: People, organization and management, process, and lastly tools. The importance of project management and project success within smart building projects can be emphasized by Standish (2014). on success rate of business projects with information technology. They present that 60% of such projects are either challenged or fail outright, resulting in the wasteful expenditure of billions of dollars annually.

Studies have long been trying to discover which factors lead to project success (Baker et al., 1997; Cooke-Davies, 2002; Pinto & Slevin, 1999). For single projects success, factors like risk management, effective project management, user acceptance, top management commitment, project team commitment and project personnel skills and knowledge (Peslak, 2012) are

important. However, when managing simultaneous and multiple projects problems arise. Studies suggest that to be able to strategically benefit from an information system long term, and continuously have successful projects the project managing practices, merriment metrics and learning strategies have to align with the overall organizational strategy (Cooke-Davies, 2002). For single projects success, factors like risk management, effective project management, user acceptance, top management commitment, project team commitment and project personnel skills and knowledge (Peslak, 2012) are important. However, when managing simultaneous and multiple projects problems arise. Studies suggest that to be able to strategically benefit from an information system long term, and continuously have successful projects the project managing practices, merriment metrics and learning strategies have to align with the overall organizational strategy (Cooke-Davies, 2002)

One strategic structural organization and strategy that are supposed to react to dynamic environments and challenges arising in dynamic and more agile environments is the ambidextrous solution developed by O'Reilly and Tushman (1996, 2004, 2013, 2016) through over 20 years research. The ambidextrous strategy is a well-known organizational paradigm promoting innovative change while utilizing the current market (Stensaker, 2018). This solution is about structuring different tasks by establishing a new organizational unit accountable for radical renewal (O'Reilly & Tushman, 2004). The attributes of the unit are listed in *Table 4*. This is not a traditional R&D department, but more closely resembles business development (diversification) where a new business unit is set up to run something quite different from the core business. The difference is that the ambidextrous solution explicitly facilitates the development of new to compete with existing products and services if necessary. Tushman (O'Reilly & Tushman, 2004) explain that established organization should structurally share radical innovation from continuous improvement of the existing. According to these researchers, separation is crucial, while belonging to the established business constitutes an important competitive advantage vis-à-vis entrepreneurs. The new unit can draw on resources and expertise from the established business, while contractors often must fight hard to secure adequate resources and necessary expertise.

	Alignment of:	Exploitative Business	Exploratory Business
1	Strategic intent	Cost, profit	Innovation, growth
2	Critical tasks	Operations, efficiency, incremental innovation	Adaptability, new products, breakthrough innovation
3	Competencies	Operational	Entrepreneurial
4	Structure	Formal, mechanistic	Adaptive, loose
5	Control- og incentive systems	Margins, productivity	Milestones, growth
6	Culture	Efficiency, low risk, quality, customers	Risk taking, speed, flexibility, experimentation
7	Leadership role	Authoritative, top down	Visionary, involved

Table 4: Differences between established units and new, innovative units (O'Reilly & Tushman, 2004; Stensaker, 2018)

Ambidexterity has long been linked to the short- and long-term performance of firms (Gibson & Birkinshaw, 2004; Koryak et al., 2018; Lubatkin et al., 2006). The challenge in cultivating a potential for organizational ambidexterity is due to different learning capacities for exploration and exploitation (Baum et al., 2000; Floyd & Lane, 2000).

"*Exploitation refers to experience acquired through local search, experiential refining, and collection and reuse of existing routines. Exploration refers to learning acquired by concerted variety, intended exploration and play*." (Baum et al., 2000, p. 768)

Traditionally, academics have advocated either exploration or exploitation (Barney, 1991; Porter, 1985) to prevent the risk of becoming mediocre at both (March, 1991); but afterwards, the notion of combining these two types of activities to ensure superior performance has gained greater acceptance (Gibson & Birkinshaw, 2004; O'Reilly & Tushman, 2013; Raisch & Birkinshaw, 2008). As companies continue to develop and enhance their core capabilities and become increasingly productive, there is the reluctance and resistance to major change (Leonard-Barton, 1992).

Koryak et al. (2018)highlight that organizational ambidexterity is dependent on many factors, like top management team, Vision, R&D Inventive, firm size, firm age, environmental factors like dynamics, manufacturing, and knowledge intensive services. Studies furthermore emphasize the importance environmental factors have on the organizations and industries ambidextrous capabilities. The literature of management has recognized for many years the value of interdependence between businesses, contributing to social ties and networks (Gibson & Birkinshaw, 2004; Koryak et al., 2018; Lubatkin et al., 2006).

One study especially highlights the increased importance of alliance when it comes to IoT and smart technology to increase the organizational ambidexterity (Bresciani et al., 2018) because of its complexity, emphasising that shared knowledge management (KM) and co-created information and communication technology (ICT) enhance alliance ambidexterity in IoT projects. . One study especially highlights the increased importance of alliance when it comes to IoT and smart technology to increase the organizational ambidexterity (Bresciani et al., 2018) because of its complexity, emphasising that shared knowledge management (KM) and co-created information and communication technology (ICT) enhance alliance ambidexterity in IoT projects. These networks can improve competitive power through co-creation, forming common sources of value creation (Prahalad & Ramaswamy, 2004), where these collaborations are particularly valuable when the market is dynamic, and companies have limited resources for innovation (Kohlbacher, 2007). When it comes to digitalization, digital innovation or digital transformation of organisations and industries, industry clusters and co-creation can be an important avenue (Olsen et al., 2020). This is particularly true when it comes to companies that have limited human and financial resources. The characteristics of the variety of regional industry clusters have proven to affect the productivity and innovation capabilities in industries too (Aarstad et al., 2016).

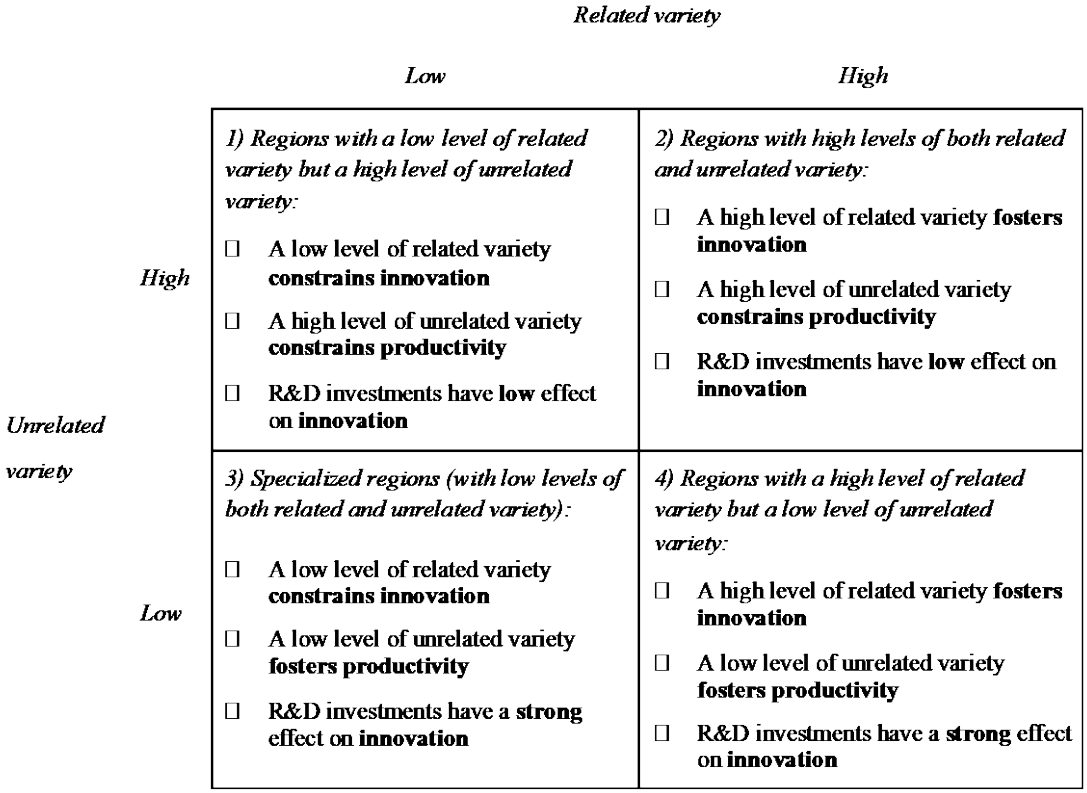


Figure 9: Related and unrelated variety - Productivity and innovation effects in economic-geographical regions. (Aarstad et al., 2016)

Suggesting that regions that have a high level of related industry variety, but a low level of unrelated industry variety fosters innovation, productivity and have a strong effect on innovation (as shown in quadrant 4 in *Figure 9*).

2.5 Framework for multi-project city-level management information system

While we see many researcher focus on the impact that environment have on each and every firms and the industry's ability to be ambidextrous, other focus on the importance of collaboration and open innovation (Scuotto et al., 2016). IBM themselves and many other smart city and IoT projects have reveal that to be able to fully exploit these opportunities one sees in the IoT and smart city and -building environment, an open innovation (IO) approach is needed (Chesbrough, 2012; Paskaleva, 2011; Schaffers et al., 2011; Scuotto et al., 2016) Where open innovation is "*the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation"* . The concept is that even the most capable R&D organizations must identify, connect to, and leverage external knowledge. This will both benefit the external industry's capability to innovate, as the

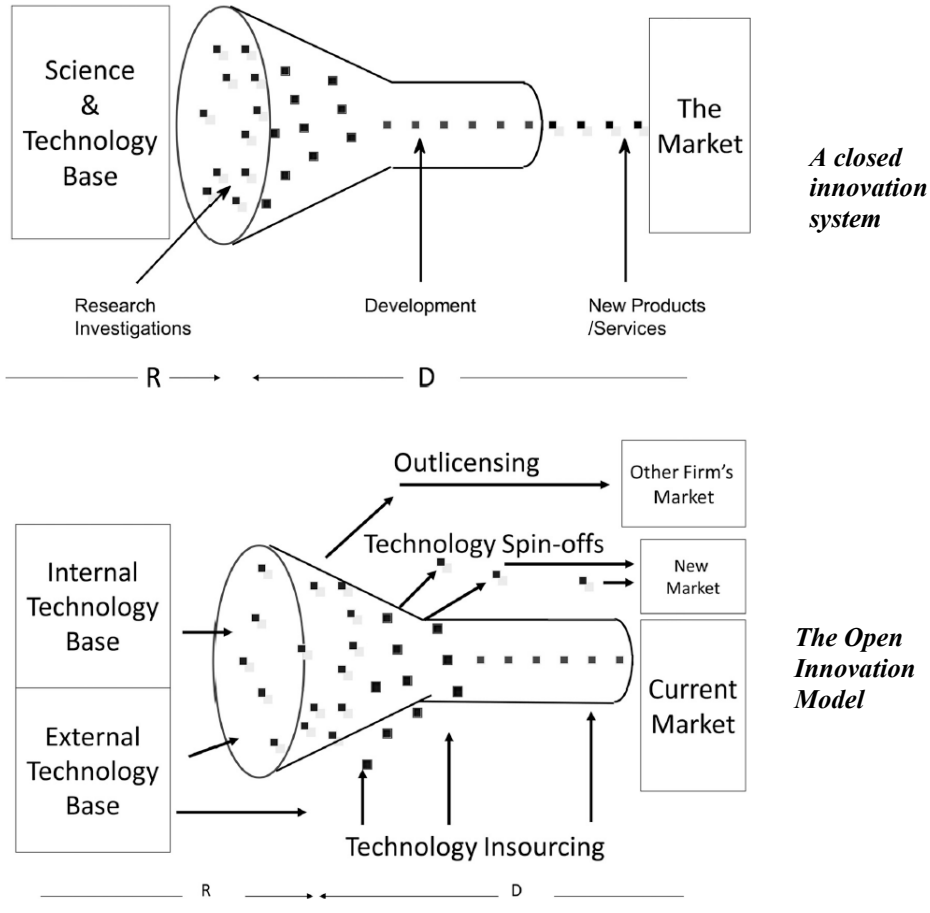


Figure 10: Differences between closed and open innovation (gathered from Chesbrough (2012)).

organization itself obtain knowledge and skills that they otherwise had to obtain internally. Benefiting all organizations involved and should be embraced by both small and large companies (Chesbrough, 2012) (see *Figure 10* for illustration).

Furthermore, to fully achieve and exploit these opportunities in a smart building environment Jia et al. (2019) specifically present 5 fields of challenges that need to be addressed:

1. Security and privacy issues
2. Data acquisition, processing, and storage issues
3. Feasibility, adaptability, and practical issues
    a. Gap between industry and academia
    b. Communications in the industry. Specifically, the protocols and standards of different buildings systems should be integrated with minimum barriers.
    c. Return of Investment (ROI) for IoT systems. Users see the short term, present services, failing to see the long-term influence of IoT systems.
4. Collaboration between IoT developer community and building industry. Need to explore how to make the most use of the technology to achieve the goals of smart building technology.

