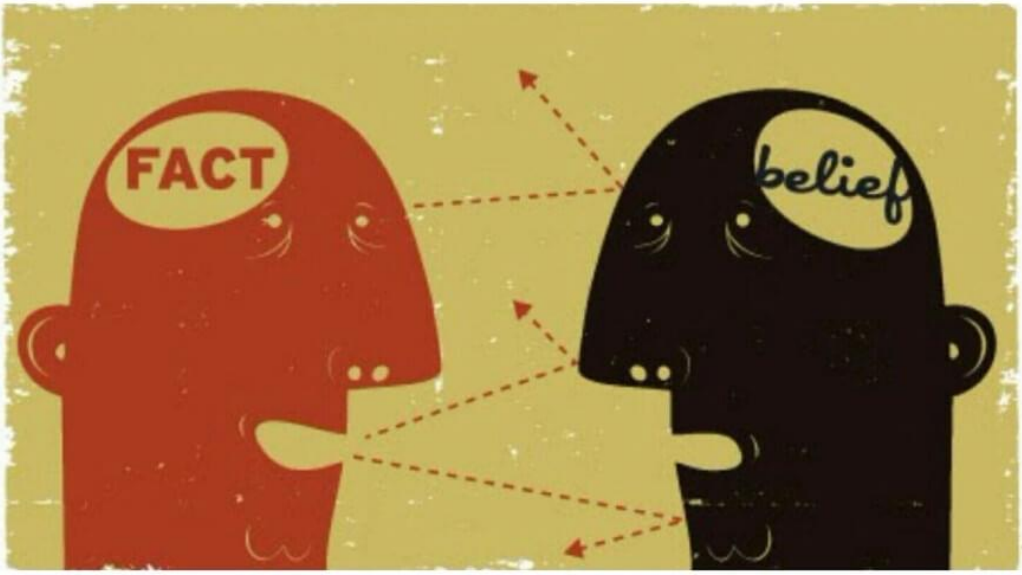
Biased decision-making in the building sector

A study on the psychological factors that influence the adoption of sustainable building methods

Björn Hofman



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Executive Summary

Since 1970, greenhouse gas emissions have rapidly increased. The effect of these gasses on the environment can be detrimental. Because of this, climate change has recently become a priority for governments and international organizations. For instance, within the European Union, many policies are developed to tackle the changing environment. Especially within the building sector, many new regulations are implemented, with the goal to change organizational behavior. This is done because the building sector is one of the biggest polluting industries. It follows that the implementation of sustainable building measures (SBMs) into the design of buildings could have a large impact. However, many organizations seem to resist change and policies do not always have the intended effect. Because of this, the use of SBMs has not spread widely in the industry.

Attempting to find the cause of this, this thesis explores individual decision-making of real estate developers. It does so by using a known decision-making model, which is used for predicting the acceptance of innovation, namely the technology acceptance model. This model explains behavior and innovation acceptance by examining the perceptions that decision-makers have of an innovation. Specifically, it uses the perceived usefulness and perceived ease of use of a specific technology. Many different factors can influence the perceptions that real estate developers have of SBMs. Financial barriers, knowledge barriers, regulatory issues, and technical issues, for example, all seem to influence the decisions of real estate developers. However, it seems that psychological factors could form a barrier to SBM adoption as well.

In order to identify how SBM adoption is influenced by psychological factors, an online survey was developed. This was done using a sample of 109 respondents. Several factors seemed relevant to the building sector. To start, the underestimation of lifecycle savings and overestimation of initial investments was explored. Additionally, an internal resistance against change and constant reinforcement of existing beliefs, which could add to the conservative nature of the industry, were examined. Finally, perceptions of hassle due to the complex information that is paired with innovation was included. The results of the survey were supplemented by two in-depth interviews.

From the survey results, it can be derived that internal resistance against change and constant reinforcement of existing beliefs indeed hinder the adoption of SBMs. Especially an internal resistance against change seems to be influential. Additionally, it seems that perceptions of hassle due to complex information can be argued to partly cause this resistance against change. This is argued to be stimulated by a lack of knowledge within the industry, as derived from the interviews and the existing literature. Because of this, perceived hassle increases the perceived complexity of projects and the level of uncertainty regarding SBMs. From the interviews and the survey results, indications were found that the building industry contains a homogenous group of risk-averse decision-makers. Due to this, the increased project complexity and level of uncertainty most likely lead to resistance against change.

Interestingly, it seems that developers that work at larger organizations experience less hassle due to complex information than their peers that work at SMEs. Also, they tend to resist change to a lesser extent. This is argued to be achieved by effective knowledge management. Large organizations tend to perform better in retaining and transferring knowledge than SMEs. Also, because of a larger workforce, employees will most likely come into contact with a wider variety of perspectives on SBMs and innovation in general. Because of this, it is argued that organizations can stimulate innovation. Investing in knowledge management could decrease knowledge barriers and the perception of hassle due to complex information. Additionally, promoting diversity in the workforce could add to decreasing the knowledge barriers and change the homogenous risk-averse nature of the decision-makers within the industry.

Furthermore, the knowledge that an internal resistance against change influences decision-makers in the building industry can be used by managers, marketers, and policymakers to develop their communication strategies. Framing strategies can be used to effectively market SBMs or communicate policy. To provide more clarity on the effectiveness of framing, an experiment was developed for future research. This experiment is designed to test whether framing an SBM or policy as the status-quo could leverage or remove the internal resistance against change that is found in the building sector. If this effect would be confirmed, it can be used to stimulate sustainable behavior in the industry.

Preface and acknowledgments

This thesis was written during the COVID-19 crisis of 2020. One of the consequences of a crisis is that people tend to become more conservative than before (Robb, 2004). Additionally, conservative people are more affected by a crisis, as they are anxious by nature (Laber-Warren, 2012). Because of this, the public calls for structure, a clear direction through the crisis, and stability (Laber-Warren, 2012). This seems to be embedded in the nature of crises, as it stems from the Greek word κρίνειν (krinein), which means to decide. To answer the public's need for structure and stability during a crisis, decision-makers need to be resolute. Without fast and strong decision-making, the way out of the crisis will be long. However, because of the public's need for stability, innovation and progress can be hindered.

The situation we are in right now is momentous. The health of many is at risk and this is on everyone's agenda. Fighting these health risks, there will be many negative consequences for the economy. This will be felt in many industries, among which is the building sector. In an attempt to reduce the impact of these consequences, some professionals already stated that the government should loosen its regulation regarding sustainable building (Pakhuis de Zwijger, 2020). However, we should not forget that we are in the middle of an environmental crisis as well. Fortunately, this view is not shared by everyone (Pakhuis de Zwijger, 2020).

This crisis did not only bring about more conservatism. It exposed a great amount of solidarity and goodwill as well. Furthermore, it revealed the capability and willingness to change and adapt to new realities. I argue that this should be used as an opportunity to adapt to another reality. That of a changing environment. Joseph Schumpeter (1942) claimed that "creative destruction" is needed to innovate. What this implies is that large changes are needed for radical innovation to happen. Perhaps destruction is not a word that is appreciated during a crisis. However, this destruction, or disruption, is already taking place.

This disruption should be taken as an opportunity to reflect on our behavior and change accordingly. If we seize this opportunity, we can emerge from this crisis as a better world. I believe this is possible, as the will and capability to adapt have surfaced. I believe that our society can adapt to our new realities and change for the better. With this research, I hope to do my part and contribute to this change.

I want to express my gratitude to all the people who have assisted me in completing this project. I would like to pay my special regards to Dr. Gerdien de Vries for the guidance during the process, the excellent assistance, and the constant involvement. Also, I wish to express my deepest gratitude to Marja Stensinski, who has provided me with continuing support, kept me motivated, and reviewed all of my work. Furthermore, I wish to express my gratitude to Dorothee Leese and Muneeb Ijaz for reviewing my thesis, contributing to the quality of my work. Finally, I would like to thank the rest of my graduation committee, Dr. Geerten van de Kaa and Maarten Ingen Housz, for their involvement in the project.

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1. *ANOVA = ANalysis Of VAriance*
2. *BI = Behavioral Intent*
3. *CFA = Confirmatory Factor Analysis*
4. *CSR = Corporate Social Responsibility*
5. *EU = European Union*
6. *IDT = Innovation Diffusion Theory*
7. *PCA = Principal Component Analysis*
8. *PEU = Perceived Ease of Use*
9. *PU = Perceived Usefulness*
10. *SBMs = Sustainable Building Measures*
11. *SDGs = Sustainable Development Goals*
12. *SEM = Structural Equation Modelling*
13. *SME = Small- or Medium-sized Enterprise*
14. *RMSEA = Root Mean Square Error of Approximation*
15. *TAM = Technology Acceptance Model*
16. *TLI = Tucker-Lewis Index*
17. *TPB = Theory of Planned Behavior*
18. *UN = United Nations*
19. *UTAUT = Unified Theory of Acceptance and Use of Technology*

1. Introduction

In this chapter, the research background is presented in paragraphs 1.1 and 1.2. To start, I discuss the state of sustainable building in the European Union (EU). Following this, barriers standing way of sustainable building are discussed. After presenting the background, the knowledge gap and the contributions of this research are discussed in paragraph 1.3, leading to the research questions and scope in paragraph 1.4. Thereafter, the approach and structure of the research are introduced in paragraph 1.5. Finally, I discuss the collaboration with PHYSEE in paragraph 1.6 and explain the connection of this research to the MOT program in the last paragraph.

1.1 Sustainable building in the European Union

Climate change is one of the biggest issues of society in the 21st century. Between 1970 and 2012 the total greenhouse gas emission worldwide doubled (World Bank, 2012). If this emission is not contained, this will inevitably lead to biodiversity loss, changing weather conditions, and reduced food security (Parry, 1990; Pecl et al., 2017). All of which have an impact on the wellbeing of the global population (Pecl et al., 2017). This issue is time-sensitive, the problem-creators are also the problem-solvers, and there is no central authority to resolve it (Levin, Cashore, Bernstein, & Auld, 2007). Because of this, climate change is labeled as a "super" wicked problem (Levin et al., 2007). In general, solving wicked problems asks for a large amount of organization and planning (Rittel & Webber, 1973). Because of this, climate change is high up the agendas of intergovernmental organizations. The United Nations (UN) has developed 17 sustainable development goals (SDGs), which were adopted by all member states in 2015 (UN General Assembly, 2015). Several of these SDGs relate to environmental issues (UN General Assembly, 2015). These are affordable and clean energy, sustainable cities and communities, responsible consumption and production, and climate action (UN General Assembly, 2015).

The EU is taking considerable action to contribute to reaching the SDGs (European Commission, 2019e). First of all, they consistently measure and report on the emission of greenhouse gasses (European Union, 2013). On top of that, they report on policies and measures regarding reductions in emissions, adapting to climate change, lower carbon use, and the support offered to developing countries (European Union, 2013). These measures enable the EU and the UN to track the performance of the EU's measures. To contribute positively, the EU adopted policies to stimulate corporate social responsibility (CSR) within the companies that operate in EU territory (European Commission, 2019d). This is done by implementing compulsory actions and introducing and promoting voluntary actions to be taken by these companies (European Commission, 2019d).

One sector that has a major impact on the environment is the building sector. The EU indicated this sector as one of three key sectors to address challenges in energy use and climate change (European Commission, 2011). The nutrition, housing, and mobility sectors make up for approximately 80% of all the global environmental impact (European Commission, 2011). Around one-third of the global energy consumption and CO_2 emission stems from buildings alone (Abergel et al., 2017; Darko, Chan, Owusu-Manu, & Ameyaw, 2017). In addition, the building sector produces about 30% of all waste generated within the EU (European Commission, 2019c). This is problematic but also presents a great opportunity to reach SDGs by tackling sustainability issues within this sector. Recently, the EU has been making more efforts to promote sustainability within the building sector (European Commission, 2019a). In 2017, the European Commission published two reports, describing a new framework for assessing the sustainability of buildings: Level(s) (Dodd, Cordella, Traverso, & Donatello, 2017b, 2017a). This framework concentrates on six macro-objectives, which contribute to several goals of the EU (Dodd et al., 2017b). Of these macro-objectives, greenhouse gas emissions during the life-cycle of the building, resource efficiency, and circular life cycles of building materials address the environmental impact of buildings (Dodd et al., 2017b).

The objective that the EU wants to achieve by implementing this framework is to bring buildings into the circular economy, as defined in their Circular Economy Action Plan (European Commission, 2018, 2019a). This would minimize the depletion of natural resources and reduce the effects of climate change (European Commission, 2019b). Attempting to reach this, the EU prioritizes construction and demolition waste, as a waste stream, within its borders (European Commission, 2019c). However, it seems that energy use during the use phase of buildings is the largest source of negative environmental impact (European Commission, 2016b). This is mainly caused by the regulation of inside lighting, temperature, and ventilation (European Commission, 2016b). By 2050, the EU aspires to have designed and built districts within its borders that are energy-positive (European Commission, 2016a). To reach this goal, it will focus on developing renewable energy sources, smart distribution energy grids, and energy efficiency (European Commission, 2019f).

Integrating sustainable building measures (SBMs) in the design of new buildings could contribute to these goals. SBMs can be defined as *"technologies that improve the sustainability of constructions"*. An example of an SBM is a solar panel that can be installed on a roof, in order to generate electricity from sustainable sources. However, there are more breakthrough examples of SBMs as well, such as SmartSkin technology. This is a smart and flexible façade, into which solar cells and sensors are integrated in every glass window (PHYSEE, 2020). By communication through an internal network, SmartSkin can regulate light, temperature, and ventilation (PHYSEE, 2020). By doing so, it does not only generate electricity from a sustainable source. The energy efficiency of the building will highly improve as well (PHYSEE, 2020). It follows that implementing these measures contributes to reaching the goals of the EU.

However, the main drivers for the adoption of SBMs do not only include the reduction of environmental impact. Just as important, or maybe even more so, are the health and comfort of occupants and company reputation (Darko et al., 2017). The technologies and skills that are needed for the construction of low- or zero-emission buildings are readily available nowadays. Meanwhile, these technologies are increasingly able to meet the additional criteria for their adoption. Still, many consumers and developers show resistance to innovation and stick to their old practices (e.g., Camisón, 2010; Hoffman & Henn, 2008; Kats & Alevantis, 2003).

1.2 Barriers to sustainable building

The resistance to innovation within the building sector is standing in the way of large-scale adoption of SBMs. This resistance is influenced by many different factors, arising as barriers to innovation (e.g., de Vries, Rietkerk, & Kooger, 2019; Häkkinen & Belloni, 2011; Hoffman & Henn, 2008). To promote the use of SBMs, these barriers must be overcome. Many new policies are developed, trying to stimulate the adoption of SBMs. Unfortunately, not all are as effective as expected (Camisón, 2010). The building sector seems to be a conservative one. Nevertheless, organizations and consumers need to change their habits, to prevent climate change. To stimulate change, it is necessary to be aware of the barriers that prevent the large-scale adoption of SBMs. It is only when these are fully known that the right measures can be taken.

Many factors influencing the adoption of SBMs can be identified (e.g., Bordass, 2010; Gifford, 2011; Hoffman & Henn, 2008; Williams & Dair, 2007). Economic concern is commonly stated as one of the most influential factors in the decision-making process (e.g., Aravena, Riquelme, & Denny, 2016; Bordass, 2010; Chan et al., 2017; Häkkinen & Belloni, 2011; Williams & Dair, 2007). Sustainable building projects are often more costly than conventional projects (Bordass, 2010; Chan et al., 2017). Additionally, long-term gains are usually not collected by the party bearing the initial costs (Bordass, 2010; Chan et al., 2017). This “split incentive” is an issue that is highly debated within the industry (Bakker, 2020a, 2020b). Although there are contractual structures that decrease or eliminate this split incentive, these are not commonly used (Bakker, 2020b). Taking into account that a lack of awareness, knowledge, and demand of clients is a commonly cited barrier to adoption, this split incentive impacts the adoption of SBMs greatly (Bordass, 2010; Chan et al., 2017; Häkkinen & Belloni, 2011; Williams & Dair, 2007). However, it should be mentioned that developers themselves tend to lack experience with SBMs as well (Chan et al., 2017; Mills & Glass, 2009).

This widespread lack of knowledge within the industry possibly causes other barriers. Risks and uncertainties that are paired with innovative SBM’s seem to be additional significant barriers (Chan et al., 2017). A lack of knowledge about a product could contribute greatly to the perceptions of uncertainty and risk. High levels of uncertainty will probably be experienced when little is known about a product.

Nonetheless, the concern about risks and uncertainties is not unfounded, as these are usually related to innovation. Professionals stated that SBM's have been inadequate, have not been tested enough, or have proven not to be reliable (Williams & Dair, 2007). Also, as the split incentive implies, there is concern about the repayment of investments.

Regardless of these issues, governments keep directing the building sector on a greener path using new policies. For instance, in 2019 the Dutch government published a set of policies designed to stimulate sustainability within the building sector (Rijksoverheid, 2019). One of its biggest concerns is the use of natural gas, and a shift towards electricity is desired (Rijksoverheid, 2019). Besides this, the government aspires to reach an increased use of sustainable energy sources. (Rijksoverheid, 2019). SBMs could play a large role in this energy transition. However, the implementation of these policies differs per region (Bakker, 2020a). This causes more uncertainty and generates concern among professionals (Bakker, 2020b). To illustrate this, the industry is currently waiting for local policies addressing the type of energy source to use (Bakker, 2020b). Without this knowledge, developers fear to invest in the wrong SBMs and generate large losses (Bakker, 2020b).

Still, this cannot entirely be attributed to the lack of guidelines. For instance, energy labels represent the energy efficiency of buildings (Rijksoverheid, n.d.). The decision was made that every office over 100 m^2 must have at least energy label C in 2023 and all offices must have label A in 2030 (Bakker, 2020a; Bloemers, 2020). Although 2023 is nearing, many building owners postpone taking measures, even though energy label C can be realized with relatively small changes (Bakker, 2020a; Bloemers, 2020). Around 60% of the offices within the North Sea Channel district, which includes the port of Amsterdam, does not even have an energy label yet (Bakker, 2020a). This poses the question whether regulatory complexity and financial risk are the only reasons for developers to postpone action. Especially, with the knowledge that offices will be shut down in 2023 if they fail to comply with these criteria (Bakker, 2020a; Bloemers, 2020).

This lack of compliance cannot entirely be attributed to financial, organizational, technical, regulatory, and knowledge barriers, which are classified as functional barriers (Ram & Sheth, 1989). It follows that other factors play a part in the decision-making processes. Several authors discuss the influence psychological and social barriers might have in the process of innovation (e.g., Antioco & Kleijnen, 2010; Gifford, 2011; Milbrath, 1995; Ram & Sheth, 1989). Ram and Sheth (1989) discuss two of these barriers, namely image and tradition barriers. Image barriers describe the phenomenon that consumers are biased against a product because of a negative image that they have associated with it (Ram & Sheth, 1989). Tradition barriers, on the other hand, explain how there is resistance due to the change that would accompany innovation (Ram & Sheth, 1989). Especially tradition barriers seem relevant in the context of the building sector, as these could explain why the industry is so conservative. Over time, many more psychological and social barriers were linked to resistance against innovation and SBMs (Gifford, 2011; Hoffman & Henn, 2008; Milbrath, 1995). Still, it is mostly the functional barriers that have been the focus of research on barriers to the adoption of SBMs.

1.3 Knowledge gap, research questions and scope

Psychological and social barriers to SBMs are not only explored far less often than functional barriers but the scope of research is limited as well. Usually, studies only explore the impact of psychological and social barriers on the decision-making of individual consumers (e.g., Gifford, 2011; Milbrath, 1995). Little is known about the influence that these barriers have in an organizational context. Hoffmann and Henn (2008) made efforts to contribute to this knowledge. They discuss several cognitive biases on the individual level, as well as some psychological and social barriers that are influential on an organizational and institutional level (Hoffman & Henn, 2008). However, more often, cognitive biases and other psychological phenomena are used to explain the environmental behavior of homeowners(e.g., de Vries et al., 2019; Gifford, 2011; Milbrath, 1995). Therefore, I identify as a knowledge gap that little is known about the effects of psychological and social barriers on the adoption of SBMs within organizations.

This research concentrates on the psychological barriers to the adoption of SBMs by real estate developers. The psychological barriers that are the focus of this research are cognitive bias and hassle. Many experiment have proven that cognitive bias influences decision-making, which is why it is assumed to be very relevant to this research (Kahnemann, 2011). Furthermore, hassle is relatively new as a topic of research. Because of this, it is interesting to see what the effects of hassle are in an organizational context.

This research explores whether cognitive bias and hassle are experienced by real estate developers. Furthermore, it establishes whether bias and hassle affect the adoption of SBMs. Also, it explores whether organizational factors affect the relationship of the adoption of SBMs with bias and hassle. Although there are many more contextual factors that might influence this, organizational factors are the most relevant. While regulatory and institutional factors presumably impact the adoption of SBMs, the knowledge gap that is identified specifically addresses the organizational context (Hoffman & Henn, 2008). Regulation will often apply to both individual homeowners as large real estate developers. However, it is organization-specific factors that divides these two groups.

Based on this knowledge gap, I formulated the following research question:

- How do psychological barriers influence the adoption of SBMs in the building sector?

To answer this question, I formulated the following sub-questions:

I. What is the influence of cognitive bias on the adoption of SBMs?
II. What is the influence of hassle on the adoption of SBMs?
III. Are there differences in the effect of bias and hassle between different organizations?

To answer these questions, it is necessary to reach professionals in the building industry. Therefore, real estate developers are chosen as the target group. This group seems to be responsible for the largest part of the development processes within the built environment. To narrow this group down even more, the scope of my research only includes the building sector in the Netherlands. However, no distinction was made between housing and commercial building projects. This would complicate the sampling process, as many organizations in the industry engage in both of these activities.

Also, as many different sorts of bias and hassle can be identified, I focus on a smaller subset. The bias and hassle in this subset are selected based on their characteristics and matched to the characteristics of the building sector. As mentioned earlier, the industry is of quite a conservative nature. Due to this, bias and hassle that could account for this nature are the most relevant. The specific bias and hassle that will be explored are discussed further in the literature review and research methodology chapters. Moreover, this research focusses on bias and hassle that can be tackled with the help of message framing. This was decided as message framing can be a practical but easily applicable tool for policy makers, managers, and marketers.

1.4 Scientific and managerial contributions

This research attempts to contribute to the literature on environmental psychology, marketing, technology acceptance, technology adoption, and diffusion of innovation. To start, this study concentrates on cognitive bias and hassle standing in the way of SBM adoption within organizations. Additionally, it is studied whether cognitive bias and hassle affect SBM adoption differently in different kinds of organizations. By doing so, more knowledge about the effects of psychological phenomena on sustainable behavior within organizations is developed. Using this knowledge, managers and marketers can target prospective clients more effectively and efficiently.

Furthermore, these effects will be analyzed using the technology acceptance model. This is a decision-making model used to predict the acceptance of innovation (Davis, 1986). Using the results, this research attempts to add bias and hassle as predicting variables in this model. By doing so, this study contributes to the model and the literature on technology acceptance. This provides new knowledge on the behavior of the majority of individual decision-makers. In the context of this research, technology acceptance can be defined as the decision to adopt SBMs. As claimed by Moore (2002), one of the hardest parts of the innovation process is reaching the majority of the public. Addressing that issue, this study provides new insights into psychological barriers to SBM adoption that the majority of the building sector experiences.

