Value-Adding Factors for Connected Entrances in the Smart Building Market

Victor Lagerfors and Arvid Ekblom

DIVISION OF INNOVATION ENGINEERING | DEPARTMENT OF DESIGN SCIENCES
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MASTER THESIS

ASSA ABLOY

Value-Adding Factors for Connected Entrances in the Smart Building Market

A qualitative study on how entrance manufacturers can meet the needs of the smart building market.

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Department of Design Sciences
Faculty of Engineering LTH, Lund University
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Subject: Innovation Engineering (INTM01)
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Supervisor: Lars Bengtsson
Co-supervisor: Roger Dreyer
Examiner: Glenn Johansson

Abstract

The building industry, like many others, are currently experiencing the effects of the digitalization, and the increased spread of smart buildings is a result of this. Much research has been done on smart buildings and their predecessors intelligent buildings, but there is limited research available on how entrance systems should be designed for smart buildings, especially regarding their connected functionality. Therefore, this thesis aims to determine the critical value-adding factors of connected entrances for smart buildings and based on these factors, give recommendations on how Assa Abloy should design an attractive value proposition of connected entrances for this market.

To answer these questions, a market analysis was carried out by performing a qualitative interview study with stakeholders in the smart building and entrances markets. The interviews followed an explorative approach, and the results of the interviews were coded for overarching themes before being analyzed using the Value Proposition Canvas and the Diffusion of Innovations theory.

Twelve (12) critical value-adding factors were identified in the following areas: data provisioning and access, remote control, improved service, IT security, sustained product support, and sustainable pricing models. Based on these factors, a recommendation for an attractive value proposition was presented based on the nine (9) following areas: physical product, service offering, communication solution, remote control & automation, data offering, value co-creation, digital access, software, and pricing. Furthermore, it was concluded that to reach the smart building market successfully, *innovative* property owners should be the target group for the connected entrances offering.

Keywords: smart buildings, Internet of Things, automatic entrances, connected entrances, Assa Abloy, value proposition design

Sammanfattning

Byggnadsindustrin, likt många andra, upplever för närvarande effekterna av digitaliseringen, och den ökade spridningen av smarta byggnader är ett resultat av detta. Det finns ett flertal studier om smarta byggnader och deras föregångare intelligenta byggnader, men endast en begränsad mängd studier berör hur entrésystem bör utformas för smarta byggnader, särskilt rörande deras uppkopplade funktionalitet. Således är målet med denna uppsats att avgöra de viktigaste värdeskapande faktorerna hos uppkopplade dörrar i smarta byggnader och, baserat på dessa, ge rekommendationer kring hur Assa Abloy bör utforma ett attraktivt värdeerbjudande av uppkopplade dörrar för denna marknad.

För att svara på dessa frågor genomfördes en marknadsanalys med hjälp av en kvalitativ intervjustudie med intressenter inom den smarta byggnads- och entrémarknaden. Intervjuerna genomfördes med ett explorativt angreppssätt, och resultaten av intervjuerna kodades för övergripande teman innan de analyserades med hjälp av Value Proposition Canvas-modellen och Diffusion of Innovations-teorin.

Tolv (12) viktiga värdeskapande faktorer identifierades inom de följande områdena: tillhandahållande och åtkomst till data, fjärrstyrning, förbättrad service, IT-säkerhet, kontinuerlig produkt- och mjukvaruunderhåll, och hållbara prissättningsmodeller. Baserat på dessa faktorer presenterades en rekommendation för ett attraktivt värdeerbjudande som grundar sig i följande nio (9) områden: fysisk produkt, serviceerbjudande, kommunikationslösning, fjärrstyrning och automation, dataerbjudande, gemensamt värdeskapande, digital åtkomstlösning, mjukvara, och prissättning. Vidare drogs slutsatsen att för att nå smarta byggnadsmarknaden framgångsrikt så bör innovativa fastighetsägare vara målgruppen för uppkopplade entréerbjudandet.

Nyckelord: smarta byggnader, Internet of Things, automatiska entréer, uppkopplade entréer, Assa Abloy, value proposition design

Acknowledgments

This master thesis has been carried out at the Division of Innovation Engineering at the Department of Design Science at LTH. It is the final step for the students' journey towards a degree in a M.Sc. in Industrial Engineering and Management.

We would like to extend our most sincere thanks to our supervisor at LTH, Lars Bengtsson, for assisting us in taking this master thesis in the right direction. The input he has provided us with, especially on methodology and research strategy, has been invaluable to this master thesis. Likewise, we would also like to extend our gratitude to our supervisor and aids at Assa Abloy, Roger Dreyer and Ulf Ahlfors, who have helped us navigate and focus our area of research, as well as have given great insights into a field we were previously unfamiliar with.

We would also like to express our sincerest gratitude to those who have been willing to help us out by volunteering for an interview. Your contribution to this master thesis has been vital to its completion and it could not have been done without you.

Lund, May 2021

Victor Lagerfors & Arvid Ekblom

Table of contents

List of figures

List of tables

1 Introduction

This chapter serves to introduce the reader to the context and goals of this thesis. First, the background to the thesis is presented. Secondly, the purpose and research questions that guide the thesis are introduced. Lastly, the delimitations of the thesis are outlined, followed by an overview of the thesis.

1.1 Background

The digitalization has become widespread in society over the last few years, affecting all businesses and consumers. One of many areas that has seen the effects of digitalization is the building industry. As the *Internet of Things (*IoT) has grown from a buzzword to an area of opportunity, the interest in connecting buildings to the IoT has grown significantly. The result of this integration is the *smart building*: a building where significant parts have been equipped with sensors, actuators and IoT connectivity, allowing for remote monitoring and control and automation of the building. The purpose of the smart building is to optimize the efficiency of the building with regards to, among other, the areas of ventilation, security, energy efficiency and comfort (Buckman et al., 2014).

The goals of smart buildings fall well in line with Agenda 2030 and the Sustainable Development Goals (SDGs). Smart buildings can be a key factor in achieving the goal of *Sustainable Cities and Communities*, with possibilities for greater energy efficiency and space utilization of our cities. As, for example, 40 % of the energy consumption and corresponding greenhouse gas emissions in the US originate from buildings, there are great energy saving opportunities to be had (United States Department of Energy, 2015).

As the interest in smart buildings grows, the demand for traditional building components that provide functionality for connection to the IoT increases, and many actors in this field are now working on designing and developing the products that include IoT capability in their offering. One such actor is Assa Abloy Entrance Systems and its subdivision Pedestrian Door Solutions (PDS). They are a large manufacturer of automatic entrances systems and are interested in entering the smart building market with *connected entrances* for several reasons. Beside the SDGs mentioned above, connected products provide great opportunities for enhancing

services and lowering costs by utilizing the data they provide. Furthermore, sustainability is a growing part of Assa Abloy's strategy, and as smart buildings promise increased energy efficiency and lowered climate impact, they are a natural focus for expanding the product line-up. To aid in Assa Abloy's ambitions of entering the smart building market, this thesis aims to explore connected entrances in this market. The results from this thesis may be relevant not only for Assa Abloy, but also for other actors in the smart building space.

1.2 Purpose

The purpose of this thesis is to explore the market for connected entrances in smart buildings and find which the critical value-adding factors for connected entrances in this market are. This thesis also aims to determine how Assa Abloy PDS should design a competitive product and service offering of connected entrances for the smart building market, based on the value-adding factors.

1.3 Definition of value-adding factor

For this study, a value-adding factor is to be defined as the value which a product or service offering provides that meets the needs or wants of a customer.

1.4 Research questions

The two research questions that will guide this master thesis are presented below.

RQ1	Which are the critical value-adding factors of connected entrances for the smart building market?
RQ2	How should Assa Abloy design a competitive product and service offering of connected entrances for the smart building market?

Table 1.1: The research questions for this thesis.

1.5 Delimitations

The following delimitations have been made to help focus the research effort.

- The interviewed smart buildings customers are present in the Swedish market.
- The entrances are meant for pedestrian use, meaning no entrances such as garage doors, industrial loading doors, or other doors not meant for pedestrian passage.
- The entrances are meant for use in a non-private setting, meaning doors for individual apartments within a smart building are excluded.
- The interviews are limited to building owners who are working actively with smart building development.

1.6 Thesis overview

This thesis will start by outlining the methodology used for the research process in chapter 2. Chapter 3 presents a more in-depth background on Assa Abloy and the smart building market, and chapter 4 focuses on the theoretical models that will be used to analyze interview material that will be collected. Chapter 5 presents the interview material, which consists of paraphrased transcripts of all interviews conducted for the research. Chapter 6 analyses the interview material with the models presented in chapter 4 and presents the findings this process yielded. Chapter 7 discussed the findings from different perspectives, and finally chapter 8 presents the conclusions of the thesis.

2 Methodology

In this section, the methodology used when conducting the research for this thesis is presented. The purpose is to give an insight into the research process, substantiating the decisions taken to provide answers to the research questions.

2.1 Research methodology

To produce results in a reproducible manner, a clear research methodology should be defined. The research methodology should help the reader follow along with the author's reasoning, and if the reader so wishes, challenge the results by performing the research according to the methodology themselves.

To help in the creation of a research methodology suitable for a specific research format, there are several frameworks available to guide the researchers for this thesis. This ensures that no important aspects are left out and gives transparency for the research process. One such method that can be used to define a research methodology is the research onion, which guides the development of a research methodology through the six layers of a metaphorical onion. As one peels an onion from the outside in, the research onion guides the development from broader philosophical statements about the research at the outside of the onion, finishing with concrete techniques and procedures at the core of the onion. Having processed all layers of the onion, a research methodology can be presented which should cover all important areas. (Saunders et al., 2019, p. 122) The research onion is illustrated in Figure 2.1.

For this study, the research onion has been adopted to fit a study with a greater focus on problem-solving aspects of research. This means that the philosophical and approach to theory development layers have been removed, as they did not contribute to the formation of the remaining layers.

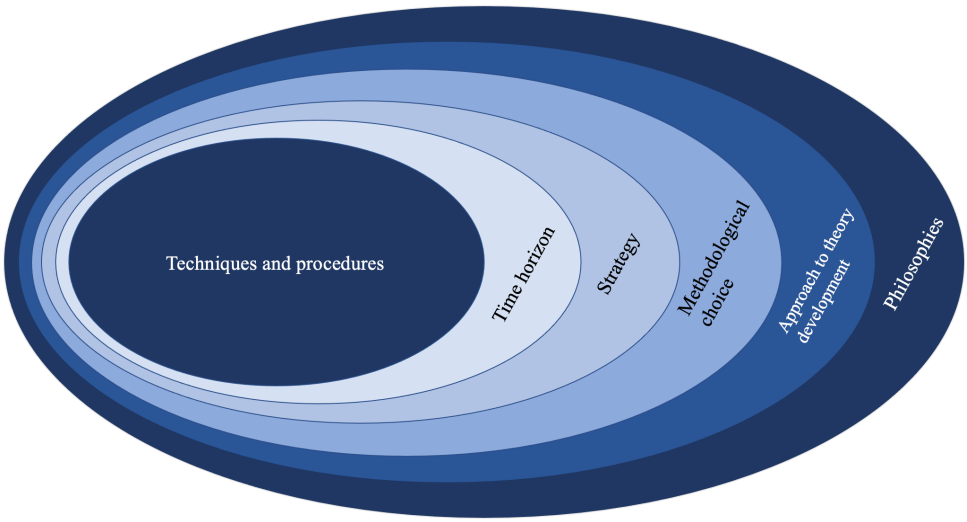

Figure 2.1: The research onion (Saunders et al., 2019)

2.1.1 **Methodological choice**

The choice of methodology aims to describe how we aim to answer our research question and guides the first concrete steps in carrying out the studies. The methods that can be used for the research are either quantitative, qualitative, or a mix of both. A quantitative methodology aims to collect numerical data on the research question being studied, commonly to find correlations between variables. Qualitative methodologies focus on collecting data which then needs to be interpreted to provide value. (Saunders et al., 2019, p. 165) For this study, a qualitative research methodology was chosen.

Höst et al. (2006, p. 114) mentions four categories into which qualitative research methods can be grouped

- *Quasi-statistical methods*, which is almost a hybrid between quantitative and qualitative methodology. Relying on source material from the study subject, it counts the occurrence of words or groups of words to judge the importance of concepts for different groups. (Höst et al., 2006, p. 114)
- *Template-based methods,* which based on a theoretical background and knowledge of terminology selects a number of key terms which are looked for in source material. The key outcome of this method contrasts to the quasi-statistical method, as the number of occurrences of terms is not of importance, rather which type of actor uses what terminology. (Höst et al., 2006, p. 114)

- *Thematic analysis* is similar to template-based methods but contrasts in the selection of which keywords are searched for. In editing methods, the keywords are selected a posteriori to the data being collected. For interviews, this would mean that the person analyzing the data selects the keywords based on what is apparent in the data, meaning that the persons interpretation comes into play. (Höst et al., 2006, p. 114)
- *Immersive methods* are methods where the person analyzing the data uses their creativity and intuition to come to their conclusion, in an unsystematic way. This methodology is lacking in scientific rigor and therefore unsuitable for scientific studies. (Höst et al., 2006, p. 115)

For the analysis of the interviews performed in this study, the approach chosen is that of a thematic analysis methodology. The researchers will attempt to identify themes based on what is said in the interviews.

A quantitative analysis methodology, while not chosen for this research project, could also have been used to investigate the research questions. Such a study would likely require the researchers to suggest several value-adding factors for the interview subjects to rate. E.g., surveys could have been used which would investigate value-adding factors based on current knowledge of theoretical possibilities and then map them based on how strongly research subjects concur or disagree with their usage and application. However, as the researchers for this project deemed much knowledge of usage and applications to not be publicly available, concerns were raised regarding the risk of the researchers not being able to ask the proper questions for a survey format. Hence, the study was of qualitative type to ease the discovery of new usages and applications, as well as provide a way of brainstorming together with the interview subject during the interview session.

2.1.2 **Strategy**

Different research goals require different research strategies. Höst et. al (2006, p. 29) highlight four main types of studies. These types are

- *Descriptive*, with the aim of finding out and describing how a phenomenon works
- *Exploratory*, with the aim of getting a deeper understanding for how a phenomenon works
- *Explanatory,* with the aim of seeking patterns of causality and explanations for how a phenomenon works
- *Problem-solving,* with the aim of finding a solution for an identified problem.

Höst et al. (2006, p. 26) also highlight that a study can be comprised of a number of smaller studies of different types, if so is suitable for answering the research

question. For our study, it is suitable to divide it into three major parts: a descriptive, an exploratory and a problem-solving study.

2.1.2.1 Descriptive study

First, a descriptive study is to be performed. The aim of this is to gain a good understanding of the pedestrian entrances market, smart building market and market for IoT technologies. The purpose is also to map what knowledge is available at the current moment, preparing to focus on areas with less coverage in the exploratory study. The descriptive study will be done through studying literature using online platforms, giving as much insight into these areas as possible from the sources available online. Some interviews will also have the goal of describing the study area.

2.1.2.2 Exploratory study

Second, an exploratory study is to be performed. This will help expand the knowledge base in the areas described in the first part beyond the information readily available to study in literary sources and initial interviews. This is achieved through interviews with individuals who have deeper insight into the mentioned areas, at different levels of organizations and at different types of actors. The exploratory study also, through interviews, aims to uncover what factors create value for different actors in the sphere of pedestrian entrance systems.

The exploratory study results in a filled-out customer profile, describing what the critical value-adding factors are for actors in the smart building space. This is done according to the Value Proposition Design framework by Osterwalder et al. (2014), where the customer profile consists of what the customer jobs, pains and gains are.

2.1.2.3 Problem-solving study

Based on the results of the two preceding stages, the problem-solving part of the study is commenced. The aim of the problem-solving study is to, with the help of the theoretical background and models, describe a value offering which Assa Abloy could provide for its potential smart building customers. This is done through creating a value map of a theoretical connected entrance offering, where the gain creators and pain relievers are anchored in what functionality is possible using IoT technology. This should be done by finding a good fit between what values the connected entrance can provide what the customer wants, described by the customer profile. The product offering is also further refined through being processed by the model for diffusion of innovations, where potential hinderances to the adaptation of connected entrances are handled and concrete product functionalities are presented.

2.1.3 **Time horizon**

The research question aims to study what the market for smart buildings demands at the current moment, and as such a cross-sectional time horizon is appropriate. This is in contrast to a longitudinal time horizon, where a phenomenon is studied over a period of time to see how it changes. In the case of a cross-sectional study of the real estate and construction industry, we believe that such a study will hold validity for a significant amount of time as the industry is said to be very slow-moving (McKinsey & Co, 2015).

2.1.4 **Techniques and procedures**

Based on the choices and assumptions made following the research onion, the following steps outline the research process.

2.1.4.1 Literature search

For this thesis, a thorough literature review has been performed. The purpose of this is to understand what research has been done that is relevant to this field, giving our research a context and allowing us to focus on performing research that adds to existing knowledge.

To search for relevant literature efficiently, a strategy for how to utilize available databases effectively was set up. This was done by defining keywords relevant to our research question and related areas, which were then input into search engines connected to databases containing academic sources. The search engines used were Google Scholar and LUBSearch. For further context and information, searches were performed outside scientific databases. The search engine used to find data in these areas was Google. In line with our research questions, the fields that we focused on finding academic material within were Internet of Things, Value Creation, Value Co-Creation, Innovation and Technology Strategy, Entrance Selection. After reviewing each relevant source from the initial search, relevant references in our selected articles were used to discover further relevant sources.

2.1.4.2 Data collection

Raw data is needed to answer the research questions , and the data collection process set out to gather data through literature search and interviews. Data was collected through interviews with individuals that possessed knowledge in areas connected to our research field. For the interviews, we chose a semi-structured interview approach. This meant that a set of questions were prepared for the interviewee to be asked, but if interesting facts came up in the answers, the interviewers could ask follow-up questions on these. The interviewers could also change the order of questions and skip questions entirely if they so deem fit. This format allows the

researchers to deep dive into the questions of interest for studying, asking specific questions on areas they were interested in researching. It also allowed the researchers to discover interesting new factors that they had not considered prior to the interview.

Interviewees were selected from a range of fields relevant to the research questions, which meant that the questions needed to be adapted based on the interviewees' knowledge. Early in the interview process, three groups were identified as being most relevant to the thesis' research questions: Assa Abloy employees, system integrators, and property owners working with smart buildings. Therefore, the interviewees were primarily found in these three categories. A complete overview of the conducted interviews can be found in chapter 5.

The first interviews were conducted with a wide scope of questions and interview subjects to provide an overview of the smart building industry. The goal was to interview at least one person in each step of the processes of constructing and procuring components for a smart building. The questions asked to the interview subjects for the initial interviews in each field were based on theory and studies analyzed prior to the interviews. These interviews would also help the researchers perform an analysis of what the procurement and development process for smart building implementations looks like today, and what it could look like for a potential smart door solution. Based on the data gathered from these interviews, the interview questions would be iteratively developed to be more focused and specific, in tandem with analysis of the data from the interviews. Depending on the perceived relevance of actors in the specific area, the number of interview subjects in the area could be extended.

For our data to be significant, we needed to ensure that our interviews had sufficient coverage over the population we are studying. As the actors in the smart building space are not numerous, this would allow us to get good coverage with the limited interviews we were able to perform.

As a result of the ongoing Covid-19 pandemic, all interviews were held virtually using digital aids. During the interviews, the answers to both structured and unstructured questions were written down by the interviewers. Nearly all of the interviews were not recorded as the interview subjects would potentially be less willing to speak freely about certain subjects. After having written down the answers to the interview questions, a summary of the interview was written in free text. This summary was then to be included for reference for academic purposes. This summary was also sent to the interview subjects, for validation in case they would disagree on anything.

2.1.4.3 Data analysis

As the gathered interview data was of the qualitative sort, qualitative data analysis methods were applied to structure the key factors from the interviewee responses.

Creswell and Creswell (2018, p. 268) highlight their five-step process for performing analysis of qualitative data sets, which is what our analysis methodology is adapted from. The method used for data analysis is illustrated in Figure 2.2.

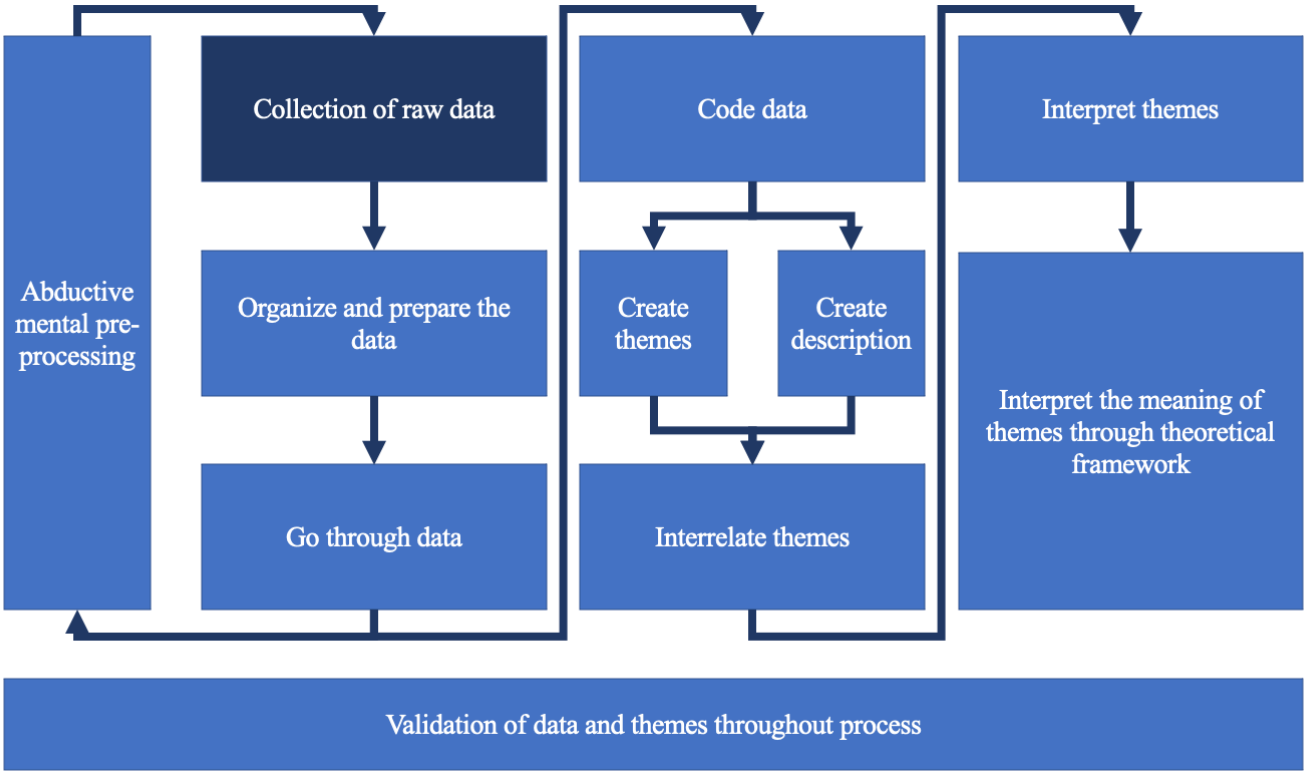

Figure 2.2: Method for qualitative analysis of interview data, adapted from Creswell and Creswell (2018, p.268)

Firstly, raw data was collected through interviews with people who have knowledge related to the field which is to be studied.

1. The first step of the analysis process was to make the data suitable for analysis. In the case of our interviews, the notes taken on answers to interview questions were written into a summarized report of what was said by the interview subjects.
2. The interview report was then read through, and overarching themes analyzed through discussion between the researchers. The researchers could then choose to adapt interview methods and templates for the next interview if so was needed to get more relevant data.