To achieve this open innovation, collaborative co-creation that many research papers point out is essential (Chesbrough, 2012; Jia et al., 2019; Scuotto et al., 2016), one need not only an industry cluster (Olsen et al., 2020), regional industry design (Aarstad et al., 2016) and ambidextrous capabilities (O'Reilly & Tushman, 2016) to foster both exploration and

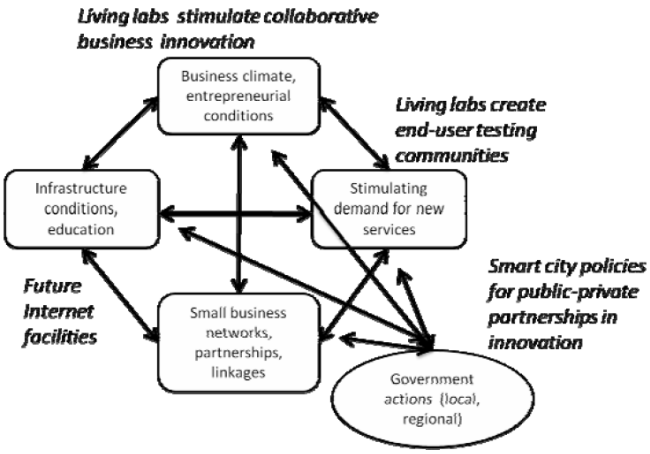


Fig. 3. Conceptualisation of smart city value creation and innovation system (based on Porter)

Figure 11: Conceptualization of smart city value creation and innovation system (reworked from Schaffers et al. (2011))

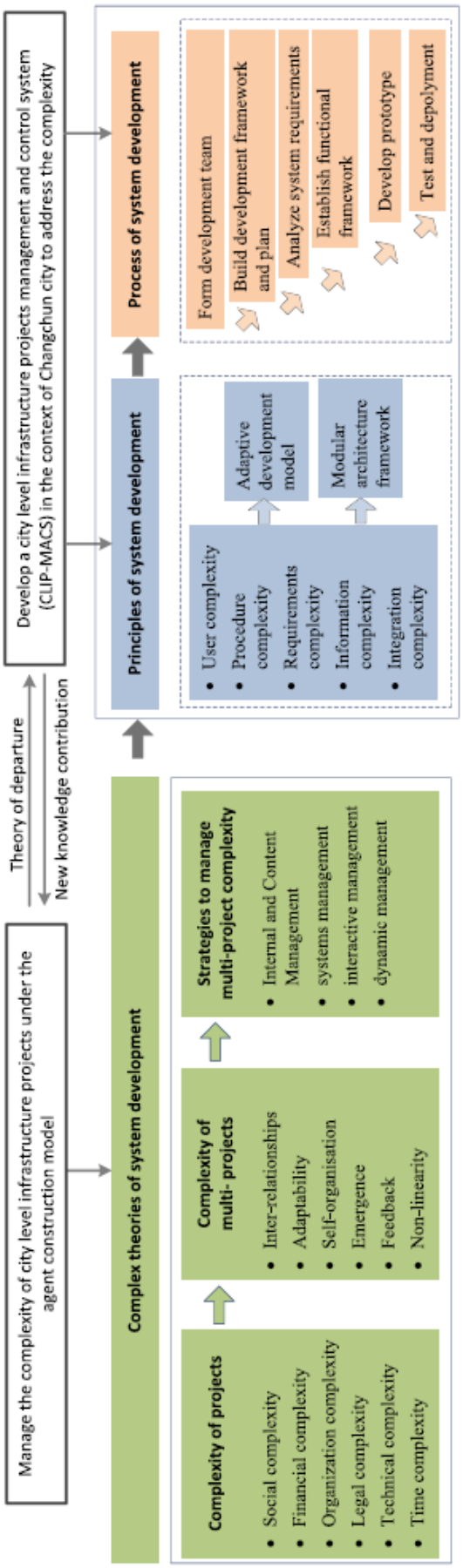


Figure 12: The process and development of a CLIPs-MACS (Li et al., 2015)

exploitation (as described in *"Success across multiple continuous projects"*), but the major challenge reside in continuity and multi-project complexity (Li et al., 2015).

Projects and multi-projects are a complex matter (Hertogh & Westerveld, 2010), and we see that a wide range of challenges reside both within a single project, but also on multi-projects and multi-project management (Li et al., 2015). These are challenges are summarized in *Table 3.*

Shaffer Schaffers et al. (2011) present a conceptualized framework (illustrated in *Figure 11*) to work with smart building projects at a larger scale to promote (1) Physical and immaterial infrastructure, (2) Networks of collaboration, (3) entrepreneurial climate and business network and (4) demand for services and availability of advanced end-users.

Li et al. (2015) has further developed a technical solution that are to address findings of Hertogh and Westerveld (2010) in single projects and Li et al. (2015) own findings on multi-project complexities (found in table #).

This framework is called CLIPs-MACS, short for City-Level Infrastructure Projects Management and Control System. The core of the framework is the Actor Construction Model (ACM) center. The main duties of the ACM center is (1) Manage and control the

construing process for all projects according to the authorized scope delegated by the municipal government to ensure the project completion is on time, on budget, and meets the expected specifications; (2) supervise all projects' outcomes and construction activities based on administrative standard and regulations, and comply with relevant laws and regulations; and (3) coordinate public projects' front–end planning and construction process with potential and relevant participants to keep the project workable.

The main benefits one achieve from creating such an modularized functional and hiarchial sctructured framework as (Li et al., 2015) present is (1) speed up system development process via parallel development for different modules, (2) minimize the influences of modifying or updating one function on other related functions, (3) increase security of user access, authorities, and data management, (4) meet users' customized requirements by combining and integrating modules, and (5) ease replicating the system to other applicable cities through changing and reorganizing particular modules in order to avoid the overall system redesign. An overview of the framework as a modularized, connected system is illustrated in *Figure 13.*

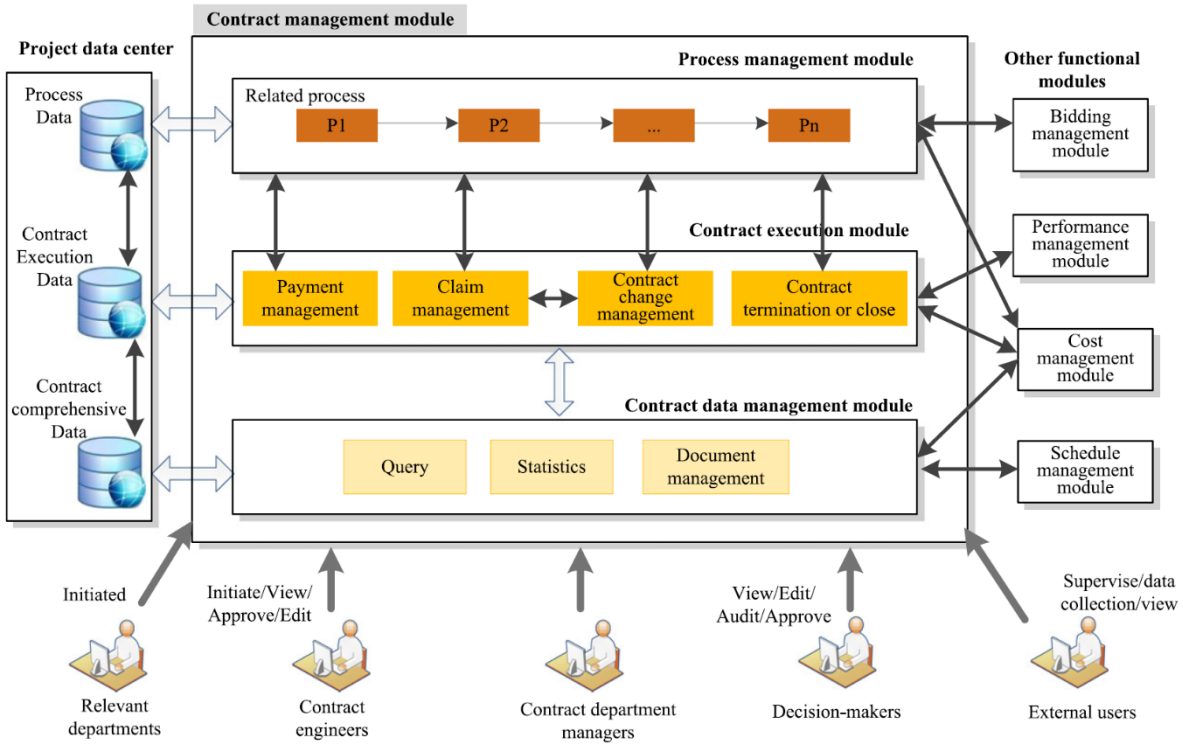


Figure 13: Modular system architecture for contract management. Gathered from Li et al. (2015)

3 Research approach and setting

The methodological choices made in this thesis will be explained in this chapter. The research approach has been built with the aim of having no presumption of challenges and theoretical backbone other than the fundamental of smart buildings and theory that are the curriculum throughout the master´s degree in "Innovation and management" at the Western Norway University of Applied Science. The theoretical fundament of this study has been built mainly during and late stages of the analysis of our findings.

3.1 Research design

The design of this study is an explorative research design to enable for an open and deeper understanding of the unclear challenges (Johannessen et al., 2006). It is a qualitative study with interview and observations as our primary research method to create a greater understanding of the situational context (Robson, 2002, p. 59) of the challenges real estate firms and -industry face during implementation of new smart building technology. This kind open explorative and qualitative research approach is especially useful if one wants to clarify a understanding of problems that is unclear (Saunders et al., 2009, p. 139). The problems, referring to barriers and challenges, in this study is unclear and are therefore considered as a preferred approach in order to answer the research question: "*What barriers property managers experience as challenging when implementing smart building technologies?"* The research methodologies and questions have been designed with the main aim of "*attempting to gain an understanding from the respondent's perspective, which includes not only what their viewpoint is but, also why they hold this particular viewpoint*" - (Easterby-Smith et al., 2015, p. 180). The study has a inductive approach where the researchers have built up a theoretical fundament around the findings throughout the study to be able to support and answer the research question: *"How property managers and real estate firms can manage challenges in projects regarding implementation of smart building technologies?"*

3.2 Interviews, data collection and analysis

The main methodological approach in this study has been collecting data through semi structured interviews. This was normally done with one researcher asking questions and the other taking notes throughout the interview, enabling the second one to better take notes of

unclear situations that we can follow up questions on. The interviews were conducted with one or two informants at the time. The approach in the interviews was used to promote a more contextual and personal experience focused, which is an important part of a research design to be able to approach our research question (Creswell, 2018).

3.2.1 Primary data

This research is an inductive qualitative study comprising of explorative, semi-structured interview as the primary empirical data source. Other primary data including recordings of talks, interview and talks with technology companies and pictures from the Smart Building Conference 2020 (ISE, 2020).

The interviews were largely dialogue-based and planned to be face-to-face interaction to enable the possibility for a workshop session at the end. A semi structured interview guide was created with close consideration of open questions and follow up questions that took a dive in examples and stories. Therefore, the interview guide gave the informants the opportunity to give situational based "storytelling", where the barriers and challenges experienced. From our predefined categories and guidelines vi find in chapter «Craftig a topic guide» in Easterby-Smith et al. (2015, p. 187) we created our interview guide into phases, before, under and after implementation. ***See chapter 10.4 for our interview guide.*** All this was created with a constructive point of view, with the roots of the pragmatic view from William James and John Dewey that "*it does not accept that there are predetermined theories or frameworks that shape knowledge and truth; nor does it accept that people can construct their own truths out of nothing*" (Easterby-Smith et al., 2015, p. 83).

3.2.2 Transcription and coding

The transcripts were printed out and imported into NVivo for analytic support. The empirical material was systematized and reduced (Miles & Huberman, 1994), mainly using pen and paper, but also Word and Excel (Ose, 2016) and NVivo tool for word queries, some coding, categorizing and content analysis. In the first run of coding, we solely identified (1) all challenges, (2) important terms, (3) definitions and (4) relevant information, marked in green, blue, red and yellow, respectively. In the next run we systemized the different findings from the different interview into same type of challenges. Thereafter, we categorized the challenges into logical categories that define the most important challenges. Lastly, we used our findings

to define what kind of theory used to explain and discuss our findings, and thereafter systemizing the findings in a logical way so it made sense to the corresponding theory and discussion.

3.2.3 COVID-19 complications

The interview was as described planned to be face-to-face and workshop based to enable the the informants to fill out a profiling tool from as an inspiration as a mapping tool for the pains, gains and tasks that our informants were to fill out with the help from us and use of sticky notes in person (see *Figure 14* underneath for an out draft of the tool and in for more information of the use of this tool). Yet, this were affected by the regulations regarding the pandemic (COVID-19) and the regulations which made it illegal to meet face-to-face within one meter and for a longer period. Since the interviews no longer could be completed face-to-face the informants where given this mapping tool to complete and send back to the researchers. Unfortunately, few of these were completed by the informants and not used in a bigger degree. However, the COVID-19 regulations have made the data collection a lot more unstructured than planned, where the researchers did not get the possibility to utilize our mapping tool. The researchers sent the mapping tool in digital form to all informants, but despite several follow-up emails and requests to fill this out, only 3 respondents have filled it out.

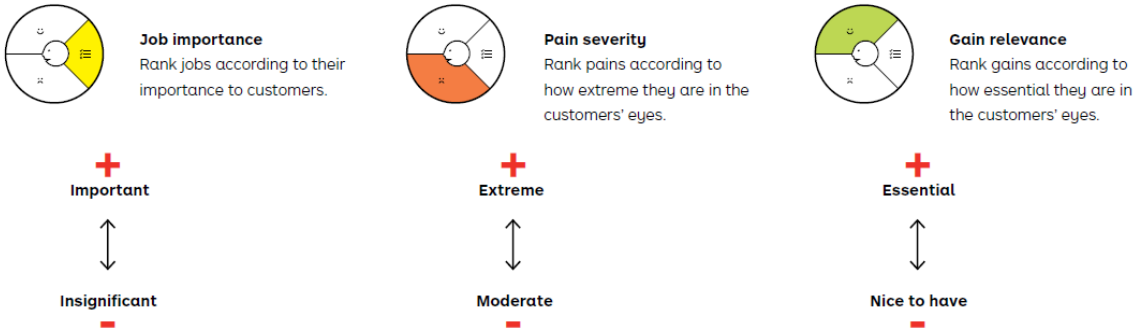


Figure 14: Profiling and mapping tool used in Value Propositon Desing (Osterwalder et al., 2014)

Adopting to the new national regulations, the researchers continued the collection of data through digital video chat and using Skype and Microsoft teams, challenging the use. The face-to-face interviews were audio recorded, and the digital interviews were video, and audio recorded. Still, only the audio recording is used to transcribe the interviews and other speakers at the Smart Building Conference 2020.

When transcribing interviews that were recorded in Skype or Microsoft Teams there were parts of the recording that was somewhat missing or too noisy.