These new insights can be used to explain the lacking customer base for SBMs. If psychological barriers hinder the adoption of SBMs by individual decision-makers, a large customer base is hard to reach. Ortt, Langley, and Pals (2013) mention a significant customer base as one of the requirements for large-scale diffusion. Due to this, the results of this study can be used to explain the diffusion pattern of SBMs. This can be used by managers to examine whether their product is ready for large-scale diffusion (Ortt,

Dedehayir, Miralles, & Riverola, 2017). If this is not the case, they should adopt a niche strategy to prevent the innovation from failing (Debruyne et al., 2002; Ortt et al., 2013).

Finally, message framing strategies that could reduce the effect of these psychological barriers are explored. All of the biases and hassles that are included in this research were selected because, in theory, they can be tackled with message framing. By doing so, I attempt to contribute to the literature on marketing and message framing. Additionally, using the framing strategies that are explored, managers and marketers can design effective communication strategies to promote their products. Additionally, policymakers can use framing strategies to communicate their policies to the public. This could increase the effectiveness of their policies.

1.5 Approach and structure of the research

Several methods will be utilized in answering the research questions that are defined. The following chapter contains a literature review. Literature is explored to develop insight into the effects of bias and hassle on SBM adoption. In addition to this, the literature on the differences between organizations and the effect of these differences on innovation is discussed. Finally, possible framing strategies to overcome the biases and hassles are presented, as discussed in the literature, where possible. By doing so, all four of the sub-questions are addressed. This is the first method that is used to answer the questions.

After this, two empirical research designs are developed in chapter 3. Survey research and in-depth interviews are used to answer the first three sub-questions. By using the literature review, the survey, and the interviews, method triangulation and data triangulation is achieved (Sekaran & Bougie, 2016). This increases the validity and reliability of this research, especially for the qualitative data (Sekaran & Bougie, 2016). The results of the empirical research methods are presented in chapter 4.

Finally, chapter 5 contains the discussion of the results and the concluding remarks. The results of all research methods are integrated and discussed. Based on this discussion, an attempt is made to answer the research questions and discuss the implications and limitations of this research. Finally, some recommendations for future research are provided and a message framing experiment is developed, based on the outcome of this research.

1.6 Collaboration

This research was developed in collaboration with PHYSEE, a company that is active in developing sustainable building measures. PHYSEE offers SmartSkin technology for developers to use in their building projects. This is a smart and flexible façade, is been integrated with sensors and PV-cells. The sensors measure temperature, light intensity, humidity, and air pressure. The data that is generated can be communicated to compatible climate regulating systems. By doing so, electricity is used much more efficiently and savings up to 20% can be made.

PHYSEE showed interest in the influence social and psychological barriers have on SBM adoption, as this research could provide them with a better understanding of the nature of the building industry. This improved understanding could help them in designing marketing strategies suitable for their target audience. Because of this, they assisted me in shaping my research. Also, PHYSEE provided me with the contact information of several developers. This kick-started my search for survey respondents and led to follow-up leads.

Developing this study, the SmartSkin technology of PHYSEE was used as an example of an SBM while designing questions and messages. Because of the collaboration with PHYSEE, I developed a good understanding of SmartSkin technology and its related services. This was helpful in designing this research.

1.7 Connection to the MOT program

Real environmental impact can be made if SBMs are widely used on a global scale. For this, innovative SBMs must reach large-scale diffusion. In the emerging and breakthrough technologies course, patterns of large-scale diffusion were discussed (Ortt, 2020c). During the lectures, factors that lead to, and barriers standing in the way of, large-scale diffusion were addressed (Ortt, 2020a, 2020b). It seems that one of the necessary conditions for large-scale diffusion is a significant customer base (Ortt, 2020b). By studying individual decision-making processes of real estate developers, this research explores how a significant customer base can be developed. Doing so, I attempt to establish whether psychological factors can be accepted as an additional barrier to large-scale diffusion. Additionally, during the technology, strategy, and entrepreneurship course it was addressed that technology acceptance and adoption are two conditions that are needed for the standardization of innovation (van de Kaa, 2019). Using this knowledge, the technology acceptance model was selected as the decision-making model to be used in this research.

The psychological factors that influence decision-making have been introduced in the inter- and intra-organizational decision-making course (Asghari, 2019). Heuristics and biases appear to influence

decision-making processes (Asghari, 2019). This research contributes to the knowledge of this influence. Furthermore, the psychological factors that are studied can all be impacted by message framing. In this course, an introduction to the power of framing in political communication was provided (de Bruijn, 2019). This knowledge is used to analyze possible solutions for psychological barriers in the way of SBM adoption. Additionally, wicked problems were explored extensively during the course (Rittel & Webber, 1973). This enabled me to identify climate change as a wicked problem and approach it as such while shaping my research topic.

Other strategies to stimulate SBM adoption that are discussed in this study were inspired by the leadership and technology management course and the technology, strategy, and entrepreneurship course. These courses provided me with insights into knowledge management and the benefits of knowledge sharing (V. Scholten, 2019; Verburg, 2017).

Finally, the leadership and technology management course and the technology dynamics course provided the necessary basics to perform this research. The leadership and technology management course addressed organizational structures and the differences between organizations (Verburg, 2017). Meanwhile, the technology dynamics course provided the tools to understand the context in which innovation takes place (Werker, 2018). Because of this, the importance of the contextual factors influencing SBM adoption was understood.

2. Theoretical background

In this chapter, knowledge from the existing literature that is relevant to this research is presented. To start, the large-scale diffusion of innovation and technology adoption is discussed in paragraph 2.1. Following this, several decision-making models are explored in paragraph 2.2. The most relevant model is selected to use in this research. After that, the most relevant factors that influence this model are discussed in paragraph 2.3.

2.1 Diffusion and adoption of innovation

In 1962, Everett M. Rogers published his famous book, Diffusion of Innovations (Rogers, 1962). In this book, he discusses the adoption of innovations and their patterns of diffusion. He defines diffusion as *"the process by which an innovation is communicated through different channels over time among the members of a social system"* (p. 11). Adoption of innovations has been one of the main interests of researchers in the field of diffusion patterns and is defined as *"a decision to use and implement a new idea"* (Rogers, 1962, p. xix). The pattern of large-scale diffusion is usually S-shaped (Ortt & Schoormans, 2004; Rogers, 1962). This is because the initial group of adopters is relatively small (Rogers, 1962). Ortt, Langley, and Pals (2013) state that the presence of a customer base is a necessity for large-scale diffusion. Because of this, innovation will need to reach adoption by the early majority. Before this is achieved, innovation will remain in the adaptation phase (Ortt & Schoormans, 2004). During this phase, the innovation is adapted until no more barriers are in the way of large-scale diffusion (Ortt et al., 2013; Ortt & Schoormans, 2004). However, progressing from the adoption by early adopters to the adoption by the early majority is one of the pitfalls of the innovation process (Moore, 2002). In the literature, this is known as "crossing the chasm" (Moore, 2002). The issue with crossing the chasm is that the characteristics between early adopters and the early majority differ (Moore, 2002). Where early adopters see the potential of innovations to help them reach a specific vision they have, the early majority needs to be persuaded that the innovation will meet its current needs (Moore, 2002).

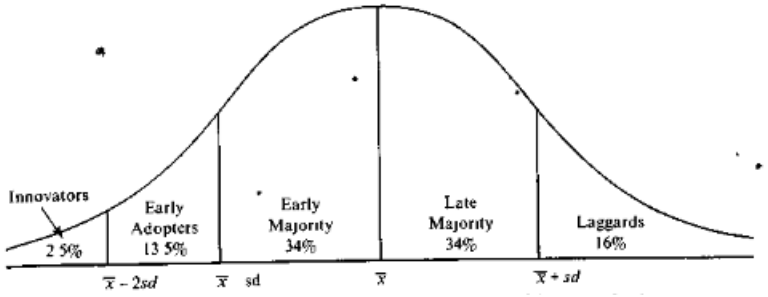

Figure 1: The technology adoption life cycle (Rogers, 1962)

In order to leverage these different characteristics, it is thus needed to gain knowledge on the decision-making processes of potential adopters. In IDT, Rogers (1962) proposes a process that includes multiple stages. He explains the diffusion process as an innovation that spreads through members of a social system. According to him, the main factors that influence decision-making are the characteristics of the decision-making unit and the characteristics of the innovation (Rogers, 1962). However, decision-making units might consist of a variety of people. Some of these individuals could be innovators, while others could be part of the early majority. In this case, they should be approached differently (Moore, 2002). This would improve the innovations' chance for success (Moore, 2002). For this reason, models are needed that explain the decision-making processes of individuals. Luckily, since the publishing of Rogers' Diffusion of Innovations, several of these models have become available (Ajzen, 1991; Davis, 1986).

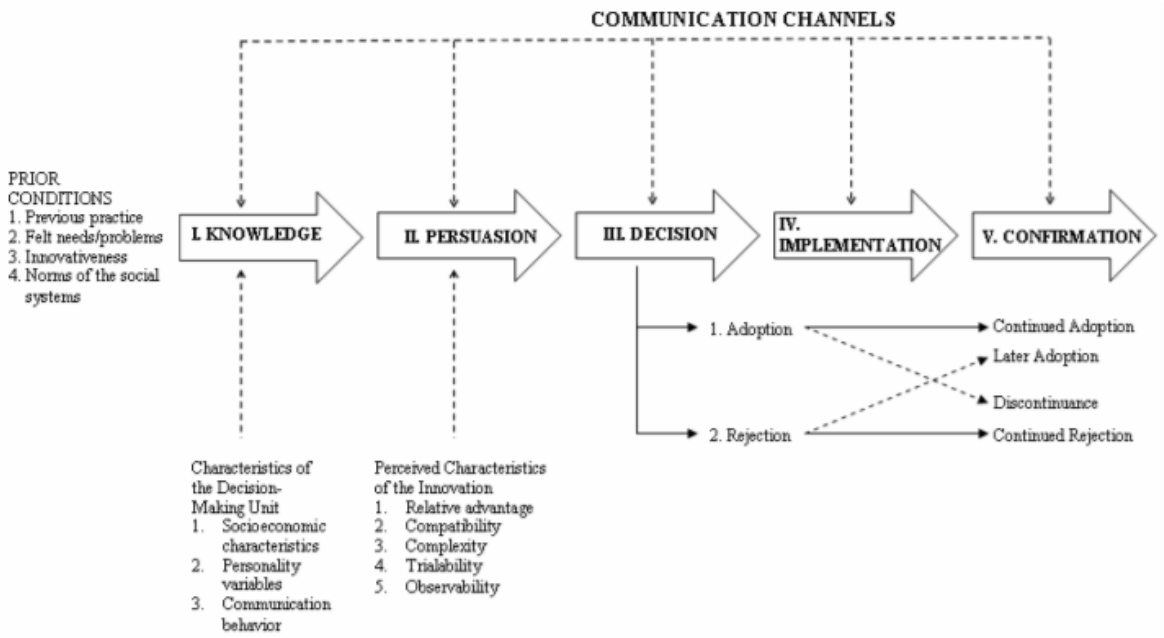

Figure 2: Stages of the innovation-decision process (Rogers, 1962)

2.2 Model selection

As Rogers' (1962) IDT is not sufficient to explain individual decision-making behavior, another model is needed for this research. The theory of planned behavior (TPB), TAM, and the unified theory of acceptance and use of technology (UTAUT) will be compared in this paragraph. While TPB can be seen as a general behavioral model, TAM and UTAUT are models that describe the acceptance of technology (Davis, 1986; Madden, Ellen, & Ajzen, 1992; Venkatesh, Morris, Davis, & Davis, 2003). As adoption has been defined as *"a decision to use and implement new ideas"*, acceptance models are very suitable to analyze the decision-making process leading up to adoption (Rogers, 1962).

Theory of planned behavior

To start, TPB describes behavioral intent (BI) as the main predictor of actual behavior (Madden et al., 1992). BI, in its turn, is theorized to be influenced by attitude, subjective norm, and perceived behavioral control (Madden et al., 1992). Previous research has integrated TPB, with both IDT as TAM simultaneously (Yi, Jackson, Park, & Probst, 2017). Yi et al. (2017) found that factors from TPB influence variables from TAM and IDT. Additionally, factors from TPB are influenced by personal innovativeness, which is derived from IDT (Yi et al., 2017). Therefore, it can be argued that some variables from TPB, partly, function in a mediating role between IDT and TAM. Because of this, it seems that TPB could be used to gain more knowledge about the diffusion process of innovation.

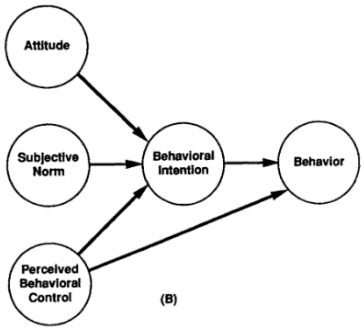

Figure 3: Theory of Planned Behavior (Madden et al., 1992)

However, the main focus of this research will be the influence of bias and hassle on the adoption of SBMs. It follows that attitude could lend itself to this research. However, the other variables in TPB seem unlikely to be directly influenced by bias and hassle. Additionally, TPB is a general behavioral model and not specifically addressing technology acceptance (Madden et al., 1992). Because of this, part of the model might not be relevant for this research. Perceived behavioral control might influence BI, but this does not seem too relevant in the case of SBM adoption. Therefore, using TPB as the model for this research would entail the inclusion of some irrelevant variables. I conclude that TPB seems a moderately good model for this research.

Technology acceptance model

Another decision-making model, which is widely accepted to describe the process of accepting innovation, is TAM (Davis, 1986). This model assumes BI to be predicted by perceived usefulness and perceived ease of use (Davis, 1986). This effect is moderated by contextual factors (King & He, 2006). Additionally, the perceptions of the innovation are influenced by prior factors and the model is influenced by external factors suggested by other theories (Davis, 1986). It is, thus, a model that is based on the perceptions of decision-makers and the factors that shape those perceptions.

Originally, this model was designed to assess the acceptance of new information systems by employees on the work floor (Davis, 1989). However, TAM has been integrated with IDT in prior studies (Y.-H. Lee et al., 2011; Yi et al., 2017). The perceived characteristics of innovation, derived from IDT, seem to influence perceived usefulness, Perceived ease of use, and BI (Y.-H. Lee et al., 2011). From this, I argue that TAM can be seen as a missing link in IDT. Because of this, TAM is applicable to use as a decision-making model in the case of the large-scale diffusion of innovation. The core model is simple, as it exists of three variables (Davis, 1986). However, the possibility of many other influencing factors has been taken into account, as the model indicates many possibilities for external influences (Davis, 1986; King & He, 2006). Also, TAM has proven to be highly generalizable (King & He, 2006). It follows that TAM is a good fit for this research.

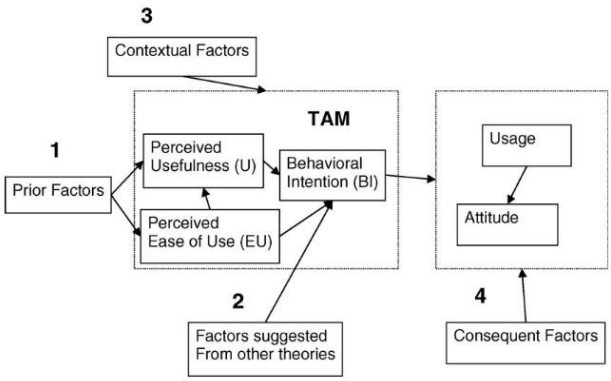

Figure 4: The Technology Acceptance Model (King & He, 2006)

Unified theory of acceptance and use of technology

Finally, UTAUT is a model that is developed by integrating eight different behavioral models (Venkatesh et al., 2003). Both TPB and TAM are part of these eight models (Venkatesh et al., 2003). This has been done to decrease the level of repetition and redundancy in various decision-making models, as they tend to have some overlap (Dwivedi, Rana, Chen, & Williams, 2011). This should provide a model that outperforms all of the models it is based on (Dwivedi et al., 2011; Venkatesh et al., 2003). Several studies, including some meta-analyses, find that UTAUT indeed provides stronger results than other models (Dwivedi et al., 2011; Im, Hong, & Kang, 2011; Khechine, Lakhal, & Ndjambou, 2016). However, there are some side notes. The effects of moderating variables have not been taken into account while conducting the meta-analyses (Dwivedi et al., 2011; Khechine et al., 2016). Because of this, the effectiveness of UTAUT could not be examined properly (Dwivedi et al., 2011; Khechine et al., 2016).

Additionally, UTAUT includes both perceived usefulness and perceived ease of use from TAM as independent variables (Venkatesh et al., 2003). For this reason, it seems very suitable for research on the effects of bias and hassle on the model. However, similar to TPB, it includes other variables that seem less likely to be influenced by bias and hassle. Also, the model includes a large number of variables and is quite complex (Venkatesh et al., 2003). For these reasons, the chance exists that some irrelevant factors will be included in the research. Based on this knowledge, UTAUT is considered to be a moderately good fit for this research.

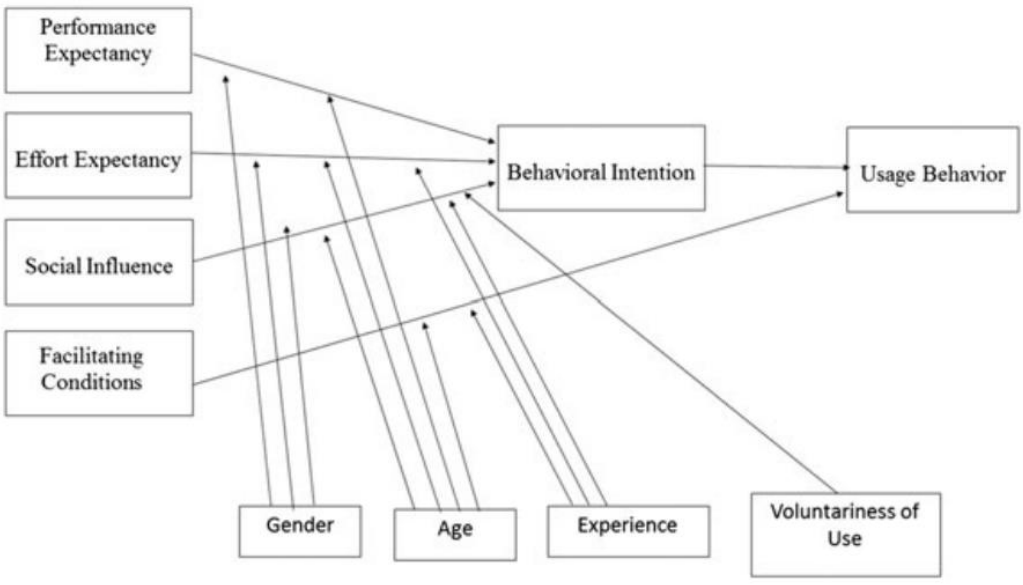

Figure 5: Unified theory of acceptance and use of technology (Khechine et al., 2016)

Selection

After comparing all three models, I have chosen TAM as the model to use in this research. TPB did not seem suitable for this research. This is because it does not focus on technology acceptance and some variables seem less relevant in the context of this research. On the other hand, UTAUT could be a more effective predictor of BI than TAM. However, due to the complexity of UTAUT, TAM seems the best choice. The core TAM consists of only 3 variables, while UTAUT includes several more. It seems like a good strategy to start with exploring the effects of bias and hassle on TAM. As perceived usefulness and perceived ease of use are both included in UTAUT, the results of this research can likely be translated to UTAUT. If bias and hassle appear to affect TAM, more complex research can be designed based on the results of this thesis.

2.3 Factors affecting TAM

I will discuss the factors that are most likely to influence TAM in the context of SBMs. To begin with, I will discuss factors that could impact perceived usefulness in paragraph 2.3.1. Next, I will explore which factors could affect perceived ease of use in 2.3.2. After that, in paragraph 2.3.3, I will examine several contextual factors that are expected to influence TAM externally. Hypotheses are developed over the course of this paragraph. Finally, a conceptual framework will be presented in paragraph 2.3.4.

This is done under two assumptions. These are needed to interpret TAM in the context of SBM adoption. First, I assume that perceived ease of use can be interpreted as the perceived value gained from SBM adoption. Second, perceived usefulness is interpreted as the perceived effort needed for the implementation of SBMs. As TAM is highly generalizable, these assumptions seem to be reasonable (King & He, 2006).

2.3.1 Perceived usefulness

As the terms perceived usefulness (PU) and perceived ease of use (PEU) suggest, TAM is entirely based on the perceptions of decision-makers. These perceptions can be influenced by many different factors (King & He, 2006). For instance, financial benefits are one of the biggest drivers of SBM adoption (Häkkinen & Belloni, 2011). Presumably, financial benefits add significantly to PU, as this is how many organizations measure success. However, the focus of this research is on psychological barriers standing in the way of SBM adoption.

The psychological barriers are selected based on relevance to the building sector, in order to reduce the number of barriers that are discussed. An additional criterion for the selection is whether the barrier could be overcome with message framing. I argue that four biases, possibly affecting PU, are interesting to explore. These are loss aversion, risk aversion, temporal discounting, and bias towards conservatism. All of these biases could be used to explain the conservative nature of the building industry. Because of this, they are of relevance to this study.

Loss aversion

Loss aversion can be defined as *"the tendency to weigh losses heavier than gains of equal size"* (Hobman et al., 2016, p. 457). Framing decisions in terms of gains and losses can, thus, have a large impact on the choices of decision-makers (Tversky & Kahneman, 1992). This effect can be observed in research by Chatterjee, Heath, Milberg, and France (2000). They experimented with presenting losses and gains in percentages instead of nominal amounts. What they found was that in the case of gains, this frame impacted the decisions significantly as the participants made them using short-cuts. In the case of losses, however, the participants did not use short-cuts to make decisions. As they were loss-averse, they processed information about the losses with more caution (Chatterjee et al., 2000). From this evidence, it can be argued that people tend to have a certain fear of losing what they have. This loss would bring forth more negative feelings than it would positive feelings, if they would obtain something new of equal value. However, it should be possible to overcome this fear of loss.

Frederiks, Stenner, Hobman, and Meikle (2015; 2016) suggest communicating through loss-framed messages, to reduce the effect of loss aversion. An example would be to state that, without installing SBMs, the consumer would lose 150 euros per month in increased energy costs. Focusing on losses that can be avoided and the low risk of the measures will have the most impact on consumer behavior (Frederiks et al., 2015; Hobman et al., 2016). They argue, basically, for changing the reference point of the recipient of the message. The change of reference point attributes the losses to the old technology and the gains to the innovative technology. Basically, this strategy is the underlying idea of prospect theory, which describes the loss-averse behavior of people (De Jaegher, 2019; Tversky & Kahneman, 1992). Using it would leverage loss aversion, causing fear for the newer technology. This could prove to be very effective in practice. However, this has to be done with caution, as leveraging negative emotions could be perceived as a manipulation (de Vries, 2020). Based on reactance theory, this could even lead to results that are opposite to the expectations (de Vries, 2017, 2020). The need for independence can cause people to reject the message based on the perceived manipulation, even when the consequences are negative (de Vries, 2017, 2020). It follows that the effects of loss framing should be thoroughly studied before using it in practice.