3. By coding the interviews, the interviews were broken down in a structured way by the researchers and categorized. Interesting pieces of information were tagged with *codes*. In the case of an interview, Creswell and Creswell (2018, p. 269) mention that labeling of the code is often based on the language used by the participant.
4. Having a coded interview report, the codes were used to both generate themes and a description of these themes. The themes were interpretations of the codes in the context of what is being researched, and the description aimed to give an in-depth analysis of the themes. Together, these constituted the key findings of the study and interviews.
5. The themes were then analyzed through interrelating them to provide a greater overview of what the themes mean and how they might interact. This helps provided greater context and connects the dots between various themes.
6. The interrelated themes then formed the aggregate dimensions of the analysis, a form of interpretation of what the more abstract goals of the actors are. This builds on how the themes interact with each other to reveal the actors' ulterior motives.
7. Finally, the themes and aggregate dimensions which have been the result of this analysis were processed through the theoretical frameworks.

Throughout the entire process the researchers also made sure to keep an open mind and attempted to continuously validate the data, making sure that what is said is reasonable and possibly cross-checking across the theoretical basis if so is needed.

2.1.4.4 Aim of data analysis

The aim of analyzing the interview was to provide us with two important sets of data. The first and foremost was to give answers to the research questions by analyzing answers to questions of what creates value for different actors. However, to assist in further nuance and to give background to these answers the interviews were also analyzed to give an overview of how doors for smart buildings are procured, and what the different stakeholders in smart buildings contribute to the ecosystem.

2.2 Research ethics

To ensure that the research set to be carried out by this thesis is in good ethical standing, the research will be carried out in line with the expectations from Denscombe (2011, p. 331)

- "Protects the interests of the participants;

- Ensures that participation is voluntary and based on informed consent;
- Avoids deception and operates with scientific integrity;
- Complies with the laws of the land."

In order to protect the interests of the participants, i.e., make sure that they do not suffer as a result of our research, the interviews were presented as summaries of key points said instead of full transcripts. This allowed the researchers to leave out details said by the interview subjects which might portray the subject unfavorably. Furthermore, the summaries were sent to the interview subjects for approval for inclusion. This allowed them to check through what they have said and allowed them to raise concerns if anything unfavorable to them is included. When the interviewers wished to record the interviews, the interview subjects were clearly notified of this beforehand and had the option of declining to allow the interview to be recorded.

Ensuring that participation is voluntary and based on informed consent was solved through recruiting interview subjects over email communication, where the scope of the research and interview was clearly presented. This resulted in a situation where the interview subject should not feel obligated to participate and could easily decline by simply not answering the email. For those that did choose to participate, there was consent in writing of their willingness to participate. Those who were interviewed were then given more in-depth information about the research to further their informed consent of their participation.

Ensuring that the researchers avoid deception and operate with scientific integrity was handled by having the researchers clearly explain what they expect from the interview subject and what data they were aiming to collect. Ethical conduct in this area was further improved by the researchers sending interview subjects the version of their interview to be included for analysis and publication. The researchers were also to take a neutral and unbiased stance to the interpretation of their findings.

Lastly, the researchers must ensure that the research abides by the laws of the land. This included ensuring that the research did not infringe on any intellectual property rights, especially of those which are used for the background and theory for which the research is based on. The data of participants as well as sensitive data from Assa Abloy was handled according to laws and regulations for these. As the data was not on a particularly sensitive subject, no extraordinary measures needed to be taken to guarantee participant data security.

2.3 Credibility of research

Through the methodology, the research should demonstrate a high degree of credibility. Denscombe (2011, p. 298) outlines four key criteria that the credibility of research can be judged by.

- Validity
- Reliability
- Generalizability
- Objectivity

2.3.1 **Validity**

The performed research should be done using data which is accurate and appropriate. To aid in ensuring good validity, researchers can use a number of methods, such as triangulation, respondent validation and grounded data. (Denscombe, 2011) To ensure a high degree of accuracy in this study, the researchers used triangulation by interviewing multiple individuals related to the area being studied. For good validity, the researchers aimed to see similar responses to key factors in question from all interview subjects. As the interviews were then summarized based on key themes discussed, this summary could be used for further validity through respondent validation. Finally, by verifying that the respondents' replies were grounded in the background research performed, the researchers could contribute to further validity in data.

2.3.2 **Reliability**

Issues with reliability relate to the question "If someone else did the research, would he or she have got the same results and arrived at the same conclusion?" (Denscombe, 2011, p. 300). To ensure good reliability, researchers shall clearly show what they have done over the course of the study so that other researchers can judge how replicable the study is. (Denscombe, 2011, p. 300) For this research project, the methodology was clearly outlined, and steps of analysis broken down for good overview of the research process.

2.3.3 **Generalizability**

The generalizability of research, especially in that of the qualitative research variant, can be questionable in the sense that the dataset studied often consists of a very small number of cases in comparison to the size of the general population. Questions

that are often raised in regards to this is “How can you generalize on the basis of such a small number?”. (Denscombe, 2011, p. 301)

The researchers for this study chose to delimit their research to a smaller group of “Innovative smart building owners” and aim for generalizability within this smaller group. This means that with a larger part of the population surveyed, the probability of those actors being outliers decreases. With respect to the transferability of the results to other groups, a discussion on this was performed in the context of the theoretical background.

2.3.4 **Objectivity**

Objectivity in research refers to what influence the researchers exert on the findings. No researcher can ever be truly objective, especially in qualitative research where interpretation is needed as part of the process of analysis. The researcher’s self, together with their values and beliefs shape this interpretive process. To best combat the potential for lacking objectivity, researchers must “approach the analysis of data with an open mind”. (Denscombe, 2011, p. 303) To aid in keeping an open mind, Denscombe (2011, p. 303) recommends to avoid neglecting data that do not fit the analysis as well as to check rival explanations.

3 Assa Abloy and the smart building market

In this chapter, background information is presented on several topics relevant for this thesis. In the first half, Assa Abloy and Assa Abloy PDS are presented, as well as automatic entrances and the automatic entrances market. In the second half, Internet of Things, smart buildings, and related topics are introduced. The information in this chapter comes both from previous studies and from the interviews conducted for this thesis, which can be found in chapter 5.

3.1 Assa Abloy

Assa Abloy Group is a multinational conglomerate that offers products and services in locks, doors, gates, and entrance automation. The company was founded in 1994 in Sweden and has since, through organic growth and acquisitions, become the international company it is today. Assa Abloy Group currently consists of 190 different brands outside of the mother brand Assa Abloy, with a varying amount of cooperation and knowledge sharing between the brands. (ASSA ABLOY, n.d.-a)

Assa Abloy Entrance Systems is one of the five division of Assa Abloy. Its headquarters are located in Landskrona, Sweden, and specializes in automatic entrance systems. Pedestrian Door Solutions (PDS) is a part of Entrance Systems that focuses on automatic entrance systems for pedestrians. (ASSA ABLOY, n.d.-a)

3.2 Automatic entrances

Entrance systems can be divided into two main types: industrial entrance and pedestrian entrance systems. Industrial entrance systems focus on allowing for efficient passage of goods and equipment, while pedestrian entrance systems focus on allowing for the efficient passage of pedestrians. There are three types of doors in pedestrian entrance systems: sliding doors, swing doors and revolving doors.

These different types all provide different benefits, making them suitable for a variety of entrance system environments. Sliding doors, i.e., doors which open by sliding horizontally, are among the most common due to their versatility. Swing doors, i.e., doors which are hinged like traditional doors and equipped with an arm to allow it to open automatically, are also common. They provide an automatic door solution for areas where space might be limited and can also be opened manually if so required. Revolving doors, i.e., doors with several compartments for people which constantly rotate, are common in environments where there is a high flow of people and a requirement to keep indoor and outdoor climates separated. This is due to the advantage of the several compartments in the entrance which ensure that the indoor and outdoor climate are never in direct contact. (ASSA ABLOY, n.d.-c)

Most automatic doors utilize some form of sensing to automatically open based on the presence of a person. Many are also connected to some form of access control system to unlock and open a door based on if an individual has permission to access the area, usually by providing authentication in the form of an access card. While many automatic doors make up the barrier between the outside and inside of the building, they are often utilized inside buildings as well.

Key factors that are of great importance for entrance systems are safety, security, climate control and pricing. In general, the entrance systems for buildings are deemed to be of great interest to building owners as it plays such a big role in allowing people to enter and exit the building.[1]

3.3 Key functionalities in traditional automatic entrances

Since the connected functionality in a connected entrance is an addition rather than an alternative to traditional entrances, the functionality that a traditional entrance provides will be present in a connected entrance as well. While these are not the focal point of this thesis, they serve as a baseline of what an entrance should provide, which a connected entrance then will build upon.

The key functionalities of automatic entrances are:

- The ability to let pedestrians enter or leave a space
- The ability to regulate the climate, primarily in acting as barrier between the inside and outside of a building
- Acting as a security barrier

[1] Per Hallgren Luterkort, interview, chapter 5

- Acting as a point of access control

Furthermore, as the service of the automatic entrance is often an integral part of a product offering, both reactive and preventative service that ensure high uptime of an entrance can be considered to be a part of the key functionalities. [2]

3.4 The automatic pedestrian entrances market

The global automatic entrances market was valued at $22,400 million in 2018, with several large players. According to a report by Allied Market Research, the largest companies in the global automatic entrances market are ASSA ABLOY Group, Deutschtec GmbH, dormakaba Holding AG, GEZE GmbH, MANUSA GEST, S.L., Nabtesco Corporation, Rite-Hite Holding Corporation, Royal Boon Edam International B.V, Sanwa Holdings Corporation, and Stanley Black & Decker, Inc. (Allied Market Research, n.d.) Assa Abloy is currently the third largest provider of automatic entrance systems for pedestrians in the Swedish market[3].

The two main revenue streams for the pedestrian entrance systems market are the sales of new equipment and installation, together with the sale of service for the installed base. For Assa Abloy PDS, these two revenue streams roughly follow a 50/50 split[4].

The sales of entrance systems in the market can happen in several different ways. The two main ways that entrances are sold are either directly to the end customer, meaning the property owner, or through a construction company that oversees the construction of a building. When entrances are sold directly to the property owner, the sale is often concerning only one or a few entrances, and they are most often to be installed in an existing building. On the other hand, when construction companies purchase entrances, they are to be installed in an ongoing construction project and the number of doors purchased are often larger.[5]

While the property owners most often specify which product they want themselves when they are the ones purchasing an entrance, the process is more complicated when a construction company purchase an entrance. The architect or property owner of the building under construction can specify which attributes, which brand or

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[2] David Andersson, interview, chapter 5

[3] Per Hallgren Luterkort, interview, chapter 5

[4] Ibid.

[5] Ibid.

which exact product that should be installed in a specific location. The construction company then follows this specification when purchasing an entrance, aiming for the lowest possible price while still meeting the requirements.[6]

As automatic entrances have many moving parts that are prone to wear, the service of the entrance is an integral part of the product offering. The sale of service contracts can happen either together with the sale of the door or at a later stage, and the company producing the door is not necessarily the company servicing the door. At Assa Abloy PDS, most of the service contracts today are not sold together with the door, but at a later stage, and PDS mostly service doors they themselves have produced and sold. The level of service can differ between contracts, with some contracts following an all-inclusive model and some only offering the bare minimum.[7]

3.5 Internet of Things

The Internet of Things is defined by the International Telecommunications Union, (2012) as "A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.". One of the main functionalities that this provides is to combine objects in the physical world with virtual things in the digital world. It adds the aspect of communicating with *any thing*, to our current abilities of communicating *any place* and *any time.* (*Overview of the Internet of Things*, 2012)

Many products are available with Internet of Things connectivity, both towards consumers and businesses. Notable products in the consumer-space, just to name a few, include connected lightbulbs in the Philips Hue ecosystem, robot vacuums from Xiaomi and Neato, as well as modern Tesla cars. Many of the IoT-functionalities in these products focus on controlling and checking the status of the devices remotely. Some functionality also focuses on providing intelligent functions based on interactions with other IoT devices, such as Philips Hue lightbulbs automatically turning on and off based on the location of the owner's phone.

When looking at solutions in the IoT space at large, many of the innovations seen can be divided into existing in either the *micro-sphere* or the *macro-sphere.* The micro-sphere includes products that the consumer interacts with directly, such as

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[6] Ibid.

[7] David Andersson, interview, chapter 5

wearables and residential IoT solutions. It also includes innovations which enable other innovations in the macro-sphere, such as sensors for data collection. The macro-sphere includes technologies and products which the end user mainly interacts with indirectly, such as data analytics, big data, and cloud computing. (Nicolescu et al., 2018)

In their article *The Internet of Things (IoT): Applications, investments, and challenges for enterprises,* Lee & Lee outline several technologies which are used heavily for enabling the creation of products and services in the IoT space: radio frequency identification (RFID), wireless sensor networks (WSN), middleware, cloud computing, and IoT application software. (Lee & Lee, 2015, p. 432)

RFID is a technology mainly used for tagging and identifying objects which are included in an IoT system, using radio frequencies for communication. This enables functionality such as detecting the position of objects and are used heavily for identification of items at a distance.(Lee & Lee, 2015, p. 432)

Wireless sensor networks are comprised of the devices in an IoT system which provide sensor data on parameters such as the surrounding environment, or the status of physical aspects of a device which is of integrated with sensing capabilities. These sensors then communicate back wirelessly, potentially over a variety of network topologies depending on the situation. (Lee & Lee, 2015, p. 432)

Middleware provides a layer of abstraction for developers between the hardware implementation aspects of an IoT component and utilizing its functionality. It removes the unnecessary details of hardware specifics and allows developers to focus on utilizing the components for application development. (Lee & Lee, 2015, p. 433)

Cloud computing, while not a phenomenon specific to IoT, is useful in an IoT context as compute resources can be shared across an array of sensors and actuators. This provides new great possibilities as the computations for data can be centralized for many devices, enabling big-data analytics. Data and compute-heavy IoT-solutions in particular are well suited for cloud computing solutions. (Lee & Lee, 2015, p. 433)

IoT applications build on the mentioned technologies to create value by organizing, processing, and utilizing data to solve a wide variety of problems.

By incorporating these technologies into products, the Lee & Lee (2015) suggest three main ways in which IoT can provide value:

- monitoring and control
- big data and business analytics
- information sharing and collaboration

Monitoring focuses on collecting data from sensors installed in various areas and settings, including equipment performance, energy usage, environmental conditions, and so on. Highlighted applications of this include smart grid and smart metering products. Control focuses on controlling IoT-connected devices at a distance, such as connected heating, ventilation, and air conditioning (HVAC) systems and lighting. (Lee & Lee, 2015)

Big data and business analytics focus on leveraging the vast amounts that IoT devices can collect through monitoring of devices. By processing large amounts of collected data, these can be used as actionable analytics regarding the type of process observed by the sensor collecting the data. (Lee & Lee, 2015)

Information sharing and collaboration focuses on connecting IoT devices, to allow them to work together and to allow them to communicate with humans better if human interaction is needed. This can be exemplified by a sensor reading unacceptable values, giving a manager a notification in their IoT-enabled phone to go have a look. It could also mean that through positioning systems in a physical store, data can be collected on what departments customers shop in to give them automated targeted advertising for those types of products they are looking for. (Lee & Lee, 2015)

While the term IoT-enabled is most often used for devices which are able to connect to the internet, the term is sometimes used for devices that do not connect to the internet, but rather to local networks.

3.6 Current IoT solutions from Assa Abloy PDS

The theoretical possibilities of what can be done with IoT-integration in an entrance system can be divided into three areas, in line with theory of IoT products and services in general. First, IoT could enable the control of entrance system functionalities at a distance. This could include unlocking and locking a sliding door remotely, setting how wide an entrance should open or how long it should stay open. Second is the possibility of collecting and processing data regarding the door system and its surrounding environment. This could include data regarding the number of times the door has been opened on a given day, what the surrounding foot-traffic has been like, temperature outside and performance of internal components. The third, and final, possibility of what can be done with IoT-solutions is the intersection of processing data and actuating the door functionalities. An example of this would be to set the door to open to different widths depending on the temperature outside or the amount of people wanting to pass through.

Recently, Assa Abloy has started offering the market its IoT solution, *Assa Abloy Insight*. The offering consists of an IoT-enabled door operator and an IoT dashboard,

which collects and present data from multiple IoT-enabled door systems. Data collected from the door includes sensor data on e.g., usage level, intrusions and energy leakage (ASSA ABLOY, n.d.-b). The main advantages that are offered by the platform are ways to enable data-driven decisions in the form of higher service efficiency, detailed business insights, and easier total cost of ownership management (ASSA ABLOY, n.d.-b). The IoT solution is still in its early stages, with the dashboard having just been made available to the market as of the writing of this thesis. The data is limited to being accessed in Assa Abloy's platform, i.e., it cannot be accessed through an API for integration with other software solutions.

An offering Assa Abloy has a large interest in internally is providing its customers with the possibility of controlling whether a door is opened or closed remotely. Notably, Assa Abloy IoT-platform lacks functionality of actuating door functions remotely. This is due to EU-wide legislation prohibiting the actuation of motor-powered functions in an automatic door at a distance.[8] This limits the possibility of what IoT-powered solutions can be built for entrance systems. Worth noting is that it is only the opening and closing of a door from a distance which is prohibited, and not necessarily the parameters of how it is opened - changing door opening parameters is still possible.

Assa Abloy intends to use the data that their IoT solution gathers to improve their offering in several different ways, with the focus on their service offering. The data from the IoT solution can be used to offer just-in-time service, with the goal of having a technician on the way before the customer knows about the issue. Furthermore, the data can be used to recommend when a new door should be installed, optimize the service organization for greater profit, and enable remote service of certain issues.[9]

3.7 Smart buildings

Smart building is a buzzword without a widely accepted definition. While academia has tried to define the term, different papers still use the term in slightly different ways. The confusion increases as one looks to the real estate and construction industries – few people can give a precise definition of a smart building, and the definitions that are given differ from those found in academia.

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[8] Ralf de Ruijter, interview, chapter 5

[9] Ibid.

3.7.1 **Formal definition**

In the paper "What is a smart building?" by Buckman et al., the authors argue that the Smart building is a more technologically advanced successor of the Intelligent building (Buckman et al., 2014). In 1995, the Conseil International du Bâtiment Working Groups defined an Intelligent Building as:

> *A dynamic and responsive architecture that provides every occupant with productive, cost effective and environmentally approved conditions through continuous interaction among its four basic elements: places (fabric; structure; facilities); processes (automation; control; systems) people (services; users) and management (maintenance; performance) and the interrelation between them. (CIB, 1995 as quoted by (Everett, 2008).*

Buckman et al. then define smart buildings as follows:

> *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.(Buckman et al., 2014)*

In essence, a smart building is then an intelligent building with an predictive instead of a reactive focus, as defined by academia. However, in the industry, the Intelligent building is rarely mentioned, and instead the term Smart building is used to refer to all buildings with multiple automatic, integrated systems. As this report focuses on aiding Assa Abloy in creating value from connected entrances in the industry space, we will use the terminology most common in the industry, and let Smart buildings refer to both smart and intelligent buildings. While this may sometimes be incorrect, it will better reflect the terminology used in the day-to-day business for those working in the building space.

3.7.2 **The smart building term in the industry**

While the term "smart building" is not a well understood term by everyone working in the building and construction sector, those who work directly with smart buildings seem to have reached consensus of what the term means. In the industry, the term refers to a building with a large number of internal data sources, such as sensors placed throughout the building, and actuators, that are combined to achieve something greater than the sum of its parts. These are connected through a variety of communication standards which enable data transmission and management of devices in a smart building. Prevalent standards include BACnet, LonWorks, KNX, Modbus and ZigBee (Domingues et al., 2016).

There are four main goals of a smart building, even though they may not all be the focus for every building.[10] These four goals are:

Improving energy efficiency

A significant amount of energy is consumed by buildings worldwide. For example, buildings are responsible for 76% percent of all electricity use and 40% of all energy use and corresponding greenhouse gas emissions in the US (United States Department of Energy, 2015). Smart buildings seek to reduce these numbers. With large amounts of data on space utilization and people flow, HVAC systems can be optimized to do the minimal amount of work; they can climate control only occupied rooms and be less active under hours when the building is less occupied. Furthermore, people can be directed to rooms close together and the same floors when the building is not fully occupied to further optimize the energy use of HVAC systems.

Connected entrances could contribute to improving the efficiency of HVAC systems in smart buildings. For example, letting the smart building keep automatic doors open at the right times to add another means of ventilation can help improve energy efficiency even more.

Data-driven improvements

With the large amounts of data that smart buildings can generate from the multitude of sensors within them, the building operators have access to a detailed overview of everything going on in the building. This enables improvements and optimizations of the building that are based on concrete evidence instead of informed guesses, for areas such as space and component utilization. The data can be used in many ways to achieve this, ranging from simply studying the data to feeding it into machine learning models. Research shows that big-data analytics on sensor data can be used to implement just-in-time services to enable insights for patterns and correlations. This can be used to improve traditional services for smart buildings and in some cases generate business intelligence. (Cardinale & Blanco, 2020)

Enabling new business models

The connectivity in smart buildings also enables new business models for building owners. While there are most likely more possibilities in this area than property owners are currently looking at, some novel business models that have been implemented include dynamic pricing of shared spaces, where data on space utilization guides pricing models, and Space as a Service (SPaaS), where anyone

[10] Malin Engelbrecht, interview, chapter 5

can access a building space through for example a subscription model.[11] Connectivity, IoT functionality and large amounts of data are the driving forces behind these new business models.

Comfort and "quality of life" features for building users

Lastly, the interconnected and IoT-integrated systems in smart buildings creates new possibilities for increased comfort and "quality of life" features for building users. Building users could for example have the indoor climate of the space they are using adapt to their preferences, either set before they are to use the space or as a saved preference in the system. Other features include ways to find their colleagues or to see where in the building it is crowded. [12]

3.8 Digital twin

A digital twin is a virtual representation of a physical object and serves as the real-time digital counterpart of that object. For buildings, this means that a digital twin is a digital version of the building, where what is happening inside the building can be viewed simultaneously in the digital twin. The digital representation is constructed from the BIM, the Building Information model, which contains all information about the static parts of the building such as dimensions and components. Then, the real-time data collected from the smart building is combined with the BIM, creating the digital real-time representation. (Khajavi et al., 2019)

The digital twin can be used in many ways. First and foremost, the digital twin provides an overview of what is happening in the building. Information about people flows, state of components, energy consumption etc. can all be viewed in the same place. The data in this consolidated form can be used not only to survey the building, but also to make informed decisions about the building and optimize it. Furthermore, the digital twin can be used to simulate changes and scenarios and see what impact they would have. In conclusion, the digital twin enables the full utilization of the data gathered from smart buildings, making the most out of this asset. (Khajavi et al., 2019)

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[11] Sören Sandell, interview, chapter 5

[12] Malin Engelbrecht, interview, chapter 5

4 Theoretical background

This section aims to present the theoretical models which will be used to process and analyze our results. The two main frameworks, the value proposition canvas, and the model for diffusion of innovations, will be presented in two separate chapters.

To give an increased insight into the reasoning behind the data analysis performed by the researchers, as well as to give the researchers a structured way for analyzing data, frameworks are used to structure reasoning around a subject. The two frameworks used in this paper consist of the value proposition design canvas from the book Value Proposition Design by Osterwalder et. al (2014), as well as the framework for Diffusion of Innovations by Rogers (2003).

This research paper seeks to answer two research questions, with the second one building on the results from the first one. The first research question is exploratory in nature, studying the demands of an unmapped customer segment, and a framework for analyzing these demands helps bring structure to the answer. For this purpose, the customer profile and value map from Value Proposition Design are suitable as they both help identifying customer demands as well as what values a product offering which meets these should provide.

The second research question is problem-solving in nature and aims to present a product and service offering which offers the values outlined in the first research question. It also aims to present such an offering which gives maximum chance of commercial success with respect to obstacles for adoption. For these purposes, the value proposition design canvas further helps map values to concrete products and service, giving these an anchor in a theoretical framework.

4.1 Value Proposition Canvas

To identify what customers want and how one should work to provide value that meets their needs, Osterwalder et al. (2014) have presented the Value Proposition Canvas, displayed in Figure 4.1.