Informant ID	Name	Type of company / position	Information about informant	Number of Employees	Date and Duration	About company
	Bergen Kommune:	**Real estate firm 1**		**Total: 28882**	**24.02.2020**	Municipality (Public sector). Informants from Agency for building and real estate, Bergen Commune. Have 1 million km^2
Informant 1	Maria Gonzalez	Advisor	Advisor organizational development and project leader	Department: 370	59 minutes 01 seconds	
Informant 2	Erik Holm-Larsen	Advisor	ICT-Advisor			
	Sammen:	**Real estate firm 2**		**Total: 779**	**12.03.2020**	Welfare Organization in Real Estate
Informant 3	Sverre Østvold	Manager	Technical Manager	N/A	77 minutes 32 seconds	
Informant 4	Arvid Ristesund	Manager	Operations Manager			
	BOB:	**Real Estate firm 3**		**Total: 162**	**24.04.2020**	Real Estate Company, building and operate homes
Informant 5	Dagfinn Edvardsen	Manager	Department manager property services	N/A	59 minutes 36 seconds	
	Entra:	**Real estate firm 4**		**Total : 179**	**29.04.2020**	Large-scale Real Estate firm with 90 buildings with 1,3 million km^2
Informant 6	Åse Lunde	Director	Director for Digitalization and Business Development	N/A	55 minutes 56 seconds	
	Vestland Fylkeskommune:	**Real estate firm 5**		**Total: 6796**	**20.03.2020**	County Municipality (Public sector)
Informant 7	Trond Helland	Engineer	Operations Engineer	Department: 430	70 minutes 52 seconds	
	Bergen Works	**Coworking space**		**Total: N/A**	**20.03.2020**	Bergen based co-wokring space that two buildings in Bergen Sentrum
Space manager 1	Stefan Eide			N/A	62 minutes 39 seconds	
	IRES & REC	**System integrator 1**		**Total N/A**	**07.04.2020**	*IRES (Idun Real Estate Solutions) AB*: Software Company in Buildings *REC (RealEstateCore) Consortium*: Non-profit System integrator for Real Estate
System integrator 1	Erik O. Wallin	CEO	CEO, Founder, and chairman	N/A	46 minutes 54 seconds	
	SALTO Systems Norway:	**System vendor 1**		**Total: 17**	**03.04.2020**	Software and Hardware Developer and vendor
System vendor 1	Ken Hugo Skutevik	KAM	Key Account Manager	N/A	52 minutes 59 seconds	
	WSP:	**Consulting firm 1**		**Total: 49 500**	**10.02.2020**	World-wide management consulting, WSP, London
Consultant 1	Matthew Marson	Consultant	Head of Smart Places	Real Estate Department: 13 900	15 minutes 33 seconds	
	Accenture:	**Consulting firm 2**		**Total: 504 000**	**10.02.2020**	Organization with consulting-, technology- and outsourcing services Consultant IoT Innovation Design and Strategy in Smart Buildings
Consultant 2	Sophie Brenny	Consultant	Consultant IoT Innovation Design and Strategy in Smart Buildings	N/A	18 minutes 47 seconds	
	Memoori	**Consulting firm 3**		**Total: N/A**	**11.02.2020**	Smart Building Research and Thought Leadership
Researcher 1	Daphne Tomlinson	Researcher	Senior Research Associate	N/A	15 minutes 57 seconds	

Table 5: Overview of informants

3.3 Informants of this study

Eleven interviews were carried out with informants from several types of companies and roles within the smart building and real estate industry and stakeholders, See "*Table 3: Overview of informants*" for an overview of the informants.

The informants are mainly property managers working in companies that build, develop, and/or operates buildings. The role and responsibility of property managers was important regarding their experience, and that they were decision-makers.

The researchers attended Smart Building Conference 2020 and interviewed a progressive researcher and two consultants, one of which is a keynote speaker. Data such as panel discussions, talks, keynote speakers and pictures were collected during this conference. The main goal of the Smart Building Conference was to build a foundation of understanding, an overview of international smart building industry and engage international actors into the study to make the study recognized on an international level too.

Later, during the collection of data and information that was given in the interviews, the researchers saw the need to interview other parties involved in projects of implementing smart building technologies. The study has therefore interviewed a vendor (or supplier) of smart building technology and a system integrator (third party between property managers and vendors as an integration service, not consultation service). This choice of informants was to find a diverse selection of companies from the real estate industry that have been working with implementing smart building technologies. Therefore, include firms that owned and managed buildings, but also their system integrators and system vendors or system developers.

By covering a wider range of the value chain made it possible to investigate the challenges companies face when implementing smart building technology. The regulations mentioned also changed the everyday life of relatively everyone, and this change in routines made some potential informants unavailable because of lack of available time. The pandemic has clearly influenced this study regarding the increased difficulty communicating and meeting with potential informants and conducting digital interviews were this is not preferred.

One of our biggest challenges in finding the right kind of companies and the right kind of informants was that there is great variation in companies in the real estate industry. Some own and manage their own buildings, but are not so involved in the projecting, planning, and building of their real estate, others is more involved in the whole process of both system development and build buildings.

The collection of secondary data was gathered from books, research papers, and websites to complement the information we gathered through our interviews from informants and observations from the Smart Building Conference 2020. Personal data such as: names, position, company name and other information identifying a specific person, has been recorded and confirmed by all informants with permission to be used for the purpose of this study. All interviews have been fully transcribed and are available for informants if wanted.

3.3.1 Bergen Kommune

Bergen Kommune is the second largest municipality in Norway. The agency for building and real estate in Bergen Kommune has 370 employees, managing over 1000 buildings, with a total of ca. 1 million km^2, about. 5300 municipal housing and 6000 unbuilt properties.

Maria Gonzalez studied a master's degree in computer science at the University of Oviedo, Spain. She has a specialty in industrial process control and have had a long experience with SCRUM, Lan Software Development, and with all these paradigms, continuous integration, testing of software. When she moved to Bergen, she started working with ICT in the Public Health Care, where she worked at the Integration Center. She has worked at Bergen Commune since 2018, where she has the role as Advisor for utilization, innovation and organization development. Today, she is the Project Leader for Bergen Commune in the Agency for building and real estate. Erik Holm-Larsen ICT Advisor at Bergen Commune, Agency for building and real estate. He has long experience as a developer in software, and development of systems.

3.3.2 Sammen

Sammen is a welfare organization that develop and manage student housing in the Vestland region in Norway (mainly in Bergen). In Bergen there is about 4 800 student housing regulated by the public (Bergen Kommune et al.). They have 779 employees in all the different departments of student housing, fitness center, kindergarten, cafeteria, and health. Sverre works

as technical manager in Sammen and has the overall responsibility for everything that has to do with operation and engineering on our buildings. And we also work a little into projects and to make sure that when we build new projects that it is adapted for the framework that we want on our buildings, so that it can be easily implemented when we buy or get something new. Sverre is the head of three others that takes care of operational and maintenance management, Arvid is one of them. Arvid is the area manager in student accommodation. We are three that are under Sverre, so we take the operation of the buildings and have the caretaker and, for my part, have plumber also under me then. Arvid is responsible for the operation of lock systems, fire systems etc. He is also involved in projects.

3.3.3 BOB

BOB is Norway's third largest housing development company and for more than 75 years have built and developed neighborhoods and housing. In addition to building homes, BOB have also managed and operated these. Their vision of building community is very strong and want to be a city and housing developer who takes care of the buildings and the people who live there, in order to facilitate the good life in and between the houses. BOB is involved and initiators in cluster collaboration which is Proptech innovation. There are two real estate services, one is craftsmanship, where there are 6 crafts: bricklayers, painters, tinsmith, plumber, flooring, and electricians. The other services are property management: fire-managers, energy-managers, environmental-managers and EHS-managers. BOB is also part of the business area with technical and legal advice.

In 2019 BOB had 20,175 members living in BOB housing, 152 new homes were completed, nearly 900,000 m2 of commercial property managed, and BOB with 24 subsidiaries.

Dagfinn Edvardsen has been involved in a numerous tech investment in property management and has begun to explore how to use IoT in our property management and operations. Dagfinn Edvardsen is the head the real estate services to BOB

3.3.4 ENTRA

Entra is a large-scale real estate company mainly operating in Norway in all 6 large regions in Norway: Bergen, Drammen, Stavanger, Sandvika, Trondheim and Oslo. They own 90 properties and own, operate and manage over 1,3 million km^2 of property. They are large on

environmental focus and city development and are an important player in the real estate when it comes to public infrastructure as 58% of their portfolio is in public sectors. They are relatively small, when it comes to number of employees, however, is a listed company with a large portfolio and high revenue.

Åse Lunde has worked in Entra for 2 years and are the director of digitalization and business development with a long experience from the bank and finance. She has the last 10-12 years been working with digitalization. Her responsibility is the IT and technology in all their buildings to find and develop new technical solutions that are needed in their buildings.

3.3.5 Vestland Fylkeskommune

Vestland Fylkeskommune is the fifth largest county municipality in Norway responsible for public buildings in the region, like high schools. Vestland Fylkeskommune was one of the initiators of this study, whereas they have had a long dialogue with the researchers on how one can enable for a better smart building environment in the region of Vestland, Norway.

Trond Helland is an operating engineer responsible for ITB and following up the multidisciplinary in the teams. They work with building control and how one can develop new building control systems in the public real estate in Vestland region.

3.3.6 Bergen Works

BergenWorks is an open entrepreneur-friendly coworking space which offers a social work environment with excellent growth opportunities for startups. They accommodate for relevant connections across members and host formal and informal events also for startups and the corporate world to join, sharing knowledge and network, enhancing their likelihood for success. They have two buildings in Bergen Sentrum. BergenWorks tailor memberships according to the needs of every individual and offers full-time desks and flexible desks.

Stephan Eide is the Space Manager at Bergen.Works responsible for developing and maintain the coworking spaces and create services that help their members. Stephan has a focus on developing very user friendly, and system agnostic coworking systems that highly benefit all their members.

3.3.7 Idun Real Estate Solutions and RealEstateCore Consortium

IdunRealEstate help property owners get their buildings ready for the smart cities of the future. Idun is a software company dedicated to making the world's buildings ready and able inhabitants of the smart cities of the future. Our vibrant set of integrated applications, based on the open source semantic language RealEstateCore, enable property owners to transform their real estate portfolio into a platform for innovation, analysis, and optimization (IRES, 2020).

RealEstateCore (REC, 2020) consortium was formed in 2017 with Vasakronan AB, Akademiska Hus AB, Idun Real Estate Solutions AB, Willhem AB, RISE, and the School of Engineering at Jönköping University, as the founders and main sponsors of the RealEstateCore project. The purpose of the consortium is to create an environment for cooperation and sharing of knowledge between property owners and partners, to prioritize and organize development of shared ontology features and associated technology/software, and to be a speaking partner for public and private sector ontology and linked data initiatives within the real estate and construction industries in Sweden. Ever increasing amounts of data are generated by and within buildings. Several different systems exist to control climate, lighting, access control, etc., not to mention all the new data sources that emerge from IoT devices, all of which generate data. These large amounts of heterogeneous data need to be organized if they are to contribute to cost-efficient and environmentally friendly real estate management.

Erik O. Wallin is the founder and CEO of Idun Real Estate Solutions AB, the founder and chairman of the RealEstateCore Consortium, as well as an active researcher in the field of semantic technology and applied machine learning for autonomous systems of large scale. With a PhD in Media and Computer Science he has had a long experience with machine learning and system development within the media industry and are now transferring this competence over to the Smart Building industry.

3.3.8 SALTO Systems Norway

Salto is an international access control hardware and system developer and vendor that was founded in 2001. Their goal is: "*to devise a world-class access control system that was simple to use and extremely efficient, giving users the ability to control all their access needs and secure all their doors without complex and expensive wiring*» (Salto systems, 2020).

Ken Hugo Skutevik is a Key Account Manager at Salto Systems Norway that are responsible to sell and follow-up customers and installers of their systems. Ken Hugo´s main job is the project management/design across the country, mainly communicating with the installers and not the end-customer.

3.3.9 WSP, London

WSP is an international multidisciplinary consulting firm with nearly 50 000 employees globally. The "Property and buildings" department have over 13 000 employees counting for 33% of their entire workforce (WSP, 2020)

Matthew is Head of Smart Places at WSP, Londin. Within the built environment, he focuses on designing and delivering digital real estate transformation and the human-centered Internet of Things (IoT) technologies. Matthew is an Architect and a Chartered Engineer. In 2017, Matthew was elected Fellow of the RSA and named Young Visionary Institute of Mechanical Engineers 2016/2017 for his work in creating The World´s Most Connected Building. Matthew is a member of the Intelligent Buildings Group of the CIBSE and is a keynote speaker at international industry events. He was a co-author in the Encyclopedia of sustainable technology.

3.3.10 Accenture, Netherlands

Accenture is one of the largest consulting firms in the world with a global workforce of 504 000 employees. Their impact on property and smart building is considerable, where they have also developed their own "Accenture Smart Building Solutions" (Accenture, 2011). Sophie Brenny is a consultant at Accenture, Netherlands specialized in IoT Innovation Design and Strategy in Smart Buildings.

3.3.11 Memoori

Memoori is a Sweden based a consultancy company based in Stockholm providing independent market research, business intelligence and advice on Smart Building technologies. Their research is a wide specter of smart building, smart city, workplace analytics, security ect. (Memoori, 2020)

Daphne Tomlinson is an advisor for Memoori based in Switzerland. As Senior Research Associate at Memoori, she specializes in research & analysis on smart buildings and is the author of private client research, multi-client reports, white papers and industry commentary on key players and smart building market trends. She is a business intelligence specialist with more than 20 years of experience at Siemens Building Technologies Headquarters in Switzerland, where she has been involved in supporting strategy and merger and acquisition projects, as well as competitor benchmarking.

3.4 The quality of the research design

The quality of the research design is important to address. One important factor is the COVID-19 pandemic and the regulations that have affected the interviews conducted in ways that we did not foresee and have created complications that have weakened both the reliability and validity of the study.

3.4.1 Reliability

Reliability refers to the degree to which your data collection techniques or analysis procedures will yield consistent findings (Saunders et al., 2009, p. 156). Easterby-Smith et al. (2015) argue that the reliability of a constructivist design, as we design, depends to a greater extent on whether there is transparency around data collection and interpretation and whether other observers or researchers see or can collect similar data. Thus, qualitative and constructivist design would have to have the transparency of the data collection methodology and presentation of how one has conducted the collection and analysis to be presented in such a way that other researchers can re-analyze or use the data in retrospect rather than the data collection itself providing the same data and found there and then. When it comes to less standardized data collection methods, such as semi-structured interviews and in-depth interviews, the goal is to capture the reality that happened at the time of data collection and thus not necessarily possible to repeat the data collection and get the same answer afterwards (Saunders et al., 2009). Thus, the quality of qualitative research tends to recognize subjectivity where quantitative researchers claim objectivity; qualitative research usually aims at internal generalization (the ability to explain what has been researched within a given setting) and not statistical generalization (conclusions beyond those studied), which is the gold standard for quantitative research.(Easterby-Smith et al., 2015, p. 270).