Risk aversion

Risk aversion can be defined as *"the tendency to prefer certainty over risk"* (Hobman et al., 2016, p. 457). According to Tversky and Kahneman (1981, 1984, 1992), everyone has a certain preference regarding the amount of risk they are willing to take. This has a great impact on the decision-making behavior of individuals. However, they claim that people tend to be inconsistent in their preferences. According to them, when losses are involved, people tend to be risk-seeking, trying to avoid any loss at all costs (Kahneman & Tversky, 1984; Tversky & Kahneman, 1981, 1992). However, Hobman, Frederiks, Stenner and Meikle (2016) argue that, as soon as the amounts at stake get high enough, people tend to avoid risks. From this, it can be concluded that risk and loss aversion are strongly related. Nonetheless, the effects of risk aversion seem to trump the effects of loss aversion as the stakes increase. Apparently, people tend to avoid taking a gamble when the consequences significantly increase (Hobman et al., 2016). This implies that risk aversion could be more important than loss aversion in the building sector. As investments and possible losses are very high, mistakes have grave consequences. It follows that risk aversion should be of greater influence than loss aversion. Previous research has provided some evidence of a negative effect of risk aversion on PU (Y.-H. Lee et al., 2011). Because of this, it seems probable that risk aversion influences the adoption of SBMs.

The proposed strategy to reduce the effect of risk aversion is the same as one of the strategies opposing loss aversion (De Jaegher, 2019). Using loss-framed messages can change risk-averse behavior into risk-seeking behavior if the stakes are not too high (De Jaegher, 2019; Hobman et al., 2016). Depending on the perceptions of risk that someone has, regarding SBM adoption, different reference points should be used in framing the options (De Jaegher, 2019). However, the issue arises that the stakes seem to be high in the building industry. This could decrease the effectiveness of this strategy. For this reason, studying the effectiveness of loss-framing in the building industry could prove quite interesting.

Temporal discounting

Several authors present temporal discounting as a barrier to the adoption of SBMs (Frederiks et al., 2015; Hoffman & Henn, 2008). People often underestimate the savings in total life cycle costs and the speed of repayment (Frederiks et al., 2015; Harris, Shealy, Parrish, & Granderson, 2019; Hoffman & Henn, 2008). It follows that they perceive the financial risk as higher than the actual financial risk. This is caused by temporal discounting. Temporal discounting can be defined as *"the tendency to act on immediate pleasure-driven desires, due to the devaluation of future rewards"* (Kekic et al., 2020, p. 1). Research has shown that the mental discount rates people use increase, as the period between the moment of deciding and the moment of getting rewarded gets larger (Frederick, Loewenstein, & O'Donoghue, 2002). This leads to decisions that are not efficient economically (Frederick et al., 2002). It can be argued that temporal discounting is partly caused by loss and risk aversion. The fact that people generally are loss-averse causes them to focus on the initial costs instead of larger future gains (Frederiks et al., 2015). Moving the timing of a reward further into the future causes loss aversion to further increase

the rate of temporal discounting (Frederick et al., 2002). Additionally, temporal discounting has been proven to relate to risk preference (Andersen, Harrison, Lau, & Rutström, 2008). As it can be argued that loss and risk aversion are implicit in bias, they are not included as separate variables in the conceptual framework in paragraph 2.3.4. Some authors have argued for the rationality of discounting utility of oneself and others (Frederick, 2006). However, it is generally believed that temporal discounting can be attributed to bounded rationality (Frederick, 2006; Harris et al., 2019).

Temporal discounting occurs within all sorts of decision-making processes. A very common area of research, for instance, is temporal discounting by people with addictions (Kekic et al., 2020). Additionally, it is often related to the avoidance of environmental behavior by consumers (Gifford, 2011). As financial considerations are very influential in the decision-making process of real estate developers, it is interesting to explore whether it impacts organizations as well (Bordass, 2010; Chan et al., 2017; Sodagar & Fieldson, 2008; Williams & Dair, 2007). Because of this, two hypotheses are formulated.

H1. Temporal discounting negatively correlates with behavioral intent

H2. The correlation between temporal discounting and behavioral intent is negatively mediated by perceived usefulness

One possible solution to temporal discounting is an emphasis framing strategy. It has been proposed to frame messages in a way that decreased costs are subordinate to long-term operational costs (Frederiks et al., 2015). An example would be to communicate a 20% decrease in energy costs over the lifetime of a building, without communicating the initial investment of an SBM. Presumably, this would nudge people into thinking rationally about life-cycle costs.

Besides emphasis framing, Scholten, Scheres, de Water, Graf, Granic, and Luijten (2019) found that specific manipulations can reduce the effects of temporal discounting. The first proposed manipulation is episodic future thinking. This is the ability of a person to imagine events happening in the future and imagine the future more vividly. When subjects were stimulated to actively think about future events, and these were linked to future rewards, a reduction in mental discount rates could be observed. Related to this is connectivity to one's future self. The idea is that, if people can envision themselves in the future, they are more likely to take a long-term perspective on decision-making. This applies to episodic future thinking as well. This manipulation has been tested, for instance, by showing people avatars of themselves in the future and by using future-focused words. These manipulations have proven to have priming effects on the research subjects. It appears that envisioning the future leads to a long term view on decision-making.

Several other methods to overcome temporal discounting are discussed by them. However, there are many indications that it would be largely beneficial to frame messages in a way that emphasizes the future and stimulates the recipients on envisioning the future more vividly. It is highly probable that this would lead to decreased mental discount rates and would stimulate positive environmental behavior. Financial risk perceptions can wrongly incentivize people in their decision-making processes, and these strategies could be a possible solution to this (H. Scholten et al., 2019).

Bias towards conservatism

The construction sector is a relatively conservative sector. As this is the case, I argue that a bias towards conservatism can be observed in the industry. There are several biases identified that can be interpreted as a part of a general bias towards conservatism. Two of them are status-quo bias and confirmation bias. Both of them seem relevant in the context of this reason. To start, status-quo bias has often been discussed as a negative influence on the adoption of SBMs. (Frederiks et al., 2015; Gifford, 2011; Milbrath, 1995). This bias explains that people tend to resist change, even when the choice to change would be beneficial (Frederiks et al., 2015; Harris et al., 2019; Milbrath, 1995). Decision-makers tend to retain the status-quo when newer alternatives are presented (Samuelson & Zeckhauser, 1988). This can be observed in the way that nudging works. For instance, opt-out models have proven to cause major increases in the number of participants (Thaler & Sunstein, 2009). This is because people tend to stick with the status quo, instead of pro-actively change their behavior.

Different underlying grounds have been presented as a cause of status-quo bias (Kim & Kankanhalli, 2009). These can be classified into three categories, namely cognitive misconceptions, psychological commitment, and rational decision-making (Kim & Kankanhalli, 2009; Wu, 2016). Of these three categories, psychological commitment and cognitive misconceptions fall within the scope of this research. Contributing to a feeling of psychological commitment are decreased costs that have already been made, feelings of control that can be impacted by adopting an unknown technology, and social norms experienced in the work environment (Kim & Kankanhalli, 2009). Cognitive misconceptions refer to loss aversion, which has been theorized to be a major cause of the status-quo bias (Kim & Kankanhalli, 2009; Salkeld, Ryan, & Short, 2000; Wu, 2016). People tend to take the status-quo as their point of reference, and being loss averse they tend to focus on possible losses resulting from changing this situation (Salkeld et al., 2000). This supports the argument that loss aversion is implicit in bias, which is why it is not included in the conceptual framework in paragraph 2.3.4.

The psychological commitment factors driving status-quo bias may be caused by an internal need for consistency (Samuelson & Zeckhauser, 1988). A measure that has been proposed to negate the effects of status-quo bias, or even leverage them, is status-quo framing (Harker Martin, 2017; Samuelson & Zeckhauser, 1988). Status-quo framing is a form of message framing that presents an innovation as the status-quo option (Samuelson & Zeckhauser, 1988). This is similar to loss-framing. However, it does not necessarily include a value component, which is essential for loss framing. The nudging example

from before can be seen as an example of status-quo framing. It seems that the effects of status-quo framing increase with the number of options presented to the decision-maker (Samuelson & Zeckhauser, 1988). Other research suggests communicating the value of switching behavior clearly to increase perceived value (Kim & Kankanhalli, 2009). While this could have an impact, there is enough evidence to indicate that the effects of message framing will be much higher (Harker Martin, 2017; Samuelson & Zeckhauser, 1988). Therefore, this is more promising as a strategy to overcome status-quo bias as a barrier to SBM adoption.

According to Nickerson (1998), the other part of bias towards conservatism, confirmation bias, causes people only to accept or consider evidence in support of beliefs they already had. Usually, this bias is used to explain people acting in this way unconsciously. Even if someone has nothing to gain personally from proving a claim true, this effect still holds (Nickerson, 1998). Not only would it affect the perception of evidence for a hypothesis (Koehler, 1991; Nickerson, 1998). It would also change the problem perception and the duration of the information search (Koehler, 1991; Nickerson, 1998). Nickerson (1998) argues that this is all because people tend to overestimate their judgment. As much value is given to one's own judgment, taking time to collect all evidence in favor of and against this judgment is often neglected. It follows that confirmation bias could cause real estate developers to process information about SBMs in a way that supports their already existing beliefs. For instance, it is possible that they only process negative information about innovative SBMs they receive. This would cause them to reject the SBMs and stick to their habitual working routines. He claims that, if they had taken a stance early in the process of innovation, they would process all future information to coincide with their original stance (Nickerson, 1998). This would reinforce the effects of confirmation bias, creating a mental cycle that is difficult to break from.

Several methods reducing the effects of confirmation bias have been explored in the literature (Hernandez & Preston, 2013; H.-H. Huang, Hsu, & Ku, 2012; Schwind & Buder, 2012). Schwind and Buder (2012) found evidence that preference-inconsistent recommendations can stimulate critical thinking and reduce confirmation bias. However, the source of such a recommendation will have a big influence on its effect (de Vries, 2017; Wilson & Sherrell, 1993). Unfortunately, Schwind and Buder (2012) did not take this factor into account.

Additionally, H.-H. Huang, Hsu and Ku (2012) argue that counter-arguments can reduce confirmation bias. They proclaim that presenting well-constructed counter-arguments, conflicting with the beliefs of the recipient, can encourage decision-makers to question their initial beliefs. Decision-makers need to be stimulated to change their initially formed beliefs. Presenting them with evidence for both sides of the arguments could promote more deliberate processing of information (H.-H. Huang et al., 2012).

Finally, not only the message itself but the method of presenting the message can influence the confirmation bias as well. All strategies to overcome confirmation bias focus on stimulating critical thinking and careful information processing (Hernandez & Preston, 2013; H.-H. Huang et al., 2012; Schwind & Buder, 2012). Hernandez and Preston (2013) claim that this can also be achieved by presenting disfluent messages. Fluency can be defined as *"the relative ease experienced during*

processing" (p. 178). Low levels of fluency make it harder for people to process the information in a message. This causes them to process the message slower and more comprehensively. This can be done, for example, by changing the font of a text to one with less visual clarity (Hernandez & Preston, 2013).

As discussed, it can be argued that both confirmation bias and status-quo bias both contribute to a bias towards conservatism. It will be interesting to explore if professionals in the building industry are impacted by this bias. Prior studies have already found correlations between some of the underlying aspects of status-quo bias and PU (Kim & Kankanhalli, 2009; Wu, 2016). Also, as the construction sector changes relatively slow, status-quo bias is probably experienced by many professionals in the industry. Because of this, status-quo bias probably has an impact on the adoption of SBMs. However, unlike status-quo bias, confirmation bias has not been explored thoroughly in the context of TAM. It will be interesting to explore whether these biases can be measured as a single bias towards conservatism. Additionally, it will be interesting to explore its influence on TAM in the context of SBM adoption. Because of these reasons, two additional hypotheses are developed.

H3. A bias towards conservatism negatively correlates with behavioral intent

H4. The correlation between a bias towards conservatism and behavioral intent is negatively mediated by perceived usefulness

2.3.2 Perceived ease of use

One of the biggest causes of resistance to innovation is the disruptive effect of new technologies on daily life (Ram & Sheth, 1989). For homeowners, this is no different. Disruption in their households seems to be one of the reasons they do not accept SBMs or even consider them in some cases (Aravena et al., 2016). This effect increases after the homeowners have had previous experiences with implementing SBMs (Aravena et al., 2016). This can be attributed to the fact that homeowners perceive it as a hassle (de Vries et al., 2019). Because Kanner, Coyne, Schaefer, and Lazarus (1981) define hassle as a micro-stressor, I expect these hassles to influence PEU. In recent work, de Vries, Rietkerk and Kooger (2019) claim that people tend to avoid this stress, leading homeowners to postpone implementing SBMs in their homes. However, disruption in their homes is not the only source of hassle for homeowners. For instance, they discuss hassle related to complex information, dealing with contractors, and arranging financing for SBMs. In theory, much action homeowners would have to take could add to their perception of hassle. Not all hassles are relevant for this research, as most interventions will probably be action-oriented. However, hassle regarding complex information could be tackled with the help of message framing (de Vries et al., 2019). For this reason, I argue that complex information hassle is interesting to explore as a factor influencing PEU.

Complex information hassle

Complex information as a barrier to SBMs has been mentioned by several authors (Chan et al., 2017; Hoffman & Henn, 2008; Milbrath, 1995). New language and terminology can be confusing to stakeholders (Hoffman & Henn, 2008). Especially in the case of innovative technologies, this can often be expected to be influential. This lack of knowledge and understanding can cause resistance against the adoption of new SBMs (Hoffman & Henn, 2008). At the very least, it will slow down the decision-making process (de Vries et al., 2019). Additionally, an overload of information can add to this perceived hassle (Harris et al., 2019). An excess of details in communication dilutes the judgment of decision-makers (de Vries, 2020; de Vries, Terwel, & Ellemers, 2014). Most likely, this perception of complex information is due to limits on the mental capacity of people (Harris et al., 2019). Possibly, this could lead to a high perceived risk of not understanding the information correctly. If this would be the case, risk aversion causes the effects of complex information hassle to be observable. This supports the choice to not include risk aversion, based on the argument that it is already implied in hassle. However, hassle is relatively new as a research topic. Complex information hassle has not been explored as thoroughly as the biases that have been explained before. For this reason, it is not only interesting to explore this hassle in the context of TAM. It would also be fascinating to develop a deeper understanding of complex information hassle as a self-standing concept. Because of this, two final hypotheses are formulated.

H5. Complex information hassle negatively correlates with behavioral intent

H6. The correlation between complex information hassle and behavioral intent is negatively mediated by perceived usefulness

In order to decrease the effects of complex information hassle, simple messaging that contains only the essential information should be presented (de Vries, 2020). However, this implies that not all information can be included in the message. This can be risky, as de Vries (2017) claims that recipients can easily feel manipulated by one-sided messaging. She claims that an emphasis on the positive aspects of SBMs, while neglecting to communicate negative aspects, can lead to a high sense of perceived manipulation by the recipients. This could lead to a result, contrary to the intended goal of the message (de Vries, 2017). However, including too much information could also have negative effects on the outcome of the message (de Vries, 2020). It follows that it is of importance to be very careful in the choice of information to in- and exclude.

2.3.3 Contextual factors

The most relevant contextual factors in the context of this research are organizational factors. This is due to the knowledge gap that has been identified. Psychological barriers to SBM adoption do not seem to have been studied in an organizational context sufficiently. Hoffmann and Henn (2008) discuss structure, language and terminology, rewards, and organizational inertia, as organizational barriers. Additionally, I theorize company size and CSR to be of great influence on the adoption of SBMs. CSR seems to be suitable in the case of sustainable innovation. Furthermore, company size is commonly used as an organizational factor (Camisón-Zornoza, Lapiedra-Alcamí, Segarra-Ciprés, & Boronat-Navarro, 2004; Damanpour, 1992). I will not discuss all of the organizational factors that Hoffmann and Henn (2008) present, as many can be related to company size (Camisón-Zornoza et al., 2004; Damanpour, 1992). The choice has been made to focus on organizational inertia, CSR, and company size. Organizational inertia is often described as a very strong force, impacting innovation (Cheng & Chen, 2013; H.-C. Huang, Lai, Lin, & Chen, 2013; O'Reilly 3rd & Thusman, 2004). Because of this, it has been added as a third factor to explore.

Corporate social responsibility

Often related to sustainability and innovation is CSR (Asongu, 2007; González-Ramos, Donate, & Guadamillas, 2014). This can be defined as *"The social responsibility of business encompasses the economic, legal, ethical, and philanthropic expectations that society has of organizations at a given point in time"* (Carroll, Shabana, & Scherer, 2010, p. 89). One of the five dimensions that are most commonly related to CSR is sustainability (Carroll et al., 2010). Because of this, I theorize CSR to be an influential factor in sustainable innovation.

Recently, CSR has been linked to the innovation performance of firms (Asongu, 2007; González-Ramos et al., 2014). One of the reasons appears to be that CSR provides for a new set of stakeholders and needs (Asongu, 2007; González-Ramos et al., 2014). Also, relations with several stakeholders appear to become better when organizations develop a commitment to CSR (González-Ramos et al., 2014). Many new opportunities for innovation can be found because of this (Asongu, 2007; González-Ramos et al., 2014). Especially in environmentally sensitive sectors, such as the building sector, Gonzáles-Ramos, Donate and Guadamillas (2014) found that large benefits can be reaped. They found that CSR stimulates both product and process innovation. However, this effect seems to be stronger for process innovation (González-Ramos et al., 2014).

Apparently, the positive effects of CSR ripple through to an increase in firm value (Peloza, 2011). Many benefits can be obtained by committing to CSR (e.g., Carroll et al., 2010; González-Ramos et al., 2014; Peloza, 2011; Servaes & Tamayo, 2013). However, some factors can influence this. The prior reputation of organizations seems to have a large impact (Servaes & Tamayo, 2013). If a firm has a bad reputation, CSR can be seen as greenwashing, which can reverse its effects (Servaes & Tamayo, 2013; Wickert,

Scherer, & Spence, 2016). This is because the public could perceive CSR communication as strategic behavior (de Vries, Terwel, Ellemers, & Daamen, 2015). Additionally, they can feel manipulated if CSR is emphasized in the organization's communication (de Vries, 2017). Still, it seems that the firms that advertise CSR experience higher increases in profitability than others (Asongu, 2007). Firms should, thus, be careful that their messaging will not be interpreted as greenwashing.

Organizational inertia

According to Hoffman and Henn (2008), it can be hard for organizations to change their standards (Hoffman & Henn, 2008). This can have a great impact, as inertia is a relatively strong force within organizations (O'Reilly 3rd & Thusman, 2004). Many firms are theorized to have failed, due to the inability to innovate that is caused by inertia (O'Reilly 3rd & Thusman, 2004; Van Witteloostuijn, 1998).

Organizational inertia can be defined as *"the speed of change within a company, relative to the speed of external changes"* (Hannan & Freeman, 1984, p. 151). Hannan and Freeman claim that a high level of organizational inertia would mean that the speed of change is low, compared to external change. Their theory takes a structural inertia perspective on organizational change. They theorized that the same characteristics that make for efficient organizations increase organizational inertia (Hannan & Freeman, 1984). Kelly and Amburgey (1991) displayed the theory of structural inertia visually, which can be observed in figure 6. As can be seen, highly structured organizations are theorized to experience high levels of organizational inertia (Kelly & Amburgey, 1991).

Organizational inertia has proven to negatively impact business model innovation (H.-C. Huang et al., 2013). By doing so, it has an indirect negative effect on firm performance (H.-C. Huang et al., 2013). Inertia, thus, limits progress, which can often be stimulated by innovative firms. From this knowledge, I assume that inertia is an influential factor in the process of SBM adoption. Organizations with a high level of inertia will not be able to adapt to the rapidly increasing attention for climate change. However, strategies to negate the effects of organizational inertia are discussed in the literature (Cheng & Chen, 2013; H.-C. Huang et al., 2013; O'Reilly 3rd & Thusman, 2004). Engaging in open innovation, by developing cooperation between organizations, seems to increase the innovation capabilities within firms (Cheng & Chen, 2013; H.-C. Huang et al., 2013; O'Reilly 3rd & Thusman, 2004). Additionally, O'Reilly 3rd and Thusman claim that the ambidextrous organization is a good strategy to decrease organizational inertia. This is a form of organization, where switches between different organizational models can be made. This builds dynamic innovation capabilities, as organizations gain experience with adapting to new structures (O'Reilly 3rd & Thusman, 2004). Organizational inertia can, thus, be overcome. However, it still seems a force to be reckoned with and is very influential in any innovation process.

FIGURE 1
A Basic View of Structural Inertia Theory

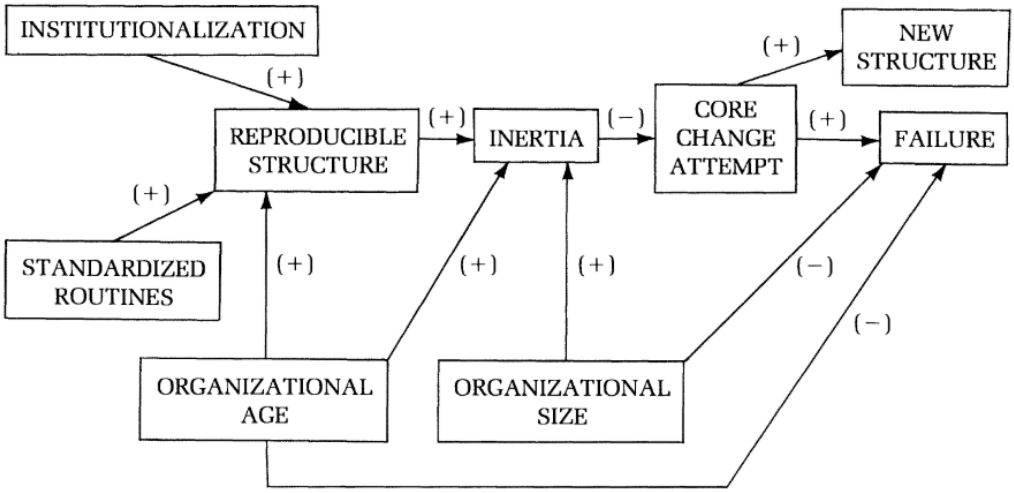

Figure 6: Cause and effect of organizational inertia (Kelly & Amburgey, 1991)

Company size

The effect of company size on innovation has been widely researched (e.g., Camisón-Zornoza et al., 2004; Damanpour, 1992; G. Lee & Xia, 2006; Shefer & Frenkel, 2005). However, there seems to be a lack of consensus (Camisón-Zornoza et al., 2004; Damanpour, 1992). Some studies have indicated a negative effect of size on innovation, while others have indicated a positive effect or none at all (Camisón-Zornoza et al., 2004; Damanpour, 1992). Proponents of the positive relation between size and innovation have proposed various reasons for this. First of all, according to Damanpour (1992) larger organizations tend to have many more resources and more diverse facilities. Additionally, larger organizations tend to have more skilled professionals employed. On the other hand, small organizations are argued to be more flexible and better equipped to adapt to change (Damanpour, 1992).

Using a meta-analysis, Damanpour (1992) has indicated that the actual effect should be positive. Other meta-analyses produce similar results (Camisón-Zornoza et al., 2004; G. Lee & Xia, 2006). The inconsistencies in previous studies seem to be caused by moderation that was unaccounted for (Camisón-Zornoza et al., 2004; Damanpour, 1992; G. Lee & Xia, 2006). Influential moderators seem to be the type of organization, stage of adoption, scope of size, and the choice of size measurement (G. Lee & Xia, 2006).