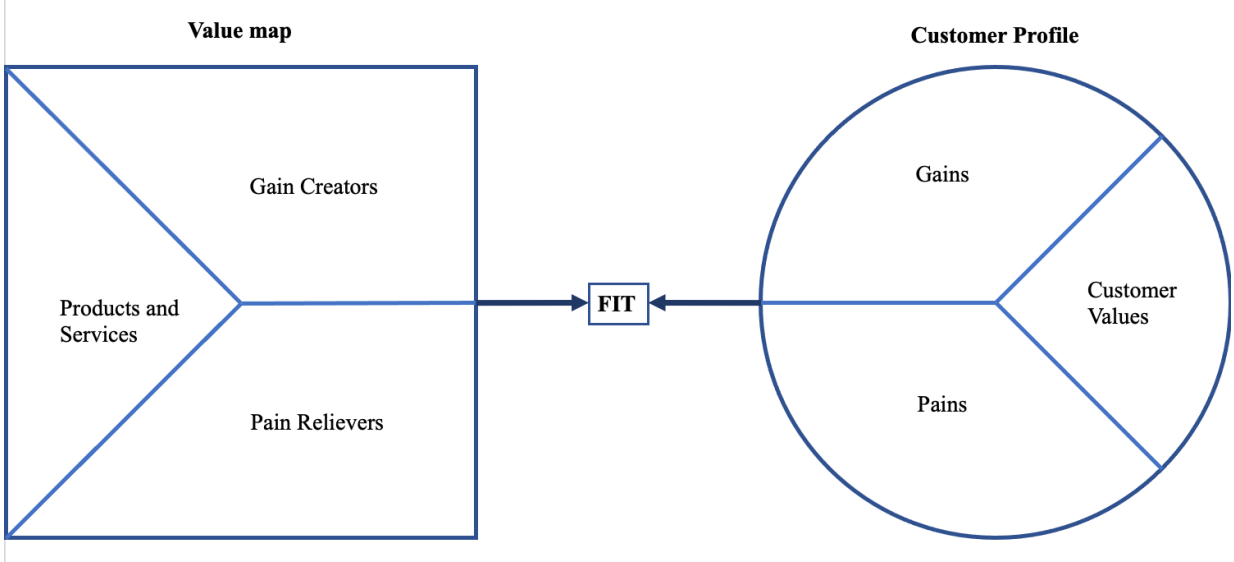

Figure 4.1: The value proposition canvas, as described by Osterwalder et al. (2014)

It originates from the business model canvas and goes into detail focusing on the parts Value Proposition and Customer Segments. When one wants to analyze a specific customer segment, a customer profile is created through breaking down the needs of the customer and what the value proposition provides. The value proposition is broken down with the help of a value map, and the customer segment is broken down with the help of a customer profile. The customer profile consists of the following three areas. (Osterwalder et al., 2014, p. 8,9)

- Customer Gains
- Customer Pains
- Customer Jobs

4.1.1 **Customer profile**

4.1.1.1 Customer gains

When analyzing the customer gains, you are trying to find what outcomes the customer is currently trying to achieve. These gains can be of many types, and

Osterwalder et al. highlights functional utility, social gains, positive emotions, and cost savings as some common examples. Osterwalder et al. also suggests segmenting the gains into four types based on their outcomes and benefits. (Osterwalder et al., 2014, p. 16)

- Required gains
- Expected gains
- Desired gains
- Unexpected gains

Required gains are gains for which without them, a solution would not be relevant. For an automatic door, this could be basic functionality as it being able to open and close. *Expected gains* are gains that are expected from a product, but not completely necessary for the product to be successful with the customer. Such gains for a door could be a good design or a fast-opening time. *Desired gains* are the types of gains are gains which the customer would love to have if possible but are not necessarily expected. Examples of such a door could be a door that requires service only once every ten years. *Unexpected gains* are the types of gains are gains which the customer neither expects nor feels a desire for, examples for this could be doors which open automatically before such doors were invented. This, however, does not mean that the gain is unwanted by the customer. (Osterwalder et al., 2014, p. 16)

4.1.1.2 Customer pains

Customer pains can be anything which a customer deems to be an annoyance for them to get a job done. They can range from obstacles to risks, and Osterwalder has grouped them into three main types of pains.(Osterwalder et al., 2014, p. 14)

- Undesired outcomes, problems, and characteristics
- Obstacles
- Risks

Undesired outcomes, problems, and characteristics as a category of pains relates to functional pains, i.e., pains that relate to a solution not producing the desired outcome or producing the desired outcome with undesirable side effects. The pains can also be social, emotional, and ancillary. *Obstacles* are pains that prevent or slow customers in their ambitions to complete a job. For an entrance system, this could be a price that is too high for the type of entrance that the customer needs. Pains associated with *risks* relates to potential outcomes which carry with them negative consequences for the customer. This could be the risk of losing credibility towards tenants in a building if a door breaks down too often. (Osterwalder et al., 2014, p. 14)

4.1.1.3 Customer jobs

The field "customer jobs" focuses on what things the customer is trying to achieve with their work. This ranges from what exact tasks the customer is trying to complete, what needs they are trying to satisfy and the problems they are trying to solve. Osterwalder has divided this into three main types of jobs together with supporting jobs. (Osterwalder et al., 2014, p. 12)

- Functional jobs
- Social jobs
- Personal/Emotional jobs
- Supporting jobs

Functional jobs are the core of what the customer wants to achieve, such as provide a well-functioning building for tenants. The aim for these is to solve a specific problem or complete some form of task. *Social jobs* are jobs that the customer performs to affect how they are viewed and perceived by others. For a customer who rents out office space, this could be marketing with the aim of attracting new tenants by appearing to offer a new, modern, concept. *Personal/emotional jobs* are jobs which the customer performs to reach a specific state of mind, usually to ease some form of tension or worry. For a customer with an office building, this could be contacting Assa Abloy for preemptive service of their doors to make sure that everything is working properly. There are three roles which make up *supporting jobs:* buyer of value, cocreator of value and transferrer of value. Buyer of value supports the other jobs through performing the actual purchase process of products and services. Cocreators of value involves the jobs of customers who help the company provide the product or service they are purchasing to create greater value, for example through collaborating with them to provide feedback for future products. Finally, transferrer of value involves jobs which relate to the life cycle of the product, for example reselling or disposing of a door which is no longer wanted by a building owner. (Osterwalder et al., 2014, p. 12)

4.1.2 **Value map**

The counterpart to the customer profile is the value map. While the customer profile section outlines what the customer wants, the value map outlines how an organization can meet those demands. The better the demands of the customer can be met, the better the fit between the customer and producer. The value map consists of three main sections. (Osterwalder et al., 2014, p. 8,9)

- Products and Services
- Pain relievers
- Gain creators

4.1.2.1 Products and Services

Products and Services are what the organization actually offers the customer. These products and services serve the purpose of aiding the customer in completing their jobs and should match well with the pains and gains apparent for the customer. Osterwalder exemplifies this through four main types of products and services. (Osterwalder et al., 2014, pp. 28–29)

- Physical/Tangible
- Intangible
- Digital
- Financial

4.1.2.2 Pain relievers

Pain relievers present in the organizations product and service offering should be a good match with the pains that the customer is experiencing. The pain relievers should, in detail, describe how an offering eases the pains for the customer. While not all pains which the customer experiences have to be addressed, the more severe pains that the customer has addressed by a product or service, the better the match. (Osterwalder et al., 2014, p. 31)

4.1.2.3 Gain creators

Gain creators present in the product and service offering describe how and what customer gains are created. These are often related to the areas of functional utility, social gains, positive emotions, and cost savings which were highlighted in the customer gains section of the customer profile. As such, the gain creators can also be required, expected, desired and unexpected. (Osterwalder et al., 2014, p. 33)

4.1.3 **Fit**

This part reflects on how well the value map and the customer segment match each other and validates whether the proposed offering addresses what the customer needs to have addressed. Most importantly, the customers most severe pains and most essential gains need to be addressed. All pains and all gains cannot be addressed by the same organization so there should be a focus on the ones that matter most to the customer. (Osterwalder et al., 2014, p. 42)

4.2 Diffusion of innovations

Diffusion of innovations is a theory first presented by Everett Rogers in 1963, in his book by the same name. The theory describes how an innovation takes hold in a society, with five stages where different groups adopt the innovation at each stage. The theory is used to understand where on the timeline an innovation currently resides, and how the market for the innovation behaves at each stage. (Rogers, 2003)

4.2.1 **Innovation vs invention**

The difference between innovation and invention is important to consider every time a new technology hits the market. Often, the market gets excited about all the features of the new technology, with little regard to what is useful and commercially viable. For businesses, it is important to keep in mind the distinction between the two concepts.

Invention is simply the creation of a new product, service, or technology, while innovation introduces the concept of the use of an idea or method. In other words, for something to be an innovation, it must introduce some kind of new usage, and also be useful. (Roberts, 2007)

When deciding what functionality to include in connected entrances, it is important to remember this distinction. The Internet of Things enables the collection of an enormous amount of data, but this does not mean that all use cases for this data are useful. Assa Abloy needs to consider which functionality is not only possible, but also valuable for the customer when entering the smart building market to truly innovate in this space.

4.2.2 **Rate of adoption**

According to Rogers (2003), the rate of adoption is defined as the "relative speed with which an innovation is adopted by members of a society", and states that the rate of adoption depends on customers' perception of five attributes of an innovation. These are:

1. **Relative advantage:** The improvement that the innovation offers compared to the old ways.
2. **Compatibility:** How compatible the innovation is perceived to be with the customer's values, needs, existing ideas, and past experiences.
3. **Complexity:** How easy an innovation is to understand and use.
4. **Trialability:** The degree to which an innovation can be tried out before purchasing.

5. **Observability:** The degree to which the results of an innovation are visible to others.

These factors will be useful to consider when attempting to answer RQ1, "Which are the critical value-adding factors of connected entrances for the smart building market?".

4.2.3 **Adopter categories**

Individuals adopting an innovation can be grouped into different categories, based on their innovativeness, which Rogers (2003) defines as the "degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of a system". The more innovative the individual, the earlier the individual will adopt the innovation. Rogers (2003) outlines the five different adopter categories as follows:

1. **Innovators:** These are the first people to adopt an innovation and are more accepting of uncertainty and risk. This acceptance allows them to adopt innovations that may ultimately fail. Their larger financial resources compared to the other categories help absorb these failures.
2. **Early adopters:** This is the most influential category of the five and demonstrates strong opinion leadership. They are more risk-averse than the Innovators, but still, accept a high amount of risk. The early adopters inspire the following categories to accept the innovation.
3. **Early majority:** The early majority adopts an innovation after a varying amount of time that is significantly longer than the innovators and early adopters. They rarely hold positions of opinion leadership.
4. **Late majority:** This group adopts an innovation after the average member of society, and typically shows a high degree of skepticism towards an innovation.
5. **Laggards:** As the last group to adopt an innovation, they are often skeptical of new ideas and value traditions highly. Replacement products to the innovation are often out in the market before they adopt the innovation.

In Figure 4.2, the timeline of an innovation diffusing through society is shown. The blue line shows when an innovation is adopted by each category, and the yellow line represents the cumulative adoption of an innovation in society.

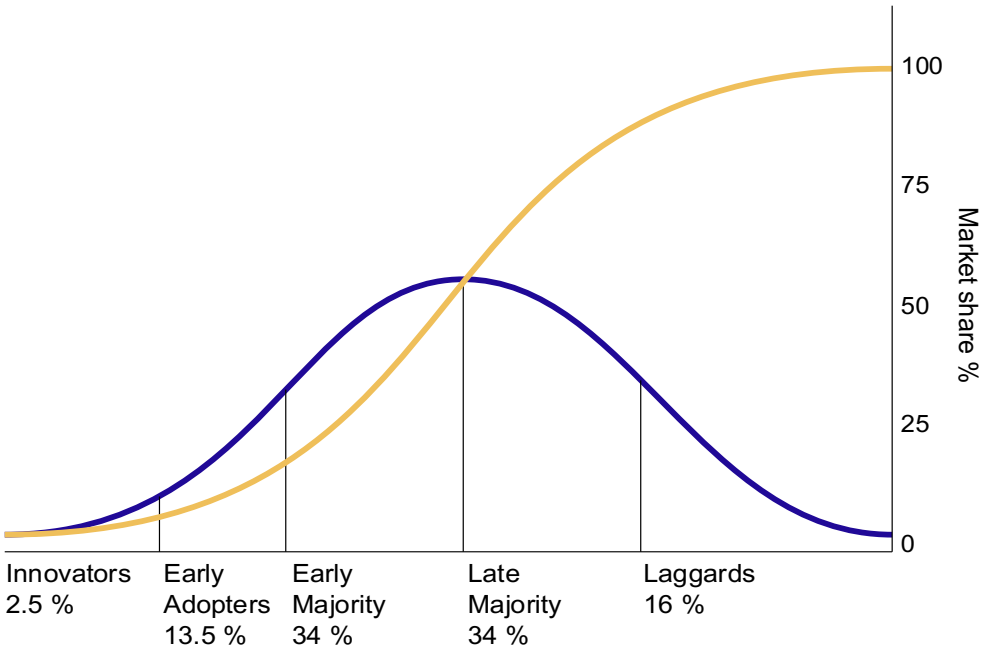

Figure 4.2: The diffusion of innovation, with adopter categories in blue and market share in yellow (Rogers, 2012)

5 Interviews

This section presents the results of the interviews held with individuals that have insight into the thesis subject. Along with the interviews, details about the interviewee, their company, and role are presented.

The interviews in this chapter followed an exploratory approach. This meant that while they were guided by interview questionnaires written beforehand, the goal of the interviews was to gain a deeper understanding of the subject, and as such the actual interviews did not follow a strict form. As outlined in chapter 2, the interview material presented here was the result of a paraphrasing of the interview, which was based on notes taken during the interviews. The resulting text was then sent to the interviewee to confirm that the text correctly reflected the information they wanted to convey and adjusted if necessary.

Early in the interview process, three groups of stakeholders were identified to be of most importance for this thesis' subject: Assa Abloy, system integrators and property owners. Therefore, the interviews focused on these three groups, and this chapter is divided into three sections to reflect this. Table 5.1 presents an overview of the interviews that were conducted. In section 5.4, a further summary of the interviews is presented.

Name	Organization	Date	Interview Focus
Ralf de Ruijter	Assa Abloy PDS Netherlands	2021-02-24	IoT at Assa Abloy PDS & service contracts
Ramon Schaaf	Assa Abloy PDS Netherlands	2021-03-03	The purchasing process of automatic doors
David Andersson	Assa Abloy PDS Sweden	2021-04-19	Service of automatic doors
Per Hallgren Luterkort	Assa Abloy PDS Sweden	2021-04-28	The sales process of automatic doors
Andreas Silvede	Honeywell	2021-02-26	IT security in smart buildings
Johan Grahn & Cecilia Sjöberg	Siemens	2021-03-02	The smart building market & system integrators
Khaldon Hindi	Siemens	2021-03-24	The smart building market
Ulf Däversjö	Akademiska Hus	2021-03-19	Property owners in the smart building market
Sören Sandell	Vasakronan	2021-03-22	How property owners can work with smart buildings
Malin Engelbrecht	Castellum	2021-04-26	Possibilities of smart buildings

Table 5.1: Overview of interviews.

5.1 Assa Abloy PDS

5.1.1 **Ralf de Ruijter, Business Unit Manager at Assa Abloy PDS Netherlands**

Assa Abloy PDS Netherlands is the largest international division of PDS and has been the main developer of Assa Abloy's IoT platform for connected entrances. Ralf de Ruijter has been deeply involved in the development of the IoT platform and therefore has insight into the goals and the future of Assa Abloy's IoT investment.

PDS Netherlands has been working on its IoT solution for two to three years but has struggled to find compelling business opportunities for the solution. One reason is that integrating IoT capability into doors is currently expensive compared to the value it offers. However, as Assa Abloy PDS is becoming a more service-oriented company, the main benefits of the IoT solution are today found in the service organization. More specifically, the applications that are mainly considered today for the IoT solution are collecting data to better optimize the service-contracts and sales of new doors. Historically, Assa Abloy has been able to use this data to identify when customers need new doors and therefore been able to proactively make new sales. This has been a good driver of growth for the company. By collecting even more data through the IoT solution, Assa Abloy PDS hopes to better optimize when doors need to be repaired, as this will provide a better experience for customers and lower the cost for the company.

During the interview, Ralf explained the different service contracts that Assa Abloy PDS offer, and how their goals might compete with each other. The service contracts on offer are bronze, silver, and gold, where bronze includes very little, and gold includes almost everything excluding the cost of a new door. The majority of customers have either bronze or gold contracts and the way Assa Abloy maximizes its earnings differ between the two contracts. As very little is included in the bronze contract, Assa Abloy wants to sell replacement parts at a high price. The opposite is true for the gold contracts, where replacement parts are included, and Assa Abloy, therefore, wants as low parts and service costs as possible. This dynamic means that the IoT solution is the most profitable for Assa Abloy with the gold contract customers, as they can service the doors at the optimal time to minimize cost. For bronze contracts, the IoT solution's ability to schedule service at an optimal time might lower the income the company can generate from these contracts.

As the IoT Solution is still in its early stages and the focus has been on creating an attractive value proposition for it, little thought has been put into opening the system for building management systems (BMS). Therefore, there is currently no way for another software to access the data that the IoT modules integrated into the door operators produce. Assa Abloy values this data greatly, and Ralf was therefore

skeptical about opening the system and providing the data to other actors in the building space. Furthermore, from Ralf's perspective, there is today little demand for this data from customers and the other actors.

Lastly, Ralf added that there are two aspects of smart buildings that have to be considered. One is the building automation part, where a large amount of data from various sources within the building is used to optimize internal systems such as HVAC and energy consumption. The other is using the data to optimize the physical aspects of the building itself, e.g., that switching from a sliding door to a revolving door would save energy and improve people flow.

5.1.2 **Ramon Schaaf, Architectural Consultant at Assa Abloy PDS Netherlands**

As an architectural consultant at Assa Abloy PDS, Ramon works with architects in specifying the right type of door for different building projects. As Ramon works at the PDS department, this means helping architects find the right type of door for the buildings' pedestrian entrance systems.

For the majority of projects, this means coming in during the second stage of the building process, where architects and design teams are creating the technical specifications for a building. Ramon claims that the earlier that Assa has the possibility of coming into the process, the better chance they have of specifying the right door and later winning the contract.

When asked about the process in which a door gets selected by an architect, Ramon claims that there is a great variation in how that happens, depending on the type of contract the architect has. In the "standard" case, however, the architect should be in contact with large amounts of people with technical knowledge and degrees in building construction, that take the building designs from paper to something that can be built. It is after that phase that Ramon can go in-depth and see how the building is going to be used so that he can help suggest the best products for the use case.

Ramon claims that the construction industry is going through a transition now, where more and more parts are becoming digitalized. Previously many new projects were "copy and paste on specification" from old ones. Nowadays, buildings are designed in a digital 3D model that contains all building elements, and this digital model is the basis for the specification. These models are used both for construction as well as for upkeep and maintenance in a smart building context when the building is complete. This means that various modeled sensors and components in the real building can be synced to their digital counterparts.

The architectural industry in the Netherlands is also changing, as the industry had previously seen problems with the technical designs handled by external parties leading to increased costs for the building process, usually outside of the available budget. This then led to the buildings being less than what the architect imagined. To solve this, more architectural firms are now working with technical knowledge in-house or co-creating with advisor bureaus, keeping costs for the building down and specifying more of the building before handing it over to the building company.

Ramon is trying to get IoT into door specifications upfront, but when interacting with architects and design teams there is currently a low degree of interest at that stage. Rather, Ramon argues that the main interest for these IoT solutions lies with those that are responsible for the installed equipment in the building, i.e., the system integrator. However, as an architectural consultant, Ramon rarely gets the chance to speak with these individuals, and when he does it is mostly because the architect has connected him to this integrator for more information on indoor climate or a revolving door. Examples of this would be questions like "Should an air curtain be installed?". Overall, Ramon claims that it is not very common that Assa is in contact with system integrators about connectivity.

5.1.3 **David Andersson, Key Account Manager at Assa Abloy PDS**

David Andersson is responsible for the sales of service contracts at Assa Abloy PDS in Sweden. As such, this interview was focused on the sales and dynamics of service contracts of Assa Abloy doors, which represent a sizeable part of the revenue streams of the company.

For the last few years, David has tried to elevate the service organization to more solution-oriented marketing, where the provided value from the service contracts is emphasized instead of the technical details. He believes that this is the way forward, both in terms of maximizing revenue and providing the correct service offering.

Currently, the majority of service contracts are of the bronze variant, which are also the most profitable (the different variants were further discussed in the interview with Ralf de Ruijter). In these contracts, a preventative service twice a year is included. In Sweden, very few of the contracts are of the gold variant. While they are less profitable in the short term, they provide many other advantages, such as securing cash flow. Furthermore, few competitors to Assa can provide the same service as a gold contract does, which would make Assa Abloy more dominant in the market if more customers shifted to gold contracts. The reason Assa Abloy PDS Netherlands can have a much higher percentage of gold contracts is because they have their own workshop for repairing doors and components, which makes the contract more profitable and feasible for Assa. David believes that Sweden will move in the same direction as the Netherlands regarding in-house repair competence

– the reason they are not yet in the same spot is because the Netherlands operation has existed for far longer than the Swedish one.

Today, very few of the service contracts are sold together with the doors. According to David, the reasons for this are plenty. Firstly, as Assa Abloy is a prosperous organization with good growth, there has been little focus on opportunities for improvement. The company has however started trying to sell contracts in conjunction with the door in recent times. The other main reason is that the doors are not often sold to the end customer. If a construction company buys an Assa Abloy door for a building, they are not interested in buying a service contract as they are not responsible for the door long-term. Today, the main ways of selling new contracts are both cold-calling Assa door customers and contacting existing service customers – customers that hold contracts for a certain number of doors often have more doors that are not covered by a service contract.

David believes that integrating IoT functionality into Assa Abloy PDS doors comes with many opportunities for the service organization. While the current focus has been on maximizing profit from the IoT technology, another possibility would be to sell the IoT functionality at a low price, as it enables cost-savings throughout the service organization. One example of this is 24/7 service. With the internet having made everything in society more accessible and accessible faster, the expectations of faster service of doors have increased. However, the size of Sweden has proven an obstacle in delivering service quickly, as it would require a large number of technicians stationed throughout the country. IoT technology can remedy this problem as many of the problems in doors can easily be fixed by the customer themselves, with aid from a remote technician, as often a simple reset of the door is all it takes to fix a problem. The connected door would gather data on the problems that arise and send it to an on on-call technician, who could guide the customer through the process of fixing the issue. While not everything can be handled remotely, this would greatly decrease the amount of trips the technicians would have to do and the amount of on-call technicians that have to be available, leading to cost savings for the service organization. Furthermore, IoT technology can provide a more seamless experience for the customer, with Assa Abloy knowing when a door is malfunctioning before the customer does and sending a technician to fix the problem before is has become an issue for the customer. David believes that this is the future of door service.

5.1.4 **Per Hallgren Luterkort, Sales Manager at Assa Abloy PDS**

Per Hallgren Luterkort is the sales manager for Assa Abloy Pedestrian Door Solutions Sweden, the organization responsible for selling Assa Abloy systems for

pedestrian entrances in Sweden. He has two and a half years of experience at Assa Abloy.

Assa Abloy sells their products and services direct-to-consumer as well as to contractors. The split between these two revenue streams is about fifty-fifty. Currently, Assa Abloy's sales of pedestrian door systems make it the third largest company in this industry. The solutions being sold by Assa Abloy PDS can be divided into two main groups: Sliding doors & carousel doors, and door automation for swing doors. They are divided into these two groups as the former is sold as a complete package, with the door operator, blade and everything else required for it to comprise a complete door solution. The latter, door automation for swing doors, is sold to consumer as a stand-alone product which needs to be supplemented with a door, fittings and more. It can be said that the former is sold as a system, while the latter is sold as an individual product. Regardless of if the product sold is the former or latter, all sales by Assa Abloy PDS include installation of the purchased products. Some products are however sold through Assa Abloy's subsidiary *Entrematic* to e.g., security companies, which have the competencies needed for installation.