In contrast to quantitative research, the contribution of qualitative research lies in its **uniqueness** - and not whether it can be copied in retrospect (Janesick, 2003). So, it is most important to clarify why one has chosen that methodology and collection technique so that other researchers can subsequently re-analyze the data rather than recreate the entire research project. Due to the use of the snowball method to obtain more irrelevant informants, the reliability of the study will probably be difficult to replicate.

3.4.2 Validity

Validity refers to the degree to which the data collection method or methods measure exactly what is intended to be measured, and to what extent the research results are really about what they claim to be about (Saunders et al., 2009). The most important step the study take to increase the validity of the study is to have a thorough pilot interview and use data we have gathered from previous interviews to find the most relevant theory and to adapt the questions correctly in advance. We want to maintain a good structure throughout the interviews using frameworks that ensure a certain structure of how we analyze the data in retrospect, despite the use of a semi-structured interview collection methodology. One additional measure to meet this was planned to not only analyze the interviews ourselves, but the informants were to rank the barriers and challenges themselves during the interview process and in a workshop during the study, so that the researcher's interpretation of the data does not becomes solely crucial for the analysis. However, these were not able to be completed in a proper manner due to COVID-19 and have mostly been set aside, as described in *chapter 3.2.3.*

Validity can be divided into two parts: internal validity and external validity (or generalization) (Saunders et al., 2009).

Internal validity is about that the findings are really what they seem to be about. (Saunders et al., 2009, p. 257). This is usually done by ensuring that the results are true, and conclusions are correct by eliminating systematic sources of potential bias (Easterby-Smith et al., 2015). One of the measures that many surveys use is to use the theory of other studies as a basis, as well as conduct a pilot interview to make sure that respondents are able to answer or that the question raises the theme to which they want to be answered. This research has had pilot interviews and/or had a pre-conversation with the informants to meet these theories.

When it comes to qualitative studies, the external validity (generalizability) is to a greater extent lower due to the low number of respondents and, as explained earlier, is more concerned with investigating and going into specific phenomena and suggests that further research can be used more quantitative, structured studies to create better generalizable findings. However, research has two arguments that seek to clarify and change the approach to generalizability or transferability of qualitative research (Saunders et al., 2009).

The first is related to the fact that a qualitative, semi-structured study often looks at a more unstructured setting. Bryman (1989) states that within a qualitative *"a wide range of different people and activities are invariably examined so that the contrast with survey samples is not as accurate as it appears at first glance*" Bryman (1989, p. 90). That is, one through qualitative interviews and case studies often comes across many different people and sentences, while research projects that often use surveys or more structured forms of research look more closely at a specific area or setting. The second argument of the approach that questions the generalizability of the quality of qualitative research or a case study is related to the importance of this type of research for theoretical propositions (Bryman, 1989; Yin, 2003). Relating the research project to existing theory is one in a position to demonstrate that the findings have a broader theoretical significance than the matter or issues that form the basis of your work. It will be up to the researcher to establish this relationship with existing theory in order to demonstrate the broader significance of your particular study (Saunders et al., 2009).

4 Findings and analysis

The interviews generated several challenges when it comes to integrating new technology into real estate. Through the analysis we will use the informants respective "*Informant ID*". In the table under we have an overview of the challenges, divided into two main segmentations: Human factors and technological factors. Human factors are factors that affect humans and how they work. Technological factors that affect the outcome or create challenges more connected to the technology creation and utilization. We found that the main challenges for implementing new technologies are:

Human Factors	**Technological factors**
Where to start	Too many systems and vendors
Project management	Lack of holistic view
User focused instead of technology driven	Lack of interoperability
User involvement	System configuration
Competence	System bias
Property managers' new role	Get insight and access to API
	Retrieving information from buildings
	System updates

4.1 Human factors

In this section, there will be presented human factors of barriers property managers find challenging when implementing smart building technologies.

4.1.1 Where to start

Our informants have presented the challenge of starting an integration project with the basics of "Where do we start?" Implementing smart building technologies can be comprehensive and may be difficult to know where to start. So, this study asked the informants about what should be in place before you start the process of implementing smart building technologies. They said one must start with the outcome, and what outcome you want to achieve. It is about where you want to be in the future. Informant 4 explained that you need to know where you are now, where you want to go, and how to get there. Consultant 1 also explains that you should look at all the

outcomes that you want to drive and make it measurable. For instance, we expect zero carbon emissions in five years, which means that we must reduce carbon emissions by x per year. Consultant 1 ´s method when consulting property owners aims to get his clients to work through the outcome that the property owners want to drive, whether them knowing. Which is normally done in some sort of human centered way. So, you need to know who you are designing it for and learn more about the users, like what do their everyday life look like. And then you need to figure out how the technology could improve an interaction with a process or a space in some way. Researcher 1 explained that CRE-team don´t want to choose a technology, they want to understand what the outcome is of implementing a solution and the use cases around it.

Consultant 1 explained that there´s not enough evidence or case studies to make people feel comfortable investing into smart building technologies, which is why "*They don´t want to be pioneers, they want to be fast followers.*" Informant 1 express how they are waiting on the sideline for the right technology to emerge. Explaining that everyone is looking into the future of BIM models and that will solve their problem, however, this is terribly slow. They do not want to be the leader in the market, but rather jump in the train whenever the best technology arrives in the market. Real estate firm 3 told that it´s better to start with something small in order to push forward, that to not do anything and not move at all. Consultant 2 explained this as the way bigger companies are risk averse and are afraid to invest in something that can turn out to be a failed project.

4.1.2 Technology driven vs. user driven

Our informants have presented the challenge when starting to implement new technologies is to be user focused instead of technology driven. Consultant 2 and 1 both said that property people are technology driven. "*People tend to be technology driven, instead of use case and user driven. Because if you implement technology for the sake of technology, there is no added human value."* – Consultant 2. Informant 1 also told us about her earlier experience from the public health sector, "patients are not like machines." Indicating that including the actual users and adapt the user experience to this, is a challenge. This means that one need to take the people's needs into account. Informant 5 pointed out that the vendor Disruptive Technologies (one of their suppliers of sensors) tend to be technology driven. They sell " *[…] the world best sensors and that it is the size of a stamp, […]",* but don't sell the use case of the sensors. However, this research finds that property people in this study (Real estate firm 3, Real estate firm 4 and Real estate firm 2) are user and use case driven. Informant 6 explains that it's not

technology for the sake of technology or that its cool. The Technology shall give value for the users of the building or for the society. Informant 6 explain that Real estate firm 4 is trying to use technology the way where it just becomes a tool to how we can create value. By implementing technology for the sake of technology you risk investing in something that ends up nor needed or wanted. As a property owner spoke at the Smart Building Conference 2020: "*Some of the tenants, in fact, most of the tenants tell us they don't need [smart building technology]. They don't need those. So, we have put an investment in, and then people don't use it."* – Unknown property owner (Panel discussion). This property owner based his decisions on assumptions of what he thought tenants wanted or needed. Consultant 1 explains how building owners are not thoroughly testing the market appetite "their decision is based on guesses rather than going to talk to their people." So, before the decision of which technology to choose, the property owner should examine the user need and use cases.

4.1.3 Project management and strategy

When starting on a project, the informants face the challenge of how to manage smart building development project regard user involvement, project structure and project methodologies Consultant 1 and 2 both argued that property people are stuck in traditional project management methods, and are "unbelievably waterfall" (Consultant 1). Highlighting that property people are not working in a flexible and agile methodology that are required to be able to involve all the stakeholders and users that are throughout the project. Yet, this study found that the real-estate firms are working to change their working methodologies and includes relevant stakeholders.

One company are using agile project management (Lean Software Development Methodology), and another are developing use case regarding the end-users. Real Estate firm 2 was evaluating the end-user needs throughout the project, to make sure that they were headed in the right direction and that the technology satisfied those needs. They used external consultants that included stakeholders as: students, cleaning personnel, operating technician, project manager etc. Their strategy is to use the system for about 10 to 15 years, and then implement something new. Reasons for this is that technologies are getting more functionalities and complexities, often making existing technologies outdated. So, after 10 to 15 years they plan to implement a new technology but will use the technology if it satisfies the needs and that it works. Real estate firm 3 created their own internal innovation team of 15 people, in the end ending up with a total of 8, that solely work with innovation consisting of people from many areas of expertise. Real

estate firm 4 too are on a more cultural level focusing on having a more flexible or innovation driven culture where they open an own building called Rebell in Oslo only to invite firms and themselves try out new technology. This sort of "Tech-hub" are meant as a place to be able to implement, pilot and meet at a user case and technological perspective, as it is an actual working building with real tenants and users in it. When using external consultants, Real estate firm 2 pointed out that internal and external management, responsibility, and leadership can be challenging. The external consulting firm changes the project manager a couple of times, making it hard to transfer the relevant information and flow throughout the project. Also, during the process they emphasized the challenge of who to direct your inquiries regarding problems and change request regarding the design of the system. Lastly the responsibility of the progress and overall management of the project itself became somewhat diffuse. When creating internal teams responsible for system development and innovation, Informant 5 draw attention to some challenges. Challenges regarding being transparent enough through sharing information about "[…], okay, now some are traveling to cool places and learn. Why exactly they got traveling? Why did you choose to travel to those places? Is my position stressed and pressured, and about to be replaced?" People in the organization need information about what is happening in the organization and why. This information also needs to be shared frequent enough. Further, Informant 5 emphasize that one must lay a proper foundation for the team that get invested into. This include a detailed expectation clarification of the involved individual and what this investment, in you as a person, mean for the organization.

The users of the building are all the people using the building. In an office building for example, there is people operating in different parts of the building, such as: cleaning, security, employees, and leaderships etc. And all these people have their own sets of needs and problems that they are facing. Consultant 2 explain what property people need to understand is what do all the users of the building have in common and how can you best fulfill the needs of the majority. She and other informants suggest that you understand the needs or problems before you choose a technology. As the Smart building influencer, Researcher 1, puts it: "*It´s about getting them together and deciding mutually what the outcome should be, what the use cases are, and then subsequently choosing the right platform or the right technology to achieve that."* So, before deciding which technology you should chose, according to our informants, depends on what on what outcome you want to achieve, and does it fulfill the needs of the users in the building.

4.1.4 Project management: user involvement

Informants emphasize the importance of properly involving their users in projects. The consultants, Consultant 1 and 2, alleges that property people are not able to focus on the users of the building, where this can be both customer, tenants, businesses, or the people managing and operate the building. When Real estate firm 2 developed their new CRM system (student housing system), Informant 3 emphasized the importance to include almost all parts of the organization during planning and implementation of a new system. They start by mapping the needs of the end-users and a traditional flow sheet. The flow-sheet outline todays processes, how they work and in which order. They created focus groups of students that were continuously evaluated throughout the process to ensure that the projects roadmap where fitting to the end-users needs. They also mentioned the importance of crucial small details that can easily be overlooked. Real estate firm 2 made sure to included affected stakeholders, like the entire operational team, cleaning personnel, operational technicians, and custodians to ensure that the backend of the system were fitting to the processes and everyday tasks of their employees. Researcher 1 summarize this really well by "*It's about them getting together and deciding mutually what the outcome should be, what the use cases are, and then subsequentially choosing the right platform, or the right technology to achieve that.*" So, by getting the individuals involved and decide mutually property manager give decision authority to others who didn´t have that. Which can mean involvement of IT, HR, OT, and even cleaning personnel, others that can be affected by the implementation.

4.1.5 Competence

Informants emphasize the importance and challenges of competence and knowledge management. Consultant 1 summarize the three biggest challenges one might face when people want to make their build smart:

"*Not having sufficient proof, and tried and tested case studies, […]. The second one would be digital literacy, and not knowing enough about the stuff that you're buying into, which cause hesitation. And the third one is not properly testing the market appetite they are all set. Their decisions are based on guesses rather than going to talk to the people.*" -

In short, this means lack of competence and what the different systems give in value. First off, there is a lack of literacy and proof that smart building technology gives positive effect in

productivity and effectiveness. Second, property people do not have enough knowledge about digitalization and digital technology. And last that property people do not examine user needs and use cases enough to build knowledge about their own users. Furthermore, informant 5 also points out the fact that there is a lack of digital- and innovation competence within their own firm, and that smart building technology is mainly reserved for the people curious and interested in technology and innovation. Informant 5 explain that the individual's curiosity and interest should be raised to an organizational and cultural level where the technology and innovation get utilized throughout the whole organization. He emphasized that even the new people coming from the real estate education lack the digital competence and innovation knowledge, where he suggests that "*when academia comes more and more into this, and posts it as part of the education (-) and such, then I think it will only naturally come into play, close to decision makers and owners then."* Informant 1 explain that vendors are pushing new tools to use in the system, again and again until one day they don´t have the software to handle it or don´t have the knowledge of the tool to do it. Consultant 2, further highlight the importance of keeping the people and competence about their system architecture within the firm. She compares the system architecture to the party game, Jenga. Every time someone takes something out and added a piece somewhere else in the system, and if no one or only one in the company knows the system end-to-end, the whole company can face a critical situation. Because if that person "*ends-under-trains*" (quits / fired ect.) the company have lost the full knowledge from end to end of how the system works. Informant 5 further explain the importance of keeping their people and competence, saying that once one invests time and money in people and their competence, one also must make sure that they stay. They highlighted how they had faced the challenge of properly motivate and put up specific expectations of the included individuals, so they know what they are a part of.

The property companies have also shown a great effort for increasing competence of smart building in the community. One company has been part of developing a smart building guideline-tool (Smart by PowerHouse). Another has been an initiative-taker and partaker in PropTech clusters. These are also relatively bigger companies in the scale of Norwegian real estate industry and show a proactive effort of sharing knowledge in the value chain. And, as part of a strategy, informant 5 explained how eating some of our own resources to be able to grow, is better than being eaten by your competitors. Consultant 2 also told that you need to try, and be more comfortable with projects failing.