Company size seems to be most influential in the earlier stages of adoption, in which the decision to adopt has to be made and opinions are shaped (G. Lee & Xia, 2006). Furthermore, different measures have been used for company size. The most common are employee count, financial resources, physical capacity, and in- and output measures (Camisón-Zornoza et al., 2004). Non-personnel measures seem to produce a higher effect (G. Lee & Xia, 2006). However, this just seems to be a marginal moderator (G. Lee & Xia, 2006). A better explanation would be that company size is a multi-dimensional construct, consisting of various measures (Camisón-Zornoza et al., 2004).

Company size is often theorized to stimulate organizational inertia (Hannan & Freeman, 1984; Kelly & Amburgey, 1991). However, Kelly and Amburgey (1991) state that there is disagreement on the effects of company size, as the results in different studies contradict each other. Still, there is reason to believe that company size does contribute to inertia. This is because organizations tend to increase the level of internal formalization and standardization as they grow. This is the main cause of organizational inertia (Kelly & Amburgey, 1991). Company size will, thus, at least, have an indirect effect on organizational inertia.

Additionally, company size can be related to CSR (Wickert et al., 2016). Traditionally, many scholars assumed large organizations engaged in CSR more than SMEs (Amato & Amato, 2007; Udayasankar, 2008). The main reason that was provided was that large organizations have more resources (Amato & Amato, 2007; Udayasankar, 2008; Wickert et al., 2016). Because of this, they would have the capability to engage in CSR (Amato & Amato, 2007; Udayasankar, 2008; Wickert et al., 2016). However, according to Wickert, Scherer, and Spence (2016) this seems to be a kind of "large-firm bias", stemming from studies on corporate philanthropy. It seems that large organizations engage more in the communication of CSR, while SMEs engage highly in CSR action. This is caused by organizational costs, which vary with company size (Wickert et al., 2016).

It is clear that company size can be linked to many other factors that influence the adoption of SBMs. Especially the link with organizational inertia and CSR is very insightful. Therefore, insights into many other factors can be developed, if the effects of company size on SBM adoption are known. Because of this, I have chosen company size as the most important contextual factor to include in my study. Company size is included as a control variable in the conceptual framework in paragraph 2.3.4.

2.3.4 Conceptual framework

Loss and risk aversion were excluded from the model to decrease the complexity of my framework. As discussed in paragraph 2.3.1 and 2.3.2, this is done as it can be argued that they are already implied in bias and hassle. As discussed in paragraph 2.3.1 and 2.3.2, the predicting variables are hypothesized to influence BI through two mediating paths. Temporal discounting and bias towards conservatism are theorized to influence BI through PU. On the other hand, complex information hassle is expected to influence BI through PEU as a mediator. This is derived from TAM, where BI is predicted by PU and PEU (Davis, 1986). To study the influence of organizational differences, company size was added as a control variable to my framework, as discussed in paragraph 2.3.3. This way, the results will clarify whether company size has an external influence on the model. This is important to consider when selecting a target audience for marketing strategies. In figure 7, the mediation paths are simplified. The proposed direct effects are not visualized in order to manage the readability of the figure. However, these are implied by the proposed indirect effects that are visualized.

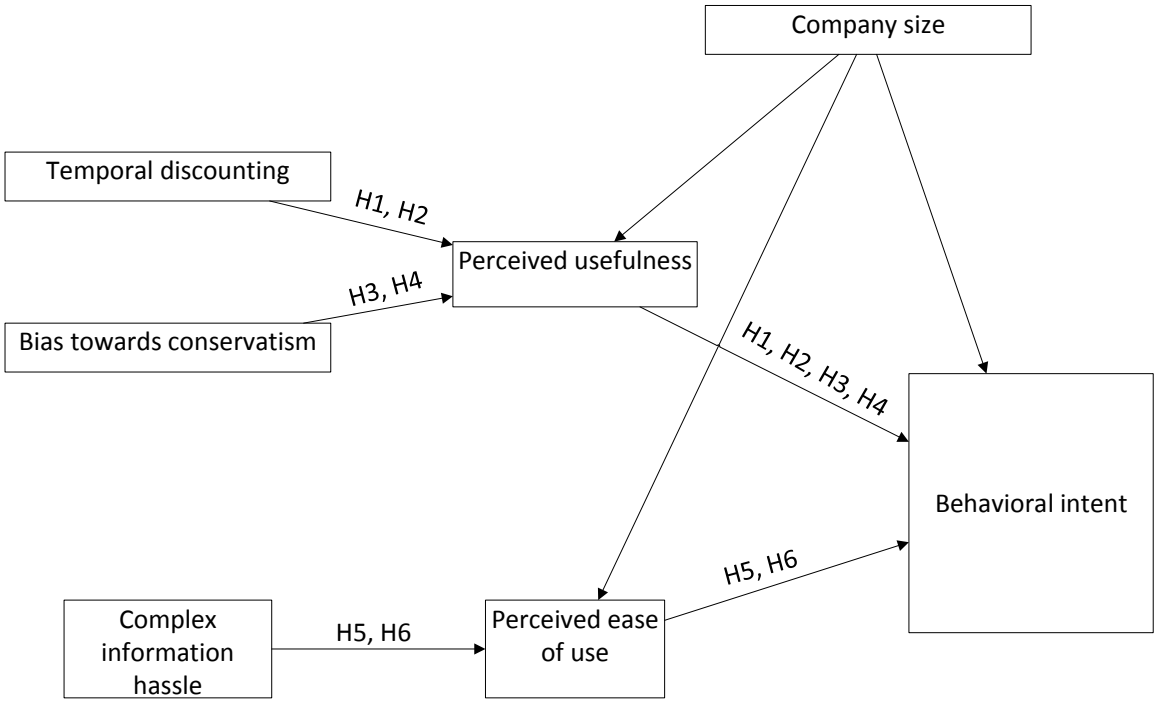

Figure 7: Conceptual framework (Author)

3. Methodology

In this chapter, two different studies are discussed. Both contribute to answering the main research question. The first method is quantitative survey research. This is described in paragraph 3.1. The goal is to establish statistically significant relations between psychological barriers and SBM adoption. After this, in paragraph 3.2, in-depth interviews are developed. These provide more detailed knowledge on the barriers to SBM adoption, as experienced by building professionals. The motivations for the choice of both these methods are given at the beginning the respective paragraphs.

3.1 Survey research

Survey research is useful for providing answers to the first three research questions. To do so, I explore the effects of bias and hassle on the adoption of SBM's. Also, I explore the effect of the differences in these effects between different kinds of organizations. Using survey data, I tested several hypotheses that attempt to answer these first three questions.

This method was chosen, as there is not much research that has tested for the effects of bias and hassle on the adoption of innovation. While Kim and Kankanhalli (2009), for instance, studied the effect of status-quo bias on PU, many studies are of an exploratory nature (e.g., de Vries et al., 2019; Hoffman & Henn, 2008). Additionally, no hypothesis testing research in the context of SBM adoption within organizations was found.

To start, the method of data collection and sampling is discussed. Next, the variables in the model are operationalized. Finally, the data analyses that were performed are explained.

3.1.1 Data collection

The choice was made to develop an online survey because professionals in the construction industry needed to be reached. This is necessary to answer the first three sub-questions of this research. The collaboration with PHYSEE eased the search process. As the survey could be sent directly to their clients, the threshold to participate was low. This way, the chance to reach a sufficient number of professionals to participate in my research increased. However, it was necessary to find participants in other places to reach a significant sample size. Because of this, personal messages were sent to professionals on LinkedIn. This platform is the most suited for this objective, as it is designed as a social media platform for professionals. To find the right participants, a selection of real estate development companies and developing contractors was made. After doing so, the employees of these companies in

a position relevant to this research were selected. These are mainly real estate developers, technical consultants, commercial developers, partners, directors, and owners. This is possible, as LinkedIn provides the option to view employee lists.

Also, due to the time constraints on my research, the chosen method is suitable as online-based surveys are usually very time-efficient (Evans & Mathur, 2005). This was of even greater importance as an experiment was designed based on the survey results, which is discussed in paragraph 5.3. This all had to be done in a time frame of four months. Also, sending direct messages to potential participants is very time-consuming. This reinforced the practicality of a time-efficient research method.

On the downside, online surveys can often be considered as spam by potential respondents (Evans & Mathur, 2005). Simultaneously, response rates are usually lower than for other research methods (Evans & Mathur, 2005). However, these issues were expected to be minimalized due to the collaboration with PHYSEE. This was expected to increase the validity of the survey, from the perspective of possible respondents. This would provide them with more incentive to participate. This would probably have the largest effect on the clients from PHYSEE's database. However, this was expected to have an effect in general as well.

The survey consists of three parts and can be found in appendix A. The first part of the survey consists of questions providing me with the background of the respondents. This provided me with knowledge about the demographics of the sample. The respondents were asked which company they work for, what their role in the company is, and if they have the power to make relevant investment decisions. In addition, they were asked about their gender, as this has been related to the effect of psychological phenomena, and about their level of education (Booth & Nolen, 2012). This information can be used to put the results of this research into perspective.

The second part of the survey consists of questions that directly relate to the professional activities of the respondents. These aim to measure PU, PEU, and BI. The answers to these questions were collected on a five-point Likert scale. All of the questions have been adopted from the literature and are proven reliable measures, as is discussed in paragraph 3.1.3. Besides these questions, one open-ended question was presented, asking the respondent for their reason for implementing SmartSkin technology or not. This reduced the chance that any relevant factors were missing.

Finally, the third part of the survey consists of questions that are not directly related to the professional activities of the respondents. These questions were expected to measure biases and hassle. Where possible the questions were formulated in a way that answers were collected on a five-point Likert scale. This is not the case for the measure of temporal discounting. This choice was made so I could adopt proven reliable questions from the literature. Also, they were asked if they experienced any hassle in the implementation process of any new technology, and if so, what this was. This, again, was done to reduce the chance that any relevant factors were missed.

3.1.2 Sampling

The conceptual framework that was designed is relatively complex. Two mediation paths and three dependent variables are included. Because of this, a multivariate analysis was performed on the collected data. A rule of thumb for the sample size in multivariate analyses is that ten respondents are needed per variable (Sekaran & Bougie, 2016). The framework that was constructed includes seven variables. As such, the smallest sample that is acceptable consists of 70 respondents. However, the response rate for online surveys is quite low (Deutskens, De Ruyter, Wetzels, & Oosterveld, 2004). Research has proven these to be as low as 12.7% in some cases (Deutskens et al., 2004). This means that the survey had to be sent out to a minimum of 552 different professionals. Taking into account the sample size of 70 respondents as the bare minimum, and accounting for even lower response rates, 800 possible respondents were contacted.

It was crucial to reach professionals working at development companies and developing contractors. Other respondents would make no sense, considering my research scope. For this reason, it was chosen to use quota sampling as the sampling method. As mentioned earlier, a list of companies was specified and their employees were targeted. This was done, based on the pre-specified number of people to send my survey to. This means that the results of my study are not very generalizable (Sekaran & Bougie, 2016). However, my research focuses on SBMs in an organizational context. The group that was reached through sampling quota consists purely of professionals working for organizations dealing with SBMs. Because of this, the results of my research should still be very applicable in the building sector.

Of these 800, the database of PHYSEE provided me with the first 35 contacts. These are of special interest as they have previously chosen to adopt SmartSkin technology or not. As SmartSkin was used as an example to formulate my questions, including these professionals would provide for a more diverse respondent sample. The remaining 765 potential respondents were contacted on LinkedIn. This resulted in a sample of 109 respondents, as is discussed in paragraph 4.1.1.

3.1.3 Operationalization

To collect data that is usable for my analysis, the variables that are analyzed had to be formulated measurably. This was done by using the main characteristics of these variables, as discussed in the literature. Based on these characteristics, questions were developed that measure if these characteristics can be observed in the behavior of the participants of my research. Principal Component Analysis (PCA) and Confirmatory Factor Analysis (CFA) were used to indicate whether they are indeed all measures of the same variable. Where possible, multiple questions were formulated. However, the number of questions varies per variable, as some have a greater diversity of characteristics than others. However,

it was attempted to keep the number of different questions measuring one concept relatively small. As seven variables were measured, this was needed to ensure that the questionnaire is of manageable size. The questions that were asked are presented in English. However, the questionnaire was in Dutch as this is more suitable considering the target audience. The questionnaire can be found in appendix A.

Temporal discounting

As discussed in paragraph 2.3.1, temporal discounting leads to an underestimation of long-term cost savings. Temporal discounting was measured by three questions. These are adopted from a recent study by Wolfe and Patel (2017). They studied whether individuals are more inclined to self-employment when they experience temporal discounting, using data from developing countries. Each question presents two options of rewards, asking the respondent to choose one of them. The answer to the first question determines if the respondent has to answer the second or the third question. This generates a single score on a four-point Likert-scale, measuring the level of temporal discounting that is experienced. The highest level is represented by four and the lowest by one (Wolfe & Patel, 2017).

TD_1	1300 euros with certainty right now or 1950 euros with certainty in one year
TD_2	1300 euros with certainty right now or 2600 euros with certainty in one year
TD_3	1300 euros with certainty right now or 1560 euros with certainty in one year

Conservatism bias

As discussed in paragraph 2.3.1, multiple known biases might affect the conservatism of a person. Two of those are status-quo bias and confirmation bias. To measure how biased the respondents are towards conservatism, I formulated several questions based on the literature about the status-quo and confirmation bias. Respondents were asked to state how much they agree with the following statements, on a scale from I disagree very much to I agree very much. For questions SQB_1, SQB_3, SQB_4, and CB_2, the highest level of bias is represented by five and the lowest by one. This is the other way around for the other questions.

SQB_1	I do not like to change my routines.
SQB_2	When I have invested in something, I do not mind replacing it with a newer alternative.
SQB_3	I can feel overwhelmed by change.
SQB_4	I do not like to work in a different way than my peers at work.
CB_1	I always try to keep searching for information about new technologies.
CB_2	Most of the information I find supports my current routines.
CB_3	I spend a lot of time searching for information about innovations within my sector.

Complex information hassle

The adoption of innovation can be hindered by the hassle people experience from dealing with complex information, as discussed in paragraph 2.3.2. Attempting to measure perceived complex information hassle, I formulated six questions. These questions are based on the literature about complex information hassle. The respondents were expected to answer on a scale from I disagree very much to I agree very much. For questions CH_2, CH_3, CH_4, and CH_5, the highest levels of hassle are represented by five and the lowest by one. This is the other way around for the other questions.

CH_1 It is easy for me to find the right information about a new technology.
CH_2 When new technologies get introduced, usually a lot of information is presented.
CH_3 I perceive searching for information about a new technology as hassle
CH_4 I experience hassle while processing information related to a new technology
CH_5 I get confused by new terminologies related to the introduction of new technologies.
CH_6 I do not mind searching through many sources of information to find what I need.

Perceived usefulness

To be able to add to TAM, I need to measure PU. As I stated in the literature review, I interpret PU in the context of SBMs as the perceived value added to a project by using SBMs. I will measure this by four questions that are adopted from a study in which Chin, Johnson, and Schwarz (2008) constructed scales to measure technology acceptance. Respondents were expected to respond on a scale from I disagree very much to I agree very much. For questions PU_1 and PU_3, five represents the highest level of PU and one the lowest. This is the other way around for the other questions. The questions are adapted to be applied specifically to SBMs. This is done by using the SmartSkin Technology of PHYSEE as an example.

PU_1 In the projects I am dealing with I expect the SmartSkin Technology of PHYSEE to add value.
PU_2 In the projects I am dealing with I expect the SmartSkin Technology of PHYSEE to be inefficient.
PU_3 In the projects I am dealing with I expect the SmartSkin Technology of PHYSEE to be quite useful.
PU_4 In the projects I am dealing with I expect the SmartSkin Technology of PHYSEE to be unhelpful.

Perceived ease of use

Also, I need to measure PEU to add to TAM. PEU is interpreted as the perceived effort needed to implement SBMs in a project. I will measure this with three questions that are taken from the study of Chin, Johnson, and Schwarz (2008) as well. Respondents answered on a scale from I disagree very much to I agree very much. For questions PEU_1 and PEU_2, five represents the highest level of PU and one the lowest. This is the other way around for PEU_3. The questions are adapted to be applied specifically to SBMs. This is done by using the SmartSkin Technology of PHYSEE as an example.

PEU_1 In the projects I am dealing with I expect the SmartSkin technology of PHYSEE to be easily understandable.

PEU_2 In the projects I am dealing with I expect the SmartSkin technology of PHYSEE to be flexible to deal with.

PEU_3 In the projects I am dealing with I expect the SmartSkin technology of PHYSEE to be unclear to deal with.

Behavioral intent

As my dependent variable, I will need to measure BI. This will be done by the use of three questions that have been proven to be reliable measures in a study by Sääksjärvi and Morel (2010). In this study, they developed a measurement scale for consumer doubt towards new products. To establish nomological validity, they analyzed BI as an outcome of this doubt (Sääksjärvi & Morel, 2010). The respondents were expected to answer on a scale from one to five. Five represented the highest level of intent for all questions. The questions are adapted to be applied specifically to SBMs. This has been done by using the SmartSkin Technology of PHYSEE as an example.

BI_1 How interesting do you think the SmartSkin technology of PHYSEE is? (Very uninteresting – Very interesting)

BI_2 How probable is it that you will apply the SmartSkin technology of PHYSEE in a project within a year from now? (Very unlikely – Very likely)

BI_3 How positive or negative do you feel about the SmartSkin technology of PHYSEE? (Very negative – Very positive)

Company size

Finally, I added company size as a control variable. As discussed in paragraph 2.3.3, company size can be related to the innovativeness of an organization, its CSR, and the level of organizational inertia. All three variables are theorized to affect the adoption of SBMs. As such, I argue that company size can be used to represent all of these factors. This choice was made as the model is already quite complex. As such, I only have to add one variable instead of multiple organizational variables. However, by controlling for company size, I expect to be able to link the results to all of these factors.

Size_1	Which company do you currently work at?

In contrast to the other variables in the model, company size cannot be measured on a pre-defined scale. Damanpour (1992) states that size is probably not a continuous variable. He suggests measuring company size as a categorical variable (Damanpour, 1992). Therefore, the respondents are divided into two categories. These categories represent large organizations and small or medium-sized enterprises (SME). This division was made based on criteria that the European Commission (2003) has developed. The criteria are based on employee count and turnover. The turnover limit for an SME is 250 million euros per year. Meanwhile, the employee count limit for an SME is 250 employees. If the company is part of a larger organization, the employee count of the whole organization has to be taken into account (European Commission, 2003).

However, building projects are very costly. Therefore, the turnover for most developing companies will be larger than that limit. This would limit my ability to make a proper division between my respondents. For this reason, I chose to exclude turnover as criteria and only take into account employee count. High turnover can be argued to have a positive impact on CSR and innovativeness, due to more available funds (Amato & Amato, 2007; Udayasankar, 2008; Wickert et al., 2016). However, it is not suitable for this research, as it does not function as an effective criterion for division. Employee count, on the other hand, is easy to measure objectively. It creates a clear division between SMEs and larger organizations, within the building industry. Also, employee count is one of the most common measures for size in the literature (Camisón-Zornoza et al., 2004). This ensures a high level of comparability with the results from previous studies.

3.1.4 Data analysis

The complexity of the model has the consequence that many common statistical analysis methods are not suitable. A method that is capable of testing complex and multi-dimensional models is Structural Equation Modelling (SEM) (Ullman & Bentler, 2003). Basically, SEM is a combination of a CFA and a multivariate regression (Ullman & Bentler, 2003). As discussed before, due to the number of variables in the model, a multivariate analysis was needed. Because of this, SEM initially seemed to be a good fit. Mostly, code was written in R to perform all the necessary statistical analyses. Additional analyses were

performed in JASP and SPSS. These programs are more convenient for some analyses. However, the lavaan package for R is developed specifically for SEM. This is the same package and language that is used in the SEM functionality of JASP. Nonetheless, by using Rstudio to write code directly, more functionalities of the lavaan package could be accesed than in JASP. This code can be found in appendix B.

Data transformation

Most of the data from the survey were collected on a five-point Likert scale. However, the questions that measure temporal discounting present a single measure on a four-point Likert scale. Because of this, it was needed to transform the data. This can be done by transforming the four-point to a five-point Likert scale, using $x(5) = \left(\frac{4}{3}\right) * x(4) - \left(\frac{4}{3}\right) + 1$.

Another option was to standardize all measures, creating new measures with a mean of zero and a standard deviation of one. This can be done by using $z = \frac{x - \mu}{\sigma}$. This generates a value that is called a z-score. It is this option that was chosen, due to the nature of the z-score. The value of the z-score represents how many standard deviations the measure is above or below the mean. This provides for a more transparent interpretation of the measure.

Besides the measurements on a scale, the respondents were asked which company they work for. As company size was controlled for, this had to be transformed into numerical values. The answers were first categorized into either SMEs or large organizations. Next, dummy coding was chosen to transform the data into numerical values. The value 1 was assigned to large organizations and the value 0 to SME's. The result was a single variable that was used as a control variable in the analysis (Daly, Dekker, & Hess, 2016; Grotenhuis & Thijs, 2015). Essentially, it was used to analyze the data of the large organizations category, using the SME category as a reference group (Daly et al., 2016; Grotenhuis & Thijs, 2015). This allowed the addition of this categorical data to the regression (Daly et al., 2016; Grotenhuis & Thijs, 2015).

Besides standardization and dummy coding, the negative and positive formulation of the questions were accounted for. The data was transformed in a way that higher scores all measure a high degree of the variable they are supposed to measure.

Validity tests and dimension reduction

The data was collected using an online survey, with variables being measures by multiple questions. The dimensions of this data needed to be reduced for it to be analyzable. This was realized with the CFA application of SEM. This did not only make the data more manageable, but CFA also established construct validity of the measurement scales. Content validity was assumed, as the measurement scales are all based on or taken from existing literature.

However, CFA is not suitable for all kinds of research. As the name implies, it is used to confirm measurement scales that are developed based on sound theory (Ullman & Bentler, 2003). Most of the measurement scales that are included were retrieved from existing literature and were therefore assumed to be suitable for CFA. Still, it has to be mentioned that I developed some of the scales myself. Although these were based on knowledge from existing literature, CFA is not as good a fit as for the other scales.

Because of this, first, a PCA was performed on the scales as well. This established whether the items are indeed indicative of the variables intended to be measured (Sekaran & Bougie, 2016). Also, it exposed whether the variables are indeed measured one-dimensionally or consisting of multiple dimensions (Sekaran & Bougie, 2016). This increased the validity of the measurement scales that are used (Sekaran & Bougie, 2016). The solution was rotated with a Varimax rotation using eigenvalues greater than 1 and excluding coefficients under 0.4. By applying the Varimax rotation, a linear combination of the original factors was found that maximizes the shared variance of the items (Abdi, 2003). Because of this, the factors are more suitable for interpretation (Abdi, 2003). Adding the PCA, I can use SEM as a method without major limitations. The PCA was performed in SPSS, as this was the most practical software for this.

Reliability tests and normality

To establish reliability, the internal consistency of the measures were tested for. Due to the timeframe of my research, the stability of the measures could not be tested for. Internal consistency was established by testing for inter-item consistency reliability. A common inter-item consistency reliability test is Cronbach's Alpha (Sekaran & Bougie, 2016). This is a good choice for the measures are used, as it is effective for scales on multiple points (Sekaran & Bougie, 2016). Company size is the only variable that is not measured on a scale. However, as this measure consists of only one item, it was not tested for reliability.

Finally, all the items of the questionnaire were tested for normality. The Shapiro-Wilk test was used for this. A non-normal distribution might affect the outcome of the analysis (Sekaran & Bougie, 2016). It is, thus, of importance to take normality into account. The Shapiro-Wilk test was performed in JASP. R only allows for testing one variable at a time, which would be too time-consuming.