When selling entrances to new construction projects, Assa Abloy sells to the contractors responsible for the project. The contractor then selects a door based on requirements set out in the design phase of the building. The actors which have the greatest influence on entrance requirements during the design phase of the building are building engineers, architects and other people with technical know-how. Architects do not usually function as a voice for the end customer towards Assa Abloy with regards to product functionality. The resulting requirements mainly specify requirements in the fields of fire protection, security and accessibility. At this current point in time, connected functionalities for door environments are not specified.

The sales philosophy behind selling direct-to-consumer contrasts greatly to that of which is used in selling to contractors. Contractors place a great degree of focus on purchasing the cheapest door which meets the requirements specified for the project. This leaves little room for upselling and identifying needs which the end user might not have realized they want. On the other hand, the half of sales which go direct-to-consumer provide ample room for identifying customer needs which they might not have considered which allows Assa Abloy to upsell. Assa Abloy is currently working towards creating stronger relationships with property owners, as well as towards having connective functionalities being a part of the requirements specification for entrance systems. While Assa Abloy has good relationships with certain property owners, those relationships are not on the level of which it is possible for the to affect their strategy around IoT.

In Sweden, the fact that door automation and access-control systems are sold separately by different business units within Assa Abloy can become problematic. Many customers want to purchase all parts of the door environment in the same

tender, but this is only done for sliding and carousel doors. Missing out on being able to provide a complete solution for swing doors can be confusing for customers at times, especially as other parts of the Assa Abloy organization produces access-control systems. Customers would like to be able to purchase complete door environments for swing doors, and many customers have requested a door solution with an integrated access-control solution.

Per considers the possibilities of what IoT can provide for Assa Abloy's product line to be great. He believes the main gains from IoT can be found for the service organization, where offerings such as online monitoring, proactive failure warnings, remote diagnostics and remote service are possible business cases. These will help Assa Abloy provide its customers with an improved customer experience, which will lead to greater customer satisfaction. He also believes that IoT and digitalization will create a demand for new product functionalities, although unsure which ones specifically. One specific use case mentioned for hospitals, Assa Abloy PDS largest segment, is the capability to with the press of a button open all doors on a floor 10cm, making it easier for the physicians to make their rounds. While not specifically referring to IoT capabilities, he believes that aspects such as touchless control of doors will lead to an increase in automatic doors over the long term, referring to an increased unwillingness to touch public objects as a result of Covid-19. He has not noted that customers have been asking for IoT capabilities on a large scale, but the interest he has noted for these types of connected functionalities has been coming from customers which have centralized a lot of their building control.

5.2 System integrators

5.2.1 **Andreas Silvede, Sr Territory Manager Nordics at Honeywell**

Honeywell is a large American international conglomerate. They provide a wide range of products and services, of which smart building solutions is one area. This includes integrating various building components into BMS. Andreas works mainly towards the security side of buildings, primarily the distribution of security systems.

Andreas claims that the goal for a BMS is to be able to integrate many different components into a single software suite. Many customers want as much data as possible from their different components for future use, and many want it all in one interface to not have to jump around between different vendor-specific interfaces.

Andreas argues that both the physical and digital aspects of security are big factors to consider for components in smart buildings. In doors especially, the aspects of physical and digital security are even more important than for other parts of the building. Security issues can lead to other alternatives being considered when

deciding on what products to integrate with a smart building solution, and this is an area in which Andreas argues there is room for improvement for Assa Abloy and their current IoT solutions. This was said in reference to Assa Abloy's *Arx* access control and alarm system, an access solution sold by another division of Assa Abloy.

5.2.2 **Johan Grahn, Head Business Line Management & Cecilia Sjöberg, Digital Business Developer at Siemens**

Siemens is a large international company with a wide variety of products and services. Johan Grahn and Cecilia Sjöberg are active mainly in the smart infrastructure space, of which buildings constitute a large part. As Siemens is specialized towards high voltage electronics, a large part of Johan's competence is towards the electrical infrastructure in buildings and how they can contribute to smart grid solutions. However, Johan's competence areas also involve the technical infrastructure in a building, i.e., the aspects that are considered to constitute a smart building.

Cecilia's area of expertise also lies within smart buildings, but with a greater focus on how the technologies can come together to create improvement opportunities for buildings as well as how they can enable new building experiences. This includes projects to increase user satisfaction through, e.g., working with sensors to visualize people flows and space usage to better optimize these.

Johan argues that the term "smart buildings" has historically been a buzzword, but during the last two to three years it has gained traction and acceptance. This comes as the knowledge of what you want a smart building to do has increased. What you want a smart building to do also varies widely between stakeholders, e.g., property owners, office renters, and end-users all have varying demands on what the building does for them.

As the construction industry is quite a conservative one according to Johan, there is no particular interest from the industry to work closely with the technological aspects of their buildings. The main demand for smart buildings comes from property owners who then ask Siemens to do the actual integration. Furthermore, the demand for smart buildings comes from all different types of property owners. The different types of property owners are referred to as different *verticals*, such as hospitals, offices, industry. While the different verticals might have somewhat differing reasons for wanting digitalization, the themes of HVAC control, safety and security are fundamental to all the verticals. Besides the property owners, the requests to integrate technologies to make a smart building also come from technology consultants such as WSP.

Siemens strives to be able to come into the process of integrating smart technologies in a building as early as possible. The earlier they can enter the process, the better

the integrations can be made, the cheaper it can be done and the better the overall result is.

Regarding compatibility and integrations, Johan argues that the different standards that are present on the market lead to difficulties. However, despite this difficulty, it is important for Siemens to be able to integrate 3rd party products. Johan does not believe that being closed with your products' APIs is a sustainable business model going forward. He instead believes that the most successful actors in the future will be those that are actively offering access to their product APIs. He considers a partnership with Assa to potentially be of great interest as Siemens's product lineup does not directly compete with Assa.

Connected doors could be of interest to Siemens, as the more data that they can collect, the better. The main interest for doors would be to map people flows and determine which doors have a large degree of utilization. The aspect of monitoring when someone is entering the building is also very interesting.

After the interview, Johan clarified some things regarding the importance of IT security in the products they integrate into smart buildings:

At Siemens, product security is handled under their PSS (Product & Solution Security) initiative. Third-party suppliers must be approved through the "PSS Supplier Classification" process before they can be used by Siemens. To get approved, suppliers must develop and produce their products in a secure manner and provide software updates to the integrated software. The products Siemens develops internally must all live up to a high standard and security updates are issued regularly and when security issues are found by their internal ProductCERT organization.

All in all, Siemens has a great focus on the security of the products that they use in smart buildings. They continue to invest in this area, with initiatives such as a centralized platform for their PSS classification of suppliers and aim to be an industry leader when it comes to product and IT security. According to Johan, IT security is a hot topic in their industry.

5.2.3 **Khaldon Hindi, Regional Manager at Siemens**

Khaldon Hindi is the regional manager for the region east at Siemens Smart Infrastructure division. His responsibilities include managing personnel in sales, project management and service.

Khaldon sees that the main demand for smart buildings is driven by technology producers and property owners. He sees that there is great value in having systems in buildings communicate with each other. Currently, the property owners that demand smart building technology are mostly the larger ones, as they are the only

ones with sufficient financial means to fund the development of smart buildings. He also sees that while some customers have an idea of what they want to do with smart building technologies, many do not see the purpose of doing it. With respect to these facts, it is important to segment the different types of customers to provide them with the right products and solutions.

Regarding APIs, Khaldon sees it highly unlikely that products that do not offer these will survive. Public APIs are the future, driven by the demand of interconnecting products. However, how the APIs operate and what data they make available is a consideration that must be made as they do not necessarily need to provide all data or provide all data for the same price. He also argues that many customers will not have the knowledge of how to process the data themselves, so Assa Abloy should provide solutions which delivers value out-of-the-box.

Hardware and software are very tightly interconnected in building related products, in the sense of the software delivered with a hardware product being unchanged for the duration of the lifetime of the product. Khaldon imagines a future where many of these products can be updated over-the-air to enable new functionalities and believes that products that lack over-the-air update functionality will have a hard time succeeding. He also believes that many products will have a hard time selling for an increased upfront price unless the products can present functionality which allows for cost-savings. Data collection through APIs is also something which is hard to pitch as the pay-off time for such functionality is long.

Khaldon sees the potential for data collection at the point of doors as substantial, as anyone passing in or out of a building passes through a door. Khaldon also notes that data regarding flows of material is of interest and can be collected as well.

5.3 Property owners

5.3.1 **Ulf Däversjö, Director of Innovation and Sustainable Development at Akademiska Hus**

Akademiska Hus is one of Sweden's largest real estate companies. It is governmentally owned and manages properties related to universities and colleges, such as premises for teaching and research. Two-thirds of all Swedish universities are customers of Akademiska Hus. While Akademiska Hus is governmentally owned, it has to generate a profit and operate with the same conditions as the private real estate market at large. However, it also a goal of the company to be at the forefront of sustainability as a result of its governmental ownership. (Akademiska Hus, n.d.)

Ulf Däversjö is the director of innovation and sustainable development at Akademiska Hus. His main tasks include leading teams working with business development within the fields of innovation and sustainability. Many of the questions being worked on within these teams are regarding concept development and cross-functional activities, while also acting as catalysts for internal development. Current areas of focus include increasing the utilization rate and providing increased flexibility for customers in how and when they can rent premises. These areas are key parts of Akademiska Hus' strategy and are part of the larger trend of providing space as a service rather than a product. A key part of providing space as a service is digital access, as the management of physical keys is unfeasible for this type of use case. Solutions for this have been a missing piece of the puzzle for some time, which has prohibited development in this area. Together with other large real estate management companies, Akademiska Hus has launched an initiative called Accessy, in collaboration with other large Swedish property owners. Accessy aims to be a digital "Bank-ID" for physical access, being the final piece of the puzzle for digital access to buildings.

Data collected from sensors in a smart building are used both for control of building systems, as well as to work in a data-driven way with optimizing building performance. Ulf claims that the business of real estate management is moving towards working in a data-driven fashion, in contrast to working with educated guesses as it has historically. Working in a data-driven fashion with buildings requires tools that allow humans to interpret the data, and Akademiska Hus does this through the usage of digital twins. The digital twin provides a model of the building overlaid with available sensor data, enabling greater analysis of what works well in the building and what works less well. In the case of entrances, a digital twin can enable the visualization of flows through an entrance to gauge the utilization rate. Data regarding people flow is of particular interest to Akademiska Hus, as they place a large importance on optimizing the flows of people. This type of data is currently collected with standalone sensors.

Regarding how Akademiska Hus works with innovations in the smart building space, the company has a responsibility to push the technological development in this area. As such, they are open to try new technological developments in their building portfolio in addition to the work they do in this space together with the universities.

When Akademiska Hus seeks new functionality in their buildings, they have competence in-house to look at the technical solutions for this functionality themselves. When they do not have this competence in-house, they collaborate with partners to realize the solutions instead. Several other real estate companies are also at the forefront of developments in smart buildings, including Vasakronan, Castellum, Humlegården, and Fabege, signaling that there is a great interest in what is possible in this space.

5.3.2 Sören Sandell, Head of IT at Vasakronan

Vasakronan is Sweden's largest property company, with a portfolio comprising 171 properties. Vasakronan owns, manages, and develops office and retail spaces in Sweden's major cities, and the majority of the portfolio is concentrated in Stockholm. The company is jointly owned in equal shares by the four national Swedish pension funds. (Vasakronan, n.d.)

Sören Sandell works both as head of IT and business development. He argues that Vasakronan is one of the most if not the most progressive and innovative property owner in Sweden, followed by Akademiska Hus and Castellum. As Vasakronan is state-owned, they can have a long-time horizon for their investments and focus on the long-term benefit of the company. This results in more investments in new technology and trialing services for the future.

A large part of Sören's work centers around smart buildings - both the development of them and finding new business opportunities with the technology that they use. Vasakronan's focus with smart buildings is on increasing sustainability and energy efficiency, optimizing the operations, and developing new services that the technologies enable.

The company achieves these goals by performing analyses and simulations of the digital twin, which they create using RealEstateCore. The software combines the BIM with data from sensors and actuators within the building and integrates with IoT technologies to create this digital representation (RealEstateCore, n.d.). Then, the digital twin is managed through ProptechOS, developed by Idun Real Estate. ProptechOS connects the RealEstateCore models with existing BMSs and other data sources and provides a platform for managing and optimizing property operations and developing applications for tenant services. RealEstateCore was a joint effort created by Vasakronan, Akademiska Hus, and other property owners and RISE. Idun Real Estate was created as a result of the RealEstateCore effort in 2019 (Idun Real Estate, n.d.). Vasakronan aims to have a digital model of 100% of its properties in the coming years.

Vasakronan has experienced an increased demand for flexibility in recent years, and this development has been accelerated due to Covid-19 and the remote work the situation has promoted. Customers want to be able to scale up and down their available office space to accommodate varying amounts of on-site employees. Vasakronan's solution to this is shared co-working spaces that customers pay for through a subscription model, available both to current renters of office space and new customers. Over the last few years, several of these kinds of spaces, which Vasakronan calls Arena, have been developed in different buildings in Sweden's largest cities. Vasakronan has developed an app for these co-working spaces, where users can book and see the occupancy of meeting rooms, monitor how many people

are currently in the space, and access services related to these spaces. All this is enabled through the smart building functionalities implemented into these buildings.

As Vasakronan starts providing more of these spaces, their need for insight into what happens in the building increases. Traditionally, the company has rented out a section of a building and let the renter have the main responsibility for the space. When customers instead access building spaces as a service, the responsibility shifts to Vasakronan. This has caused an increased demand for smart building functionality, to enable the company to better monitor, control and service these spaces.

Sören believes that we will see more of these types of spaces as a service in the future, and that smart buildings would be a good investment for most property owners. However, the initial cost might be an inhibiting factor.

Although Vasakronan is an innovative property owner that wants to be at the forefront of digitalization, they do not simply buy digitally enabled solutions for the sake of being innovative. Sören argues that it is important to see a clear use case for a solution before Vasakronan is interested in implementing it. While this might seem obvious, it implies that a manufacturer cannot just integrate connectivity into a product and expect it to sell. A clear vision of the use case and cost-saving possibilities has to be presented for each product or solution.

Regarding products and solutions, Sören also notes that Vasakronan tries to avoid proprietary solutions as far as possible. The company wants the connected products they include in their buildings to integrate into their digital models directly, and not require the user to use stand-alone software to access the data from the product. Sören argues that the full potential of the smart building is reached when all components can be monitored and managed in centralized software. This also creates new possibilities through using the data from the different components together. This is in contrast to the silo-like way of working that is common in the industry today.

Accessy (mentioned in the interview with Ulf Däversjö) was developed as a joint venture by Vasakronan, Akademiska Hus, Castellum among others. In addition to what was said in the interview with Ulf Däversjö, Sören adds that Accessy can be used by renters of an office or building space to access the digital representation of that space in the digital twin. The renter can then use the information provided in the digital twin for business purposes, such as seeing people flow peaks.

5.3.3 **Malin Engelbrecht, Project Manager Strategic Initiatives at Castellum**

Castellum is one of Sweden's largest property owners, with a current portfolio size of 642 properties (Castellum, n.d.). The company is a privately owned and decentralized organization present in more than 20 Swedish cities. Malin works as project manager for strategic initiatives at Castellum and is as such responsible for innovation and digitalization projects.

Castellum has put additional focus on their innovation work since 2016 and has started an innovation lab with a separate budget, similar to an R&D department. The innovation lab trials innovation projects without a profit requirement, and Malin leads the projects that come out of the trials. Castellum has introduced services such as co-working, e-commerce pickup spots, and ready-to-use offices in the last years. The Space as a Service (SPaaS) concept has been introduced as well. Castellum expanded their co-working offering in 2019 when they bought the Swedish co-working company United Spaces, with offices in five cities across Sweden.

Other initiatives that the company has taken include a project called Matilda, where sensors are placed throughout a building to measure people activity and flow. The data from this project as well as from other sources are collected in a data lake, which Castellum hopes to use to enable data-driven improvement and optimization of their buildings. The main difficulty of this project currently stems from the fact that the data from different component suppliers are of different formats, making it difficult to analyze. Business models such as dynamic pricing of conference rooms have been enabled by this data-driven approach, and Castellum hopes to further utilize their data lake to develop self-learning buildings in the future.

According to Malin, the main driving factors behind their smart building investments are energy efficiency and cost savings, data-driven improvements, and novel business models. Furthermore, improving the environment for the people within it is an important factor. This includes features such as climate control, seeing occupancy of rooms and finding colleagues.

Castellum, much like Vasakronan and Akademiska Hus, uses Accessy in their buildings and RealEstateCore as the base of their digital twins. Malin says that the goal is for RealEstateCore to become an industry standard for smart building digital twins.

While Castellum has some in-house competence when it comes to smart buildings, they take in the majority from external partners. This is especially true for endeavors further removed from the building sector, such as their data lake initiative and the development of their phone app.

According to Malin, the property owners are the main drivers behind the development and spread of smart buildings in Sweden. She adds that they often get

courted by tech suppliers that want to sell their systems, but that Castellum wishes to remain in the driver's seat when it comes to smart buildings, as they feel like they have come far in that area. Furthermore, as a large company, Castellum feels that it is their responsibility to drive the development of this sector forward.

5.4 Summary of interviews

In Table 5.2 below, the interviews presented in this chapter have been summarized. Furthermore, a guide for which interviews discuss what topics is available in the following table, Table 5.3. The interview material presented in this chapter will be the basis of the analysis in the following chapter.

Name	Interview summary
Ralf de Ruijter	Ralf described Assa Abloy PDS's current IoT solution for automatic entrances, with its goals, possibilities, and limitations. The interview also highlighted the service possibilities with IoT.
Ramon Schaaf	As Ramon works as an architectural consultant, his interview focused on the entrance selection process, as well as on who influences the purchase decisions.
David Andersson	This interview focused on the service of automatic entrances at Assa Abloy: how the service organization works, the sales of service contracts, and possibilities for improved service through IoT.
Per Hallgren Luterkort	Per described the sales channels for automatic doors, who makes purchasing decisions and when. Future possibilities for Assa Abloy were also discussed.
Andreas Silvede	This interview focused on the security aspects of connected entrances and smart buildings, and Andreas highlighted that as an overlooked area.
Johan Grahn & Cecilia Sjöberg	In this interview, the dynamics of the smart building and building automation market were described, as well as their thoughts on this market going forward. IT security was briefly discussed too.
Khaldon Hindi	Khaldon talked about the smart building market today and the different segments that will exist in this market in the future. He also discussed what the development in software for smart buildings might look like.
Ulf Däversjö	Ulf described the goals of smart buildings for property owners, how they work with smart buildings today, the value of measuring people flows in buildings, digital access, and industry collaboration.
Sören Sandell	Sören's interview described how Vasakronan works with smart buildings, new business models that they can enable, and technical aspects and industry standards for smart buildings.
Malin Engelbrecht	This interview confirmed many findings from the other property owner interviews: the four main goals of smart buildings, the importance of data access and formats, and new business model opportunities.

Table 5.2: Summary of interviews

Topic	Interview
Software maintenance	Khaldon Hindi
Data utilization and optimization	Ulf Däversjö, Sören Sandell, Malin Engelbrecht
Data security	Andreas Silvede, Johan Grahn & Cecilia Sjöberg
Business model developments	Ulf Däversjö, Sören Sandell, Malin Engelbrecht
Open data access	Johan Grahn & Cecilia Sjöberg, Sören Sandell, Malin Engelbrecht
Adherence to data format standards	Johan Grahn & Cecilia Sjöberg, Malin Engelbrecht
Digital Access	Ulf Däversjö, Sören Sandell, Malin Engelbrecht
Service	Ralf de Ruijter, David Andersson, Sören Sandell
Pre-processed data for easy value realization	Khaldon Hindi
Smart building market	Johan Grahn & Cecilia Sjöberg, Khaldon Hindi, Sören Sandell, Malin Engelbrecht
Automatic entrances	Ralf de Ruijter, Ramon Schaaf, David Andersson, Per Hallgren Luterkort, Andreas Silvede, Khaldon Hindi, Johan Grahn & Cecilia Sjöberg

Table 5.3: Overview of interview topics

6 Analysis & Findings

This section presents the analysis of collected data, as well the findings from this analysis. Through thematic analysis and utilization of theoretical frameworks, value creating factors are extracted, target customer segments are identified, and product and service offering guidelines are presented.

6.1 Overview of analysis

The qualitative analysis of interviews took place according to the method defined by the methodology chapter and shown in Figure 2.2 The exact coding transcript which resulted in the codes presented in this chapter is presented in Appendix A.

The analysis of the interviews is presented in four major parts. First, the interviews are processed with the aim of giving an overview of key subjects and themes that were present in many of the interviews. This forms a context for the overarching themes of importance in the smart building space. The three remaining sections and their accompanying diagrams presented are based on analyzing the interviews from the perspective of the Customer Profile described earlier and in Value Proposition Design. The analysis then continues by using the model for Diffusion of Innovations and the Value Map from Value Proposition Design to design a product and service offering, based on the customer profile and technical possibilities for smart buildings.

6.2 Overarching themes

The coding of the data, with the aim of providing a generalized overview of the application and use of smart building technologies, generated several different themes. These are shown in Figure 6.1, with the themes generated described in greater detail below it.

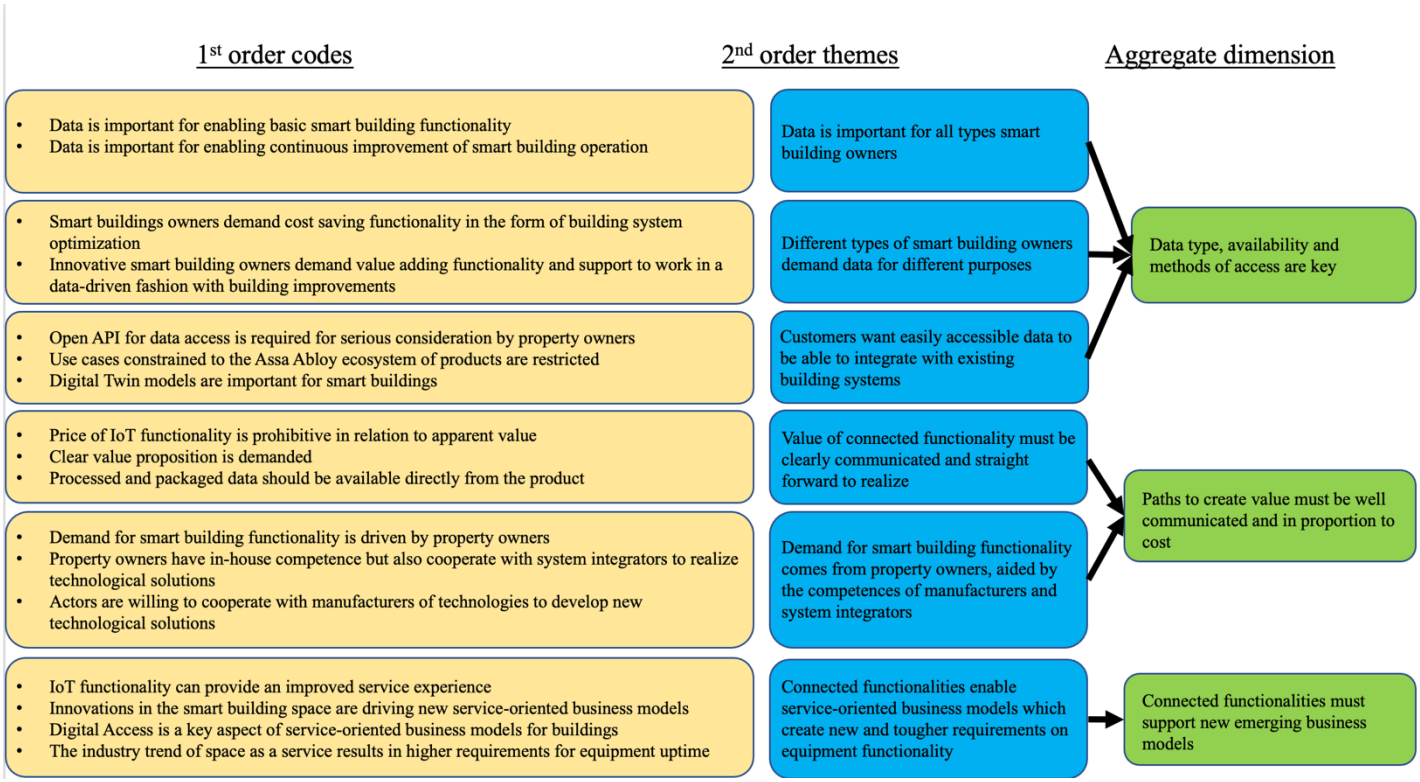

Figure 6.1: Interview coding for overarching themes

Data is important for all types of smart building owners

Regardless of what the goal of the property owners were, interviewees made it clear that data was at the very core of all smart building functionality. Interviews revealed two main ways in which building owners were working with smart building functionality. The most common way in which they are being used today is to provide some sort of cost-saving through optimization of building systems using sensor data. However, a new type of smart building owner is emerging, one which uses smart building technologies to create greater value for the individuals using the building. By working in a data-driven fashion with sensors and building systems, the environment and functionality of the building is improved for people using the building. Common for both groups is that they need data in some form to provide their wished smart building functionality.