4.1.6 Property managers new role

Some of our informants explained that the property managers' role has changed. Consultant 1 points out that he learned all the top leaders "*How you build a business case, because they've never dealt with anything as a service before because they normally just capitalized stuff."* He himself has a "smart school" that learn property managers how to better involve their users and customers when it comes to smart technology. This school builds an overview of that smart building technology is, all from technological trends, what a platform is, system architecture, HR analytics, IoT and how to get a mobile app built. This is because, as stated above, real estate people usually haven't dealt with business cases and use cases before. Researcher 1 points out that the "*And so the occupant is a stakeholder whereas they weren't before.*" She explains that the occupants were not a stakeholder before. Now, however, people choose where they want to work. And they want to work in buildings with the latest technologies. Furthermore, System integrator 1 highlight the emergence of coworking spaces role. He thinks that property owners "… have to start to think a little bit different." He sees that a big driver for property manager are that they are afraid of organizations and business models like WeWork and AirBnB. There is easy to build a business model like WeWork and he mean that there will emerge many new businesses like these. Property owners invest hundreds of millions, or even thousands of millions of kroners, while System integrator 1 explains that WeWork charge 50% more rent than traditional property managers. System integrator 1 compares this to how Telenor invest a lot of capital into infrastructure while Netflix utilizing and benefitting from Telenor's infrastructure to create added value. Where Netflix is WeWork and AirBnB, and Telenor is the property managers.

4.2 Technological factors

This section will present technological factors of what barriers property managers find challenging when implementing smart building technology.

4.2.1 Too many vendors and solutions

There is a unanimous agreement across all our informants that the main barrier is that there are too many systems and vendors. Researcher 1 out that there are big barriers when implementing any technology in smart buildings: "*One of them is diversity of solutions, the number of companies and the range of vendors offering all of those products."* Informant 1 further emphasize that *"[…] each one of them is developed in different parts of the world*." When it comes to organization level, System integrator 1 points out that "*Property owners have a large portfolio of different buildings with many different systems."* During a mapping of systems in old buildings he found 15 different systems. He further explains how the property industry is like media companies regarding large portfolios with all sorts of different systems. Not only do they have to deal with a large portfolio of system in a building project, but also a large diversity in number of companies and range of vendors offering these products.

Yet, many vendors and systems available in the market does not pose as a problem in itself, but the way these systems are developed and operate in the market seem to cause challenges regarding interoperability, configuration, and updates of the systems and retrieving information from buildings. Before these challenges are presented, this section will present the findings regarding system developers and vendors lack ability to have a holistic view.

4.2.2 Having a holistic view

The informants in this study expresses a concern regarding system developers and that vendors lack the ability of a holistic view. Informant 1 said*: "[…] I see it like, it is not whole. It is like a small system here and a small system there, with very specific applications, but they don't see the whole picture."* Choosing between a wide range of technologies that serves the right purpose for the right use case in a building has challenging at several informants. Space manager 1 notes that one should find a system that is easy to use. He focuses on the outlay and user experience of the system is the main reason to choose a system, and further points out that the problem with choosing the right system can be challenging when trying to find one-system-

that-serve-all and choosing niche products. This is because that one-system-that-serves-all usually are not particularly good at doing everything, such as a niche product can serve one small purpose very well. However, several informants point out that several niche systems often don't reach its full potential or are not utilized to its full meaning because of system integrating and the lack of a holistic system.

Informant 1 explains with the story: "The Blind Men and The Elephant". This is a folk tale from India that teaches intercultural knowledge by demonstrating how different viewpoints contribute to different viewpoints. The story is about six men born blind and are arguing about what an elephant is. Since each blind man have only touched one part of the elephant each, they argue very differently, for example one say it´s a rope (tail) and another a wall (side-body). The lesson taken form the story is how each person sees their own little part and not the whole value chain.

The informants argued that developers don´t take the end-user into consideration. Informant 6 explain that developers and vendors focus more on a small piece or part of the technology, and therefore don´t see the big picture of how all systems can be connected. Informant 5 also point out how products are aiming to solve world problems, but in reality, it serves a very small purpose. He further emphasizes that the developers are working with blinders when working on their products. They need the idea of see the big picture and the holistic view, in order to create the bridge from them to the people who are actually going to use it and those who have the authority to make the investment. And, it might be here we need a standard in the real estate industry. Informant 5 further point out that the system developers need to come together to create a package deal that are "eatable" by the end-users and property managers.

System vendor 1 told that they are extremely far way or distant from the end-users. He also explained that connecting the systems are not their responsibility, but however, open up to collaborate to, e.g. API's and working with larger project to be able to create a more interconnected system.

4.2.3 Interoperability

Interoperability is emphasized by all of our respondents that create several challenges. After System integrator 1 telling about that old buildings have 15 systems, he told us "[…] *and very, very rarely are any of those interconnected"*. Several of our informants say that systems "speak

different languages" and this makes it hard to normalize data. Real Estate Core´s fundamental purpose is to interconnect, or make it easier to integrate, similar and complementary systems together by "normalize data". However, this is a time consuming and manual task that many of our informants use a lot of resources on, but with the help of "semantically connected self-learning systems" RealEstatCore gather data from several systems to be able to do the heavy lifting of programming the tag list (values and attributes as in "temp" or "temperature" or "celcius") into one uniform tag/value (eg. Just "temperature", instead of "temp", "Celsius" and "t"). The Real Estate Core ontology is a technical solution that help to do the heavy lifting of programming the tag lists (values/attributes) as described over. A snapshot and link to their ontology is in the *Figure 15* below.

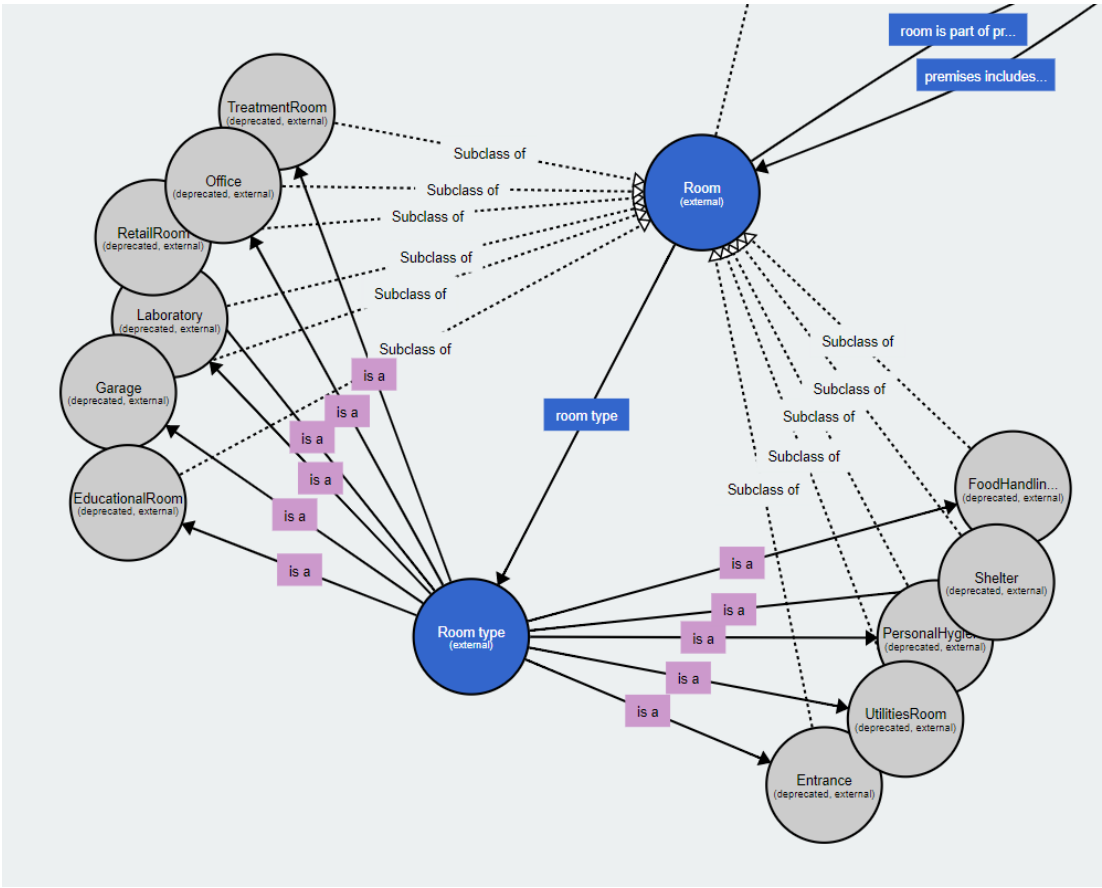


Figure 15: Snapshot from the The Real Estate Core Ontology (Hammar et al., 2020)

The concept to RealEstateCore is that the nodes indicate different values that are connected to different other values within a building and its components (i.e. sensors, actuators, devices (ref "*Figure 2: Overview of applications of IoT on smart buildings (goals, technologies, and related building systems) gathered from Jia et al. (2019)*")

Furthermore, Real estate firm 1 face challenges about the "*suppliers in the [real estate industry] […] are not really into standardization and interoperability*". She emphasizes that they cannot maintain the blueprint models (BIM-models) because of the lack of interoperability. It somewhat resides in the fact of them having "*[…] a person knowing one tool, and then they give us another [new] tool."* This makes it challenging and very time consuming to transfer information from one system to another, and maybe they do not even have the knowledge or tools (and tools may even be incompatible) to do it. Informant 4 points out that the lack of "*[…] one place we log on and see everything*.", makes him have a large Word document with all his usernames and passwords. This is not only *not ideal*, but also creates security issues and unnecessary complexity to his everyday workday. Real estate firm 2 and Real estate firm 1 also points out that there are many documents, files and information in flow, data stored several places and sometimes documents, values and important information is just stored or lost in some e-mail or on a hard drive somewhere instead of within one universal system.

4.2.4 System configuration

The configuration of the technical system itself have proven to be challenging. System integrator 1 specify "[…] its very, very, very simple; or I shouldn't say simple, very complex, rule-based systems. That took extremely many hours to learn, extremely many hours to configure and reconfigure." He further emphasizes

"[…] they are so proprietary, and they require so many engineering hours that I needed to configure them. But usually, you end up with (-) you don't actually configure them to the full meaning of what you can do with the system because its too complicated and you never get there."

System integrator 1 (even with long experience and PhD within computer science and AI) point out that the systems are so complex, that it takes too much time to configure them, and that it takes so long to configure that once you (may) get there you have to reconfigure and reconfigure and even end up misconfigured so it does not reach its full potential.

4.2.5 System updates

Several informants have highlighted that system updates create challenges. Real estate firm 2 explained that if they discover and inquiry an issue to a large-scale vendor like the Unit4 system,

they get a respond that they must wait for the next big update. However, when they had a partnership with the small local software house, they had social ties where they knew almost everyone. In this scenario it was easier to request "quick fixes" for critical issues. From a vendor's perspective, System vendor 1 emphasize that whenever they sit down with a project, the issue that are presented to them must be on a relatively larger scale. If there is not enough potential from the vendors perspective, they can choose not to engage in the project. Real estate firm 2 said that system vendors which has a large variety of companies in their customer portfolio, they do not wish to have special solutions for every single company. With a large variety in customer portfolio they focus on the fundamental functionalities that serves all the customer to make it easier to implement new solutions and update the system. If a system vendor with a large portfolio tries to offer specialized solutions for each customer, makes it harder to run updates.

Vendors are pushing new tools to use in the system, again and again until one day Real estate firm 1 don´t have the software to handle it or don´t have the knowledge.

4.2.6 Get insight and access to API

Informant 3 explains how vendors have changed over the years. Because there are very many proprietary systems, and no one want others to have insight to their systems. To get, not only insight, but access informant 3 and 4 demand access to the systems interface of their vendors, which means they will have access to the data collected by the system. They demand to get access before they buy into any technology, they think this is crucial. Real Estate firm 2 makes sure that the vendor frees the interface by opening their API, so they can implement this with other systems. Informant 4 points out that if you asked a vendor for data exchange for 10 to 15 years ago, this would not happen. Yet, this has change over the years, and today vendor must open up their API and free their interface to their costumers (informant 3). The vendors have realized that they must do this because the customers will no longer buy the closed API. However, opening the API for the property managers doesn´t solve any problems highlighted in this study, e.g. configuration and connecting between systems.

4.2.7 System bias

Informants tell us that interconnection and several other system related errors and challenges seem to reside by the fact that systems are created by humans. Different people and different

minds create cognitive bias. Informant 1 gave an example of how Google´s algorithm that recognizes people are biased to recognize things in the way people see the world. What Informant 1 means is that: "*[…] our cognitive systems are always gonna be biased by the people that have made it. So, it is really difficult to bring all the angles, all kinds of people, all the kind of ideas, and everything, into one algorithm."* Several informants pointed out that there are cognitive biases in software development. Furthermore, System integrator 1 highlight how two same systems have bias from the people creating them. Drawn from his experiences, he explains that even though the systems are the same, the system can end up with different "languages" (tag list) and the configuration of the systems can end up differently. He points out that this comes from that they are made by two different engineers implementing the same system. He also told that even the same engineer can create different "language" because it was implemented on two different points of time.

4.2.8 Retrieving information from buildings

Retrieving information and data needed to implement new systems to your portfolio and building is time-consuming and expensive. This is explained by System integrator 1 and the reason is because one usually has quite different quality on the blueprints of the documentations of your buildings, information systems etc. Real estate firm 1 mentions that the information about the building they need are sometimes missing, and the older the buildings are, the more often can it happen. Informant 2 told that the minimum needed are the correct data and the right amount. There has not been required by property owners to document data and information about the building in a structured way, and this has made it difficult for property owners to collect needed data and information in relatively older buildings. Informant 2 explained that this is one of their biggest challenges: "we have older buildings that doesn´t have that information necessarily." System integrator 1 told about one of the biggest "headaches" was that the documentation you need about the building are on an Excel Spreadsheet or even in an E-mail. And, it´s not given that you have the blueprint of the building in digital form, or they might just have a scanned paper drawing if it´s old enough. The cost and the work you need to put into digitizing those drawings are quite large (Informant 1).

5 Discussion

In this section we will discuss how the real estate owner's role in the marked is challenged by several challenges and drivers. We see that the real estate owners must create a new role and their way of working must change to meet customer expectations and market drivers. We have had a very explorative and open approach to reveal what challenges and complexities the real estate industry is facing when implementing new technology into their buildings and operations and to be able to address the research question.