Model fit

Model fit was tested for based on three fit indices. These are the Tucker-Lewis index (TLI), the Root Mean Square Error of Estimation (RMSEA), and the χ^2 test. It has been under debate whether the χ^2 test is a good measure of fit in SEM, as large sample sizes are almost always statistically significant (Kenny, 2015). However, considering the sample size of this survey, it is a relatively good measure of fit (Kenny, 2015). Still, it is not the most reliable index, as it allows for too much Type-1 error when the data is not normally distributed (Kenny, 2015). Because of this, the decision was made to include two more indices.

RMSEA and TLI are the most commonly used measures of fit for SEM (Kenny, 2015). Both of these are based on the χ^2 test and have a penalty for complexity (Kenny, 2015). As my model is quite complex, it is important to take this into account. Failing to do so would lead to biased results. The largest difference between these two tests is that RMSEA is an absolute measure of fit, while TLI is an incremental measure of fit (Kenny, 2015). This means that TLI is not much affected by normality or sample size (Kenny, 2015). On the other hand, RMSEA is positively biased by non-normal distributed variables and smaller sample sizes (Kenny, 2015).

Model testing

Multivariate regression was used to test for correlations between the variables in the model. This established whether my hypotheses could be accepted or had to be rejected. Furthermore, SEM does not only enable me to test direct correlations between variables. It is also possible to test for the indirect and total effects of the independent variables on the dependent, through their mediation paths. This facilitated a more in-depth interpretation of the results.

In addition, the independent variables were tested for covariance. This demonstrated whether the independent variables influence each other. This is common practice in SEM, as the covariance between the independent variable can influence the correlations of the tested model (Little, Slegers, & Card, 2006). Additionally, these variables were chosen based on their possible contribution to the conservative nature of the building sector. Because of this, a certain degree of covariance was expected to exist.

3.2 In-depth interviews

Following the survey research, in-depth interviews were conducted. These were developed as semi-structured interviews. The semi-structured interview is especially suitable in research, where it is known which information is needed (Sekaran & Bougie, 2016). Because this was known, the interviews were designed beforehand and were used for validation instead of exploration. However, during the interviews, additional questions were asked, based on the conversation itself.

The interviews were used to validate the results from the survey research, gain information that is complementary to the results, and compare the opinions of professionals with these results. While survey research was used to test hypotheses, in-depth interviews can provide more detailed information about the relations that are found in the survey. Because of this, the survey results can be contextualized and explained based on insights from the industry. To reach these objectives, the interviews were developed based, partly, on the results of the survey research.

The reach of the survey is limited and by using semi-structured interviews it is possible to gain more information than with survey results only. First, the data collection is discussed and the sample for the interviews. After that, the concepts that were discussed with the interviewees are operationalized. Finally, the method of analysis is presented.

3.2.1 Data collection and sampling

The interviews were conducted through video calls. This provided the benefits of telephone interviews, as well as those of face-to-face interviews. As the interviewees are professionals with demanding jobs, it was of importance that the interviews would not cost them much time or effort. Conducting the interviews through video calls removed this barrier. Because of this, it was easier to reach my interviewees (Sekaran & Bougie, 2016). However, because the interviewees were still visible, it was possible to read nonverbal cues (Sekaran & Bougie, 2016). For example, doubts about the question could be noticed by reading facial expressions (Sekaran & Bougie, 2016). Still, this was harder to do than in face-to-face interviews. Because of this, some nuances in the conversation could have been missed. Nonetheless, video call interviews were a good choice, because of the time advantages. This was of great significance, as the information needed to be extracted in a limited time frame and little interviewees were available.

The interviewees were found while conducting the survey research. Two respondents of the survey expressed their interest in answering additional questions. This provided me with the opportunity to set up these semi-structured interviews and add an extra element to my research. Both of the interviewees are professionals in the building sector. However, one of them is working at an SME, while the other is working at a large organization. Also, they both have a different position within their respective companies. This provided answers from two different perspectives. It is interesting to see in which way their opinions differ.

3.2.2 Operationalization

Starting the interview, the research was explained to the interviewees. After this, it was explained to them that the answers they provide me with will be completely anonymized. Finally, they were asked if they approve of the conversation being recorded. This eased the process of data collection. After these actions, the actual interview started. It should be noted that the questions that are presented in this paragraph are the questions that were prepared before the interviews. During the interviews, additional questions were asked based on the course of the conversations.

A common strategy to open interviewees up is to ask relatively easy questions in the beginning (Sekaran & Bougie, 2016). This strategy was pursued by starting a line of questioning about the sector in general.

The assumption was made that every professional in the building sector will have some initial opinions about the sector. For this reason, it was believed that both of them feel comfortable answering these kind of questions. In order not to lead the answers to a certain outcome, it was attempted to only ask open-ended questions and not to ask guiding questions. To open up this line of questioning, they were asked the following questions.

- What are your feelings about the innovativeness of the building sector?
- What is your opinion on the rate at which new technologies get adopted in the building sector?
- What is your opinion on the need for new technologies?

After this, they were asked about their perspectives on the future of the building sector. The goal was to explore where the professionals themselves see the biggest issues and opportunities in the industry. This provided insight into the barriers to innovation that are experienced by professionals in the industry. This can be utilized to substantiate the results of my survey research. The professionals were asked the following questions.

- What do you think is needed to change the conservative nature of the building sector?
- What would stimulate the innovativeness of the sector?
- What is standing in the way of this innovativeness?

These questions, together with the ones that follow from the conversation, produced relevant insights into the perceived nature of the building sector and the envisioned future of the industry. It was interesting to see whether the professionals provided answers that coincide with the theorized conservative nature of the industry. After exploring the interviewees' views on the sector, the results of the survey research was discussed with them. By doing so, it was attempted to gain more insights that could help to answer my first three research-questions. They were asked whether they have any explanations for the results that were found. Also, possible explanations that were formulated were discussed with them if needed. First, it was explained to them that it was found in my survey research that the decision to adopt a new SBM is influenced by the status-quo bias and the confirmation bias. After that, it was briefly explained to them what these biases are. Then they were asked the following question.

- How do you feel about these results?
- Could you provide an explanation for why I could have observed these results?

After exploring the influence of bias on BI, complex information hassle was discussed with the interviewees. Again, the concept was briefly presented to them. As no correlations were found, they were not presented with these results. They were asked the following question.

- Do you think complex information hassle influences the decision-making processes of organizations?
- If so, why do you think this is the case?

After this, company size was discussed with the interviewees. First, it was explained to them that a division was made between SMEs and large organizations. It was explained that this was done so based on an employee count of 250. After this, an attempt was made to capture their initial thoughts on the influence of company size on the biases and hassle. Finally, the results were discussed with them and their thoughts on it were explored. This was done by asking the following questions.

- What do you expect the influence of company size to be on the level of bias and hassle, if any?
- Why do you think status-quo bias and complex information hassle is experienced less in larger organizations?

3.2.2 Data analysis

To analyze the interview data, thematic analysis will be used. According to Braun and Clarke (2012), this is done in six steps. However, these six steps can be reduced to three general steps, as argued by Sekaran and Bougie (2016). First, the data will need to be reduced into a smaller dataset (Braun & Clarke, 2012; Sekaran & Bougie, 2016). After that, the data will have to be displayed in an orderly manner (Braun & Clarke, 2012; Sekaran & Bougie, 2016). Finally, conclusions can be drawn from the data (Braun & Clarke, 2012; Sekaran & Bougie, 2016).

Data reduction

The interviews were 30 minutes and one hour respectively. One and a half hours of conversation produced a very large amount of text that had to be analyzed. To do this systematically, the text had to be reduced to an analyzable dataset. This was done through data coding (Braun & Clarke, 2012; Sekaran & Bougie, 2016). Communalities in the text were coded with a common label (Braun & Clarke, 2012; Sekaran & Bougie, 2016). This was done manually. The dataset only consists of two interviews, so manual coding was not as time-consuming as it can potentially be. By coding manually, the codes and categories could be tailored to fit this research. After coding, commonalities between codes were found and themes were created. These themes represent the variables that influence SBM adoption. After the themes were reviewed, defined, and named they have been divided over several categories to develop more structure in the data. The labels of the codes, themes, and categories that were used can be found in appendix C.

Data display

To make sense of the reduced data, it had to be visually displayed. The most relevant method of display differs per dataset (Sekaran & Bougie, 2016). The codes and categories in this research are presented in matrix form. Matrix presentation is a very descriptive method (Sekaran & Bougie, 2016). This is very useful, as the outcome of my interviews is used to validate and substantiate the results of the survey research. Also, because only two interviews were conducted, the number of themes is lower than for a larger dataset. For this reason, the matrix is not excessively large. Additionally, due to the categorization of the themes, the matrix is very comprehensible. This provides a clear overview of the interview results.

Drawing conclusions

After the data was displayed, an attempt was made to provide an answer to my research question. The interview data is linked to the theory, in order to explain the recurring themes. As the two interviewees are very different kinds of professionals, the results from the interviews were also compared to each other. This provided an opportunity to explore more answers to the third research question. Also, by analyzing the questions on the bias and hassle, possible answers to the first two research questions are explored. Observations about the nature of the sector, and the interviewees' opinions on this, are linked to the last research question.

4. Results

In this chapter, the results of this study are discussed. The results of the survey research are discussed first in paragraph 4.1. After that, the interview results are presented in paragraph 4.2.

4.1 Survey research

4.1.1 Respondent demographic and descriptive statistics

Demographic

The online survey was sent out to 800 possible respondents. Of these, 109 filled out the survey, which is equal to a response rate of 13.6%. This is comparable to the response rate of 12.7%, on which the choice to contact 800 possible respondents was based. As a sample of 70 respondents was the bare minimum, 109 is assumed to be a representative sample size.

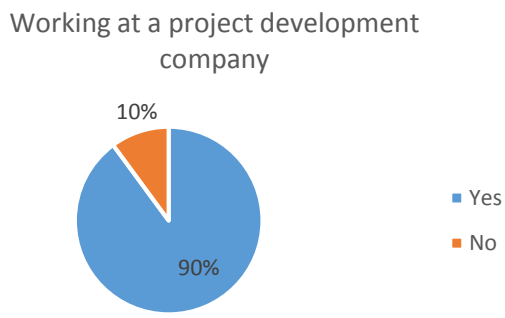

Figure 8: Percentage of respondents working at a development company (Author)

I believe to have reached a sample that is representative of my target group. 90% of the respondents stated to work for a project development company. Meanwhile, the other 10% are either working for independent consulting firms or developing contractors. Although not purely development firms, these organizations are relevant in the context of my research.

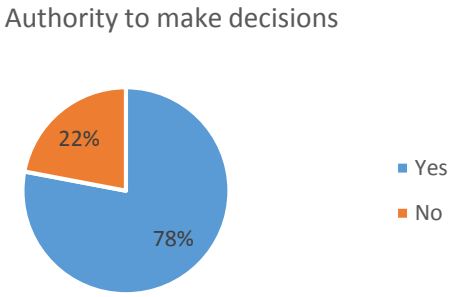

Figure 9: Percentage of respondents that have the authority to make decisions (Author)

Additionally, 78% of the respondents stated to have the authority to decide about the implementation of new technologies. It follows that a large majority of my sample is directly involved in the decision-making process. On the other hand, the remaining 22% have no authority. However, almost all of them are employed as real estate developers. This means that they are probably still involved in decision-making processes indirectly. At the very least, their work will contribute to the opinions that are formed by the actual decision-makers. From this, the conclusion is made that these respondents are still representative of the target group.

The gender of the respondents is not evenly distributed. 88% of the sample is male and only 12% is female. However, this is quite representative of the building sector. It can be argued that this is a consequence of the conservative nature of the industry. The employee lists that were used in the selection of the sample are dominated by male employees. However, this does not apply to each company.

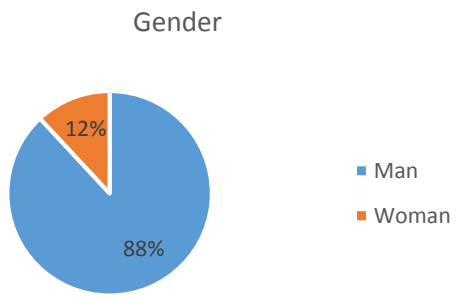

Figure 11: Gender of the respondents (Author)

Furthermore, 39% of the respondents are working at large organizations, while 61% are working at SMEs. This seems counterintuitive, as large organizations have the largest employee lists. However, it appears that many SMEs are focused solely on real estate development. Almost their entire employee list consists of real estate developers, which are relevant to my research. On the other hand, large organizations engage in a wider variety of activities. Also, real estate development is often not their core business. Usually, this is construction or contracting. Because of this, their employee lists contain many professional irrelevant to this research.

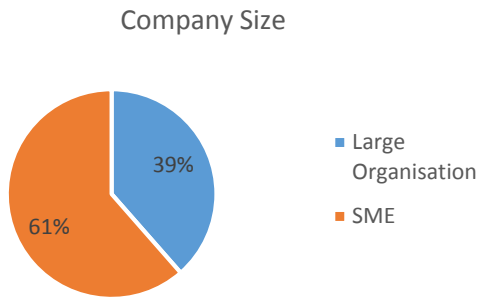

Figure 10: Size of the companies (Author)

Finally, the respondent group is predominantly highly educated. With 53%, the majority of the sample has a master's degree from a university. 27% of the respondents have a bachelor's degree from an HBO, which is the Dutch equivalent of a university of applied sciences. This seems reasonable, considering the demands of real estate development jobs. The other 20% is spread out over the other five categories, as can be seen in figure 10.

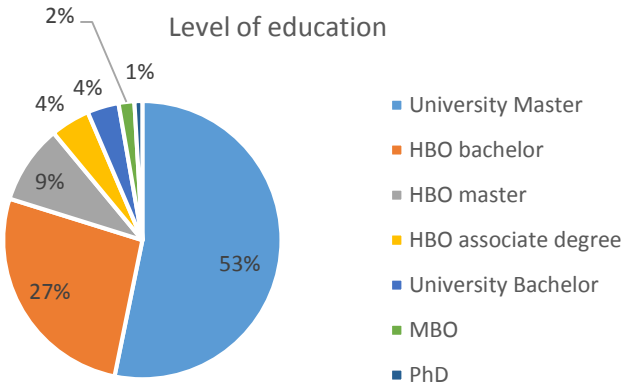

Figure 12: Level of education of the respondents (Author)

Normality test

The Shapiro-Wilk test was used to test the data for normality. This provided a significant result for every variable, using a p-value of 0.05 as the cut-off value. This indicates that non-normal distributions can be assumed for all variables. As discussed in paragraph 3.1.4, this has implications for the analysis. To start, the RMSEA model fit index is higher than it should be for normally distributed variables (Kenny, 2015). Also, standard error estimates of individual variables may be underestimated due to non-normality (Curran-Bauer Analytics, 2019). Because of this, adjustments were made to the analysis output, as discussed in paragraphs 4.1.4 and 4.1.5.

4.1.2 Reliability and validity

Principal Component Analysis and Cronbach's alpha

Before testing for correlations, the measurements were tested for reliability and validity. The output of the PCA and the Cronbach's alpha test can be found in appendix D. Some adjustments were made to ensure the highest level of validity and reliability. First of all, it was not possible to measure bias towards conservatism directly. Instead, status-quo bias ($\alpha = 0.59$) and confirmation bias ($\alpha = 0.69$) were added to the model as separate variables, both measured by only two items. Using a cut-off value of 0.7 for Cronbach's alpha, status-quo bias is considered to be unreliable. Confirmation bias is considered to be reliable, as it is only 0.01 beneath the cut-off value. Both were proven to be valid using PCA. Additionally, complex information hassle ($\alpha = 0.73$) is proven valid and reliable. This variable is measured by five separate items.

Unfortunately, the items that were used to measure PU ($\alpha = 0.75$), PEU ($\alpha = 0.45$), and BI ($\alpha = 0.69$) did not load on the separate factors as expected. They are, thus, not proved to be valid with PCA. These were measured by four, three, and three items respectively. On the other hand, the measures for PU and BI are considered to be reliable. However, the measure for PEU is not. This is remarkable as the questions were taken from existing literature.

Examining the items, an explanation for these results can be found. All of the items cover the respondents' opinions of SmartSkin. As the items can be seen as similar to each other, it could be the case that the respondents did not interpret them differently. This could be because the original questions were translated from English to Dutch. Possibly, the nuances in the questions were not translated properly.

Also, it could be caused by a lack of prior knowledge of SmartSkin technology. As is discussed in paragraph 4.1.3, an excessively large number of respondents gave neutral scores on several items measuring these three variables. In an open question, many of the respondents presented not knowing the technology as the motivation for their answer. It seems that the respondents did not feel comfortable

making a choice, based on the information that I presented them with. While this can be due to a lack of information, I believe that sufficient information was provided for an initial opinion.

Finally, temporal discounting and company size are both measured by one item. Because of this, they were not tested for reliability and validity.

Because of these results, I had to slightly change my model to be tested. Instead of bias towards conservatism, status-quo bias and confirmation bias are now included as two separate independent variables in my model. The sample size of 109 is still sufficient, as the model now consists of eight variables. A sample size of 80 would be the lowest allowable. Based on these changes, my hypotheses had to be adjusted accordingly.

H1. Temporal discounting negatively correlates with behavioral intent

H2. The correlation between temporal discounting and behavioral intent is negatively mediated by perceived usefulness

H3. The status-quo bias negatively correlates with behavioral intent

H4. The correlation between the status-quo bias and behavioral intent is negatively mediated by perceived usefulness

H5. The confirmation bias negatively correlates with behavioral intent

H6. The correlation between the confirmation bias and behavioral intent is negatively mediated by perceived usefulness

H7. Complex information hassle negatively correlates with behavioral intent

H8. The correlation between complex information hassle and behavioral intent is negatively mediated by perceived usefulness

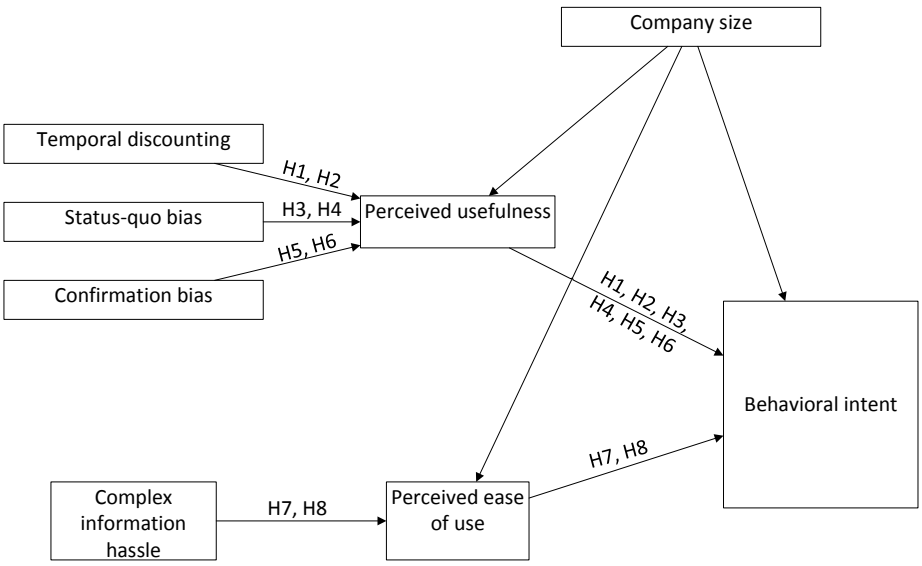

Figure 13: Modified conceptual framework survey research (Author)

Confirmatory Factor Analysis

The final test of validity is the CFA. In appendix D, the total standardized solutions can be found. The variables that were tested were modeled as latent variables in SEM. These latent variables are built up of the items in the measurement scales. Using SEM, a CFA was performed to establish construct validity. As can be seen in appendix D, almost all items have a p-value lower than 0.05. The only variable that cannot be seen as valid is PEU. The Cronbach's alpha test indicated that the measure for PEU is not reliable. Consequently, the PCA and CFA proved that the measure is not valid either. This leads to the conclusion that this measure is not representative of PEU. As such, this has implications for the interpretability of the model. However, PEU is still included as it is a core variable of TAM. Because of this, it is not feasible to remove it from the model.

4.1.3 Answer distributions

As the data are not normally distributed, it is interesting to take a closer look at each item. In appendix E, the percentages of the respondents are given that agreed, did not agree, or answered neutrally. The fact that a very large proportion of the respondent group does not experience bias and hassle is interesting to note. Apparently more than 80% of the 109 respondents do not seem to be affected by temporal discounting. However, the actual percentages vary per psychological factor and item. Still, a significant number of respondents do experience bias or hassle.

Another striking result is the fact that a very large part of the respondent group feels neutral about PU and PEU, as can be observed in appendix E. In fact, for some items, this is an absolute majority. Nonetheless, the respondents feel significantly more positive than negative about PU and PEU. As mentioned in paragraph 4.1.2, this is probably caused by a lack of prior knowledge about SmartSkin technology. This will be addressed further in paragraph 5.2.

Finally, by observing the distribution of the items measuring BI in appendix E, it can be concluded that most respondents think that the technology is interesting and feel positive about it. On the other hand, they believe it is unlikely that they would implement the technology within the timeframe of a year. As for PEU, this could be due to a perceived lack of information. Presumably, the respondents need more information about costs and lifetime savings to decide to adopt the technology. This could possibly be attributed to a risk-averse and conservative nature of the industry.

4.1.4 Model fit

The first step in testing the model is to examine its fit. Three indices were used for this. The χ^2, the RMSEA, and the TLI. As discussed, some of these indices are susceptible to non-normally distributed data, which was observed. For this reason, SEM's default maximum likelihood estimator was used, adding a correction for non-normality. A good method for this is the Satorra-Bentler adjustment (Satorra & Bentler, 1999). The option to use this mean-adjusted maximum likelihood estimator is built into the lavaan package. Because of this, it could be applied conveniently. To interpret the test statistics, the robust model fit indices were used instead of the standard indices.

Table 1: χ2 test (Author)

χ^2 test statistic	df	p-value	Scaling correction factor (S-B)
256.670	168	<0.001	1.123

Table 2: Tucker-Lewis & RMSEA (Author)

Tucker-Lewis index	RMSEA	RMSEA p-value
0.739	0.070	0.028

The estimates of the tests do not indicate similar fits. As can be seen, the χ^2 test is statistically significant. The p-value is lower than 0.05, which is the cut off value, as can be observed in table 1. As discussed previously, this test is relatively reliable due to the smaller sample size. It follows that the model is a relatively good fit, based on the first index.

The RMSEA has several cut-off values that are commonly used in the literature. These are 0.01 for an excellent fit, 0.05 for a good fit, and 0.08 for a moderately good fit (Kenny, 2015; MacCallum, Browne, & Sugawara, 1996). It follows that the model is a moderately good fit based on the RMSEA, as can be observed in table 2.

However, the final test indicates something different. A typical cut-off values for the TLI is 0.90 for an acceptable fit, while a value of 0.739 can be observed in table 2. Because of this, the model cannot be considered to fit well, based on the TLI value.

All in all, two of the indices indicate that the model is a relatively good fit. One of the indices indicates a poorly fitting model. As two out of three indices indicate a good fitting model, an acceptable model fit is assumed.