Different types of smart building owners demand data for different purposes

With interviews having outlined two main types of smart building owners, it became clear that these two groups had different requirements for what data they needed.

The group that used smart buildings as a method to reach cost savings has the main focus on data that enables the optimization of their HVAC and other building systems. Examples of this could be to gauge how often a door is opened to optimize the ventilation for an area. More innovative smart building owners, while still being interested in cost savings, were very interested in having data that allowed them to work in a data-driven fashion with building improvements and building user experience. Examples of such work would be to have data on how an entrance was currently performing; if a sliding door entrance were to be open 90% of its daytime operating hours, that data would support looking into switching to a revolving door or installing an air curtain.

Customers want easily accessible data for integration with existing building systems

The arguably most important aspect for smart building technologies, an aspect highlighted by nearly all interviewed, is the aspect of being able to access data from systems with connected functionality. This is commonly requested as demand for open APIs, to be able to integrate the data available from systems into an existing BIM system. The BIM system is the heart of the smart building and integrates closely with the digital twin of the building, another core technology for smart buildings. Some of the interviewees go so far as to claim that systems that do not offer an open API are doomed. The need for open APIs is further supported by actors both outside and inside Assa Abloy, who consider the possibilities of what can be done solely inside the Assa Abloy ecosystem limited. However, interviewees did not exclude the possibility of having an app or service which only interfaces with the Assa Abloy equipment, as long as the possibility of integrating the data flows over an API to another system is still possible as well. This is an expected outcome from the interviews, as having different systems create value together is one of the key aspects of smart buildings

Value of connected functionality must be clearly communicated and straight forward to realize

One key aspect that could be distinguished from the data is that smart building owners need to be able to identify how they can realize value from connected functionalities in their systems. This shows that despite innovative building owners working actively to experiment with new technologies in smart buildings, they are not willing to purchase equipment with connected functionality without a clear path of how to realize the value. For some applications, this could result in the cost of adding on connective functionality to a system being prohibitive in contrast to the apparent value, if it is not clear what value can be produced. It is apparent that actors put significant consideration into if new offerings are innovative or solely inventive

without providing value for their applications. For the case of connected entrances, many of the interviewees have had problems distinguishing between an entrance system and an access control system, as well as a lack of knowledge of what a connected entrance could do.

This theme is important as it shows that the hype for smart building technologies is not enough to drive an interest for purchasing IoT-technology enabled devices that do not have a clear value proposition.

Demand for smart building functionality comes from property owners, aided by the competencies of manufacturers and system integrators

The data from the interviews with actors throughout the value chain involved in the creations of smart buildings points to the demand for smart building technologies coming from building owners. This would be in contrast to a hypothetical scenario where building owners only demand cost improvements and hire system integrators who would look at ways to carry this out. This would result in the system integrators driving the demand for smart building technologies. Building owners at the forefront of smart building innovations are actively looking at how they can create value and enable new experiences through new technologies and have much of the competencies needed to realize this in-house. However, the smart building owners and system integrators are open to cooperating with each other as well as manufacturers with the aim of developing new and more complex solutions that require expertise from many fields.

Connected functionalities enable service-oriented business models which create new and tougher requirements on equipment functionality

Smart buildings owners at the forefront of innovation, such as Vasakronan, Akademiska Hus and Castellum are working actively towards increasing the utilization rate of their buildings. One of the main ways they are doing this is through new business models, where instead of offering their building premises as a long-term lease, they are instead offered as a service. This could mean that in a co-working setting for example, that the meeting rooms were available to reserve in an app for an hourly rate. These new service-oriented business models are enabled by innovations in IoT technologies, digital access, and smart buildings. However, when building space is offered as a service and clients are paying only for the time you use it, the client has higher requirements for the level of service they expect to receive. For building systems, this means a higher requirement for equipment uptime and the possibility to integrate with data to enable these new business models.

6.3 Customer profile

In the following section, the customer profile will be outlined based on the interview material. This will be done according to the *Value Proposition* model, described in more detail in section 4. The interviews will be coded and analyzed again, with the focus on finding the pains and gains smart building customers experience and the jobs they perform. Then, a value map that responds to these three areas will be proposed, forming the basis of a compelling value proposition.

In section 6.1, it was found that property owners are the main customers of smart building components and that they drive the development of the market, together with manufacturers and system integrators. Therefore, the customer profile will be based primarily on the property owners, but with input from manufacturers and system integrators taken into account.

The figures found in the following sections present the coding of the interview material with respect to customer pains, gains, and jobs. The figures also present the overarching themes that were extracted from the coding, as well as the aggregate dimensions of the themes.

6.3.1 **Customer jobs**

Customer jobs describe what concrete tasks the customer is working to achieve. Figure 6.2 shows the thematic analysis of interviews, with the customer jobs in focus.

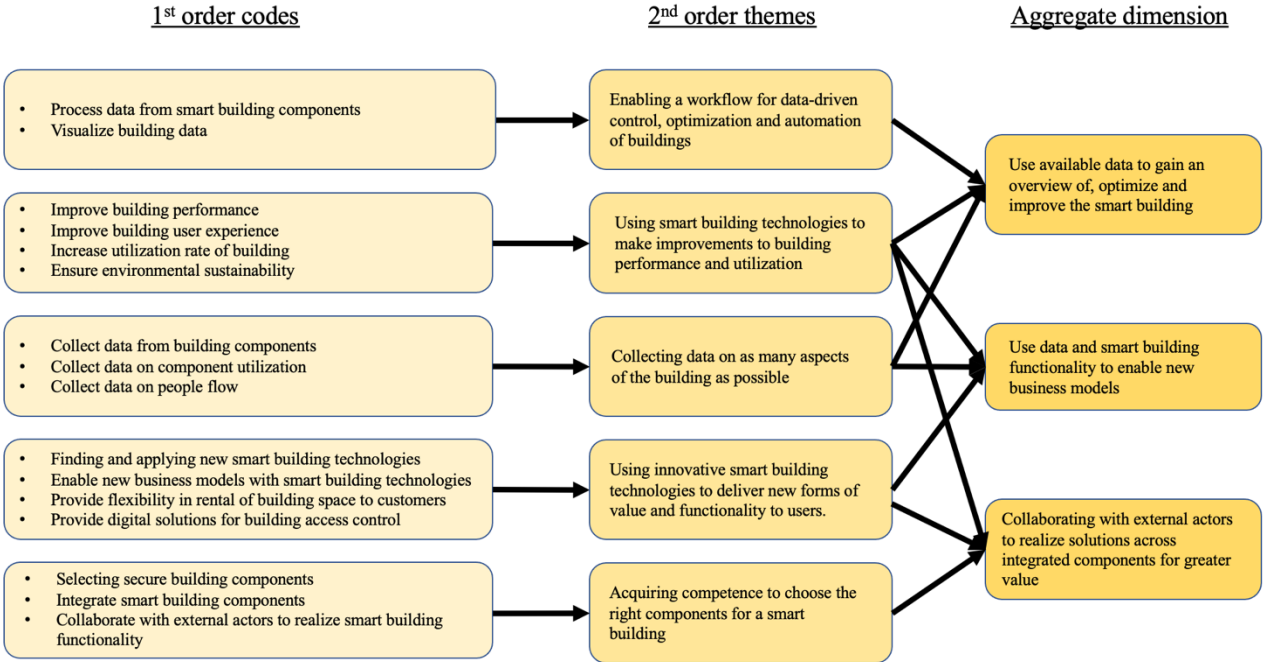

Figure 6.2: Interview coding for customer jobs

6.3.1.1 Themes

Enabling a workflow for data-driven control, optimization, and automation of buildings

Interviews with customers for smart building components highlighted their large focus on working with data to optimize buildings. However, to enable the data-driven processes they strive for, smart building owners require tools to handle the large amounts of data. This manifested itself with customers as a demand for technologies that visualize building data, such as digital twins and systems that process data to make it understandable and software that enable control of building systems in an efficient way.

Using smart building technologies to make improvements to building performance and utilization

Interview subjects highlighted goals of using the functionalities which smart building technologies provide to achieve improvements in building performance. Traditionally, this has manifested itself as cost and environmental improvements regarding building operations, and interview subjects were working to achieve this.

An emerging field where smart building technologies are also being utilized is to improve the building performance in regard to space utilization and user experience, and this is of great interest to smart building owners.

Collecting data on as many aspects of the building as possible

The collection of data was of great importance for many interview subjects, as it lays the groundwork of being able to implement smart building functionality and optimizations. This included data on the equipment in the building as well as data on what is going on inside the building in the form of people flow or climate. Even in situations where they might not know what to do with collected data off the bat, it was of interest to collect it in, e.g., data lakes for later use.

Using innovative smart building technologies to deliver new forms of value and functionality to users

Historically, much of the smart building technology implemented in buildings has focused on optimizing building operations, usually with regards to cost. Now many smart building owners have realized that through being at the forefront of innovation, they can provide increased value through new building functionality. This was exemplified through digital access methods making it simpler for customers to use the building, enabling more flexible usage for the customer. This in turn leads to new business models where space can be offered as a service rather than a product.

Acquiring competence to choose the right components for a smart building

When planning for new smart building functionality, there are many factors which need to be considered. This includes selecting components which are secure from both a physical and IT perspective and selecting components which can be integrated into existing building systems. Smart building owners do not necessarily have competence in these areas and often must collaborate with external actors to make the right choices.

6.3.1.2 Aggregate dimensions

The 2nd order themes come together to form the aggregate dimension, in this case a synthesis from the concrete jobs the smart building owners are carrying out into what they are trying to achieve on a more generalizable level. For these customer jobs three aggregate dimensions were found.

Use available data to gain an overview of, optimize and improve the smart building

Smart building owners have ambitions of collecting as much data as possible, using tools to gain an overview for data-driven improvements and control, and using the available technologies to optimize performance and space utilization. This is generalized to the data centric workflow of using available data to gain an overview of, optimizing and improving the smart building.

Use data and smart building functionality to enable new business models

The ambitions with smart building owners to improve building performance and utilization, collecting as much data as possible and using innovative smart building technologies can be generalized to an ambition of using data and smart building functionality to enable new business models. One of these new business models that were mentioned in the interviews were space as a service.

Collaborating with external actors to realize solutions across integrated components for greater value

Much of the value smart buildings provide is believed to come from the integration of components which earlier were working separately. This process can be complex however, and to realize additional functionality and extract the maximum value, competency spread across several actors is required. Therefore, collaboration with external actors to realize solutions across integrated components is needed to achieve greater value.

6.3.2 **Customer pains**

Customer pains describe anything that annoys the customer before, during and after trying to get a job done. Furthermore, pains are things that prevent the customer from getting a job done, as well as potential risks the customer sees to getting the job done poorly or not at all. Here, the themes and aggregate dimensions found in the interviews are shown in Figure 6.3, with further description below.

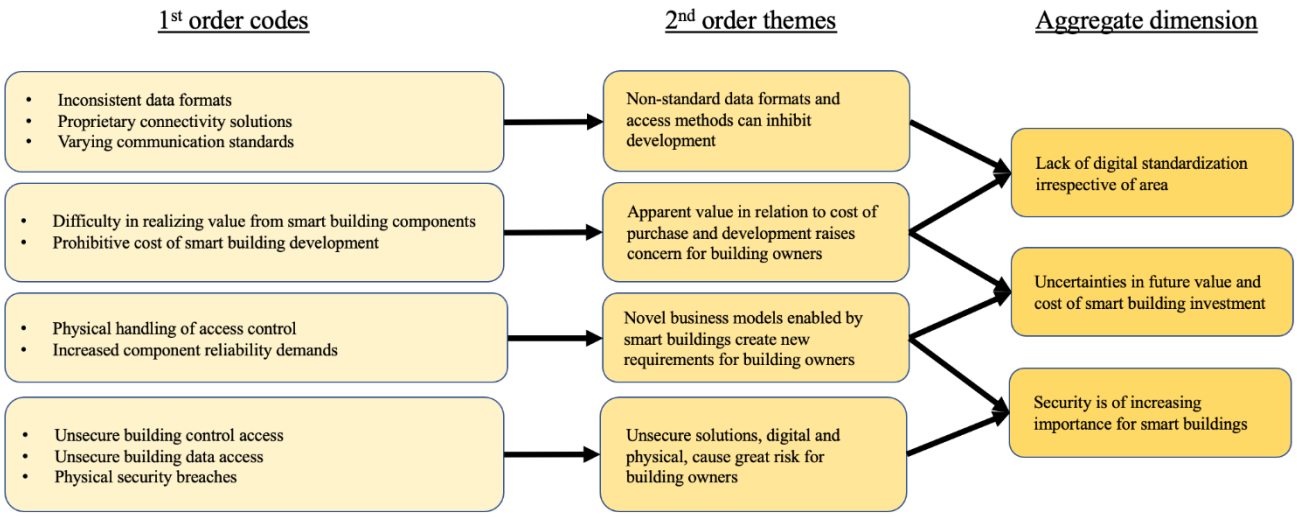

Figure 6.3: Interview coding for customer pains

6.3.2.1 *Themes*

Non-standard data formats and access methods can inhibit development

During the interviews, the problem with varying methods of accessing component data and data formats was highlighted by multiple interviewees. Differing methods of data access makes it difficult to integrate data sources into a centralized system, either requiring extra software integration or making it impossible to access the data in an automated fashion. Proprietary solutions can be guilty of causing this problem, why several interviewees described their aversity to these solutions. Different data formats on the other hand makes it difficult to use the data after it has been retrieved. Again, additional software or further processing of the data is required if it is at all possible.

Apparent value in relation to cost of purchase and development raises concern for building owners

While there can be great value to be found in smart buildings, the way to getting there is not always clear since the value of the smart building system comes from the sum of its parts rather than the parts themselves. Moreover, the integration of all data sources and components that this necessitates presents a relatively large up-front cost for the customer. These issues are a risk for the customer and can make their job difficult.

Novel business models enabled by smart buildings create new requirements for building owners

The new business models that building owners create or want to create with smart building technology often raise the requirements on the existing building systems. For example, with business models that provide flexible access to building spaces, the responsibility for the space is shifted more towards the building owners compared to traditional business models of renting an office space to an organization. In this case, there are increased requirements on component uptime and service, as well as security and access systems.

Unsecure solutions, digital and physical, cause great risk for building owners

See "Security is of increasing importance for smart buildings" in chapter 6.3.2.2.

6.3.2.2 Aggregate dimensions

Lack of digital standardization irrespective of area

The absence of a defined standard for system design and data formatting leads to integration issues in smart buildings, either complicating parts of the integration or making them unfeasible. This issue can also negatively impact what is possible in terms of data-driven optimization or automation. These issues combined can obscure the cost of and benefit of smart building ventures.

Uncertainties in future value and cost of smart building investments

Furthermore, part of the incentive to invest in smart building is the promise of new use cases and business models that the technology can enable. This is inherently an uncertain area, which presents a risk for the smart building owner.

Security is of increasing importance for smart buildings

As the smart building relies on connectivity to both the internet and other devices to a much greater extent than traditional buildings, IT security becomes a larger issue that has to be addressed. The requirements on physical security too can increase, for example in the case of flexible access to building spaces, as was discussed in "Novel business models enabled by smart buildings create new requirements for building owners" in the previous section, 6.3.2.1.

6.3.3 **Customer gains**

The gains indicate what positive aspects building owners are seeking to achieve through their jobs. The gains extracted from thematic analysis interviews are presented in Figure 6.4, with descriptions below.

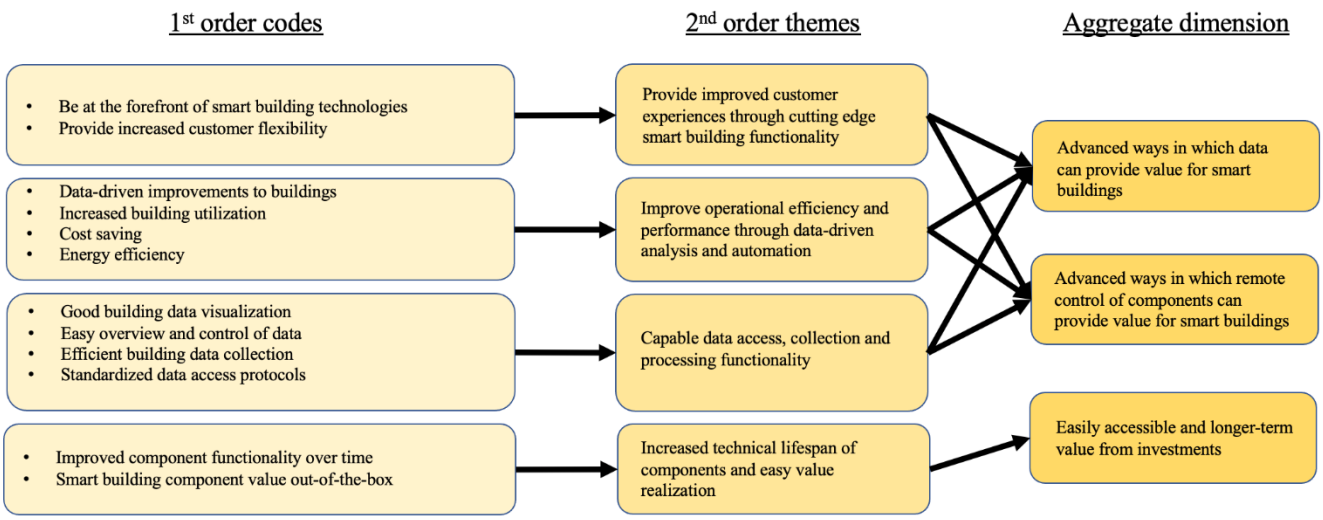

Figure 6.4: Interview coding for customer gains

6.3.3.1 Themes

Provide improved customer experience through cutting edge smart building functionality

One of the main gains that smart building owners are trying to achieve is to give the customers of the building an improved customer experience. This is to be achieved through providing new smart building functionality. Increased customer rental flexibility is one example of the gains which they are attempting to achieve through digital access. Innovative smart building owners also aim to appear as such, strengthening their image towards the customers of being at the forefront of smart building technologies.

Improve operational efficiency and performance through data-driven analysis and automation

Smart buildings aim to achieve improved operational efficiency and performance by working in a data-driven manner with their improvement work. This is in contrast

to the historical way which has involved a lot of guesswork, where data-driven methods provide a much more efficient framework instead. This provides large gains as the financial assets of the building owner can be more well focused

Capable data access, collection and processing functionality

To support data-driven work processes for improvements in smart buildings, building owners seek gains in good building data visualization, as well as easy overview and control of data. Gains in this area makes it easier for humans to efficiently work with the data. Efficient building data collection and standardized data access protocols provides gains in ease of integration of new components, making it easier to extract value from them.

Increased technical lifespan of components and easy value realization

Smart building owners tend to experience long pay-off times for their investments into connected functionalities for components. This is partly due to the need for integrating the component into the building management system for creating functionality. As such they seek gains both in what value a product can provide over time, as well as being able to realize the value of connective functionalities out-of-the-box. Gains in this area would shorten the pay-off time and increase the total value produced over the lifespan of the component.

6.3.3.2 Aggregate dimensions

Advanced ways in which data can provide value for smart buildings

Smart building owners can already realize lots of value today through their existing connective functionalities. Many are now looking for more advanced applications for their data to extract value from. This also includes collecting more data on building operations in general. As the industry moves towards a data-driven way of working, many hope to improve the way they process data so as to realize more complex data-driven improvements.

Advanced ways in which remote control of components can provide value for smart buildings

Connected functionalities provides the possibility of remote-control and automation of components. Remote-control of components is already producing value, as the simple and clear use cases are already implemented. Smart building owners believe

there is more value to be realized and are now looking for ways in which remote control enables the creation of complex automation and control schemes.

Easily accessible and longer-term value from investments

Acquiring connected functionality is treated as an investment by smart building owners, as acquisition of such tends to incur costs. As such, they are evaluated on their merits of how they provide value or reduce costs. As the pay-back time is long for advanced smart building functionalities, building owners seek easily accessible value out-of-the-box and consistent value over the long term for their components.

6.4 Value map

With the customer profile having outlined the pains and gains smart building owners were experiencing related to their current jobs, the value map sets out to describe how a potential solution would offer value-adding factors which address them.

While the value map as described by Osterwalder et al. (2014) uses the map to evaluate an existing product offering to assess the current, the value map will in this case consist of value adding factors which are theoretically possible with current smart building technologies. In essence, it will be used to outline the value adding factors which a connected entrance should offer. The value adding factors necessary for a connected entrance product offering to be successful with smart building owners will be the result of this process.

6.4.1 **Gain creators & Pain relievers**

Below, possible gain creators and pain relievers of a connected entrance offering are presented in Figure 6.5 for gains and Figure 6.6 for pains. These are presented together with the specific pains and gains they address in the customer profile, for an easy overview of how they relate to the customer's needs.

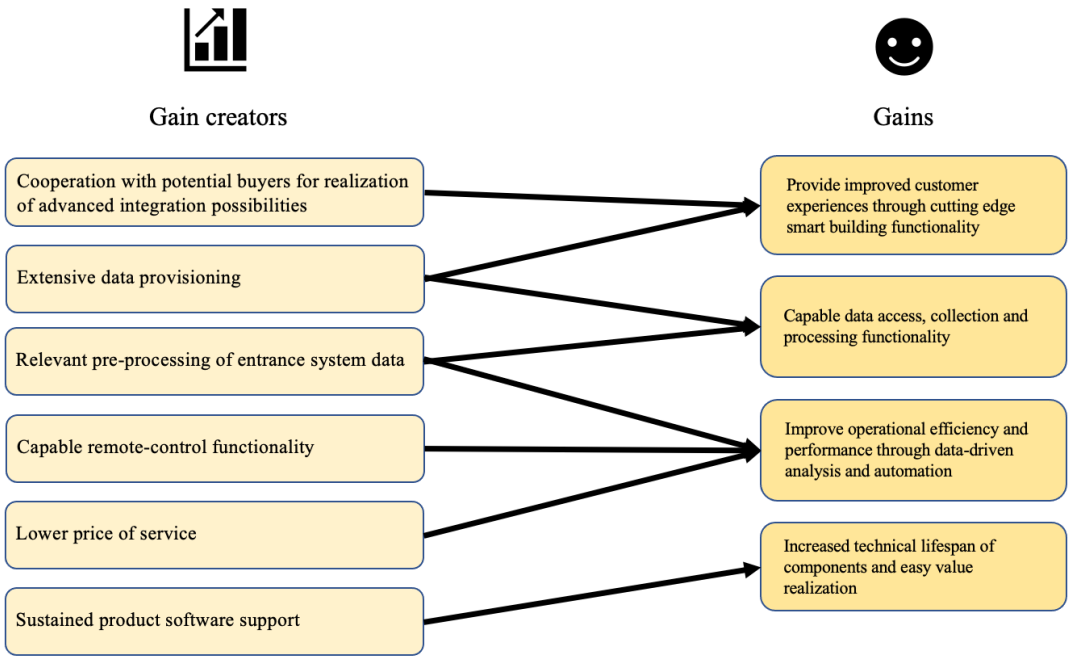

Figure 6.5: Mapping of gain creators to gains

Cooperation with potential buyers for realization of advanced integration possibilities

Through smart building technologies, many building owners aim to provide an improved experience for those using their buildings. Among building owners, there is a subgroup of the most innovative smart building owners who want to be at the forefront of available technologies. By being at the forefront, they want to be able to offer the most advanced functionality to their customers or position themselves as innovative actor in the market. If manufacturers cooperate with these building owners and supply in-depth knowledge on system functionality and use cases, they can assist them in achieving the gains of being at the cutting edge of smart building functionality.