5.1 The real estate owner's new role

The real estate industry is heavily defined, both by recent reports (Armstrong & Gilage, 2016) and by many of our informants as a "traditional" and an industry that are not visionary to use technological development. An industry that earlier just have been capitalizing real estate and are unbelievably waterfall, where real estate owners and property mangers' tasks, processes and way of working is pressured and challenged, requiring them to adopt to a new role in the market and become more digital. Our analysis find that the real estate owners' new role is changing due to them being challenged by three factors: (1) Change in users' behavior and expectations, (2) emerging technology and (3) change in competitive landscape.

5.1.1 User behavior and expectations

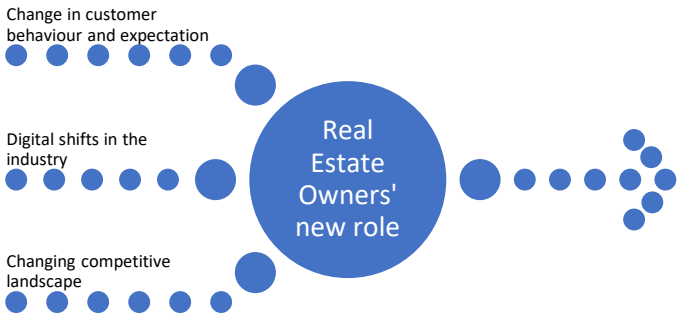
The change in customer behavior and expectations made the occupants (tenants, customers, and users of their building) more of a stakeholder, whereas they were not before. The change in occupant's behavior and expectations seems to be making property more as a service rather than just a place to work, pushing the building owners and property managers to deliver more than just a building. This study find that the real estate industry has a low digital maturity, which is consistent with large scale surveys and articles (Armstrong et al., 2019; Bjørheim, 2018; Weir et al., 2019), also emphasize that tenants in a higher degree can choose where they want to work; and often they choose to work at places or in buildings that have the best technology. New technologies emerge at great speed, such as connectivity of devices and mobile data access (Yoo, 2012), which is true for real estate industry through smart building technology. Advances in ICT and business globalization have created a need for flexible workplace settings, in which workers have more choices for how, when, and where to work. (Kojo & Nenonen, 2017)So, the

change in customer behavior and expectations, and the emergence of technology can be seen as drivers behind how the occupants have become more of a stakeholder.

5.1.2 Change in the competitive landscape.

Further we find that the rising stream of technology that both enable new functions, customer value and need for flexible office environment have further created a change in the competitive landscape. This study find that the building's owners increased importance of a service providence can be seen through the emergence of companies like WeWork and AirBnB. This is especially true when it comes to coworking and office buildings. Informants told that the new kind of business model that WeWork and AirBnB have, utilize the infrastructure that the real estate owners have invested into and deliver the service-oriented real estate that the tenants now expect. This is in consistency with the findings Kojo and Nenonen (2017) present, especially regarding coworking places' emergence and challenge traditional design and construction convention. One of the slowest adaptors to this growing work practice has been office landlords (Green, 2014). Although coworking is a small niche market aiming for startups, freelancers and small business, studies show that the workplace and business logic within real estate are changing towards service-oriented business logic (Weir et al., 2019). Furthermore, studies emphasize the importance of how coworking is changing the work concept (Leclercq-Vandelannoitte & Isaac, 2016) and with the changing nature of the work force and the technological improvements many of these benefits have been superseded due to the technological advancements (Waters-Lynch & Potts, 2017). Commercial real estate firms should therefore position themselves better in the market and creating their role in the flexible office environment seeing the increase in value that coworking spaces can create by utilize real estate property. (Foertsch, 2019).

Overall, these findings, of drivers toward change, is consistent with Osmundsen et al. (2018a) and Skjelvan (2015) drivers for change in digitalization work. Leading to the fact that real estate owners need to find or create a new role in the market to be able to (1) meet the new customer behavior and expectation, (2) utilize and benefit from the digital shift and emergence of new technologies and (3) meet the change in competitive landscape.



5.2 How can the real estate companies change?

The three factors for driving the change of a new role, puts pressure on the real estate firms to be more user centric and user driven whenever doing real estate- and smart building projects to better fit their user's needs. This further create the challenges of (1) user involvement and user/customer definition, (2) focusing on use case rather than technology and the real estate itself and (3) competence within digital technology and innovation.

5.2.1 User involvement and use case

Our informants emphasize the importance of involving the user to be able to meet the change in customer need and expectations. The increasing stream of technology and the users' increasing usage of these technology to benefit their own everyday work life can somewhat make it complex to find the right technology and use case for them. However, this study´s informants stress the importance of being user centric and focusing on finding the right use case (business case) whenever working on an IT-development project rather than focusing on the technology itself. This is also a theme that is discussed and emphasized in KMPG's surveys. Theory also emphasize the importance and challenges on user involvement (Bano & Zowghi, 2015; He & Wong, 2004).

Furthermore, this underline the importance of building a proper use case and define the outcome of the project before starting to develop a service or system to serve your occupants and not focus on the technology. Consultants in this study emphasizes the importance of user involvement and the use of use/business case to achieve project success. Being clear whenever presenting a change (Jacobsen, 2012), and in some way creating a sensemaking of the change. Therefore, important to include and clarify with the user. Some say that the challenges of using

a business case is that it is used wrong and are mainly used to make decisions. Decision-makers hide behind business cases and fails to try and understand the use cases, and then, justifies the rejection to a project because of the high risk, since information is scarce. But with a goal of innovation one might have to try, even though there is a lack of proof and tried case studies. This is also consistent with Einhorn et al. (2019)that conclude that business case is a long process and is not fully utilized.

The consultants of this study argues that property people lack the ability to be user centric. However, this study finds that firms (especially Real estate firm 2, Real estate firm 3 and Real estate firm 4) that are represented in this study have had a very user centric kind of methodology to work with development projects. One property company Real Estate firm 3 is using Lean Software Development methodology, which is an agile project management methodology. Real Estate firm 2 develops use case in order to understand the end-user and their needs, not only in the beginning, but throughout the whole process of the project. This contradicts what the consultants argue about property people being traditional and waterfall, and thus challenging the statement of that user inclusion is a big barrier. This paper, however, has not done a thoroughly, empirically viable study about user involvement to what kind of specific user involvement challenges that the firms face. Informants have on the other side highlighted that user involvement can be challenging in several phases of the project management, and explaining that challenges and complexities like, where in the project phase, how and in what degree should one include the users is not straight forward. Despite the high degree of focus on user involvement the property companies have done, this still wasn´t enough. User involvement literature is still a widely discussed, and in a systematic literature review concluded that the degree of user involvement "depends" (Bano & Zowghi, 2015), but also highlighting that user involvement is most effective in early stages, such as requirement analysis and design. Bano and Zowghi (2015) point out that user involvement is a complex matter, where challenges and solutions vary depending on several contextual factors like e.g. users' experience, organization culture, desired result ect. Moreover, Bano and Zowghi (2015) provides an overview of challenges for user involvement which can be used as a practical research focused guideline to user involvement for businesses looking to improve their project management-user involvement capabilities.

To summarize, the real estate owners' role has been challenged by the fact that the tenant is becoming more of a stakeholder and that the property managers are challenged through the new service-oriented mindset. The importance of user involvement in projects, including how and in which degree one should involve users, have long been an important factor within software and system development (Tait & Vessey, 1988). But the effect of user participation suggest that user participation alone may not be sufficient to predict the success of projects, especially when it comes to productivity outcomes (He & Wong, 2004). Einhorn et al. (2019) suggest that the literature indicate the use of business case contributes to project success but cautions that most business case processes are not easy to follow.

5.2.2 Competence and resources

This study found that competence and resources are a challenge when it comes to smart building development projects. The lack of sufficient proof, tested use cases and digital knowledge cause uncertainty in a project. This lack of knowledge and competence in return can cause them to hesitate or not even go through with a project. But as stated above, the new role creates the need for a more service oriented and user centered way of thinking, which in return require some form of trying and failing to meet the use case and user needs. Competence and human resources are a scarce resource in business IT projects. Our informants highlight that the competence to complete the project itself can either reside inside or outside the firm, creating complexities of communication and knowledge transfer.

One challenge resides in how one ensures the continuity in competence and resources, and the allocation of it. This study found that firms used different approaches and methodologies when it comes to develop and implement technology into real estate. Ranging from solely using external resources and consultants, to building their own internal team through ambidextrous solution to focus on innovation and to development, and lastly creating an industry wide cultural tech-hub to thrive the technological development in the industry. However, this differ widely depending on the firm's total resources and competence overall, but also on the strategy of the firm. Informants in this study found it challenging to allocate the right people on the right projects, and still ensuring their importance in their day-to-day operations. Also, when conducting smart building- and business IT projects in general the informants see that real estate firms need an increase in innovation and technical skills and competence to perform such projects, requiring them to employ or hire external consultants and independent system developers. In return, making it challenging with communication and make sure technical and

innovation skills reside within the firm. One firm chose to use external competence, driven by the fact of that consultant's competence on innovation processes and technical solutions would give a better result. They managers in this scenario had adequate knowledge and competence to choose between technologies and consultants, and the decision of implementing the technology externally was merely based on their strategy and that they would get a new systems in 10 to 15 years. And, therefore saw no need to develop a group of individuals continuously working with the system, enabling them to focus on their strategy in property management itself. A other firm adopted a sort of the ambidextrous solution (as seen in *Table 2*) of a separate department solely working with innovation and technology projects. This was undermined by the fact of eating some of our own resources to be able to grow, is better than being eaten by your competitors. However, this create the challenges of making sure to keep the best individuals minds, internal communication as of goals and vision and cost of building an in-house competence. Lastly, our study highlights a larger scale firm involve external tech firms that develop and create smart building technologies into development project in their tech-hub. This way they ensure that they are involved into the competence building environment and at the same time inspire the real estate- and smart building industry to come together at a common place to create solutions that fit the users' need together. This again create the complexity of project-, competence- and sharing management, regarding communication with the end-users, between vendors, and also at an industry level.

These challenges (or tensions) can be related to the findings that Aust et al. (2015) and Lindland et al. (2018) have shown in their articles regarding HRM paradoxes and resource allocation. Which comes of great importance regarding human resources where one have to weigh between the aspects of: (1) learning, (2) Belonging, (3) Organizing and (4) Performing (See *chapter 2.4*) The strategies that the firms of this study chose is neither a right nor wrong, but is rather anchored in the contextual strategy that each business chose to pursue. Studies suggest that an ambidextrous solution is the best way to achieve the best organizational performance and grade of innovation (O'Reilly & Tushman, 2016), still there are many factors of importance for an in-organization ability to both develop and implement new technologies. Koryak et al. (2018) point out that inculcating a culture of continuous improvement in their business is a most important aspect. Something that we see most of our informants in real estate firms do, but still face challenges.

To summarize, firms face the challenge of (1) knowledge management and (2) resource allocation and (3) task and resource responsibility. These findings can be linked with project management theory presented in *chapter 2.4*.

Overall, the real estate companies changing role has changed due to changing competitive landscape. The advancement in technology has pushed forward the changes in working ways, which in return has opened opportunities for coworking spaces and more flexible office spaces. Although coworking is a small niche market aiming for startups, freelancers, and small businesses, research has shown that the culture of flexible office spaces is reaching the commercial real estate and corporate office spaces too (Antoniades et al., 2018; Leclercq-Vandelannoitte & Isaac, 2016). These drivers have affected the way real estate owners need to work to meet the users need, requiring them to work in different ways by including the users more in projects, constantly focusing on the use case of the implemented solutions and thereby the way they are working and the methodologies they use in project management. The changing market doesn´t only challenge the way they work, but also the competence that are required to deliver that customers want and need, especially within digital competence and innovation.

5.3 Project context and complexity

This study found that there are too many solutions (systems) and too many vendors offering these products, which is all within the context of projects when implementing smart building technologies. The long range of vendors and different systems create complexities regarding project management.

Having many vendors or suppliers in a market is not a problem by itself, as many scholars suggest that perfect competition will foster innovation in a positive way (Porter, 2000). However, studies have shown that too many players in the market can stagnate the exploitative capabilities within an industry, making strategy formation more complex (Koryak et al., 2018) and more affected by time pressure (Baum et al., 2000). This is connected to the complexity within an industry, however, this situation surface and can be seen more clearly when information about specific buildings where given by the informants. Whereas the informants explained how they would manage too many systems and in only one building i.e. whereas a building can have 15 different system. Moreover, the property managers also must work with all these different vendors supplying these systems. And Real estate firm 4 which have 95 buildings can lead to bigger challenges regarding the operations and management of the building itself. These systems within buildings are very rarely interconnected.

In the context of projects and the challenges of having several different suppliers and many different systems in a single building makes it difficult to make one system that interconnects all systems. This means that the complexity, that so many informants are referring to as too many solutions and vendors in one building, makes it hard to reach the exploitative capabilities.

The lack of connection and many systems that serves a small purpose can indicate that interoperability within the value chain can pose as a challenge. Which can be a sign of modest collaboration within the value chain. However, the informants (property companies) of this study has shown effort in collaborating on a technical and business level by participating in developing Smart by Powerhouse, take part in clusters as well as being one of the pioneers and drivers in the cluster. This study doesn´t argue, in any way, that the companies mentioned are not willing to collaborate, it´s merely a technical aspect of configuration and interconnections between systems which cause property managers to use time and resources on tasks that potentially could have been avoided.

It also seems that vendors collaborate with property managers more than they have before. For just a decade ago, vendors would not open up their API and interface, which would mean sharing and give access to the data and information gathered by the systems. Today, they must. Factors that have caused this may be vendors looking for a competitive advantage or if their customers demanded that they get access to the data. There may be other factors that have caused this. Based on information given by informants, there seems more likely that the latter, based on the information given from the informants. However, the problems with connecting and updating of systems are still an issue, even though the vendor open their API to the property manager.

This lack (or more barrier) of seeing the end-users need connected to the building systems can also clearly be seen in the RealEstateCore's ontology (see *Figure 16*) The ontology is hardly mentioning people, and no attribute in the whole system are mentioning the "user-needs". The complexity of including the user when developing a system could be implemented into the technical phase of software development and the overview of tags, functions, systems, and vendors that a system alike that Real Estate Core delivers. Bresciani et al. (2018) suggest that internal capabilities of firms, combined with external knowledge accessed through alliances with external partners are intertwined, especially in MNE's.