4.1.5 Model testing

Main effects

As discussed before, not only the model fit measures can be impacted by the non-normality of the data. The standard errors are likely to be underestimated as well. This will be accounted for by using robust standard errors, which is enabled by the lavaan package. The output can be found in table 13, in appendix F. Values lower than ± 0.39 are defined as weak correlations, values between ± 0.4 and ± 0.59 as moderate correlations, and values higher than ± 0.6 as strong correlations. The upper region of the weak classification can be seen as weak-moderate. The lower region of the strong classification can be described as moderate-strong. This classification is common to psychology research (Dancey & Reidy, 2011).

Three statistically significant relationships can be observed. First, in accordance with the existing literature, a strong positive correlation is found between PU and BI ($r = 0.817$, $p < 0.001$). This relation has been confirmed in various studies, as it is one of the core variables of TAM (King & He, 2006).

However, it is interesting to note that PEU has no significant correlation with BI ($r = 0.090$, $p = 0.579$), which contradicts the exiting literature on TAM. Most likely, this is due to the fact that the measurement scale for PEU has proven to be invalid an unreliable in this study. Possible causes for this are discussed in paragraph 4.1.2.

Furthermore, a moderate negative correlation between status-quo bias and BI was found ($r = -0.411$, $p = 0.051$). As the p-value for this correlation is only 0.001 above this value, I assume this to be statistically significant. As 20% to 40% of the respondents possibly experiences status-quo bias, there is a significant possibility that this hinders the adoption of SBMs.

Finally, a weak-moderate negative correlation between confirmation bias and PU was found ($r = -0.310$, $p = 0.048$). The group of respondents that possibly experiences confirmation bias is quite significant, as can be observed in appendix E. However, as the correlation is not very strong, the effects seem to be limited.

To interpret the regression, the indirect and total correlations between the independent variables and BI were analyzed as well. The output can be found in Table 14, in appendix F. One other significant correlation was found. A weak negative correlation between confirmation bias and BI can be observed ($r = -0.253$, $p = 0.062$). The p-value is above the commonly used cut-off value of 0.05. However, the p-value is still below 0.1. I argue that the indirect correlation between confirmation bias and BI can be considered as marginally significant. However, similar to the correlation between confirmation bias and PU, the effects of this correlation will presumably be limited.

Based on this information, three out of six hypotheses can be accepted.

H3 can be accepted, as status-quo bias has a medium negative correlation with BI.

H5 and H6 can also be accepted, as confirmation bias indirectly has a weak negative correlation with BI. The indirect correlation indicates that the correlation with BI is indeed mediated by PU. This is coherent with the significant correlation between confirmation bias and PU.

Additions to TAM

It follows that bias can be integrated into TAM. However, the model that was initially theorized does not hold entirely. Based on the results of the analysis, only status-quo bias and confirmation bias can be added to TAM. Following the interpretation of TAM, as presented by King and He (2006), status-quo bias is included as a factor that influences BI externally. Factors from other theories can be added, which increases the predictive power of TAM (King & He, 2006). As it appears that status-quo bias only correlates with BI directly, I argue that it is included as an external factor.

Additionally, prior factors are theorized to influence the predictors in TAM, which are PU and PEU (King & He, 2006). I argue that confirmation bias is such a factor. Supporting this, the correlation between confirmation bias and BI is mediated by PU. Furthermore, there is no direct correlation between BI and confirmation bias. Because of this, I argue that confirmation bias is included in TAM as a prior factor. The model, as proposed, is displayed in figure 16. The proposed model will have to be validated with experimental research, in order to prove causality.

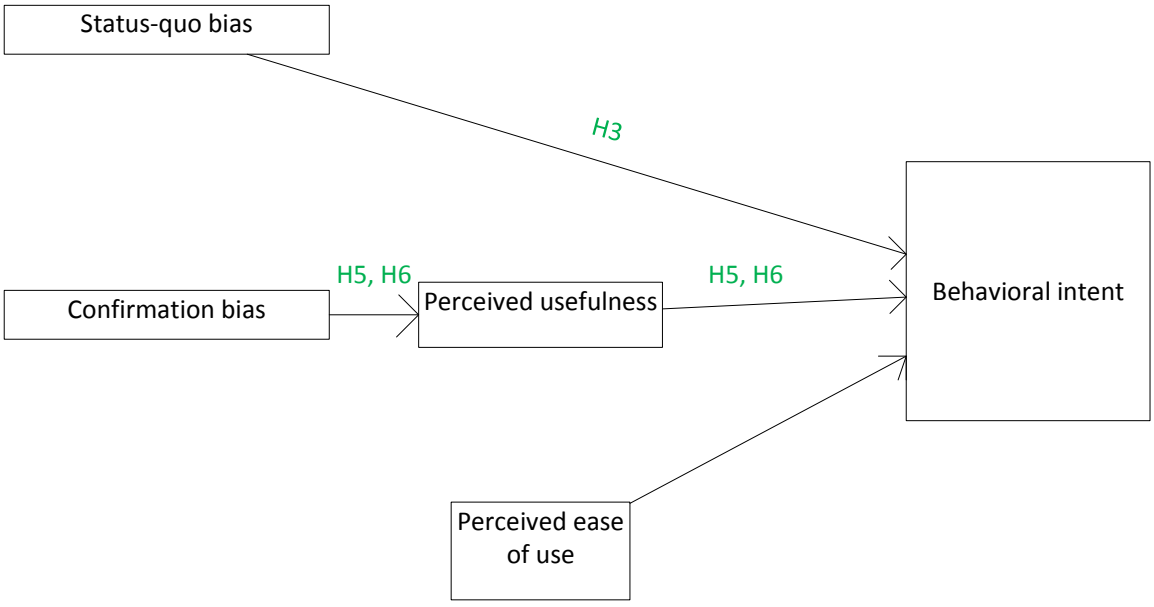

Figure 14: TAM updated with the integration of bias (Author)

Additional testing of main effects

Some of the results are surprising. First of all, PEU does not seem to correlate with BI. This is incoherent with the existing literature on TAM (King & He, 2006). This is explained by the invalidity and unreliability of the measure, as discussed in paragraph 4.1.2. However, it also seems that no significant correlations are found for complex information hassle. This is remarkable as many authors argue for the influence of complex information on SBM adoption (de Vries et al., 2019; Hoffman & Henn, 2008). Because of this, it was decided to test the effects of the independent variables separately to see whether the results would differ. Most of the results remained similar. However, there appeared to be two major differences. These can be observed in table 3.

First, status-quo bias has no significant correlation with BI, when tested separately. This indicates that the effects of status-quo bias can only be observed due to the addition of the other variables that were modelled. Second, complex information seems to have a significant correlation with PEU. This indicates that the effect of complex information hassle seems to be absorbed by other variables in the model. Combining these two effects, it seems that the effect of complex information hassle on the adoption of SBMs is exerted through status-quo bias.

Table 3: Changes in effect if tested separately (Author)

	R^2	*Correlation coefficient*
Status-quo bias → Behavioral intent	0.001	-0.026
Complex information hassle → Perceived ease of use	0.034	-.185**

Covariance between independent variables

Using SEM as the method of analysis, the covariance between independent variables was analyzed as well. The output can be found in table 13, in appendix F. Some interesting results were retrieved from this analysis. However, unlike correlation coefficients, these estimates are difficult to interpret. The magnitude of the covariance coefficients is affected by the value assigned to the variables, as well as the relation between them. Because of this, only the direction of the covariance coefficients can be interpreted.

To start, complex information hassle co-varies positively with status-quo bias ($r = 0.466$, $p = 0.005$) and with confirmation bias ($r = 0.495$, $p = 0.007$). It seems that complex information hassle could possibly add to the level of bias that is experienced. This will be discussed in more detail in paragraph 5.1.1. Furthermore, these findings support the argument that complex information hassle exerts its influence on SBM adoption through status-quo bias.

Additionally, company size co-varies negatively with status-quo bias (r = -0.347, p = 0.004) and with complex information hassle (r = -0.259, p = 0.022). The p-value of the correlation with the status-quo bias is lower than 0.01. It seems that larger organizations could be impacted less by bias and could be better equipped to process complex information.

R^2 test

Finally, I analyzed the R^2 statistics of the model. The scores for the dependent variables are presented in table 11. It can be observed that this model accounts for 69.2% of the variation in BI. However, this can presumably be attributed to the high correlation between PU and BI, for the largest part. Still, it is assumed that the status-quo bias explains quite some variation in BI.

The R^2 scores for PU and PEU are quite low. Still, this model explains 11.8% of PU and 6.3% of PEU. This could indicate that bias and hassle do have a significant effect on the adoption of SBMs.

Table 4: R^2 test output (Author)

	PU	*PEU*	*BI*
R^2	0.118	0.063	0.692

4.2 Semi-structured interviews

4.2.1 Respondent demographic

As mentioned in the methodology chapter, two interviews were conducted. This is a big limitation to my research, as this sample is very small. No statements can be made based on the rate of occurrence of certain codes. The analysis of the results is purely based on the opinion of two professionals in the building sector. However, the results are still quite useful in validating the results of the survey research and as an exploration of additional barriers to the adoption of SBMs.

The interviewees are addressed by pseudonyms to ensure their anonymity. The first interviewee is addressed as Eric and the second interviewee as Paul. Eric is a commercial manager at a large developing contractor. Before this, Eric was working at an SME. Because of this, he is able to answer my questions from a broad perspective. As a commercial manager, Eric has a lot of contact with clients. Because of this, he should have a lot of knowledge about barriers that relate to client interaction.

There are quite some differences between the profiles of Eric and Paul. Paul was working as a real estate developer for large organizations before he decided to start his own company. He is currently the partner

and founder of an SME that specializes in real estate development. Paul has a lot of experience as a real estate developer. In my opinion, as the founder of an organization, his opinion is backed by a certain authority. Paul has a passion for sustainability, which was very noticeable in the interview. However, his experience at multiple organizations does provide him with the ability to speak from different perspectives.

4.2.2 Codes, categories and themes

Attempting to create structure in the interview data, three layers of data were developed after reduction. At the base, the codes provide the most detailed information. These codes were sub-divided into different themes. These themes depict various variables that could be related to the adoption of SBMs. Additionally, overarching categories were developed to create a sub-division of these themes. These categories are the institutional context, people, decision-making considerations, bias and hassle, and organizational context. In this paragraph, the themes are presented, subdivided by categories, and analyzed based on the coding. A visual representation of the analysis can be found in appendix C.

Institutional context

The first category that was defined is the institutional context in which SBM adoption takes place. Within this category, three themes were observed. These are the conservative nature of the industry, social pressure, and regulation. First of all, both interviewees share the view that the building sector is conservative. The reasons provided for this are the lack of the right drivers for innovation in organizations and a lack of room for interpretation in contracts. This seems to lead to frustration at parties that do want to innovate. Based on this, the initial assumption about the nature of the industry is confirmed.

Additionally, building professionals seem to experience social pressure. Social pressure can have either a positive or a negative effect, depending on the source of this pressure. It was mentioned as a stimulus for innovation. If other parties are innovating it is important not to fall behind. However, this can also translate into parties that wait on others to innovate first. It seems that many parties engage in the same kind of innovation. This could mean that only a small group of pioneers exist, which is followed by the majority of the industry.

Finally, regulation seems to play a great role in the adoption of SBMs. Similar to social pressure, regulation can be a stimulus and a barrier to innovation. Both interviewees mentioned that lacking regulation can hinder the innovation process, while only one of them also presented it as a driver of innovation. This can be seen as a difference in attitude between the two interviewees. Paul wants to innovate and experiences regulation purely as a hindrance. He states that investors have a very narrow set of requirements for the purchase of buildings, due to regulation. On the other hand, Eric stated that

organizations generally do just enough to comply with the existing regulation. According to him, more regulation could increase the amount of effort done by many parties. However, they do agree on the important role that regulation plays in the industry. Several authors studied the influence of regulations before and this seems to be coherent with their findings (Chan et al., 2017; Häkkinen & Belloni, 2011; Sayce, Ellison, & Parnell, 2007; Williams & Dair, 2007).

People

The next category, people, explores the influence of different actors on the innovation process. Two themes were defined. The category includes the stakeholders and supply-chain, as well as a split incentive with the client. First of all, the stakeholders and supply-chain seem to be influential in the decision-making process. Many authors agree on the influential role of the network of stakeholders, as this has been studied often (Chan et al., 2017; Häkkinen & Belloni, 2011; Williams & Dair, 2007). However, Paul is the only interviewee that addressed this in detail. According to him, many actors are involved in the process. Also, he states that many of them are hard to educate and convince. He experiences issues in the supply chain as a barrier to the adoption of SBMs. However, according to him, actors in the supply chain are manageable. The right social network will facilitate this and stimulate innovation. It is important to create the same incentives for all the actors involved in the process, which can be quite political. However, this seems to be possible within organizations and in the supply chain.

A larger problem is creating shared incentives with the client. The split incentive was addressed in the introduction of this thesis and indeed seems to be a very actual problem. This is acknowledged by many professionals and scholars (Aravena et al., 2016; Bakker, 2020a, 2020b; Bordass, 2010). Both interviewees mentioned the need to align the incentives of the developers and clients by using sound business models. This has been made very explicit, as it was mentioned ten times in two interviews. However, they have two completely different views on this. Paul feels that organizations should innovate and engage with the end-user during the process. He thinks developers hide behind the risk for investors and investors used to only buy houses that fit their narrow portfolio requirements. Because of this, he chooses to involve end-users in the process to ensure there is a market for his innovations. He believes that a market can be created by finding the end-users that are willing to be pioneers. When this is achieved, the rest of the market has to be persuaded with strong business models. This view is concurrent with the take of Moore (2002) on early adopters and the majority. Eric, on the other hand, feels like the initiative should entirely come from the side of the client. In his opinion, it is not the responsibility of the organization to innovate and create a market themselves. Eric is, thus, more accepting of the split incentive while Paul is trying to work around it. This is an indication that Paul is more on the innovative side of the industry and Eric is more on the conservative side. This is coherent with their differing views on regulation.

Decision-making considerations

Besides the institutions in which developers operate and the people they deal with, another category is the decision-making considerations they encounter. Four themes fall into this category. These are certifications related to sustainability, proven results of technology, financials, and project complexity. If a project fulfills certain requirements, it will get certified. This proves the level of sustainability of the project. Both interviewees consider this certification as a barrier to innovation and think of it as being mainly important as a marketing tool. This is not fully coherent with the literature, as some authors see it as a driver as well (Häkkinen & Belloni, 2011; Sayce et al., 2007). This can be explained by considering certification as a form of stimulating policy. It seems that Eric finds it important to obtain certain certifications. He considers it as proof of fulfilling the sustainability goals of the project. Paul, on the other hand, does not care for certification at all. He does not believe that it is possible to create a certificate that is fitting for every project. According to him, certain companies are even able to use certification as a method for greenwashing. For this reason, he does not pursue certification. He does state that his projects always end up with the right certification, as he pursues projects that he feels are good and sustainable.

Related to certification and concurring with the existing literature is the second theme, proven results (Williams & Dair, 2007). As Eric states, proven results are needed if developers want to use technology to obtain certification. Both interviewees think that proven results can be both a stimulus and a barrier in the innovation process. However, Eric expresses a much stronger need for proven results than Paul does.

Additionally, both interviewees think of financial considerations as strong stimuli and barriers in the innovation process. This I coherent with the literature, in which it is repeatedly proven to be one of the influences on SBM adoption (e.g., Chan et al., 2017; Darko et al., 2017; Häkkinen & Belloni, 2011; Williams & Dair, 2007). The decision-making processes of most organizations seem to be strongly financially driven. This can stifle innovation, as new technologies can be more expensive than older ones. However, according to Eric, SBMs are becoming more and more profitable. As mentioned earlier, it seems to be important to convince the client with a sound business model. Because of the increased profitability, financial considerations can thus be used to convince clients and stimulate the adoption of SBMs. However, it should be noted that projects can be pursued for strategic gains instead of financial gains. It follows that stimuli do not always have to be financial.

Finally, project complexity plays a role in the choice to innovate. In the building industry, projects tend to be quite complex and project requirements and team composition changes with every project. Due to this, many professionals rely on best practice behavior to manage their projects. Eric thinks that, because of this complexity, innovation will start to take place when there are many similar projects to be done. He believes that this takes up less mental capacity of the developers, enabling them to think of innovative solutions. However, Paul does not agree with Eric's opinion. He believes that this will only lead to standardization and optimization, instead of innovation.

Bias and Hassle

The first three categories cover subjects that were not included in the survey research. This provided me with insight into the remainder of the issues that are important in the adoption process of SBMs. The fourth category, bias and hassle, complements the survey research with the two themes it encompasses. These are status-quo bias and complex information hassle. This category is of direct relevance to my first two sub-questions, covering the effects of biases and hassles on the adoption of SBMs. Both of the interviews provide evidence that implies status-quo bias plays a significant role in the building sector. Paul mentioned a couple of times that it is hard to get actors to do something they have not done before. Similarly, Eric stated that the conservative way will always be the preferred method if projects get complex. As mentioned before, project complexity leads developers to engage in best practice behavior. This means that they will stick to known processes and technologies, standing in the way of innovation. According to Eric, generally, innovation will always be compared to the status quo in the building sector. Knowing developers tend to stick to known processes and technology, this comparison will benefit conventional technologies over innovative SBMs.

On the other hand, the opinions of the two interviewees on complex information hassle are divided. Paul believes real estate developers are affected by complex information hassle in their decision-making. According to him, there are many organizations with a lack of knowledge that are affected by complex information hassle. Also, he believes that complexity and overload of information lead to portfolio requirements, on the investor side, that are not defined properly. Eric, on the other hand, does not agree with this. He states that this should not play a role, as there is sufficient in-house knowledge to negate this effect. According to him, organizations put a lot of effort into matching the right professionals with the right projects. This would ensure that professionals with specialized knowledge about innovations are always available.

Organizational context

Finally, organizational context was observed as the last category. This is of relevance to my third sub-question, on the difference between organizations. The themes that fall within this category are risk aversion, commitment, knowledge, and company size. Risk aversion could be categorized under bias and hassle. However, I chose to include it in organizational context, as it appears to be deeply embedded in organizations in the building sector. According to Paul, risks are high in the building sector, as losses can be extremely high when something goes wrong. Also, it appears that the building sector is an industry in which risk aversion is applauded. Whether this is related to the high risk perceptions in the industry is not clear but very plausible. This led to risk-averse professionals climbing high in the ranks of organizations. Because of this, the most important decision-makers in the sector all tend to be very risk-averse. This led to, as was already mentioned, risk aversion being deeply embedded in organizations. This is not only the case on the development side but at the client side as well. Many clients will not accept new technologies in their projects if they do not get some guarantees. This is

probably one of the consequences of the split incentive that was discussed before. If incentives would be similar for all parties, risk will be more evenly distributed.

While risk aversion can stifle innovation, commitment can be a stimulus. A certain passion for the industry and the job can be beneficial, as professionals have to be willing to be different to innovate. Unfortunately, this passion for the job and drive to be different is not often found in organizations. Eric suggested that changing the culture of an organization, to include sustainability in its core, can be a stimulus for innovation. This could create a commitment to sustainability. By doing so, commitment is created in a different place and the will to be different is less needed to innovate.

Knowledge can be directly related to complex information hassle. As discussed, complex information hassle is partly caused by a lack of knowledge in the industry. Several scholars have found evidence concurring with this (Chan et al., 2017; Sayce et al., 2007; Sodagar & Fieldson, 2008; Williams & Dair, 2007). Often, project teams consist of highly specialized professionals. While this is efficient in standardized projects, this is not effective for innovation. Paul believes that it is needed to assemble a team consisting of professionals with knowledge of more than one specialty. A variety of backgrounds in a project team produces many different views on the project, which stimulates innovation. However, if they can also understand the others and think about the project from the others' perspective, this opens everyone up for more innovative ideas. While Eric, as discussed, believes complex information hassle can be negated by assembling a team of specialists. Paul believes the specialists should also be able to understand more than their specialty. This would truly remove knowledge barriers in his eyes.

Finally, company size was included as a variable in the survey research. There are several insights into the influence of company size that were developed during the interviews. First of all, there seems to be a direct link to complex information hassle. Both of the interviewees agree that large organizations are less impacted by complex information hassle. Paul mentioned that the knowledge barriers to enter the market are very low, which allowed many SMEs to enter the market. According to him, many of those have a large information deficit. This relates directly to the knowledge barriers discussed before, which is again linked to complex information hassle. Eric mentioned that large organizations have more resources and because of this are more capable to innovate. This could be one of the reasons that larger organizations spend more time searching for the right information. However, both of the interviewees also agree that SMEs are more flexible and can adapt to innovation faster. Additionally, according to Paul, larger organizations translate their higher understanding of complex information hassle into risk. As discussed before, risk aversion is embedded in many organizations in the industry. This seems to be the case at large organizations more often that at SMEs. This could, thus, be due to the difference in the interpretation of information. It can be concluded that both large organizations and SMEs have characteristics that are stimuli and barriers to innovation. As Eric implies, collaboration between large organizations and SMEs could be the stimulus for innovation that is needed in the building sector.

5. Discussion and conclusion

In this chapter, I discuss the results from this study and provide my concluding remarks. As one of the main objectives of this research is to add to TAM, the results are discussed accordingly. This is done in paragraph 5.1. After that, the conclusion of this research is presented in paragraph 5.2, as well as the limitations of the research, the implications of the results, and recommendations for future research.

5.1 Discussion

The survey respondents and the interviewees are considered representative of my target group. For this reason, the results of this research are assumed to apply to the building sector. While survey research is not very generalizable, in-depth interviews were held to substantiate the results. It follows that the results from this research can safely be used in practice, within the industry. More research is needed to study whether the results can be translated to other industries.

Before discussing the variables that were tested in the survey research, one other factor is addressed. I believe risk aversion to be very influential in the decision-making processes in the building industry. Because of this, it is discussed in more detail. While numerous other influential factors were derived from the interviews, many are already explored extensively in the literature. Not all factors will be included in the discussion. However, risk aversion needs to be examined closer. Additionally, several other factors will be used to explain the influence of bias and hassle on TAM.

Risk aversion

From the interviews, implications are derived that risk aversion is deeply embedded in the building sector. While it should be noted that it is just one person's opinion, there is more evidence pointing in this direction. To start, the building sector is an industry where large investments are made. Because of this, consequences are large if something goes wrong. As people tend to avoid risk when the stakes get high, it can reasonably be assumed that this applies in the building sector as well (Hobman et al., 2016).

Furthermore, risk can be defined as *"the tendency to prefer certainty over risk"* (Hobman et al., 2016). This implies that people tend to avoid choices that come with a high level of uncertainty. As discussed in paragraph 4.1.2, the answer distributions for the questions that asked for a judgment on SmartSkin technology were out of balance. A disproportionate number of respondents chose to answer neutral. Additionally, when asked about the reason for choosing SmartSkin technology or not, many provided uncertainty about the technology as a reason. This implies that they chose to avoid the question because they prefer certainty over risk. However, the choice was only a survey question, and there was no risk

of generating large losses because of a wrong answer. It seems that real estate developers do not even feel comfortable in providing an initial opinion about a technology under uncertainty. From this, I conclude that they tend to be risk-averse.

From the interviews, it is derived that this risk aversion seems to stem from the fact that, traditionally, risk aversion is applauded in the sector. Due to this, high-level decision-makers all tend to be risk-averse. Because of this, I argue that the industry has a risk-averse nature.