Extensive data provisioning

While a basic level of data is needed to enable fundamental smart building functionality, more extensive data provisioning provides possibilities for more advanced solutions for innovative smart building owners. More extensive data can

enable the sought-after gain of being at the cutting edge of smart building functionality, as well the gain of having capable data access, collection, and processing functionality.

Relevant pre-processing of entrance system data

A connected entrance can provide large amounts of data, and this places substantial requirements on each customer to have the capability to effectively process the data to extract value. With customers seeking gains in data processing, a connected entrance should provide pre-processing of relevant data, as it provides value beyond what the customer could achieve by themselves. This data could in turn help the customer better improve their operational efficiency and performance through data-driven analysis.

Capable remote-control functionality

While most gains smart building owners seek relate to the analysis of data, there is also a demand for solutions in automating devices and controlling them remotely. By supplying capable remote-control functionality for connected entrances, it allows smart building owners to realize their sought gains in improving operational efficiency and performance through automation.

Lower price of service

Many actors seeking improved operational efficiency and connected functionality for entrances can help lower the total cost of ownership by providing building owners with lower service costs through e.g., just-in-time service or remote service.

Sustained product software support

Connective functionalities enable the remote delivery of changes and additions to the software of a product. By providing robust and sustained software support for connected entrances, security updates and new functionality can be added through the life of the product which increase its technical lifespan and total value.

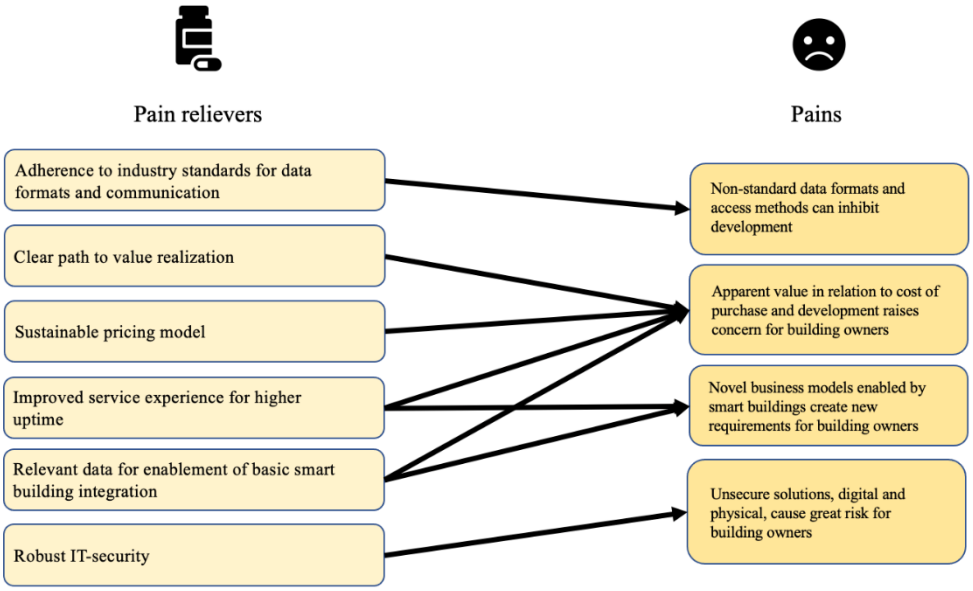

Figure 6.6: Mapping of pain relievers to pains

Adherence to industry standards for data formats and communication

The communication of collected data from components in smart buildings is essential. With many actors highlighting concerns regarding varying data formats and proprietary protocols for communications, connected entrances should ensure adherence to industry standards for data formats and communication protocols. This addresses the pain that customers are experiencing regarding non-standard data formats and access methods which inhibit development possibilities.

Clear path to value realization

While many smart building owners highlight their desire to integrate as many devices as possible into their smart building systems, they also highlight the pain of not knowing exactly how these integrations will produce value. This pain can be alleviated by the manufacturer giving clear paths and examples for how value in their product can be realized in a smart building context.

Sustainable pricing model

Potential customers of smart building technologies do not only raise concerns on how they should realize the value from connected functionality, but they also show concerns on how the value gained from the functionality stands in relation to the cost of purchase and integration. If manufacturers provide pricing models that fit the preferences of the different types of actors, this pain could be alleviated.

Improved service experience for higher uptime

As smart building technologies are becoming central to enabling novel business models in buildings, these new business models also result in higher requirements for building components. Many of these requirements are related to the uptime of building components, where an improved service experience made possible by connected functionality can help address this pain. An improved service could also allow the customer to better see the value of a connected entrance offering, addressing the pain of apparent value.

Relevant data for enablement of basic smart building integration

Not only do smart building owners demand data access methods and formats which adhere to industry standards, but the data itself must be of value for enabling smart building functionality. While much data can potentially be available from a connected entrance, it is important that the available data is relevant in basic smart building integration. By providing the right data, building owners can better realize value from the product and ensure progress towards meeting new requirements posed by novel business models.

Robust IT security

Lacking digital security can be a great risk for smart building owners. As such, this pain should be addressed by ensuring that manufacturers guarantee robust IT security for their products.

6.5 Diffusion of innovations analysis

In the previous section, 6.4.1, the Gain Creators and Pain Relievers which can provide the found customer values were presented. Here, the *Diffusion of innovations* theory presented in section 4 will be used to analyze these and suggest potential ways to improve the different elements of the product offering to increase

the likelihood of market adoption. Furthermore, the state of the market in terms of innovation diffusion will be examined, and a target customer segment will be proposed.

6.5.1 **Adapting products & services with Rate of Adoption**

In the *Diffusion of innovations* theory (Rogers, 2012), the *Rate of adoption* is a framework for analyzing the rate of which a product or service gains traction in the market. The Rate of adoption framework consists of five variables, and in this section, the connected entrance product offering will be examined from the perspective of each variable and adapted to increase the likelihood of market adoption.

Relative advantage

As outlined by the pain relievers and gain creators, connected functionality for entrances can produce significant relative advantages compared to traditional entrances in smart buildings. As entrances are the only points of entry of a building, a connected entrance has a significant advantage in people counting applications. Furthermore, the potential for improved service provides notable value over traditional entrances, and the possible integration with HVAC systems too can be an important advantage.

While the full value of the product is realized only when it is integrated into a smart building system, the sought customer is one planning to build or already owning a smart building, so this will not be a sizeable problem.

Compatibility

The fact that connected functionality in almost any building component is of interest to smart building owners points to a large degree of compatibility with the smart building market. In particular, connected functionalities in the entrance is of interest as entrances are a key point of interaction between users and the building. Furthermore, building owners in the group surveyed were very willing to experiment with new technologies as well as to cooperate with actors in realizing them, pointing to even more compatibility.

Complexity

Smart building owners have highlighted that the complexity of getting value out of investments can vary greatly depending on what type of value is aimed for. Some applications can deliver value directly out-of-the-box with relatively low complexity for the building owner, but many solutions which realize value are of the complex variant, requiring integration into a smart building system for data collection and automation use cases. This complexity can potentially be off-putting

but can be remedied through providing knowledge in integration and possible use cases.

Trialability

There are multiple issues relating to trialability of connected entrances for smart building owners. If the price of the connective functionality is too high, building owners could potentially be unwilling to experiment with how such a solution could produce value. This would be a barrier for adoption, which can be remedied in some ways. If Assa Abloy can be relatively sure that the customer will be willing to use the functionality if they get a chance to test it, the cost for providing the functionality can initially be absorbed by Assa Abloy. The functionalities could then be provided as a subscription, where building owners pay a fee to access the functionality.

Another significant issue regarding trialability is the need for integration before the full value can be realized from the connected entrance. Smart building components in and of themselves only provide limited additional value compared to their traditional counterparts; the full value of the components is only realized when multiple components and systems are interconnected, making the building smart. This severely limits the trialability of a connected entrance.

One possible remedy for this problem is experts from Assa Abloy consulting the customer before purchase, demonstrating hypothetical use cases which would be possible with connected functionality. Moreover, clear marketing of the possibilities that the connected entrance enables is important to further rectify the trialability problem.

Observability

From a technical perspective, functionality in the product which enables and simplifies integration into a smart building would be very visible to actors working with the implementation aspects of smart buildings. Depending on these individuals' potential to affect the decision process, this provides a degree of observability. If these types of individuals do not have a large degree of influence however, this major selling point for the product can go unnoticed. In this case, it could make sense to use some form of certification or marketing to highlight the standards adhered to by the entrance for greater observability.

Advantages such as a better service experience can have a large degree of observability towards decisionmakers, as such advantages most likely could be presented as monetary or performance gains for the entrance. The monetary and uptime gains would however come over time, and not be immediately visible to the customer.

Functionality which can be provided out-of-the-box, without any integration needed, also provides increased observability as those functionalities would constitute concrete use cases. This would be in contrast to the more problematic

aspect of observability for applications requiring integration with a smart building. For aiding observability in this area clear advertisement of prior use cases with other actors should be a point of focus.

6.5.2 **Target customer segment**

According to the *Diffusion of Innovations* theory, the market can be divided into five segments based on how early they adopt an innovation. This is shown in Figure 6.7.

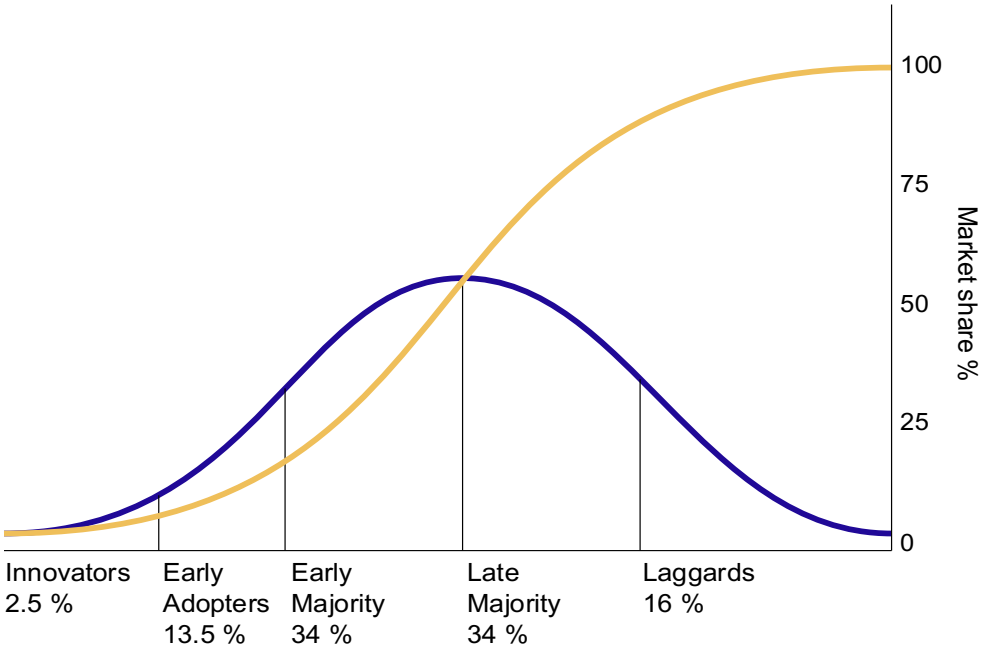

Figure 6.7: The diffusion of innovation, with adopter categories in blue and market share in yellow (Rogers, 2012)

The interviews have shown that the smart building market is still in its early stages, with smart buildings becoming more common but still not being widespread in society. The property owners that currently invest in smart buildings are open to trying new technologies and business models and value being in the vanguard, indicating that smart buildings have reached either the Innovators or Early Adopters category.

The theory shows that the earlier adopter categories lead the way and inspire the following categories to adopt an innovation. As such, it stands to reason that Assa

Abloy should target the innovative property owners with its product offering in the initial phase of the connected entrance's release and life cycle. These will be the most open to try new technologies, and if the product gains a footing in this adopter category the following categories are more likely to purchase a connected entrance in the future.

6.6 Products & Services

With Gain Creators & Pain Relievers outlining what the critical value adding factors for connected entrances are, and the diffusion of innovations analysis of these outlining their accompanying obstacles to adoption, Products & Services outlines how a connected entrance product offering would provide these values and eliminate obstacles. The nine areas presented incorporate the Pain Relievers and Gain Creators and take the diffusion of innovations analysis into account, to address include the value-adding factors found for connected entrances. The products and services presented includes the physical and digital product as well as the services

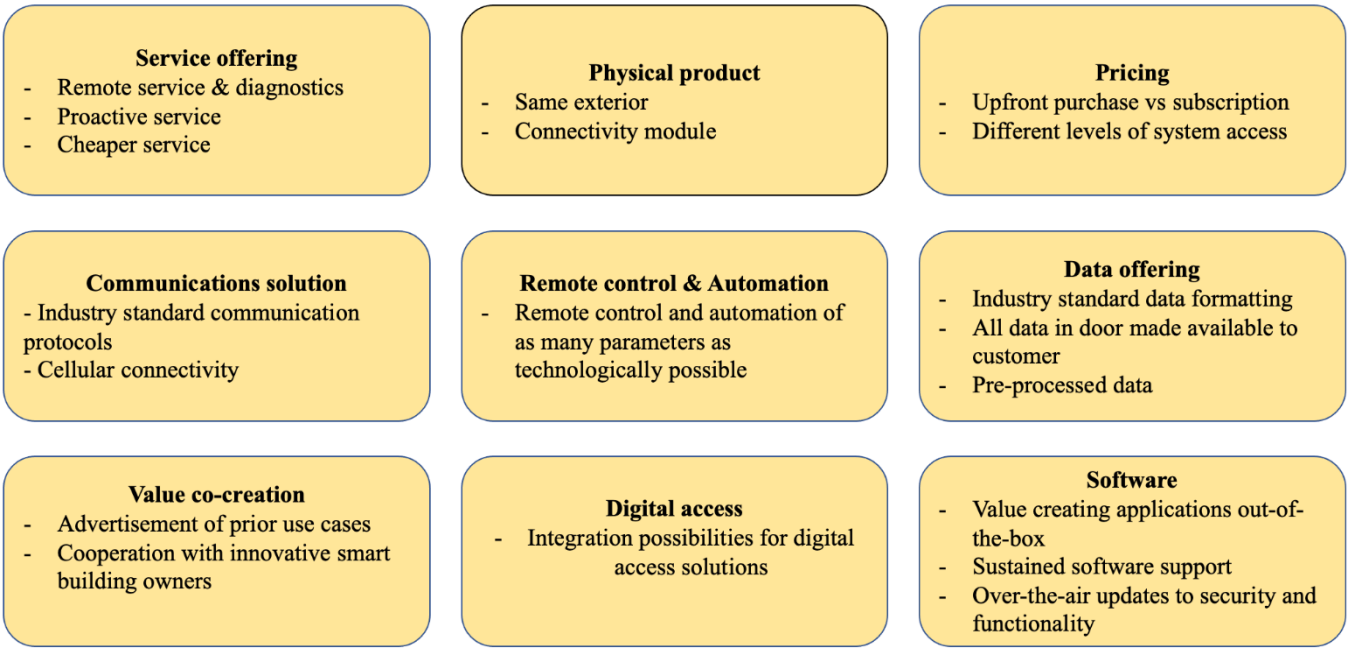

Figure 6.8: Summary of proposed product & services offering

which accompany them. A summary of these products and services are presented in Figure 6.8.

6.6.1 **Physical product**

The connected entrance system is physically largely similar to a traditional entrance system. The differentiating aspects are not new ways of operating the door but rather the data collection and remote control connected functionality provides. Therefore, the additional components of the door compared to a traditional entrance are the connectivity module and various sensors. The connectivity module communicates with a network and provide access to the data collected by the sensors, as well as remote control capabilities. The various sensors collect data about the entrance usage, its state, people flows and other suitable factors. If Assa Abloy is to provide pre-processed data from the connected entrances, the processing does not have to be performed on the entrance's system and could be offloaded to a cloud computing service.

Most, if not all, of the additional functionality in a connected entrance compared to a traditional one could be built into modules that can be installed in existing, non-connected entrance systems, making it possible to upgrade existing entrances and facilitating the construction of new connected entrances.

6.6.2 **Communications solution**

The most important functionality for Assa Abloy to provide in a connected entrance is the communication solution that enables integration into a smart building management system. The communications solution should consist of an API for data access and control, making the door and its data accessible outside the Assa Abloy ecosystem. Integration of data and control functionality into a building management system is key for smart building components, and products which cannot be integrated will have a hard time succeeding in this market. Furthermore, while there must be an API for data access, the way in which this data is collected needs to follow industry standards. The leading industry standard for communication, which should be supported by the entrance system is BACnet. However, if Assa Abloy wants to provide an even more flexible solution to their customers they could choose to include more standards such as Modbus or Lonworks.

For Assa Abloy to perform big-data analysis on their data to provide a better service experience, as well as to provide pre-processed data to building owners, connected entrances should also be outfitted with a connectivity solution which enables communication with Assa Abloy servers. As this aspect of the door functionality is not necessarily visible to consumers, it would likely be best received if the customer did not have to perform any setup relating to this. Therefore, cellular connectivity over 4G or 5G could be suitable for such connectivity and ensure that as many

entrance systems as possible can provide Assa Abloy with data for their big-data analysis, especially if the door is to be installed in a not-so-smart building.

6.6.3 **Data offering**

Not only should Assa Abloy provide methods for making data access possible, the data offered should also meet the data needs of building owners. The data from the entrance should at least be sufficient for enabling basic integrations and analysis of its performance. While which exact data this would consist of is not completely clear and might vary between customer use cases, many customers highlighted integration with digital twins as an important aspect of smart building development. This would mean that data such as if the door is opened, closed, locked, or unlocked and errors would constitute minimum requirements.

Going beyond the bare minimums there are further gains to be realized, with building owners seeking to gather as much data as possible in their buildings. Hence, the more data from the door that Assa Abloy would be able to provide, the better. This would allow the customer to choose what data they want to use freely. Furthermore, Assa Abloy could make their data offering towards their customer even more attractive by providing pre-processed data sources according to predefined big data models, leveraging data from the entire installed base to provide analysis. For example, through models for proximity sensor data, a people counting data model could be provided by utilizing the data available. One use case that would be useful to have pre-processed data in to help data-driven optimizations is to analyze whether the door the customer currently has is suitable for their use case. For example, if a door has a utilization of above 90%, that could indicate that the door should be switched to one with a higher capacity.

For smart building owners to efficiently utilize the data, it should adhere to industry standards for data. By adhering to, for example, the RealEstateCore ontology Assa Abloy would make sure that its products are easy to work with and can be well received by building owners. However, as there will probably be more work done in this area, Assa Abloy should be open to implementing support for several standards.

6.6.4 **Software**

Data access, control and service are the key components of what is offered towards consumers. These functionalities are enabled by an underlying software suite, which needs to be sufficiently capable of providing these services. As the smart building space evolves, it is likely that the needs of consumers change and therefore the software. In such a case, customers would likely find it cumbersome to have to

replace the entire door for a software update for enabling new functionality. Therefore, Assa Abloy should ensure that they provide sustained software support and updates for their connected entrance lineup. Preferably, this is done through an over-the-air update for consumers to minimize their effort in keeping their systems up to date.

The software delivered with the entrance should also provide some functionality out-of-the-box to make the connected functionalities more attractive and their value more visible for the customer. For example, software for people counting could be provided out-of-the-box. If many customers later recognize the need for digital access solutions, an update which enables integrations with such solutions could be possible.

Ongoing software support also ensures that Assa Abloy can work to provide a product with good IT security, where security patches can be applied remotely if so would be needed. Assa Abloy needs to provide good IT security to be relevant for this market, and Assa Abloy's efforts in this area should be highlighted towards customers.

6.6.5 **Remote control & automation**

Remote control and automation possibilities can help customers realize value from their connected entrances. However, Assa Abloy are limited in what type of remote control and automation possibilities they can provide, as opening or closing an entrance remotely is forbidden by law in the EU and possible elsewhere. While it might seem like this eliminates the possibilities for remote control, there are still parameters which could be controlled remotely. Some notable ones include controlling if the door is locked or unlocked, opening a door a set amount, and setting the time for which a sliding or swing entrance stays open after being triggered. For a connected entrance offering, Assa Abloy should allow building owners to control as many aspects of the door as is possible remotely, to enable as many use cases as possible. If regulation would change, Assa Abloy should be quick to adapt as the possibility of remote opening or closing can enable many attractive use cases.

6.6.6 **Digital access**

The smart building owners who are working at the forefront of innovation are also currently exploring the service of digital access. Together, several of them have launched the initiative *Accessy* to enable the provisioning of digital keys for building owners. With Assa Abloy providing entrance solutions, it would be natural for Assa Abloy to offer some form of digital access solution integration with their products.

6.6.7 **Service offering**

The potential for improvements to Assa Abloy's service offering enabled by connective functionality is substantial. A large base of installed entrances providing data enables big-data analysis which can help optimize Assa Abloy's service offering. Better knowledge of failure rates and indicators can allow Assa Abloy to decrease the amount of failures in active equipment, potentially making the cost of service cheaper and therefore being able to provide cheaper service contracts. Using big data to predict failures can also improve proactive service, which would ensure higher uptime for customers as doors are serviced just in time, minimizing downtime and cost. This is especially critical for customers who have high requirements for their equipment uptime, which includes many of the innovative smart building owners surveyed.

Customers could also gain an improved service experience through Assa Abloy being able to remotely diagnose and service certain errors. Using remote service, a technician would better know what needs service before being sent out, increasing the probability that they would be able to fix the issue on the first visit. Remote service could also be used to remotely reset malfunctioning doors, something which Assa Abloy sees great value in as many problems can be solved with a simple reset, which today needs to be done by pushing a physical button.

6.6.8 **Value co-creation**

To help customers realize value from their investments in connected functionality and establish a presence on the smart building market, Assa Abloy should cooperate with smart building owners to assist with knowledge related to integration and application of their products. With customers striving to work at the forefront of available technologies, cooperation with manufacturers can help them utilize the available technologies at their full potential. This cooperation could exist in many types of services.

Clear advertisement of prior use cases would be a way of helping customers discover how they can realize value from such a solution. Clear advertisement of use cases which have not yet been realized but are technologically possible is another path which could be taken.

Assa Abloy could also take a more active role in this cooperation, where for example an "Integration and automation specialist" from Assa Abloy with expert knowledge of the connectivity functionality helps a customer tailor a solution to their specific needs. These use cases could then be used for advertisement of possibilities for subsequent smart building owners.

6.6.9 **Pricing**

The hardware and software efforts associated with enabling connected functionality comes at a cost. Customers might not know beforehand how much value the connected functionality will provide, and therefore might be unwilling to pay if the price is significant. This leads to a chicken and egg problem relating to some of the functionality Assa Abloy could realize with a connected entrance offering. For example, providing customers with proactive service requires big data analysis, which in turn requires a big set of data to base it on. If customers are not willing to pay for a solution which, e.g., does not provide the benefits of big data there is a problem.

One potential method which could be used to remedy this is that the connected functionality is installed into every entrance system per default. Assa Abloy would then absorb the cost for this with the aim of building their datasets, and then aim to recoup it through optimizations of service contracts and repairs later. Then, for customers to access the functionality of the installed connectivity solution, they could pay a one-time or subscription fee for unlocking it. Assa Abloy could also further segment between types of smart building owners, by giving access to more extensive data depending on which subscription they would choose.

6.7 Summary of analysis

The analysis of the interview material through the lens of the theoretical models revealed several useful results. Firstly, a profile of the potential customer for connected entrance for smart buildings was created, outlining the pains, gains and jobs that relate to their work. Based on this profile, corresponding gain creators and pain relievers were proposed. These gain creators and pain relievers represent the value-adding factors that the potential customer would like to find in a connected entrance product offering, as relieving pains and creating gains corresponds to adding value for the customer.