Overall, we see that many of the complexities can be related too, and found in articles regarding complexity in project (Hertogh & Westerveld, 2010), multi-projects and system development

5.3.1 Adopting to the technological change

Many of the large firms are trying to create the technological and innovative value creation that coworking spaces offer through creating and using the ambidextrous solution and creating independent departments that are responsible for the business development and innovative creations. The property companies of this study have shown a great understanding and acceptance the technological change by adapting and proactively share knowledge to the market. This is also true on a global PropTech scale, where 97% of companies in the real-estate industry believe that innovation will change their business, and overall 73% of them see it as an opportunity, and 25% believe it can be both a threat and an opportunity (Weir & Pyle, 2018).

Real estate firm 3 in this study have taken an internal, sort of cultural change and adapted a form of the ambidextrous solution, where engaged 45 interns into several cases and ended up

with a team of 15 interns working focused on 3 cases. These units where working separately from the main business and were to explore new possibilities. Real estate firm 4 is trying to adopt a more external, cultural industry change, by facilitating for technological change and tesing in their "Techhub" (Rebell in Oslo), which is more of an "open innovation" approach. This is closely related to the theory, first by Schumpeter himself, where bigger firms can exploit and explore at the same time because of their economic situation and size of the firm. The same argument are agreed upon in a study with more than 400 small and medium sized companies in the UK (Koryak et al., 2018) and over 20 years of research on the ambidextrous solution by (Koryak et al., 2018) and over 20 years of research on the ambidextrous solution by (Koryak et al., 2018); O'Reilly and Tushman (1996, 2004, 2013, 2016); Tushman et al. (2010).

5.4 The road ahead

Following the thread of the discussed findings and theory above and the theory of project management (and its success factors), co-creation and ambidexterity both internally and across organizational borders this study suggest that a proper knowledge management and information and communication technology (ICT) system across different players in the industry could be crucial. This is to ensure that one can property manage organizational ambidexterity through alliances (Bresciani et al., 2018). A technical solution inspired by (Li et al., 2015) and RealEstateCore (2020) ontology that enable knowledge sharing and communication across projects, organizations and system can enhance the possibility of creating an industry standard that can help the real estate industry exploit the technological advancements better.

The technical solution should consist of the important requirements that are defined by Li et al. (2015) (Theoretical framework can be found in chapter *3.5* and the overview of "The use case and functional modules' relationship in the CLIPs-MACS system can be found in *chapter 2.5 and Figure 13*. An overview of these requirements are : (1) Organizational mechanism, integrated system development team (ISDT), (2) User's requirements analysis, an "Agent construction model" (ACM) to integrate all available industry resources, (3) process and information integration, to be able to connect and systemize processes and information from thousands of participants and organizations, which data may be of varying fragmentation and quality.

The concept of the system is a modular functional framework increase feasibility of product or component change, increase product variety, decoupling tasks, easing of product upgrade, maintenance, repair and disposal. These are all awfully specific challenges that our informants also face regarding smart building development and continuity. The main goal of such a modularized functions and hierarchical structure framework such as Li present (in *chapter 2.5*) is to:

1. speed up the system development process via parallel development for different modules
2. Minimizing the influences of modifying or updating one function on other related functions
3. Increase security of user access, authorities, and data management
4. Meet users' customized requirements by combining and integrating modules
5. Ease replicating the system to other applicable industries, locations and context through changing and reorganizing particular modules in order to avoid the overall system redesign.

The integration and knowledge database should be maintained and developed by a single entity (firm, cluster, collaboration team , or similar) collaborating with stakeholders like; system developers, system integrators, real estate mangers/owners and end-users, all ranging from small businesses to large enterprises. Such an entity could be design with the mind of Olsen et al. (2020) and Aarstad et al. (2016) findings that suggest that intelligently designed industry clusters that co-create foster both innovation and productivity capabilities. The suggested framework is rooted in and also supported upon the suggestions from Wysocki (2011) that suggest that the best way to reduce the uncertainty of functional requirements in projects is through close cooperation between the business stakeholders and technicians, between users and developers, and between functional and project departments.

This way an industry cluster may co-create and employ a sort of "knowledge database", inspired by the Real Estate Core ontology and evolve it, by connecting the user need and use-case, shared knowledge, resources and integration like illustrated in *Figure 16*. This may help overcome the challenges this study present and both the interoperability challenge digitalization create (Skjelvan, 2015). This hopefully gives some information that might be of value in situations when facing the complexity project management and the user involvement.

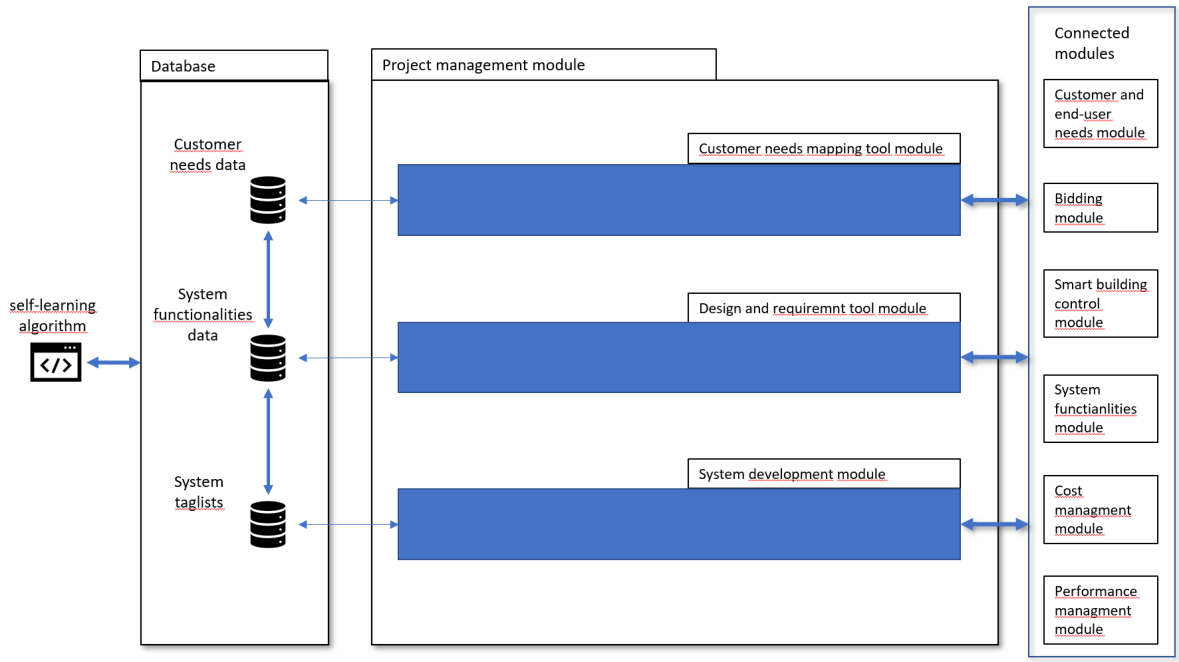


Figure 16: Prototype of a modularized project management system for smart building development project.

The concept of the framework is to connect the vast majority in industry players into one unified project management tool. By i.e. using the customer/end-user module one can use practical tools to map customer and end-user needs, pains and gains in tables. These can be used throughout the development and testing phase of single projects, and as the database grow the connection between user needs and system functionalities can be linked, to better understand what functionalities a system developer has to enhance to better serve a specific customer need. Furthermore, this data will be centralized and normalized with self-learning algorithm (like the RealEstateCore) within one project management database so it can be used and shared across all industry players. Enabling an open innovation, data sharing mindset, where the data that are gathered on one project can be used on the next one by any party using the project management database.

So, the point of the conceptual framework is to (1) aggregate the dynamic market, (2) connect the system developer closer to the end-user (by using the customer/user module throughout the whole PMLC) and (3) lighten the integration and project work by using technical tools and machine learning to do the heavy lifting. However, we see that this potential tool have some meaningful conditions to be fully utilized: (1) it needs to be used by all involved stakeholders throughout the whole project management lifecycle and (2) it has to become a some sort of standard to be able to reach its full potential (hence, that this have to be created in collaboration

between industry partners and alliances, i.e. in an industry cluster or open innovation collaboration om some sort).

6 Conclusion

To answer the research question: "*What barriers property managers experience as challenging when implementing smart building technologies?"* this study has used an inductive, explorative research design to uncover challenges and barriers the real estate industry face when implementing new technologies. The researchers have aimed to study the real estate industries technology challenges by including firms across the whole smart building industry value chain. This study gathered information from informants at companies varying from property managers, project managers, coworking manager, consultants, a system integrator company, a vendor, and a researcher, to cover a sample of the entire value chain in the real estate industry. The interviews were designed to generate situational stories to uncover individual's perception of challenged based on their personal experiences.

This study has shown how landlords and property managers, are facing a new role in the market due to their overall responsibility for buildings and decision-making. Their role has for long been traditional and of the status of "capitalizing" but is being challenged toward a more service-oriented real estate. This study has also presented that the Norwegian property companies in this study have shown a greater ability to adopt to their new role and tasks.

This study highlights that the drivers behind these changes is the emergence of more flexible working concept and that traditional real estate is challenged by the concept of coworking spaces. Even though coworking is a niche market targeting startups, freelancers and small business, the traditional way of working has been superseded due to the technological advancement of digital technology and how coworking spaces meet this increasing change in working concepts. The coworking spaces increasing market share and business model challenge the way traditional capitalizing business models of real estate work and utilize the huge investments that traditional real estate companies' property by creating added value to the end-user. This challenge real estate owners and property managers to become more user-centric and have changed the way projects are conducted through project management. The tenant's options increasing to more possibilities to choose between flexible office spaces without renting a whole office space, put the tenants and occupants of the building's satisfaction and stakeholder position of more importance. With the tenants increasing stakeholder position, this study show how project management needs to focus more on the end-user, the users of the building.

In contrast of traditional waterfall methodologies, agile project management focus on the end-user needs throughout the whole project lifecycle. The study suggests that traditional project management methodologies in real estate industry seem to be outdated due to their change in role. The study highlight how user involvement is important to define proper use- and business cases to reach the desired results. One should be utilized business cases in a higher degree throughout the whole lifecycle and as a strategic activity tool, rather than just a decision-making information tool to ensure strategic benefits and reach the desired result of the projects. Furthermore, the study explains how the importance of involving the right set of individuals and clarify the change throughout the whole project is important for uncertainty regarding investment in technology that satisfy and correspond to the end-users needs. The technology should thus solve a problem or exploit an opportunity, while still the implementation is needed or wanted. Ultimately, if a project manager (and property manager) don't understand the users' needs of the building, they will base their decision on assumptions and risk that the investment in the technology become unwanted or not needed.

The study further emphasizes how the new role changes the day-to-day operations, where key personnel in the organization (or building) has to undertake a bigger role in projects, whereas human resource allocation toward successfully complete a project can become a challenge. The HRM-paradox and the organizations overall strategy become essential in these decisions. Firms need to balance the resources between day-to-day operations and projects, and balance between learning need skills and competence and maintaining skills that serve the core of the current business.

In conclusion, this study found barriers and challenges that in the projects´ context that not only the implementation of new technology, but as a holistic view on the industry context. The amount of systems and solutions, in combination with the number of suppliers delivering these systems, it creates a complex project context. This study finds that cumbersome methods for configuration and updates of these systems can be traced back to the lack of interoperability within systems and between system vendors. Even though this study primarily has not focused on the supplier's role in relation to the property managers, these findings were not possible to oversee. Even though a dynamic environment with lots of suppliers and systems don´t necessarily have a negative effect on the market. However, the systems are developed by themselves and individually serve a small purpose, and the study finds that these systems are rarely connected. The "languages" and values the systems use are not unanimous and thereby

the property managers and especially property manager operators have to spend more time and resources on maintaining and updating the systems every time they want to update, upgrade or implement new features. One possible and logical explanation that the findings suggest is the reason why there are many solutions in the market may be because end-users´ needs can differ, which would mean every building (and its users) needs are different. If systems are developed to serve one or a few buildings need it makes sense that there will be a lot of different systems. Yet, this does not explain why the system is rarely connected. Another explanation the study findings explain why there are many vendors and solutions to smart building technology are that vendors lack a holistic view. Property managers of this study argue that the vendors do not have a holistic view. Explaining that they do not see the whole picture of the real estate owners, property managers and the end-users needs and use cases. In discussion, the study suggests that there is a long distance between the vendor and the end-users. The industry value chain can be perceived as rather linear, where the communication between those developing the systems and the ones actually using it are both physically and psychological a long distance apart. Moreover, it is not a demand for or perceived as the vendors responsibility or job to asses this situation and can argue that even though all vendors did take the responsibility, the question of time and resources used to create a technical interconnection is still a relevant factor.

To answer the research question: "*How property managers and real estate firms can manage challenges in projects regarding implementation of smart building technologies?"* this study further suggests that, to meet the necessary increase in user focus, flexibility and agility and change in competence, skills and knowledge in projects, digital technology and innovation, require real estate firms to become more cocreational and ambidextrous in a project managing perspective. Each and every real estate company see the need to develop the capabilities to face the digital technological advancement and increase in innovation and user focus. The industry itself need a standard that foster the innovative capabilities, but still not stagnate the competitive landscape of the industry. With inspiration from frameworks around cocreating and other smart building and full-scale smart city projects and research, this study present a suggested modularized industry wide database framework for the road ahead to foster interoperability, knowledge sharing, innovation and cocreating. The framework itself are meant to accelerate the innovation capabilities in the real estate industry and are meant also to be able to transfer between geographical and industrial barriers.

Even though the aim the study was to uncover challenges and barriers real estate owners and property mangers face when implementing smart building technology in commercial real estate, this study uncovered how dynamic environmental factors can stagnate an industry's innovational capabilities by being too complex and varied.