5.1.1 Perceived usefulness

Status-quo bias

To start, it appears that professionals that are strongly biased towards the status quo are less intent on adopting SBMs. While the measurement scale that was used in the survey was somewhat lacking, almost all of the evidence pointed in that direction. Furthermore, industry professionals strongly agree with these results. They believe it is hard to persuade developers to try new things. When things get increasingly complex, change will be avoided. This can be explained by three things. First, derived from existing literature and the interviews, there appears to be a lack of knowledge in the industry (Chan et al., 2017). This increases the perceived complexity of projects, which is amplified by constantly changing project requirements. Second, status-quo bias seems to be experienced stronger when complex information is perceived as a hassle. As developers perceive projects as very complex, the chances that they experience hassle increases. It follows that they will avoid change as much as possible. Finally, status-quo is partly caused by psychological commitment (Kim & Kankanhalli, 2009; Wu, 2016). I argue that the perceived complexity translates to a feeling of losing control. Feelings of control contribute to psychological commitment and professionals will stick to the status-quo to attempt to stay in control (Kim & Kankanhalli, 2009). Furthermore, this supports my argument that project complexity is experienced as a hassle. It can be argued that fear of losing control is reinforced by the risk-averse nature of the building sector. Developers presumably perceive a high risk of losing control of a project. While the effects of adopting SBMs can be very positive, they are not willing to take this risk due to their aversion.

From this, I argue that the decision-making processes in the building sector are affected by resistance against change. Presumably, a significant number of real estate developers reject SBMs because they are biased towards the status quo. I argue that, due to this, the customer base for SBMs remains small and large-scale diffusion cannot be reached without addressing this bias. As innovative SBMs are new and often unknown technologies, it would only make sense that developers would reject them if they internally resist change. While it is accepted knowledge that status-quo bias influences the behavior of consumers, this was not the case for organizational settings (Frederiks et al., 2015; Gifford, 2011; Milbrath, 1995). However, it appears that this is not different in an organizational context. Status-quo bias seems to be influential for professional, as well as personal decisions. However, it has to be noted

that further research is needed. As the measure for status-quo bias was not proven reliable, it is recommended to recreate this research using an improved measure. Furthermore, it would be interesting to test the influence of feelings of control on TAM as a separate factor. As I theorize this to be the most influential part of status-quo bias, this line of research will provide more knowledge about how perceptions of SBMs are formed.

Confirmation bias

Continuing, the survey results have demonstrated that intent to adopt SBMs is lower when people are biased towards confirming their existing beliefs. This is because SBMs seem to be perceived as less useful by professionals that experience high levels of confirmation bias. According to Nickerson (1998), it can be assumed that they interpret information in a way that reinforces their existing beliefs. Additionally, searching for information contradicting those beliefs is probably neglected (Nickerson, 1998). Meanwhile, a notable amount of developers confessed to not spending much time searching for information about innovation at all. On top of that, one of the interviewees stated that professionals will always form an opinion and try to find evidence to back that up. It follows that if the information search is short, and the information that is found gets interpreted favoring existing methods, developers will satisfice with conventional technologies. This would lead to innovative SBMs being seen as less useful.

I argue that this is because developers relate their perceptions of innovative SBMs to their perceptions of conventional technologies. One of the interviewees mentioned that innovation will always be compared to the status quo. Additionally, there seems to be a lack of knowledge in the industry. Therefore, it is difficult for developers to assess the added value of innovative SBMs. Because they experience discomfort by processing information about SBMs, they encounter difficulties in processing it (de Vries, 2020; de Vries et al., 2019; Harris et al., 2019). This, again, leads to perceived hassle due to complex information. Furthermore, their lack of knowledge is only reinforced as they neglect to spend a lot of time on the information search. Consequently, they will experience many uncertainties about SBMs. Because of this, SBMs are most likely perceived as very risky. As building professionals tend to be risk-averse, it will be difficult to change their preference for conventional technologies. Furthermore, as confirmation bias will only reinforce their existing beliefs, PU of SBMs will only decrease further over time. This can create a negatively reinforcing cycle which is hard to break (Nickerson, 1998).

In an organizational context, this negatively reinforcing cycle can have severe consequences. This cycle could slow down the innovation process considerably. Without innovating, organizations can experience difficulty in maintaining their competitive advantages for longer periods of time (Schilling, 2013). Although product life-cycles in the building industry are large, this will prove to be quite challenging in the long-term. However, the influence of confirmation bias on the adoption of SBMs does not appear to be strong. While developers that experience confirmation bias are less likely to adopt innovative SBMs, this bias should not be interpreted as the main cause of this. It will prove more effective to deal with other factors influencing this decision.

Temporal discounting

Contrary to status-quo and confirmation bias, temporal discounting does not appear to influence the decision-making processes in the building industry. This is remarkable as it is accepted that temporal discounting influences consumer choices, preventing sustainable behavior (Frederiks et al., 2015; Gifford, 2011). Additionally, scholars have argued for the negative influence of temporal discounting in organizational decision-making (Harris et al., 2019; Hoffman & Henn, 2008). However, approximately 85% of the survey respondents seemed to experience low levels of temporal discounting. This indicates that temporal discounting does not play a large role within the industry, which could be attributed to the risk-averse nature of the sector.

One of the interviewees mentioned that when projects start to get complex, the protocol is to involve senior decision-makers actors in the project. Under the assumption that complex projects are seen as riskier, this can be seen as a strategy to manage the risk of the project. It can be assumed that organizations will have more protocols and guidelines to reduce risk. If organizations have specific guidelines about rate of returns or return periods, it could nudge professionals into rational discounting behavior. This reduces the chance of mental discounting shortcuts. Additionally, from the interviews, it can be concluded that it is very important for developers to convince clients with a sound business model. From this, it can be reasonably assumed that financial professionals are included in the process. As these professionals are trained in systematically applying the right discount rates, the odds are low that they will use mental shortcuts.

Nevertheless, I do not immediately want to disregard the existing literature. It is possible that the measure of temporal discounting was not suitable for this research. The questions have been taken from existing literature. However, the target group of respondents in this research was a group of employees in developing countries (Wolfe & Patel, 2017). Furthermore, the questions were meant to gain insight into personal decision-making (Wolfe & Patel, 2017). Because of this, the amount of money presented in the questions is relatively low. On the contrary, decisions made in the building sector involve very large sums of money. Due to this, the survey respondents might have perceived the sums of money in the questions as insignificant. If this would be the case, the results of this research do not reflect reality. There is consensus, in the literature and the industry, about the significance of financial considerations in the building sector (Bordass, 2010; Chan et al., 2017; Sodagar & Fieldson, 2008; Williams & Dair, 2007). However, more research is needed to make any conclusive statements about psychological influences on these considerations.

5.1.2 Perceived ease of use

Complex information hassle

To start, it is interesting to note that complex information hassle can be measured as a one-dimensional concept. The measurement scale that was developed proves to be a good tool for measuring this hassle. This scale includes questions relating to both information search and information processing. From this, it is concluded that both of these processes can lead to complex information hassle. Difficulties in the search process or confusion about the information add to a stronger perception of hassle. This can reasonably be assumed, as the measure proved to be valid and reliable. However, more evidence for this can be gathered by testing the measure for complex information hassle with different datasets. Using this measure more frequently will validate it even more.

Differently, complex information hassle does not seem to directly influence TAM. While testing the model, no evidence was found that complex information hassle influenced intent to adopt SBMs or perceptions of SBMs. However, when high levels of status-quo and confirmation bias are experienced, it seems that complex information is strongly experienced as a hassle as well. Since status-quo and confirmation bias do influence the intent to adopt SBMs, it seems that complex information hassle should have an indirect effect on TAM. Based on the relation between them, I strongly believe that these both contribute to the conservative nature of the building sector. Many scholars argue for the negative effects of complex information on SBM adoption (Chan et al., 2017; Hoffman & Henn, 2008; Milbrath, 1995). Therefore, I am hesitant to immediately accept these results. Unfortunately, the interviewees do not agree on this subject. Because of this, the interviews cannot be used to take away my doubt.

Trying to clarify this issue, it was explored whether the outcomes of my research were similar if all relations were tested separately. Interestingly, it seems that PEU seems to decrease when complex information is perceived as a hassle. Meanwhile, high levels of status-quo bias are not associated with lower intent to adopt SBMs, when tested separately. I argue that the influence of complex information hassle on TAM is completely exercised through status-quo bias. As claimed before, there are indications that a lack of knowledge, and the perceived complexity that follows from it, partly cause status-quo bias. Therefore, it seems plausible that complex information hassle indirectly influences the decision to adopt SBMs.

However, it has to be mentioned that PEU was not measured reliably or valid. Because of this, no conclusive statements about the role of complex information hassle within TAM can be made. This is presumably because the respondents did not feel comfortable answering the questions based on the information that was provided. This is discussed in more detail in paragraph 4.1.2.

5.1.3 Organizational contextual factors

Company size

No direct effects of company size on the intent to adopt SBMs can be observed. Meanwhile, in the existing literature on the effects of company size on innovation, results seem to vary (Camisón-Zornoza et al., 2004; Damanpour, 1992). However, this seems to be caused by the moderation of type of organization, size measurement, scope of size, and stage of adoption (G. Lee & Xia, 2006). Because of this, it is possible that the results would have been different if size was measured on team level, and based on project funds (G. Lee & Xia, 2006). Nevertheless, the current method of measuring size was chosen due to its practicality.

However, there are some other interesting effects of company size. From the survey results, it can be concluded that complex information is perceived as less of a hassle in larger organizations. Both interviewees stated that they agree with this finding. According to them, the largest knowledge deficit can be found at SMEs and larger organizations have the resources to deal with complex information. Larger organizations appear to have more internal knowledge readily available. This can be explained by several things. To start, larger organizations simply have more employees. Because of this, I argue that there is a higher chance of finding someone with knowledge about a specific SBM to put on a project. Because someone with specialized knowledge is on the team, others will probably have to process less information that is complex to them. Furthermore, this also means that employees have many different colleagues to speak with. I believe that because of this, much information can be obtained first-hand through conversation and discussion. When someone perceives information as complex, a colleague with more experience on the subject can probably be approached. Additionally, professionals can learn from casual discussions about topics of interest. Presumably, professionals with many different backgrounds are employed at large organizations. From the interviews and from diversity literature, it can be derived that this can stimulate innovation and performance (Roberson, 2019). Based on this, I argue that in large organizations the chance of a conversation on innovative SBMs might be high due to a large number of colleagues with diverse interests.

Finally, large organizations often have well-developed knowledge sharing systems (Sedera, 2016). More important, Sedara (2016) indicated that large organizations perform better in knowledge retention and transfer than SMEs. I argue that due to the large number of employees and projects, there is a reasonable possibility that someone encountered a similar SBM in a project before. If this experience was entered into this system, it is available for all employees to find. Following from this, I believe that this will reduce perceived complexity as well. This is most likely not the case for SMEs. Presumably, employees working at SMEs will often have to gather their knowledge externally. This means that they will have to put more effort into finding the right information. I argue that this reduces the perceived reliability of the information. Probably, more time will be spent on source screening because of this. I argue that this will all contribute to a heightened perception of hassle.

However, there is no conclusive evidence that perceived hassle due to complex information leads to less intent to adopt SBMs. One of the interviewees even argued that large organizations have a better understanding of information, but translate this information into risk. As decision-makers seem to be risk-averse, a better understanding of complex information could even be counterproductive. Research into the relation between complex information hassle and risk perceptions is needed to provide more clarity.

Additionally, it seems that in larger organizations less bias towards the status quo can be observed. This is quite interesting, as they tend to have a higher level of formalization and standardization (Kelly & Amburgey, 1991). Also, both interviewees agreed that SMEs are more flexible and able to adapt to change. From this, it would be reasonable to assume that SMEs are less impacted by status-quo bias. However, there is no consensus that company size causes organizational inertia (Kelly & Amburgey, 1991). Similar to complex information hassle, I argue that this is due to readily available knowledge. When large knowledge bases are available, a wider variety of projects and technologies can be encountered. Being presented with many different solutions to solve a project, the mental barriers to change work processes will probably be lower. Additionally, large organizations have more funds than SMEs. Because of this, the consequences for them will be lower when change goes wrong. One of the interviewees mentioned that this makes large organizations more suited for innovation. From this, I argue that increasing size does increase the intent to adopt SBMs. However, this is an indirect influence, exerted through status-quo bias. Furthermore, larger organizations experience less complex information hassle. As I believe complex information hassle to influence BI through status-quo bias as well, company size will have an even larger indirect effect on the intent to adopt SBMs.

5.1.4 Influence on TAM and sustainable building

The findings that are discussed in this chapter were used to add to TAM. In figure 15, the hypotheses that are accepted can be observed. Company size has been removed from this model for clarity, as it was added as a control variable and no hypotheses were formulated related to size. On the other hand, the indirect and direct effects are visualized in this figure. By doing so, it is clear which hypotheses are accepted and rejected. As discussed in paragraph 4.1.5, it seems that status-quo bias and confirmation bias affect BI and can be added to TAM. However, as elaborated upon in this chapter, it is likely that complex information hassle indirectly affects BI.

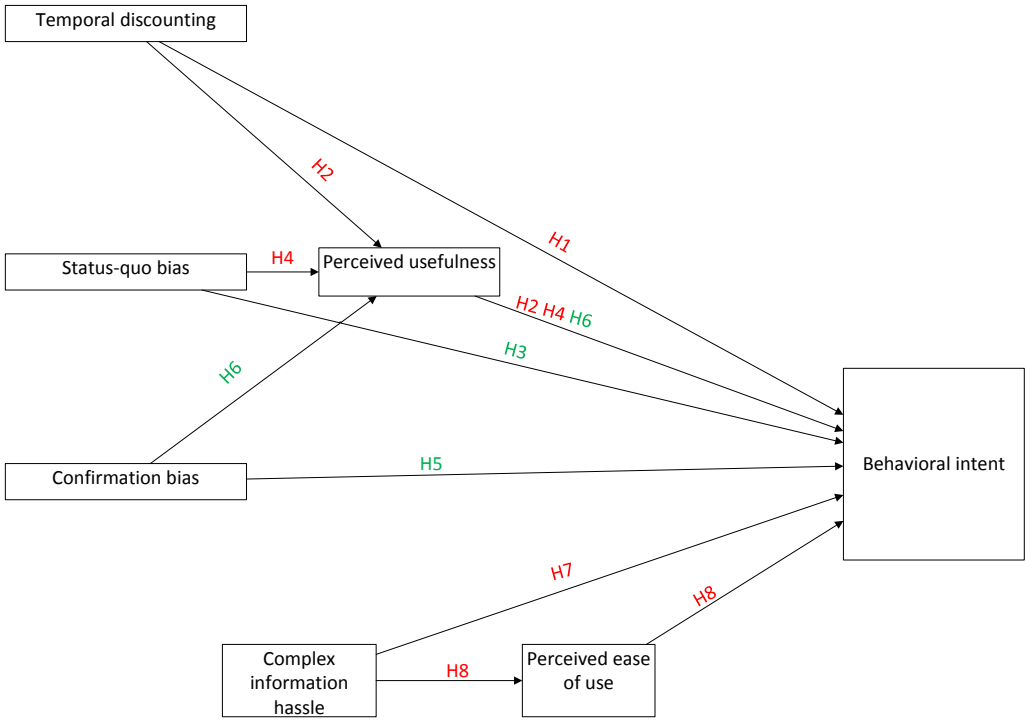

Figure 15: Accepted and rejected hypotheses (Author)

Integrating the knowledge from the discussion in this chapter, it seems that decision-makers in the building industry are affected by bias. This is most likely due to a lack of knowledge in the industry. This lack of knowledge is argued to cause complex information to be perceived as a hassle. In turn, this is presumed to lead to fear, or risk, of losing control that partly causes status-quo bias. Additionally, as complex information is most likely avoided or not well understood, many uncertainties about innovation arise. As the decision-makers in the building industry seem to be a homogeneous risk-averse group, this would most likely lead to the rejection of SBMs.

However, I argue that large organizations are less impacted by these effects because they have a larger and more diverse workforce than SMEs. Also, they seem to be better equipped for effective knowledge management than SMEs. It follows that improving methods for knowledge retention and sharing could prove very effective in decreasing the effect of bias within organizations. Additionally, it could prove essential to stimulate diversity in the workforce. A variety of academic and professional backgrounds would presumably stimulate different perspectives on projects. Also, it would improve the knowledge base within an organization.

Furthermore, to decrease the homogeneity of the decision-makers in the building sector, it could prove useful to stimulate diversity in other areas than academic background as well. As can be derived from paragraph 4.1.1 and the employee lists of real estate developers in the Netherlands, the workforce in the building industry is dominated by a large majority of Dutch men. Promoting the inclusion of women and professionals with other cultural backgrounds could also be very effective. This would possibly change the conservative nature of the industry.

5.2 Conclusion, limitations, implications and future research

5.2.1 Conclusion

It seems that cognitive bias affects SBM adoption. From the survey results, it was derived that the intent to adopt SBMs tends to decrease when status-quo bias and confirmation bias are experienced. However, temporal discounting did not seem related to SBM adoption in any way. This answers my first sub-question: *what is the influence of cognitive bias on SBM adoption?* While the influence of confirmation bias seems to be weak, status-quo bias has a stronger relationship with the intent to adopt. It is argued that this can be attributed to a lack of knowledge in the industry that leads to high levels of perceived project complexity. Due to this, it is argued that higher levels of perceived hassle will be experienced due to complex information, and developers will increasingly feel the risk of losing control of their projects. Supported by the risk-averse nature of the building sector, it is claimed that this leads to resistance against change. This resistance against change is supported by the interview data.

This argument implies that status-quo bias is partly caused by complex information hassle. This is supported by the finding that developers tend more to be biased towards the status-quo when complex information is perceived as a hassle. On the other hand, it did not appear that intent to adopt is lower when complex information is perceived as a hassle. However, testing all variables separately, these results did not hold. While complex information seemed to influence the model in this case, the effect of status-quo bias disappeared. This is argued to occur because complex information hassle exerts its influence through status-quo bias. This, again, supports the argument that it partly causes bias. For this reason, I strongly believe that complex information exerts a negative influence on SBM adoption through status-quo bias. This answers the second sub-question: *what is the influence of hassle on SBM adoption?*

Furthermore, complex information hassle and status-quo bias are experienced more often in larger organizations. As these factors seem influential in the decision-making process of developers, it seems that larger organizations could be better equipped for innovation than SMEs. This answers my third sub-question: *are there differences in the effect of bias and hassle between organizations?* I argue that this can be explained by effective knowledge management in large organizations and a larger and more diverse workforce. Because of the large number of employees, chances are high that someone can be found with knowledge on a specific SBM or an innovative perspective. Additionally, due to a well-designed knowledge sharing architecture information is easy to find. This would reduce the perceived complexity of information. As such less hassle would be experienced. According to the argument that complex information hassle partly causes status-quo bias, this, in turn, would lead to less status-quo bias.

To conclude, indications that bias and hassle hinder SBM adoption exist. Especially, a strong internal resistance to change seems to affect SBM adoption. This seems to be caused by the fact that complex information is perceived as a hassle, which can be explained by a lack of knowledge in the building sector. The homogeneous group of risk-averse decision-makers in the building sector will most likely resist change, as hassle will increase project complexity and the level of uncertainty. However, there seem to be differences between organizations. Larger organizations, with larger workforces and better knowledge management capabilities, seem to be less impacted by bias and hassle. Therefore, it can be argued that real estate developers can influence the manifestation of bias and hassle in their organization. By promoting diversity in the workforce, it is possible to create a less homogeneous group of decision-makers. Additionally, this would create a larger knowledge base within organizations, reducing the lack of knowledge in the building sector. This could be stimulated even more by investing in effective knowledge management.

5.2.2 Limitations of the research

This study only addresses a specific aspect of decision-making processes. As such, there are several limitations to it. Because of this, no knowledge can be derived from the frequency of occurrence of the codes. The data from the interviews merely represent the opinions of two professionals working in the building sector. Because of this, they might not be representative of the entire building sector (Sekaran & Bougie, 2016). No conclusive statements can be made that are based merely on the interview results. However, these opinions are still relevant and can be used to support the survey results. Nevertheless, this limits the strength of some of my arguments.

Furthermore, organizational context is solely represented by company size. While this is argued to be relatable to many other organizational characteristics, this cannot be seen as a complete representation of the characteristics of an organization. Furthermore, company size was added as a control variable to the model to be tested. Presumably, contextual factors, working externally on TAM, can have moderating effects (King & He, 2006). Because of this, it could be a more realistic representation of reality if size is added as a moderating variable.

Additionally, institutional context was not considered in the survey research at all. This was done to limit the complexity of the model. Only organizational context was considered as this was deemed more important. However, in the interviews, it was indicated that institutional context could be very influential in the building sector. Because of this, adding institutional context to TAM could increase the generalizability of the research. By studying institutional differences, the research could be applicable in other countries as well. Because this was not done, the knowledge from this research might only be applicable in the Netherlands and countries with similar regulations and a similar culture.

Also, no direct measure of risk aversion was included in the survey research. This was decided as I argued that risk aversion is embedded in the bias and hassle that was tested. Due to the interview results,

combined with the literature review, this belief is only strengthened. However, it appears that risk aversion could play such a large role that its effects on TAM should be studied separately. As the influence of risk aversion on bias, hassle, and TAM are not proven statistically, my argumentation for the observed effects is significantly weakened. Consequently, it can be considered as a limitation that many other biases and hassles were not included in this research.

Finally, I studied individual decision-making. However, decision-making processes in the building sector often involve numerous actors. For this reason, individual decisions cannot be assumed to be final. The opinion forming of all actors should be taken into account to enable accurate prediction. Creating a multi-actor decision-making model would be needed to fully grasp the decision-making processes in the industry.

5.2.3 Contributions and implications of the research

Contributions to the literature

It appears that the intent to adopt SBMs tends to be low if status-quo bias and confirmation bias is experienced. This result was used to integrate bias into TAM. By doing so, I offer new insights into the mental processes that lead to the adoption of innovation. While many scholars have studied TAM, cognitive biases have not been studied in its context often (King & He, 2006; Y.-H. Lee et al., 2011; Yi et al., 2017). The effects of status-quo bias on technology acceptance have been studied before (Kim & Kankanhalli, 2009; Wu, 2016). However, to the best of my knowledge, confirmation bias has not been explored in the context of TAM previously. Because of this, a contribution is made to the literature on technology acceptance.

This newly attained knowledge provides insights into the mental barriers standing in the way of innovation adoption. The hardest part of the technology adoption lifecycle is crossing the chasm between the early adopters and the early majority (Moore, 2002; Rogers, 1962). Innovators and early adopters tend to see the potential of innovations, this group can be targeted to develop an initial market (Moore, 2002). However, it takes effort to persuade the majority of the public (Moore, 2002). By indicating that status-quo bias and confirmation bias influence the adoption of innovation, I advance the knowledge about the decision-making processes of the majority of the public. By doing so, I contribute to the literature about crossing the chasm between early adopters and the early majority.

This, in turn, leads to more knowledge about the large-scale diffusion of innovation. A significant customer base seems to be a necessary condition for this large-scale diffusion (Ortt et al., 2013). Because innovation adoption by individuals and individual organizations adds to this customer base, it stimulates large-scale diffusion. It follows that knowledge of technology acceptance and adoption can be used to explain diffusion patterns. This research provided more insights into the barriers that prevent the growth of this customer base. Implications are found that cognitive aspects can be included as an additional

indirect barrier to large-scale diffusion, as defined by Ortt, Langley, and Pals (2013). It follows that this research contributes to the literature on the large-scale diffusion of innovation.