Based on these value-adding factors, a product & service offering was proposed. The proposed offering seeks to include most if not all of the identified value-adding factors, creating an attractive value proposition for the potential customer. The offering also took the factors affecting adoption rate into account, with the goal of removing barriers for adoption and increasing the attractiveness of the offering. A summarized version of the value design canvas is shown in Figure 6.9.

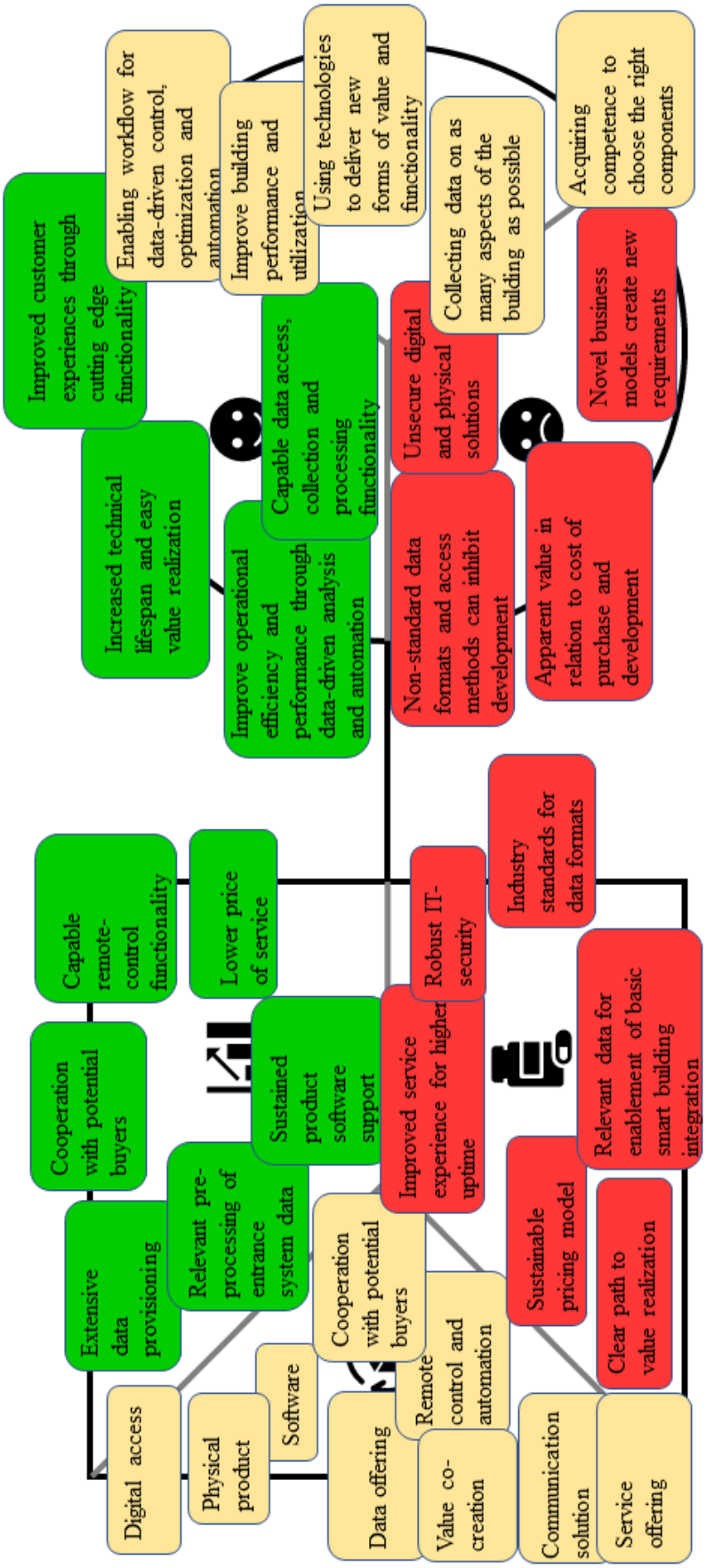

Figure 6.9: The value proposition canvas, mapped

7 Discussion

This chapter discussed the findings that were presented in the previous chapter from several different perspectives. The results are discussed in relation to previous studies, their impact for Assa Abloy, and their impact for other stakeholders in this market.

7.1 Results in comparison to previous studies

The results from this study appear to be well in line with the existing theoretical knowledge outlined in previous studies. Aspects such as the segmentation of the macro-sphere and micro-sphere for Internet of Things products is apparent in the results, with cloud computing and big data services being just as important as the actual hardware in the field for connected entrances. The resulting factors of value creation through connected entrances also agrees strongly with previous studies regarding value creation for IoT in general. Monitoring and control, big data, and business analytics as well as information sharing and collaboration were all topics highlighted by the results to be of great importance for connected entrances in smart buildings, further concurring with previous studies.

A novel aspect outlined in this paper which, to the authors knowledge, has not been studied previously is the role of data for data-driven building optimizations. While this paper does concur with the importance of having data for building systems such as security, HVAC, and fire safety, it primarily adds to this knowledge by presenting new findings in what is seemingly an emerging field among innovative smart building owners. Findings of further importance which also add to the current knowledge surrounding smart buildings is the attitude towards proprietary versus non-proprietary solutions for connected components in a smart building. This research also points to how new business models can be enabled using Internet of Things technologies in new contexts and indicates how this trend might affect other products relevant for buildings.

7.2 Impact for Assa Abloy

The results provide several implications for Assa Abloy as to how connected entrances can provide value. When it comes to data, it has been said that it is the modern-day gold. Hence, it is understandable that actors that have access to and control over data sources are potentially unwilling to give other actors full access to that data. E.g., if Google were to reveal all data it has on everyone profiled for advertising, that would mean a huge loss in competitive advantage as the data can be used by other actors to target advertising as well. For the case of Assa Abloy, the questions must absolutely be raised regarding how much data they should be willing to share with other actors going forward. How valuable is the raw data on Assa Abloy's entrance performance to other actors?

Regardless of the answer to this question, to be relevant for the smart building market Assa Abloy needs to at least give a sufficient degree of data access to those aiming to utilize the products for smart buildings. Several interview subjects highlighted that they did not see a future in the smart building market for products that do not provide an open API for access to the product data through other software. Assa Abloy should also consider how any potential sensitive data is to create value and if it can be provided without risk for *individual* smart building owners. For example, some data might only produce value in a big data context where one has access to thousands of doors, and in such a case the data from one door in a smart building does not decrease Assa Abloy's competitiveness for applications of big data.

While suboptimal for the smart building industry, a hypothetical scenario where Assa Abloy places restrictions on data-sharing could lead to advantageous lock-in effects for products in the Assa Abloy ecosystem, given that Assa Abloy has the right product offering. This research, however, does not support that such lock-in would be a good idea, given the attitudes of the targeted customer segment regarding investments in proprietary connectivity solutions. Furthermore, seeing as Assa Abloy does not produce a complete system for building automation, this lock-in would not serve the customers any additional synergies which they would otherwise receive for sticking to an ecosystem of products.

Digital access is shown to be of growing interest to smart building owners, with the market seemingly at its infancy. With digital solutions for all aspects of everyday life gaining traction, and a demonstrable demand by customers to not have to carry keys shown by products such as the smart lock Yale Doorman, digital access is an area which has large potential. Assa Abloy's knowledge in both access systems and entrances should give it a leg up on other actors when it comes to being competitive in this area. However, as the internal organization of Assa Abloy does not put entrances and access systems in the same silo, there is need for great internal cooperation to be a competitive player for digital access. Furthermore, the fact that

swing door operators are not sold together with a complete door package is another obstacle to being a leading player for digital access.

This paper should also aid Assa Abloy in helping them understand the role of their entrances in a smart building context. With Assa Abloy having looked inwards for use cases for the functionality enabled by connectivity, they have missed much of what is key to smart building owners. While providing out-of-the-box use cases leveraging connected functionality is valued and provide advantages for adoption, many of the value-creating use cases are such that an Assa Abloy entrance needs to be integrated with other systems in a building to realize the value. Assa Abloy cannot expect to adequately cover the market by letting Assa Abloy's platform be at the core of the functionality and should therefore make sure that the products integrate as well as possible into the building management system and digital twin. This integration is key to success in the smart building space.

Many of the suggestions that are presented in this research take place in the macro-sphere for IoT, using technologies such as big data and cloud computing for processing of entrance system data. Assa Abloy should ensure that they have sufficient competences for utilizing such technologies in a scalable manner to ensure success for many of the suggested connected entrance technologies. The functionalities based in big data potentially suffer from a chicken and egg problem as highlighted earlier, where having no offering in this area can lead insufficient amounts of data for big data use cases, which in turn hampers the value of the product offering. With a growing focus on data across many industries, Assa Abloy will need its own data to be able to provide these types of advanced services. To gather data through connected entrances, Assa Abloy should consider how large of an investment it is willing to make in achieving this.

Assa Abloy should also note that the proposed product and service offering is based on what the market looks like at the current time. Going forward it is likely that these exact product functionalities might not be valid, as technological advances make them obsolete. In such a case, it would be possible to instead look at the answers to RQ1 and attempt to design a product & service offering incorporating the same values around the new technological possibilities at that time. As more time passes it is very possible that the customer profile will change as well, and this should also be considered if these recommendations are to be implemented at a later time.

7.3 Impact for the Smart Building Industry, Policymakers, and Society

7.3.1 **Digitalization in society**

Smart buildings are yet another step in the overall trend of increasing digitalization throughout society. Not only are we now connected anywhere and at any time, but anything can now be connected as well. This shift into connecting anything is believed to have great potential in society, and the application for connectivity in building contexts is just the realization of one of those applications. The increase in digitalization carries a wide range of effects in society, and the negative ones must be considered as well. How should policymakers ensure that the less digitally inclined can participate just as well in society as the digitally proficient? Should individuals who don't have access to smartphones not be able to fully utilize something as basic as a building properly, if digital access and other new business models get widespread adoption? Such questions should be considered by policymakers to ensure that digitalization is for the good of all. Moreover, increased digitalization makes society more vulnerable to disruptions as more points of failure are introduced, which are also targetable by offensive measures from potential adversaries. With increasing tensions between nations worldwide, and demonstrable hacker-attacks on infrastructure, the IT-security of everything connected may very well be of national interest.

7.3.2 **The smart building industry**

This study showed a demand for standardization in smart building connectivity and data formats. To help aid the development of additional smart building functionality and integration of connective functionality into traditional building components, the industry must ensure that there are clear and up-to-date standards for manufacturers to adhere to. This is very important for both data and connectivity functionality, as uncertainty in this area can lead to a fragmented landscape for these types of products, leading to higher costs for implementation. The industry should also standardize IT-security practices for manufacturers to further ensure good practice.

Most actors interviewed signaled a high willingness to cooperate with other actors in the smart building space. Greater cooperation overall throughout the space, as well as developmental models where many actors get to take part in developing smart building experiences can help push the industry forward, growing the market and the technological possibilities.

7.3.3 **Agenda 2030**

With Assa Abloy's ambition to become more sustainable being in line with the goals set out by the Paris agreement, it is of interest to note how connected entrances could contribute to that ambition. The values which the theoretical products and services provide certainly have synergies with working towards a more sustainable Assa Abloy.

A large part of the reason for why smart buildings are of interest for building owners are the cost savings they can produce, especially with regards to minimizing energy consumption. With Assa Abloy's connected entrances providing further avenues for energy optimization in a smart building context, especially given the entrance's role as a barrier between the outside and inside climate, Assa Abloy can certainly help further reduce carbon emissions through a well-designed connected entrance offering. Such emissions could both be connected to the interaction with other building systems, but also through data-driven models suggesting actions such as switching the type of door for improved energy efficiency.

By extending the lifespan of entrances and providing good service possibilities for customers, further steps towards the Agenda 2030 goals can be taken. Connected entrances were through this research project shown to provide improvements in these areas. For example, connected entrances could provide an improved service experience where doors are diagnosed remotely and serviced just-in-time as well as remotely. By being able to diagnose and service entrances remotely, the carbon footprints of technicians who would otherwise have to travel to repair entrances would be decreased. Just-in-time service would also serve to minimize unnecessary repairs and trips. With the lifespan of the entrance lengthened through software updates and better service, the carbon footprint for the manufacturing and service of an entrance is spread out over more years, leading to a lower total carbon footprint for the building over its lifespan.

7.4 Discussion on credibility of research

7.4.1 **Validity**

With the analysis pointing to several factors which are determined to be answers to the research questions, the important questions should be asked: are the results valid and reasonable? With three interviews with building owners, accompanied by several other interviews from which the conclusions support each other, the results are achieved through a form of triangulation.

The aspect of how reasonable the results are deemed to be was discussed together with the supervisor for the research project at Assa Abloy. The discussion was about if the results would be suitable for Assa Abloy, as well as if they made sense in general based on their knowledge of the smart building market and available technologies. The discussion concluded that while some aspects that were uncovered were new to Assa Abloy, many of the findings were in line with what was expected prior to the study. The findings were also deemed to be reasonable in terms of usefulness for Assa Abloy to shape a potential connected entrance offering if they would choose to in the future.

For further validation, it could be fitting to examine the findings together with experts in IoT technologies as well as a more extensive number of smart building owners. Such validation could also help provide further information regarding the generalizability of the results, depending on the reception of the validating parties.

Looking at the results from a theoretical perspective, it is also clear that what the building owners sought after fell in line with the factors highlighted as key areas of value creation for IoT products in previous studies, with connected entrances creating value in the areas of monitoring and control, big data, and business analytics as well as information sharing and collaboration.

7.5 Reliability, Generalizability and Objectivity

This report gives a detailed description of the steps taken to reach the conclusion. The link between interview summaries, coding, analysis, and conclusion have been shaped to give as clear of an insight into the process as possible for the reader. One aspect however which could potentially be opaque to the reader is the process from interview to summary of an interview, and therefore cause issues for a reader aiming to reproduce the results. The choice to not transcribe interviews word-for-word came from the prioritization of what there would be time for, and concerns regarding if increased time consumption would take time away from other aspects of the

report. We deemed the increase in efficiency and time for additional analysis vs. the loss of reliability to be favorable for summarizing the interviews for this study, and do not deem the loss or skewing of data because of it to be significant. Furthermore, having the interviews presented in the way that it currently is makes them more easily accessible to the reader.

The generalizability of the results was also in line with the aim of the study, i.e., to reach generalizability within this smaller group of individuals being studied. We believe that the generalizability is further strengthened by having the conclusions be in line with the theoretical framework surrounding IoT and smart buildings prior to the research. The researchers made their best efforts to keep an open mind throughout the research endeavor, and questioned concepts and results through discussions with each other.

8 Conclusion

This chapter presents answers to the research questions detailed in the introduction. In addition to the answers themselves, it also presents limitations and risks related to the answers, how the answers to contribute to the theory of the field, as well as suggestions for further research in the field.

8.1 Answers to research questions

With the value proposition that addresses the customer profile outlined in the analysis, we are ready to answer the research questions posed in the beginning of the thesis. The different parts of the value proposition each answer RQ1 or RQ2. The gain creators and pain relievers answer RQ1, and from those the product and service offering that encompass them was derived, and that offering answers RQ2.

8.1.1 **Which are the critical value-adding factors of connected entrances for the smart building market?**

The gain creators and pain relievers presented in the value proposition are the critical value-adding factors of connected entrances, as they respond to the customers' needs.

In total, there are 12 value-adding factors which are critical to connected entrances for the smart building market: (1) Cooperation with potential buyers for realization of advanced integration possibilities, (2) Adherence to industry standards for data formats and communication, (3) Extensive data provisioning, (4) Clear path to value realization, (5) Relevant pre-processing of entrance system data, (6) Sustainable pricing model, (7) Capable remote-control functionality, (8) Improved service experience for higher uptime, (9) Lower price of service, (10) Relevant data for

enablement of basic smart building integrations, (11) Sustained product software support and (12) Robust IT-security. These are visualized in Figure 8.1.

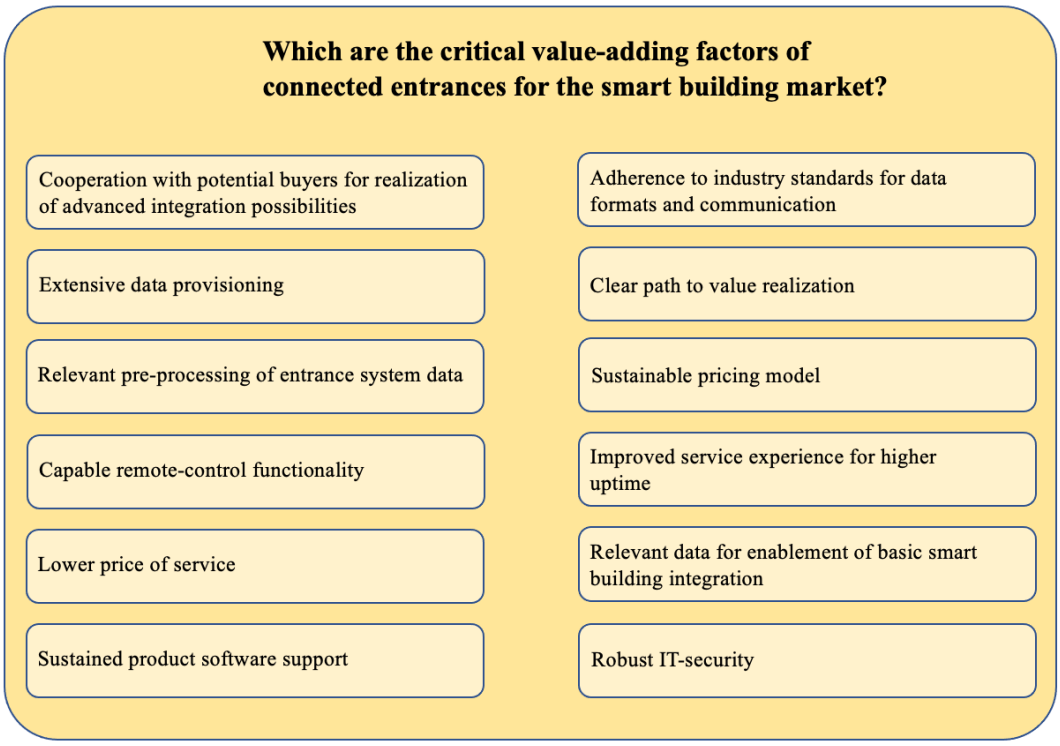

Figure 8.1: Critical value-adding factors of connected entrances.

8.1.2 How should Assa Abloy design a competitive product and service offering of connected entrances for the smart building market?

Building on the value-adding factors presented in the answer to RQ1, the factors presented in Figure 8.2 should be present in the product and service offering of a connected entrance from Assa Abloy.

The Diffusion of Innovations analysis also showed that Assa Abloy should target the more innovative property owners in the initial release of the connected entrance product offering, which include Vasakronan, Castellum, Akademiska Hus. This segment is the most likely to invest in new products and technologies in the smart

building market and can pave the way for further market adoption of connected entrances.

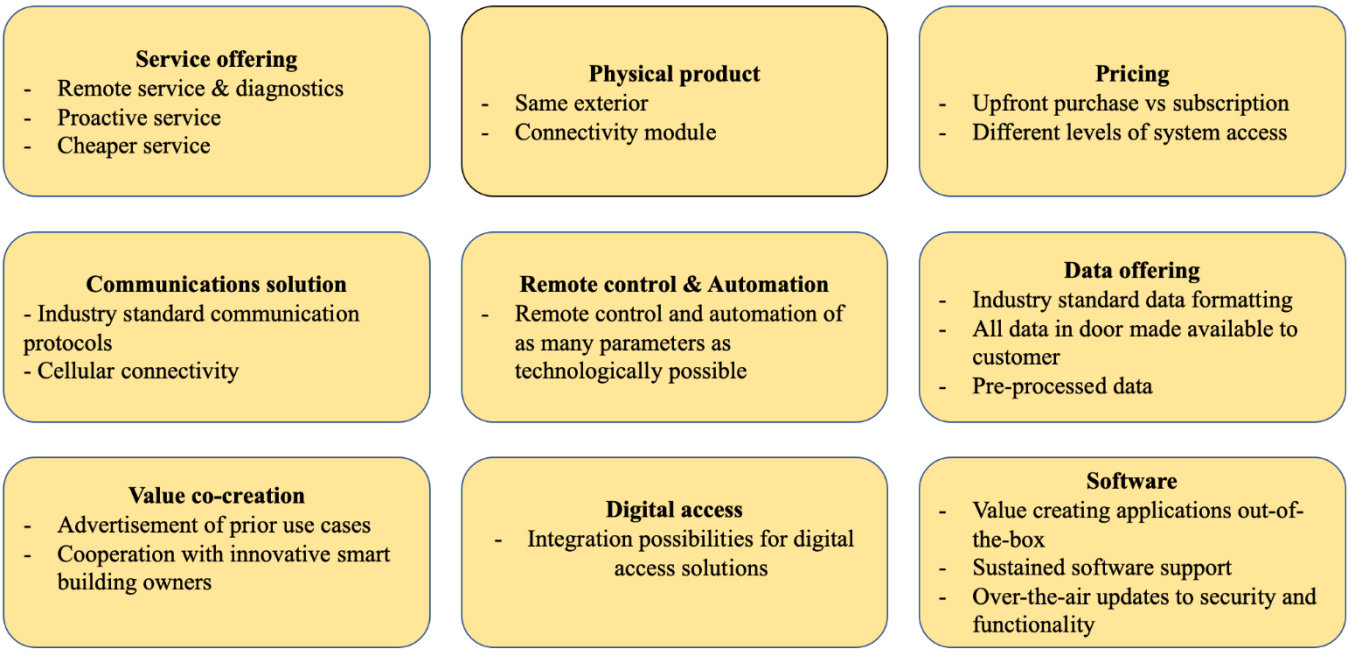

Figure 8.2: Proposed value proposition elements

8.2 Limitations and risks

Our methodology gives us insight into the current state of needs among innovative smart building owners in Sweden. Conversely, smart building owners who are not working as actively with new technologies are not necessarily covered and might have different customer profiles. Neither are smart building owners outside of Sweden covered. As such, the conclusions of this thesis are limited to the group innovative smart building owners present in Sweden. As previously stated however, these might very well set the pace for the future development of the market which will spill over to the remaining adopter categories. Attention should also be paid to the number of interviews for each category of interviewees. While the number of interviews is not deemed too small for us to draw these conclusions looking at the number of smart building owners who we identify as innovative, it is possible that the actors not interviewed would be diverging in their attitudes to new smart building technologies.

It should also be noted that this is an analysis of what product functionalities that customers want, and not a business plan evaluating if it is a good idea strategy wise for Assa Abloy to provide these functionalities. Interviewees have also been actors in established companies who have a profit motive and might therefore be working to shape Assa Abloy's products in their specific favor. Therefore, the business side of any potential implementation of features, functionalities, or services should be considered to minimize this risk.

While the building market is a traditionally slow moving one, the field of smart building technologies is relatively new, and the conclusions of this thesis must be put in the context of what the market looks like at the time of writing this thesis.

8.3 Contribution to theory

This thesis has attempted to map which values are important in connected entrances for smart building owners. The process for doing this has however taken a generalized approach to discovering value-adding factors for smart building components. Hence, many of the aspects brought up in the customer profile are applicable when converting any form of building component to one meant for smart buildings. Furthermore, the details regarding door functionality are not specific to Assa Abloy doors and could potentially be used for guiding the integration of connective functionalities into any entrance system. Furthermore, this thesis has contributed further to knowledge on how IoT products can produce value.

8.4 Suggestions for further research

This report has focused on the smart building owners who are the most innovative, and therefore further studies could be made to map the demands of other groups of smart building owners or building owners not currently active in the smart building market. Studies could also be conducted to arrive at a more generalizable map of the demand for adding connected functionality to other building products.

Studies could also be made into the prioritization of the value adding factors presented, to help actors aiming to utilize this material in deciding what factors should be prioritized. Furthermore, a study into the business feasibility of implementing these would also bring additional value.

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Appendix A Coding transcript

A.1 Coding for overarching themes

Type of data demanded

Reference 1 - 0.83% Coverage

While the different verticals might have somewhat differing reasons for wanting digitalization, the themes of HVAC control, safety and security are fundamental to all of the verticals.