6.1 Theoretical and practical implications

This study complements the smart building literature with the insight of the "many suppliers, many vendors" insight. Surveys (i.e (Armstrong et al., 2019; Weir & Pyle, 2018; Weir et al., 2019))and literature (i.e (Hylving & Schultze, 2013; Lanzolla et al., 2018; Piccinini et al., 2015; Skjelvan, 2015)) on smart building and PropTech have a great focus on the fact that real estate firms need to change their culture to adapt to the digital transformation and become more adaptable. However, this study finds that the system vendors and industry on whole need to create a common understanding, or system to be able to adapt to more rapid changes and closer user involvement. Suggesting that literature and surveys need to further explore project management and environment complexities when it comes to smart building development projects.

BNL (2017) did suggest 4 enablers that were to simplify and enhance the possibilities to become fully digital. However, the plan needs a structural framework and database that can cope with the complexity both in multi-projects and a dynamic environment by structuring and connecting data across firms and projects. With the help of our prototype heavily inspired by Li et al. (2015), a modularized framework have practical implications regarding challenges the real estate firms and industry are facing in smart building projects.

The study are especially aimed for larger scale real estate firms that need to facilitate for themselves and small-scale real estate firms and PropTech firms to test out, structure and open up for a collaboration between all stakeholders in the industry, as all stakeholders and the industry as whole will benefit from the suggested solution in *chapter 5.4*: "*The road ahead*".

6.2 Limitations of the study

All studies have their limitations. The biggest limitation of this study is that it does not go into depth to any of the presented challenges. The aim of the study was to uncover and create a

overview of the challenges, and from theory and other studies suggest theoretical and practical implications that can help researchers and the real estate industry to manage these challenges. However, the amount of data collected have been heavily simplified to make it as simple as possible. Lots of useful, and interesting data and challenges was revealed during the interviews and observations that was not relevant for our main finding of "Too many systems and too many vendors" that creates project- and environmental complexity.

We would want to interview more system vendors and a larger scale of the value chain, although we got a great overview from the situation from a vendor perspective from system vendor 1 and the smart building conference. However, we had planned to interview several system vendors and integrators, but with the COVID-19 pandemic hitting firms and the global market right in our data collection, created other priorities within firms, resulting in many informants pulling out of the interview.

The COVID-19 pandemic is of course an important factor that have heavily weakened the study's validity and reliability and are an important limitation with that were not possible to foresee. Lower quality interview, the lack of ability to conduct proper workshops and enabling for more personal interactions and the filling of our mapping tool has made it more difficult to structure our data.

This leads us to the limitation of time. As we started with the data collection and the Smart Building Conference, we understood the scope of smart building concept, and the complexities that were built around it. Such an comprehensive study that wanted to completely explore the challenges that real estate firms meet in smart building projects should have been conducted over a longer period of time, with several, both unstructured and structured interview and workshops with a more diverse set of informants throughout the whole value chain. However, with an inductive and explorative approach and relatively small network within the real estate industry, a lot of time were used to connect and find the right people to talk too.

6.3 Further research

This study does not present an empirical valid findings of either project management, co-creation or user involvement and has to be further studies with quantitative empirical studies to give proposals of ways to change the industry and each organization are working with smart building technology.

As stated in the former chapter, the study is of a qualitative design and lots of data that could be gathered in a more structured way. Even thought that we planned to use a structured form of challenge ranking, we did not get the possibility to do so. We suggest, however, that such a mapping exercise can be further conducted with the use of the fundamental challenges and concepts from this study.

Furthermore, the suggested framework of a project management system needs to be thoroughly tested with relevant stakeholders. We suggest that academia and the industry come together to create a better understanding of the connection between system development, user involvement and co-creation.

One of the important factors that the study find is that there is a lack between system functionalities and user needs. This is a research field that both academia and real estate firms can further explore and map in a structured way using the suggested framework in this study.

7 Appendix

7.1 SINTEF Application

Fornavn: Christian
Etternavn: Bru
epost: christian.bru@hotmail.no
Mastergrad: Innovasjon og Ledelse
Universitet: Høyskolen på Vestlandet
Soknad: Vår masteroppgave skal ta for seg markedsrettet problemstilling, hindringer og utfordringer knyttet til å implementere Internett of Things (IoT) /smarthus og digitale teknologier inn i både gamle og nye forretningsbygg.
Prosjektet skal ta utgangspunkt i et studentselskap, SimplifyID, som ønsker å skape en mer sømløs arbeidshverdag og ser på utfordringen med administrative verktøy ved å drifte forretningsbygg.
Vi har allerde fått samtykke fra Hordaland Fylkeskommune om at dette er en case de ønsker SimplifyID å se på, samt at vi jobber med å gå med Bergen Kommune, GK Inneklima, Unloc og Tibber med som partnere i masteroppgaven.
Slik blir det en masteroppgave som er veldig markedsrettet og aktuell også for næringslivet da vi inkluderer både offentlige og private aktører direkte inn i prosjektet.

Vi har tatt som utgangspunkt å se på tre ulike bedrifter: En som har moderne teknologi og spørre om suksessfaktorer og utfordringer med implementering. En bedrift som er i prosessen med å utvikle og implementere nyere smarthus løsninger for å se hvilke direkte utfordringer de står ovenfor nå og hvordan de takler dette. Og til slutt ønsker vi å snakke med noen som ikke har startet å implementere eller sett på nyere teknologi og se hvorfor de ikke ser på muligheten for å implementere smarthus løsninger og digitale verktøy i sin drift.

I denne undersøkelsesfasen har allerede sett på universitet i Oslo og Høyskolen på Vestlandet som to motpoler, hvor UiO har allerde utviklet og implementert velfungerende smarthus løsnigner, mens HVL og Sammen er i prosessen av å utvikle og implementere. Slik kan vi se på de utfordringene som UiO har og har hatt ved implemnteringen og se på hvordan dette er i forhold til HVL og Sammen i Bergen. Dermed kan vi også gi god tilbakemelding til HVL og Sammen om mulige suksessfaktorer og prosessen ved å implementere smarthus løsninger i sin drift.

Målet er å kunne se på forskjellen mellom bedriftene og sammenligne hvilke utfordringer de står ovenfor, eventuelt se på hvilke faktorer som er viktig for å vellykket implementere ny smarthus løsninger inn i en eksisterende bedrift.

Vi søker om penger til å reise og intervjue relevante aktører i Oslo området, spesielt knyttet til UiO og deres løsninger. Herav f.eks. Unloc og Tibber, samt GK Inneklima som er et landsdekkende selskap. Vi ønsker også å komme i kontakt med de riktige menneskene ved UiO for å kunne bli videre dirigert til de selskapene som de har hatt samarbeid med under implementeringen av sitt system. Vi ønsker å dra til Oslo fordi vi ser det er der mange av hovedkvarterene til de teknologiske utviklingene innenfor Proptech ligger her. Vi ønsker å ha face-to-face intervjuer og kunne observere hvordan teknologien fungere hos UiO i praksis og få innsikt direkte hos de selskapene som er involvert.

Sum: 25000

Samtykke: Ja

7.2 Letter of sponsorship from SINTEF

Christian.bru@hotmail.no

From: [redacted]
Sent: tirsdag 17. desember 2019 18:55
To: christian.bru@hotmail.no
Subject: SINTEF-stipend 2019
Attachments: sintef-stipendet-web.pdf

Hei!

Vi har gleden av å informere deg om at ditt prosjekt har fått tildelt SINTEF-stipend på NOK 25 000,- for 2019. Dette fordi din masteroppgave og søknad svarer på vår visjon "Teknologi for et bedre samfunn", og fordi du har et spennende prosjekt.

For å kunne utbetale stipendet ønsker vi tilsendt kopi av ID, kopi av siste karakterutskrift og navn på din veileder.

I tillegg trenger vi din postadresse, ditt kontonummer og personnummer (alle som får utbetalinger fra SINTEF må registreres med personnummer).
Kontonummer og personnummer kan oversendes per SMS til tlf. [redacted] og dokumentasjonen kan sendes i scannet versjon på e-post til [redacted]
Vi ber deg sende inn disse opplysningene så snart som mulig, slik at utbetaling kan skje raskt.

En rapport på inntil 5 sider om resultater og dokumentasjon for bruk av midler må sendes inn senest ett år etter tildeling av stipendet. Mottaker av stipendet plikter å nevne at støtte er mottatt fra SINTEF når prosjektet blir diskutert offentlig, for eksempel i forbindelse med foredrag, posters, publikasjoner etc.

SINTEF påberoper seg retten til å bruke resultater fra prosjekter som har fått tildelt støtte i videre markedsføring av stipendet.

Se også vedlagte info om SINTEF-stipendet, spesielt avsnittet ang. bruk av stipendet: for at du skal kunne motta stipendet skattefritt, er det viktig at vilkårene her overholdes.
Vennligst ta kontakt dersom du har kommentarer eller spørsmål.

Vi ønsker deg lykke til med masteroppgaven og håper stipendpengene kommer til god nytte.

Med vennlig hilsen
[redacted]
Instituttkoordinator

[redacted]

www.sintef.no

7.3 Interview guide: Norwegian

Tema	Spørsmål	Forklaring
1. Oppvarming 2-5 min uformell samtale	Vi ønsker å komme med praktisk informasjon til andre som ønsker å digitalisere eksisterende bygg. Vi ønsker også å se smarte samfunn i fremtiden. Snakk gjerne om et spesifikk bygg eller alle bygg du har vært med på å digitalisere. Hvis det er spørsmål som du tenker en annen person kan fortelle oss mer om vil vi mer enn gjerne få en prat med personen.	Fortell om forskningen og målet med oppgaven.
2. Rammesetting og friske opp i hukommelsen	Hva er smartbygg for deg? Bruker du ordet «smartbygg» eller kaller du det noe annet? Hvilke elementer av bygget er det som vanligvis digitaliseres? Kan du ta oss med gjennom de viktigste stegene i prosessen med å gjøre eksisterende bygg smart?	-Etablere en forståelse om hva som legges i begrepet, ettersom det finnes flere tolkninger av begrepet og andre nærliggende begreper. Hva som digitaliseres er viktig kontekst å kunne gi når vi forklarer utfordringer og løsninger. Spørre om prosessen for at objektet drar på en mental reise tilbake til prosessen av digitaliseringsprosessen, og på den måten kan huske bedre hva som ble gjort. Bruk gjerne pen og papir eller en tavle for å tegne opp prosessen hvis det er mulig.
3. Erfarte utfordringer og hvordan håndterte de disse utfordringene:		
3.1 Før implementering	Hva bør være på plass før man setter i gang med digitaliseringen av et eksisterende bygg?	Gode forberedelser kan gjøre prosessen lettere og møte færre utfordringer. Kan også tenkes at man «må bare prøve seg fram», men det kan tenkes at det finnes måter å forberede seg på. Stiller også oppfølgingsspørsmål (laddering up / down).

	Hvilke utfordringer har du opplevd før du starter digitaliseringen av et eksisterende bygg? Hvordan løste dere dette? Virket dette? Og hvorfor virket det / virket det ikke?	
3.2 Under implementering	Hvilke utfordringer ble møtt underveis? Hvordan løste dere dette? Virket dette? Og hvorfor virket det / virket det ikke?	Stiller også oppfølgingsspørsmål (laddering up / down).
3.3 Etter implementering	Hvilke utfordringer opplevde du etter at digitaliseringsprosessen var regnet som over? Hvordan løste dere dette? Virket dette? Og hvorfor virket det / virket det ikke?	Stiller også oppfølgingsspørsmål (laddering up / down).
4. Tips (Spør direkte)	Hvis vi var en bedrift som ønsker å digitalisere et eksisterende bygg og har aldri gjort det før. Hvilke tips ville du gitt oss basert på din erfaring? (Hva å se opp for? Hvis det skjer, hva gjør vi da? Osv.)	Her ber vi om konkrete tips for å trekke ut det viktigste og putte det i et relativt kjent scenario.
5. Still spørsmål om ting som ble sagt for å gi kontekst eller på en annen måte tydeliggjøre det som er blitt sagt. Spør også om det er noe mer de ønsker å legge til.	Oppfølging av kontekst og informasjonen gitt i intervjuet. Er noen andre vi kan kontakte som du anser som en god kilde som kan gi verdifull informasjon som kan hjelpe denne forskningen?	

Interview guide: English

Subjects	Questions	Descriptions
1. Warm up. 2-5 min Small talk	What is your role and responsibility in this company? How did you get to where you are today? We aim to bring practical information to other companies that wish to implement Smart Building Technologies. In order to do that we want to hear about your experiences regarding implementing and usage of Smart Building Technologies in existing buildings. In order to answer the questions following in this interview, we ask you to draw from your own experience. Talk about what you know and from your standpoint. Be sure to explain if you are talking about a specific building, time or place.	We explain our study, and also our aim and research purpose.
2. Framework and refreshing informants memory.	Can you tell us about how you interpret the word “smart building”? Do you use the word “smart building” or do you use a different term? What parts of your building(s) are digitalized or made smart? Can you tell us about the last time you implemented a smart building technology?	Researchers aims to establish an understanding of how the informant interprets the term (smart building technology), gives the research a clear understanding of what the informant is talking about when using this term. We do this because there are several interpretations of the term and other related concepts. What parts of the buildings is made smart is important context for us, in order to understand when and where informants face challenges and solutions. And what technologies are used in these areas can give us information about what is being made smart and who delivers the technology or system. By asking about the process the informant can better remember former projects (related to the research question). If possible, use a pen and paper or blackboard to draw the process.
3. Experienced challenges and how the informant handled these challenges.		
3.1 Before implementing	What should be in place before you start the process of implementing a smart building technology?	Well done preparations can make the process easier and face fewer challenges.

	Before the process of implementing the technologies, have you ever experienced any challenges? How did you solve this? Did it work? Why/why not?	(Follow up questions. Laddering up/down.)
3.2 During implementation	What challenges did you face during the implementation of a smart building technology? How did you solve this? Did it work? Why/why not?	(Follow up questions. Laddering up/down.)
3.3 After implementation	After the technology was in place, what did you experience as difficult or challenging? How did you solve this? Did it work? Why/why not?	(Follow up questions. Laddering up/down.)
4. Tips (Straight to the point)	If we had a company with a building, and we wish to implement smart buildings technologies and have never done it before. What tips would you give us?	We ask the informant to give information about what should be in place before implementing smart building technologies.
5. Questions about what has been said to gain a clearity to what contexts or situations the information given is referring to. Ask if there anything else they might want to add.	Follow up on context and information given. Anything else to add? If there is someone else you might think can give valuable information to this study, we would like to talk to these individuals.	

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