Reference 2 - 0.89% Coverage

The main interest for doors would be to map people flows and determine which doors have a large degree of utilization. The aspect of seeing that someone is entering the building is also very interesting.

Reference 3 - 0.91% Coverage

Data regarding people flow is of particular interest to Akademiska Hus, as they place a large importance on optimizing the flows of people. This type of data is currently collected with standalone sensors.

Reference 4 - 1.09% Coverage

Khaldon sees the potential for data collection at the point of doors as substantial, as anyone passing in or out of a building passes through a door. Khaldon also notes that data regarding flows of material is of interest and can be collected as well.

Space as a service

Reference 1 - 0.60% Coverage

A key part of providing premises as a service is digital access, as the management of physical keys is unfeasible for this type of use case

Reference 2 - 0.57% Coverage

Customers want to be able to scale up and down their available office space to accommodate varying amounts of on-site employees.

Reference 3 - 0.44% Coverage

All this is enabled through the smart building functionalities implemented into these buildings.

Processed data should be available

Reference 1 - 0.80% Coverage

He also argues that many customers will not have the urge or knowledge of how to process the data themselves, so Assa Abloy should provide solutions which delivers value out-of-the-box.

Price of IoT is prohibitive compared to value

Reference 1 - 0.50% Coverage

One reason is that integrating IoT capability into doors is currently expensive compared to the value it offers.

Reference 2 - 0.60% Coverage

Sören believes that smart buildings are a good investment for most property owners, but the initial cost might be an inhibiting factor.

Reference 3 - 1.29% Coverage

He also believes that many products will have a hard time selling for an increased upfront cost unless the products can present functionality which allows for cost-savings. Data collection through APIs is also something which is hard to pitch as the pay-off time for such functionality is long.

Open API important

Reference 1 - 0.52% Coverage

Johan does not believe that being closed with your products' APIs is not a sustainable business model going forward.

Reference 2 - 0.58% Coverage

He instead believes that the most successful actors in the future will be those that actively offering access to their product APIs.

Reference 3 - 1.34% Coverage

Sören also notes that Vasakronan tries to avoid proprietary solutions as far as possible. The company wants the connected products they include in their buildings to integrate into their digital models directly, and not require the user to use stand-alone software to access the data from the product.

Reference 4 - 0.35% Coverage

Public APIs are the future, driven by the demand of interconnecting products.

IT-Security is important

Reference 1 - 0.40% Coverage

digital aspects of security are big factors to consider for components in smart buildings.

Reference 2 - 1.71% Coverage

In doors especially, the aspects of physical and digital security are even more important than for other parts of the building. Security issues can lead to other alternatives being considered when deciding on what products to integrate with a smart building solution, and this is an area in which Andreas argues there is room for improvement for Assa Abloy and their current IoT solutions.

IoT can provide improved Service experiences

Reference 1 - 0.36% Coverage

the main benefits of the IoT solution are today found in the service organization

Reference 2 - 1.47% Coverage

More specifically, the applications that are mainly considered today for the IoT solution are collecting data to better optimize the service-contracts and sales of new doors. Historically, Assa Abloy has been able to use this data to identify when customers need new doors and therefore been able to proactively make new sales

Reference 3 - 0.71% Coverage

Assa Abloy PDS hopes to better optimize when doors need to be repaired, as this will provide a better experience for customers and lower the cost for the company.

Finding use cases within Assa Abloy is difficult

Reference 1 - 0.50% Coverage

IoT solution for two to three years but has struggled to find compelling business opportunities for the solution.

Digital Twin functionality important

Reference 1 - 2.17% Coverage

Previously many new projects were "copy and paste on specification" from old ones, whereas now buildings are designed in a digital 3d model with all building elements contained and the basis of the design becomes the hard specification. These are used both for construction as well as for upkeep and maintenance in a smart building context when the building is complete. This means that various

modeled sensors and components in the real building can be synced to their digital counterparts.

Reference 2 - 0.75% Coverage

Working in a data-driven fashion with buildings requires tools that allow humans to interpret the data, and Akademiska Hus does this through the usage of digital twins.

Reference 3 - 0.57% Coverage

In the case of entrances, a digital twin can enable the visualization of flows through an entrance to gauge the utilization rate.

Reference 4 - 2.22% Coverage

The company achieves these goals by analyses and simulations of the digital twin, which is built through combining the BIM with data from sensors throughout the building. They use RealEstateCore to create the digital twin. The software combines the BIM with data from sensors and actuators within the building and integrates with IoT technologies to create this digital representation (RealEstateCore, n.d.). Then, the digital twins are managed through ProptechOS, developed by Idun Real Estate.

Digital Access important

Reference 1 - 0.60% Coverage

A key part of providing premises as a service is digital access, as the management of physical keys is unfeasible for this type of use case.

Reference 2 - 0.56% Coverage

Accessy aims to be a digital "Bank-ID" for physical access, being the final piece of the puzzle for digital access to buildings.

Demand comes from system integrators

Reference 1 - 0.79% Coverage

Rather, Ramon argues that the main interest for these IoT solutions lies with those that are responsible for the installed equipment in the building, i.e. the system integrator.

Demand comes from property owners

Reference 1 - 0.50% Coverage

The main demand for smart buildings comes from property owners who then ask Siemens to do the actual integration.

Data important for continuous improvement

Reference 1 - 0.81% Coverage

The other is using the data to optimize the physical aspects of the building itself, eg. that switching from a sliding door to a revolving door would save energy and improve people flow.

Reference 2 - 0.70% Coverage

This includes projects to increase user satisfaction through, e.g., working with sensors to visualize people flows and space usage to better optimize these.

Reference 3 - 1.43% Coverage

Connected doors in particular would be of interest to Siemens, in line with the more data that they can collect, the better. The main interest for doors would be to map people flows and determine which doors have a large degree of utilization. The aspect of seeing that someone is entering the building is also very interesting

Reference 4 - 0.68% Coverage

Current areas of focus include increasing the utilization rate and providing increased flexibility for customers in how and when they can rent premises.

Reference 5 - 0.76% Coverage

Data collected from sensors in a smart building are used both for control of building systems, as well as to work in a data-driven way with optimizing building performance.

Reference 6 - 0.78% Coverage

Ulf claims that the business of real estate management is moving towards working in a data-driven fashion, in contrast to working with educated guesses as it has historically.

Reference 7 - 0.83% Coverage

Vasakronan's focus with smart buildings is on increasing sustainability and energy efficiency, optimizing the operations, and developing new services that the technologies enable.

Reference 8 - 1.09% Coverage

Khaldon sees the potential for data collection at the point of doors as substantial, as anyone passing in or out of a building passes through a door. Khaldon also notes that data regarding flows of material is of interest and can be collected as well.

Data important for building functionality

Reference 1 - 0.79% Coverage

One is the building automation part, where a large amount of data from various sources within the building is used to optimize internal systems such as HVAC and energy consumption.

Reference 2 - 0.76% Coverage

Data collected from sensors in a smart building are used both for control of building systems, as well as to work in a data-driven way with optimizing building performance.

Reference 3 - 0.83% Coverage

Vasakronan's focus with smart buildings is on increasing sustainability and energy efficiency, optimizing the operations, and developing new services that the technologies enable.

Clear value proposition required

Reference 1 - 0.37% Coverage

they do not simply buy digitally enabled solutions for the sake of being innovative.

Reference 2 - 0.54% Coverage

Sören argues that it is important to see a clear use case for a solution before Vasakronan is interested in implementing it.

Reference 3 - 0.64% Coverage

He also sees that while some customers have an idea of what they want to do with smart building technologies, many do not see the purpose of doing it.

Cooperation with system integrators

Reference 1 - 0.61% Coverage

He considers a partnership with Assa to potentially be of great interest as Siemens's product lineup does not directly compete with Assa.

Reference 2 - 0.77% Coverage

As such, they are very open to trying new technological developments in their building portfolio in addition to the work they do in this space together with the universities.

Reference 3 - 0.29% Coverage

they collaborate with partners to realize the solutions instead.

A.2 Coding for customer profile

Be at the forefront of smart building technologies

Reference 1 - 0.91% Coverage

Regarding how Akademiska Hus works with innovations in the smart building space, the company has a responsibility to push the technological development in this area. As such, they are very open to trying new technological developments in their building portfolio in addition to the work they do in this space together with the universities.

Reference 2 - 0.75% Coverage

When Akademiska Hus seek new functionality in their buildings, they have competence in-house to look at the technical solutions for this functionality themselves. When they do not have this competence in-house, they collaborate with partners to realize the solutions instead.

Reference 3 - 0.93% Coverage

Other initiatives that the company has taken include a project called Matilda, where sensors are placed throughout a building to measure people activity and flow. The data from this project as well as from other sources are collected in a data lake, which Castellum hopes to use to enable data-driven improvement and optimization of their buildings

Cost saving

Reference 1 - 0.34% Coverage

According to Malin, the main driving factors behind their smart building investments are energy efficiency and cost savings,

Data-driven building improvements

Reference 1 - 0.46% Coverage

Data collected from sensors in a smart building are used both for control of building systems, as well as to work in a data-driven way with optimizing building performance.

Reference 2 - 0.47% Coverage

Ulf claims that the business of real estate management is moving towards working in a data-driven fashion, in contrast to working with educated guesses as it has historically.

Reference 3 - 0.58% Coverage

Business models such as dynamic pricing of conference rooms have been enabled by this data-driven approach, and Castellum hopes to further utilise their data lake to develop self-learning buildings in the future.

Reference 4 - 0.07% Coverage

data-driven improvements

Easy overview and control of data

Reference 1 - 0.29% Coverage

many want it all in one interface to not have to jump around between different vendor-specific interfaces.

Reference 2 - 0.89% Coverage

In addition to what was said in the interview with Ulf Däversjö, Sören adds that Accessy can be used by renters of an office or building space to access the digital representation of that space in the digital twin. The renter can then use the information provided in the digital twin for business purposes, such as seeing people flow peaks.

Efficient building data collection

Reference 1 - 0.66% Coverage

Khaldon sees the potential for data collection at the point of doors as substantial, as anyone passing in or out of a building passes through a door. Khaldon also notes that data regarding flows of material is of interest and can be collected as well.

Energy efficiency

Reference 1 - 0.34% Coverage

According to Malin, the main driving factors behind their smart building investments are energy efficiency and cost savings,

Improved component functionality over time

Reference 1 - 0.59% Coverage

Khaldon imagines a future where many of these products can be updated over-the-air to enable new functionalities and believes that products that lack over-the-air update functionality will have a hard time succeeding.

Increase building utilization

Reference 1 - 0.17% Coverage

Current areas of focus include increasing the utilization rate

Provide increased customer flexibility

Reference 1 - 0.18% Coverage

flexibility for customers in how and when they can rent premises.

Reference 2 - 0.85% Coverage

Vasakronan has experienced an increased demand for flexibility in recent years, and this development has been accelerated due to Covid-19 and the remote work the situation has promoted. Customers want to be able to scale up and down their available office space to accommodate varying amounts of on-site employees.

Smart building component value out-of-the-box

Reference 1 - 0.49% Coverage

He also argues that many customers will not have the urge or knowledge of how to process the data themselves, so Assa Abloy should provide solutions which delivers value out-of-the-box.

Standardized data access protocols

Reference 1 - 0.89% Coverage

Sören argues that the full potential of the smart building is reached when all components can be monitored and managed in centralized software. This also creates new possibilities through using the data from the different components together. This is in contrast to the silo-like way of working that is common in the industry today.

Reference 2 - 0.30% Coverage

Malin says that the goal is for RealEstateCore to become an industry standard for smart building digital twins.

Collaborate with outside actors to realize smart building solutions

Reference 1 - 0.75% Coverage

When Akademiska Hus seek new functionality in their buildings, they have competence in-house to look at the technical solutions for this functionality themselves. When they do not have this competence in-house, they collaborate with partners to realize the solutions instead.

Reference 2 - 1.38% Coverage

Then, the digital twins are managed through ProptechOS, developed by Idun Real Estate. ProptechOS connects the RealEstateCore models with existing BMSs and other data sources and provides a platform for managing and optimizing property operations and developing applications for tenant services. RealEstateCore was a joint effort created by Vasakronan, Akademiska Hus, and other property owners

and Rise. Idun Real Estate was created as a result of the RealEstateCore effort in 2019 (Idun Real Estate, n.d.).

Reference 3 - 0.39% Coverage

Accessy (mentioned in the interview with Ulf Däversjö) was developed as a joint venture by Vasakronan, Akademiska Hus, Castellum among others.

Reference 4 - 0.76% Coverage

While Castellum has some in-house competence when it comes to smart buildings, they take in the majority from external partners. This is especially true for endeavours further removed from the building sector, such as their data lake initiative and the development of their phone app.

Collect data from building component

Reference 1 - 0.54% Coverage

Many customers want as much data as possible from their different components for future use, and many want it all in one interface to not have to jump around between different vendor-specific interfaces.

Reference 2 - 0.81% Coverage

Connected doors could be of interest to Siemens, as the more data that they can collect, the better. The main interest for doors would be to map people flows and determine which doors have a large degree of utilization. The aspect of monitoring when someone is entering the building is also very interesting.

Reference 3 - 0.32% Coverage

As Vasakronan starts providing more of these spaces, their need for insight into what happens in the building increases.

Reference 4 - 0.66% Coverage

Khaldon sees the potential for data collection at the point of doors as substantial, as anyone passing in or out of a building passes through a door. Khaldon also notes that data regarding flows of material is of interest and can be collected as well.

Collect data on component utilization

Reference 1 - 0.15% Coverage

determine which doors have a large degree of utilization

Reference 2 - 0.34% Coverage

In the case of entrances, a digital twin can enable the visualization of flows through an entrance to gauge the utilization rate.

Collect data on people flow

Reference 1 - 0.15% Coverage

The main interest for doors would be to map people flows

Reference 2 - 0.24% Coverage

The aspect of monitoring when someone is entering the building is also very interesting.

Reference 3 - 0.55% Coverage

Data regarding people flow is of particular interest to Akademiska Hus, as they place a large importance on optimizing the flows of people. This type of data is currently collected with standalone sensors.

Enable new business models with smart building technologies

Reference 1 - 0.44% Coverage

A large part of Sören's work centers around smart buildings - both the development of them and finding new business opportunities with the technology that they use.

Reference 2 - 0.88% Coverage

Vasakronan's solution to this is shared co-working spaces that customers pay for through a subscription model, available both to current renters of office space and new customers. Over the last few years, several of these kinds of spaces, which they call Arena, have been developed in different spaces in Sweden's largest cities.

Reference 3 - 0.27% Coverage

All this is enabled through the smart building functionalities implemented into these buildings.

Reference 4 - 0.99% Coverage

Like Vasakronan, Castellum has introduced services such as co-working, e-commerce pickup spots, and ready-to-use offices in the last years. The Building-as-a-Service concept has been introduced as well. Castellum expanded their co-working offering in 2019 when they bought the Swedish co-working company United Spaces, with offices in five cities across Sweden.

Reference 5 - 0.58% Coverage

Business models such as dynamic pricing of conference rooms have been enabled by this data-driven approach, and Castellum hopes to further utilise their data lake to develop self-learning buildings in the future.

Reference 6 - 0.49% Coverage

According to Malin, the main driving factors behind their smart building investments are energy efficiency and cost savings, data-driven improvements, and novel business models

Ensure environmental sustainability

Reference 1 - 0.21% Coverage

However, it also a goal of the company to be at the forefront of sustainability

Reference 2 - 0.50% Coverage

Vasakronan's focus with smart buildings is on increasing sustainability and energy efficiency, optimizing the operations, and developing new services that the technologies enable.

Finding and applying new smart building technologies

Reference 1 - 0.73% Coverage

This comes as the knowledge of what you want a smart building to do has increased. What you want a smart building to do also varies widely between stakeholders, e.g., property owners, office renters, and end-users all have varying demands on what the building does for them.

Reference 2 - 0.91% Coverage

Regarding how Akademiska Hus works with innovations in the smart building space, the company has a responsibility to push the technological development in this area. As such, they are very open to trying new technological developments in their building portfolio in addition to the work they do in this space together with the universities

Reference 3 - 0.50% Coverage

Vasakronan's focus with smart buildings is on increasing sustainability and energy efficiency, optimizing the operations, and developing new services that the technologies enable.

Reference 4 - 0.84% Coverage

Although Vasakronan is an innovative property owner that wants to be at the forefront of digitalization, they do not simply buy digitally enabled solutions for the sake of being innovative. Sören argues that it is important to see a clear use case for a solution before Vasakronan is interested in implementing it.

Reference 5 - 0.78% Coverage

Castellum has put additional focus on their innovation work since 2016 and has started an innovation lab with a separate budget, similar to an R&D department.

The innovation lab trials innovation projects without a profit requirement, and Malin leads the projects that come out of the trials

Reference 6 - 0.94% Coverage

Other initiatives that the company has taken include a project called Matilda, where sensors are placed throughout a building to measure people activity and flow. The data from this project as well as from other sources are collected in a data lake, which Castellum hopes to use to enable data-driven improvement and optimization of their buildings.

Reference 7 - 0.27% Coverage

This includes features such as climate control, seeing occupancy of rooms and finding colleagues.

Improve building performance

Reference 1 - 0.46% Coverage

Data collected from sensors in a smart building are used both for control of building systems, as well as to work in a data-driven way with optimizing building performance.

Reference 2 - 0.50% Coverage

Vasakronan's focus with smart buildings is on increasing sustainability and energy efficiency, optimizing the operations, and developing new services that the technologies enable.

Improve building user experience

Reference 1 - 0.24% Coverage

Furthermore, improving the environment for the people within it is an important factor.

Increase utilization rate of building

Reference 1 - 0.17% Coverage

Current areas of focus include increasing the utilization rate

Integrate smart building components

Reference 1 - 0.32% Coverage

Andreas claims that the goal for a BMS is to be able to integrate many different components into a single software suite.

Reference 2 - 0.30% Coverage

The main demand for smart buildings comes from property owners who then ask Siemens to do the actual integration.

Reference 3 - 0.19% Coverage

HVAC control, safety and security are fundamental to all the verticals.

Reference 4 - 1.11% Coverage

The company achieves these goals by analyses and simulations of the digital twin, which is built through combining the BIM with data from sensors throughout the building. They use RealEstateCore to create the digital twin. The software combines the BIM with data from sensors and actuators within the building and integrates with IoT technologies to create this digital representation (RealEstateCore, n.d.).

Reference 5 - 0.95% Coverage

The company wants the connected products they include in their buildings to integrate into their digital models directly, and not require the user to use stand-alone software to access the data from the product. Sören argues that the full potential of the smart building is reached when all components can be monitored and managed in centralized software.

Reference 6 - 0.25% Coverage

He sees that there is a great value in having systems in buildings communicate with each other.

Reference 7 - 0.48% Coverage

Regarding APIs, Khaldon sees it highly unlikely that products that do not offer these will survive. Public APIs are the future, driven by the demand of interconnecting products.

Process data from smart building components

Reference 1 - 0.49% Coverage

He also argues that many customers will not have the urge or knowledge of how to process the data themselves, so Assa Abloy should provide solutions which delivers value out-of-the-box.

Provide digital solution for building access control

Reference 1 - 1.51% Coverage

A key part of providing premises as a service is digital access, as the management of physical keys is unfeasible for this type of use case. Solutions for this have been a missing piece of the puzzle for some time, which has prohibited development in this area. Together with other large real estate management companies, Akademiska Hus has launched an initiative called Accessy, in collaboration with

other large Swedish property owners. Accessy aims to be a digital "Bank-ID" for physical access, being the final piece of the puzzle for digital access to buildings.

Provide flexibility in rental of building space to customers

Reference 1 - 0.18% Coverage

flexibility for customers in how and when they can rent premises.

Reference 2 - 0.14% Coverage

providing premises as a service rather than a product

Reference 3 - 0.85% Coverage

Vasakronan has experienced an increased demand for flexibility in recent years, and this development has been accelerated due to Covid-19 and the remote work the situation has promoted. Customers want to be able to scale up and down their available office space to accommodate varying amounts of on-site employees.

Selecting secure components

Reference 1 - 0.70% Coverage

Security issues can lead to other alternatives being considered when deciding on what products to integrate with a smart building solution, and this is an area in which Andreas argues there is room for improvement for Assa Abloy and their current IoT solutions.

Visualize building data

Reference 1 - 0.91% Coverage

Working in a data-driven fashion with buildings requires tools that allow humans to interpret the data, and Akademiska Hus does this through the usage of digital twins. The digital twin provides a model of the building overlaid with available sensor data, enabling greater analysis of what works well in the building and what works less well.

Reference 2 - 1.11% Coverage

The company achieves these goals by analyses and simulations of the digital twin, which is built through combining the BIM with data from sensors throughout the building. They use RealEstateCore to create the digital twin. The software combines the BIM with data from sensors and actuators within the building and integrates with IoT technologies to create this digital representation (RealEstateCore, n.d.).

Reference 3 - 0.23% Coverage

Vasakronan aims to have a digital model of 100% of its properties in the coming years.

Reference 4 - 0.39% Coverage

This has caused an increased demand for smart building functionality, to enable the company to better monitor, control and service these spaces.

Reference 5 - 0.38% Coverage

Castellum, much like Vasakronan and Akademiska Hus, uses Accessy in their buildings and RealEstateCore as the base of their digital twins.

Difficulty in realizing value from smart building components

Reference 1 - 0.39% Coverage

He also sees that while some customers have an idea of what they want to do with smart building technologies, many do not see the purpose of doing it.

Reference 2 - 0.78% Coverage

He also believes that many products will have a hard time selling for an increased upfront cost unless the products can present functionality which allows for cost-savings. Data collection through APIs is also something which is hard to pitch as the pay-off time for such functionality is long.

Inconsistent data formats

Reference 1 - 0.46% Coverage

The main difficulty of this project currently stems from the fact that the data from different component suppliers are of different formats, making it difficult to analyse.

Increased component reliability demands

Reference 1 - 1.01% Coverage

Traditionally, the company has rented out a section of a building and let the renter have the main responsibility for the space. When customers instead access building spaces as a service, the responsibility shifts to Vasakronan. This has caused an increased demand for smart building functionality, to enable the company to better monitor, control and service these spaces.

Physical handling of access control prohibits business development

Reference 1 - 0.68% Coverage

A key part of providing premises as a service is digital access, as the management of physical keys is unfeasible for this type of use case. Solutions for this have been a missing piece of the puzzle for some time, which has prohibited development in this area.

Physical security breaches

Reference 1 - 0.70% Coverage

Andreas argues that both the physical and digital aspects of security are big factors to consider for components in smart buildings. In doors especially, the aspects of physical and digital security are even more important than for other parts of the building.

Prohibitive cost of smart building development

Reference 1 - 0.15% Coverage

However, the initial cost might be an inhibiting factor.

Reference 2 - 0.50% Coverage

Currently, the property owners that demand smart building technology are by a large majority the larger ones as those are the only ones with finances great enough to fund the development.

Reference 3 - 0.46% Coverage

He also believes that many products will have a hard time selling for an increased upfront cost unless the products can present functionality which allows for cost-savings.

Proprietary connectivity solutions

Reference 1 - 0.34% Coverage

Regarding products and solutions, Sören also notes that Vasakronan tries to avoid proprietary solutions as far as possible.

Reference 2 - 0.48% Coverage

Regarding APIs, Khaldon sees it highly unlikely that products that do not offer these will survive. Public APIs are the future, driven by the demand of interconnecting products.

Unsecure building control access

Reference 1 - 0.70% Coverage

Andreas argues that both the physical and digital aspects of security are big factors to consider for components in smart buildings. In doors especially, the aspects of physical and digital security are even more important than for other parts of the building.

Unsecure building data access

Reference 1 - 0.70% Coverage

Andreas argues that both the physical and digital aspects of security are big factors to consider for components in smart buildings. In doors especially, the aspects of

physical and digital security are even more important than for other parts of the building.

Varying communication standards in components

Reference 1 - 0.38% Coverage

Regarding compatibility and integrations, Johan argues that the different standards that are present on the market lead to difficulties.