Finally, I have developed a measurement scale for complex information hassle. While the influence of hassle on sustainable building is argued for, research on hassle perceptions is relatively modern (de Vries et al., 2019). Due to this, I wished to develop a deeper understanding of complex information hassle as a concept. The newly developed measurement scale for complex information hassle contributes to the literature on hassle perceptions. This is because the items included in the measurement scale provide insight into the aspect causing this hassle. Additionally, it will contribute to future research by enabling scholars to use this measure in future quantitative research on hassle perceptions.

Implications for practice

The knowledge that was developed in this research can be used by managers that attempt to market innovative SBMs to real estate developers. Knowing the effect bias has on the decision-making processes of their target group, they can develop strategies aimed at this bias. As confirmation bias is not strongly related to the decision to adopt, they should not give this too much attention. However, managers and marketers should consider status-quo bias when forming strategies to market their products. In theory, these strategies can be based on the use of message framing. Several authors argue for using status-quo framing to negate the effects of status-quo bias (Harker Martin, 2017; Samuelson & Zeckhauser, 1988). By presenting products as the status-quo and conventional technologies as alternatives, communication to the outside world could prove effective (Harker Martin, 2017; Samuelson & Zeckhauser, 1988). Meanwhile, indications were found that status-quo bias is partly caused by complex information hassle. Because of this, it is just as important that the messages are clear and concise.

However, not only organizations that try to market their innovations can benefit from the outcome of this research. Real estate developers can benefit from it as well. This is because it seems that status-quo bias and complex information hassle is experienced more in large organizations. I argue that this is caused by the availability, closeness, and variety of information within an organization. Developers that want to stimulate innovation and create competitive advantages can use this knowledge to their advantage. By creating and promoting a culture of open knowledge sharing and promoting diversity in the workforce, they could reduce the level of bias and hassle that is experienced in their organization. Additionally, it could prove effective to invest in the improvement of the organization’s knowledge sharing architecture.

Finally, this research produced more clarity as to why sustainable building is still being resisted. Many policies are developed, trying to stimulate sustainable building (e.g., EC, 2011, 2016a, 2016b, 2019c). However, it seems that many of them do not reach their intended effect (Camisón, 2010). Many consumers and organizations stick to the status quo and resist environmental change (e.g., Camisón, 2010; Hoffman & Henn, 2008; Kats & Alevantis, 2003). Using the results of this research, policymakers can develop effective framing strategies. By doing so, they can communicate their policies more effectively.

5.2.4 Recommendations for future research

I recommend five topics to study in the future. These will contribute to both an understanding of psychological influences on decision-making processes and strategies to overcome these. To start, the additions to TAM that I propose should be tested in an experiment. By establishing causal relations, bias could conclusively be interpreted as a predictor of the intent to adopt SBMs. Additionally, this research should be recreated in different industries to increase its generalizability.

Moreover, the influence of risk aversion on the adoption of SBMs should be studied. I argue that risk aversion partly explains many of the effects that were observed in this research. Research is needed on the power of risk aversion, as a predictor in TAM. Also, it should be studied whether risk aversion is a cause of bias.

Also, further research is needed on complex information hassle. Similar to risk aversion, I argue that complex information hassle partly explains many of the effects that were observed. Therefore, it should be studied whether complex information hassle can be seen as a predictor of bias. Additionally, its role within TAM should be reviewed again. This is because the measure for PEU was not reliable and valid. Because of this, the results of this research are not conclusive.

Furthermore, the effects of knowledge management on bias within organizations should be studied. The differences between various kinds of knowledge sharing architectures are of particular interest. Using this knowledge, organizations can design effective knowledge sharing platforms. This could reduce the effect of bias and stimulate open knowledge sharing and innovation.

Finally, I designed an experiment for future research, which is presented in paragraph 5.3. This experiment is developed to test the effects of status-quo framing on the intent to adopt SBMs. I propose that the effects of framing on bias and hassle should be studied in the future, starting with the execution of this experiment. This will provide managers and marketers with more tools to create effective communication strategies. Also, it will provide policymakers with additional tools to shape their communication to the public.

5.3 Message framing experiment

Attempting to develop a strategy against the biased decision-making in the building sector, an experiment was designed. Experimental research was chosen, as it is necessary to know whether there are causal effects from the framing strategy. This would ensure that managers and policy makers, which will use this strategy, do not invest their resources in vain. The results from the survey research and the interviews were used as input for this experiment. It has a solid foundation, as it is backed by the data of the two other research methods that were used. Additionally, the barriers to continuing this line of research will be lower, as the methodology is already developed. This should stimulate others to explore the effects of framing strategies. Because of this, I believe that designing this experiment contributes to future work.

5.3.1 Conceptual framework

The survey research indicates that status-quo bias has the strongest correlation with BI. Using message framing to negate the effects of the status-quo bias could, thus, significantly influence the adoption of SBMs. The measurement scale for the status-quo bias that was used is not very reliable. However, the data from the interviews point in the same direction as the survey research. The interviewees believe that the decision-making processes in the building sector are influenced by the status-quo bias. For this reason, I believe that the results from the survey research do not have to be completely rejected based on the unreliable measurement scale. As discussed in existing literature, status-quo framing could be a good strategy to negate the effects of the status-quo bias (Harker Martin, 2017; Samuelson & Zeckhauser, 1988). Because of these reasons, I developed an experiment that tests the effect of status-quo framing on the level of status-quo bias and BI. Three hypotheses were developed.

H1. Status-quo framing decreases the level of status-quo bias that is experienced

H2. Status-quo framing increases the intent to adopt SBMs

H3. The level of status-quo bias mediates the relation between status-quo framing and the intent to adopt SBMs

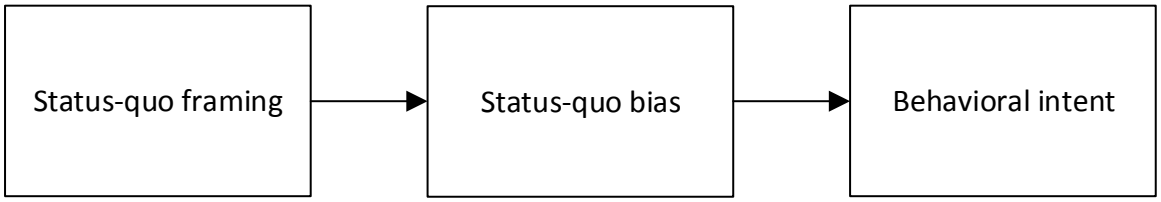

Figure 16: Conceptual framework framing experiment (Author)

5.3.2 Data collection and sampling

Experiment design

The data will be collected using a laboratory experiment. This choice was made as the internal validity of such experiments is very high and a causal relationship can be established (Sekaran & Bougie, 2016). On the downside, the generalizability of such experiments is often quite low (Sekaran & Bougie, 2016). However, it is the most suitable method to explore the effects of framing strategies. The results of this research can be used to design marketing messages, to stimulate the adoption of SBMs. To effectively design these messages, it is necessary to know if it is a certain framing strategy that increases BI. For this, a causal relationship has to be established.

It is needed to measure the change in the level of status-quo bias, which is experienced, due to the use of status-quo framing. To do this, it is necessary to measure the level of experienced status-quo bias before and after presenting the participants with messaging. For this cause, it is sufficient to select a pretest-posttest with control group design (Sekaran & Bougie, 2016). However, it is also needed to measure BI. The problem with this is that BI cannot be measured without presenting a certain explanation of the SBM in question. Because of this, a pretest-posttest design is not suitable. Providing a neutral message to measure initial BI can influence the effect of the framed message. Because of this, a Solomon four-group design was chosen for this research. Two of the four groups will only be subjected to a post-test. Because of this, the influence of neutral messaging on the effect of status-quo framing can be measured. This is interesting, as it will establish whether prior knowledge of a certain SBM decreases the effects of message framing. To measure the effect of status-quo framing, the participants will be presented with a framed message as a treatment. The control group will be presented with a neutral message. The Solomon four-group design also controls for other testing effects, as two out of four groups are not subjected to a pretest (Sekaran & Bougie, 2016).

Solomon four-group design

Group	Pretest	Treatment	Posttest
1. Experimental	O_1	X	O_2
2. Control	O_3		O_4
3. Experimental		X	O_5
4. Control			O_6

Figure 17: Experiment design (Sekaran & Bougie, 2016)

Sampling

Based on a rule of thumb, twenty participants per group are needed in experimental research (Sekaran & Bougie, 2016). It follows that a total of 80 participants are needed to conduct this experiment. However, this is the bare minimum. It seems that much larger samples are common in psychological research (Brysbaert, 2019). Because of this, 50 participants per group seems a more reliable sample size. Additionally, this creates a buffer in the case that participants would drop out. Accordingly, a total of 200 participants is needed. To simplify the search for participants, 200 university students can be gathered. It is easier to find a sample of students that have the time to participate than building professionals, as professionals tend to have a high workload. This could cause selection bias to influence the results (Sekaran & Bougie, 2016). However, if students are selected from faculties that are related to the building industry this is less influential. Furthermore, the students will be randomly assigned to one of the four groups. This negates the effects of the selection bias as well (Sekaran & Bougie, 2016).

The pre-test will be administered directly before the manipulation. By doing so, the chance of history, and maturation effects will be negated (Sekaran & Bougie, 2016). This drastically increases the chance of testing effects (Sekaran & Bougie, 2016). However, the Solomon four-group design allows for the control of testing effects. Because of this, the occurrence of testing effects is not as significant as negating the other effects.

5.3.3 Operationalization

Main variables

To test the hypotheses, three variables have to be operationalized. These are the frame that will be used, BI, and the status-quo bias. For BI and status-quo bias, the same measurement scales will be used as in the survey research. This was decided to create coherence with the rest of the research. Although the status-quo bias was not measured reliably, the scale was valid and the interview data was coherent with the survey results. Because of this, it can be assumed that the scale can be used for the experiments as well. The scales are adjusted so they only include the items that were actually included in the survey analysis. To ensure an even higher level of coherence, the SmartSkin technology of PHYSEE will be used as the example SBM again. However, if the researcher that will perform this experiment prefers, this can be tailored to fit another technology without adapting much. The questions that will be presented to the participants are the following:

BI_1 How interesting do you think the SmartSkin technology of PHYSEE is? (Very uninteresting – Very interesting)

BI_2 How probable is it that you will apply the SmartSkin technology of PHYSEE in a project within a year from now? (Very unlikely – Very likely)

BI_3 How positive or negative do feel about the SmartSkin technology of PHYSEE? (Very negative – Very positive)

SQB_1 I do not like to change my routines. (Very much disagree – Very much agree)

SQB_2 I can feel overwhelmed by change. (Very much disagree – Very much agree)

Because the variables will be measured by the same scales during the pretest and posttest, there will be no interference in the results due to instrumentation effects. The data that represents the status-quo bias and BI is collected on a Likert scale again. On the other hand, the presence of the framed message will be presented as a categorical variable. All groups will be assigned a different value. As mentioned before, the framing strategy that will be deployed is status-quo framing. This means that SmartSkin technology of PHYSEE has to be presented as the status-quo (Harker Martin, 2017; Samuelson & Zeckhauser, 1988). This means that conventional technologies have to be framed as deviating from the normal choice (Harker Martin, 2017; Samuelson & Zeckhauser, 1988). Furthermore, as loss aversion is part of the theorized construct of the status-quo bias, a value component will be added to the frame to increase the expected effectiveness (Kim & Kankanhalli, 2009; Salkeld et al., 2000; Wu, 2016). However, as the stakes are high in the building sector, this could still induce risk-averse behavior (De Jaegher, 2019; Hobman et al., 2016). Therefore, it is of importance that the value in the message is not presented as an uncertainty. Besides this, the choice to implement an innovative SBM depends greatly on its value. Because of this, the addition of a value component seems to be sensible. To decrease the chance of participant fatigue, the messages are under 150 words each. The two different messages that will be used are the following:

Neutral message

SmartSkin technology is a smart and flexible façade, which has PV-cells and sensors integrated into every window. The sensors measure temperature, light intensity, humidity, and air pressure. The data and electricity from the windows are linked to climate function in the façade through a grid. These functions include blinds and façade ventilation.

Because of this, the climate functions can dynamically regulate light intensity and temperature, based on pre-defined comfort and energy settings. This is beneficial for the comfort of the spaces inside and provides for efficient use of energy, light, and air. Lowering the cooling and heat load can increase energy efficiency with up to 20%.

Framed message

SmartSkin technology is a smart and flexible façade, which has PV-cells and sensors integrated into every window. The sensors measure temperature, light intensity, humidity, and air pressure. The data and electricity from the windows are linked to climate function in the façade through a grid. These functions include blinds and façade ventilation.

Because of this, the climate functions can dynamically regulate light intensity and temperature, based on pre-defined comfort and energy settings. ***Selecting alternative façades will harm the comfort of the inside spaces. Also, alternative façades use energy, light, and air less efficiently than SmartSkin technology. Because they have a higher cooling and heat load, alternative façades increase the energy bill with up to 20%.***

Control variables

Besides the main variables of interest, there are several variables for which must be controlled. Mostly, the same control variables as in the survey research will be used. Because of this, the results from the experiment will be comparable to the survey results. However, as the participants will be students, they will not be asked about their job. Instead, their academic background will be used as a control variable. Students with a background that is significant to the building sector are the most relevant participants. By controlling for background, the results will be more comparable to the survey, which was conducted within the building sector.

AB_1. What is your academic background?

Also, the importance that the participants assign to environmental action can influence the effect of the message. The possibility exists that they are naturally more inclined to support the technology. Because of this, the effect of the message framing itself will be low. However, the effect would seem higher than it is if only a post-test is administered, as high levels of intent are expected. The green consumer value scale that was developed by Haws, Winterich, and Naylor (2010) will be used to measure this. Over the course of six studies, they developed and validated this scale, which has proven to be highly reliable and valid (Haws et al., 2010). All questions will be measured on a five-point Likert scale, ranging from I disagree very much to I agree very much. The highest level of green consumer value will be represented by five for all questions.

GCV_1. It is important to me that the products I use do not harm the environment. (Very much disagree. (Very much disagree – Very much agree)

GCV_2. I consider the potential environmental impact of my actions when making many of my decisions. (Very much disagree – Very much agree)

GCV_3. My purchase habits are affected by my concern for our environment. (Very much disagree – Very much agree)

GCV_4. I am concerned about wasting the resources of our planet. (Very much disagree – Very much agree)

GCV_5. I would describe myself as environmentally responsible. (Very much disagree – Very much agree)

GCV_6. I am willing to be inconvenienced in order to take actions that are more environmentally friendly. (Very much disagree – Very much agree)

5.3.4 Data analysis

Testing for normality

The goal of the analysis is to test the effect of status-quo framing on BI and the level of status-quo experienced. Additionally, it has to establish whether the relation between status-quo framing and BI is mediated by the level of status-quo that is experienced. To achieve this, several different analysis methods will be utilized. To start, the Kolmogorov Smirnov test will be used to examine whether the data is normally distributed (Sekaran & Bougie, 2016). This is done because, the other methods that will be used are based on the assumption of normality (Sekaran & Bougie, 2016). If the data is not normally distributed, either adjustments to the data have to be made or more suitable methods should be chosen during the analysis. However, designing the experiment I assumed that the data will be normally distributed.

Reliability and Validity

As in the survey research, some of the operationalized variables are not taken from the literature. As such, they are not proven reliable and valid. Because of this, the same methods as in the survey research will be used to test for reliability and validity. To start, a PCA will be performed to reduce the dataset and test for validity. This indicates whether the factor loadings represent the variables as they are theorized. After that, reliability will be tested using Cronbach's alpha. This indicates whether several items will have to be removed from the measures. Additionally, measures that were used in the survey are tested for test-retest reliability. This is because these measures are used again in this study. Finally, a CFA will be performed as an additional test of validity. This can be done while fitting the model, as SEM seems to be a good method for mediation analysis.

Mediation analysis

As the main method of analysis, a mediation analysis will be performed. This can be done using SEM, as has been done in the survey research (Ullman & Bentler, 2003). This proved to be a practical method and suitable for this cause. Alternatively, PROCESS in SPSS can be used, if the researcher that will perform this experiment feels more comfortable with it (Hayes, 2012). Using mediation analysis, it is possible to distinguish between direct and indirect effects of status-quo framing on BI (Hayes, 2012). Additionally, the direct effects of status-quo framing on the level of status-quo bias will be provided.

The independent variable, which is the framed message, is categorical. Because of this, it is needed to use dummy coding to represent this variable. The group that will receive treatment and a pretest will be called PT and the control group that receives the pretest will be named PC. The group that will only receive treatment, but no pretest, will be addressed as group T, while the final group will be assigned the name C. Of these, group T, PC, and PT will be coded as a dummy variable. These three variables will be entered as independent variables in the mediation analysis. These variables will all be related to group C, and differences between the groups can also be used to interpret the results.

MANOVA

As an additional test, the effect of status-quo framing on BI and on the level of status-quo bias that is experienced will be tested by a multivariate analysis of variance (MANOVA). This is a variation on the analysis of variance (ANOVA), which is used to indicate differences in the means of three or more groups (Sekaran & Bougie, 2016). An independent samples t-test would not suffice, as this can only compare up to two groups. Furthermore, the difference between a MANOVA and ANOVA is that a MANOVA allows testing the effects of the independent variable on multiple dependent variables simultaneously (Sekaran & Bougie, 2016). This is needed because testing these two relations at the same time is more correct than testing them independently. This is because all of the variables are theorized to be interrelated. However, it is important to realize that the MANOVA is not the main method of analysis. It is purely meant as an additional test, used to support the outcomes of the mediation analysis. An independent interpretation of the MANOVA would not be very useful as mediation is theorized.

Post hoc test

Finally, it is needed to perform a post hoc test (Kucuk, Eyuboglu, Kucuk, & Degirmencioglu, 2016). This is important as multiple testing will be used in the analysis methods (Goldman, 2008). This is due to the inclusion of multiple groups that are tested simultaneously. Because of repeated testing, the chance that a significant effect is observed seems to increase significantly (Goldman, 2008). However, this is not correct (Goldman, 2008; Kucuk et al., 2016). Only the chance of type I error actually increases (Goldman, 2008; Kucuk et al., 2016). A commonly used method to reduce the chance on type I error is the Bonferroni correction (Goldman, 2008; Kucuk et al., 2016). This correction divides the cut-off p-value by the number of observations (Goldman, 2008; Kucuk et al., 2016). By doing so, a much stricter cut-off value is adopted (Goldman, 2008; Kucuk et al., 2016). While some scholars argue that the Bonferroni correction is too conservative, it remains one of the most widely applied post hoc tests (Goldman, 2008; Kucuk et al., 2016). For this reason, the Bonferroni correction is selected to be used in the analysis of this experiment.

6. References

Abdi, H. (2003). Factor Rotations in Factor Analyses. In *Encyclopedia of Social Sciences Research Methods.* Sage. Retrieved from http://www.utdallas.edu/

Abergel, T., Dean, B., & Dulac, J. (2017). *Towards a zero-emission, efficient, and resilient buildings and construction sector*. Retrieved from www.globalabc.org

Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behavior and Human Decision Processes*, *50*, 179–211. https://doi.org/10.15288/jsad.2011.72.322

Amato, L. H., & Amato, C. H. (2007). *The Effects of Firm Size and Industry on Corporate Giving*. *Source: Journal of Business Ethics* (Vol. 72). Retrieved from https://www.jstor.org/stable/25075376?seq=1&cid=pdf-reference#references_tab_contents

Andersen, S., Harrison, G. W., Lau, M. I., & Rutström, E. E. (2008). Eliciting Risk and Time Preferences. *Econometrica*, *76*(3), 583–618. https://doi.org/10.1111/j.1468-0262.2008.00848.x

Antioco, M., & Kleijnen, M. (2010). Consumer adoption of technological innovations: Effects of psychological and functional barriers in a lack of content versus a presence of content situation. *European Journal of Marketing*, *44*(11), 1700–1724. https://doi.org/10.1108/03090561011079846

Aravena, C., Riquelme, A., & Denny, E. (2016). Money, Comfort or Environment? Priorities and Determinants of Energy Efficiency Investments in Irish Households. *Journal of Consumer Policy*, *39*, 159–186. https://doi.org/10.1007/s10603-016-9311-2

Asghari, H. (2019). MOT1451 - Introduction. Retrieved from https://brightspace.tudelft.nl/d2l/le/content/132598/viewContent/1255631/View

Asongu, J. J. (2007). Innovation as an Argument for Corporate Social Responsibility. *Journal of Business and Public Policy*, *1*(3), 1–21.

Bakker, D. (2020a). Een bedrijf sluiten gaat wel erg ver. *Management Scope*, 22–26.

Bakker, D. (2020b). We staan eindeloos in de wacht. *Management Scope*, 29–33.

Bloemers, J. (2020). Verduurzaming van uw kantoor: Kom nu in actie. *Management Scope*, 18–21.

Booth, A. L., & Nolen, P. (2012). Gender differences in risk behaviour: Does nurture matter? *Economic Journal*, *122*(558), F56–F78. https://doi.org/10.1111/j.1468-0297.2011.02480.x

Bordass, B. (2010). Cost and value: fact and fiction. *Building Research & Information*, *28*(5–6), 338–352. https://doi.org/10.1080/096132100418492

Braun, V., & Clarke, V. (2012). Thematic analysis. In *APA handbook of research methods in psychology, Vol 2: Research designs: Quantitative, qualitative, neuropsychological, and biological.* (pp. 57–71). https://doi.org/10.1037/13620-004

Brysbaert, M. (2019). How many participants do we have to include in properly powered experiments? A tutorial of power analysis with some simple guidelines. *Journal of Cognition*, *2*(1), 1–38.

Camisón-Zornoza, C., Lapiedra-Alcamí, R., Segarra-Ciprés, M., & Boronat-Navarro, M. (2004). A Meta-analysis of Innovation and Organizational Size. *Organization Studies*, *25*(3), 331–361. https://doi.org/10.1177/0170840604040039

Camisón, C. (2010). Effects of coercive regulation versus voluntary and cooperative auto-regulation on environmental adaptation and performance: Empirical evidence in Spain. *European Management Journal*, *28*(5), 346–361. https://doi.org/10.1016/j.emj.2010.03.001

Carroll, A. B., Shabana, K. M., & Scherer, R. W. (2010). The Business Case for Corporate Social Responsibility: A Review of Concepts, Research and Practice. *International Journal of Management Reviews*, *21*(1), 85–105. https://doi.org/10.1111/j.1468-2370.2009.00275.x

Chan, A. P. C., Darko, A., Ameyaw, E. E., & Owusu-Manu, D.-G. (2017). Barriers Affecting the Adoption of Green Building Technologies. *Journal of Management in Engineering*, *33*(3), 1–12. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000507

Chatterjee, S., Heath, T. B., Milberg, S. J., & France, K. R. (2000). The differential processing of price in gains and losses: The effects of frame and need for cognition. *Journal of Behavioral Decision Making*, *13*(1), 61–75. https://doi.org/10.1002/(SICI)1099-0771(200001/03)13:1<61::AID-BDM343>3.0.CO;2-J

Cheng, C. C. J., & Chen, J.-S. (2013). Breakthrough innovation: the roles of dynamic innovation capabilities and open innovation activities. *Journal of Business & Industrial Marketing*, *28*(5), 444–454. https://doi.org/10.1108/08858621311330281

Chin, W. W., Johnson, N., & Schwarz, A. (2008). A Fast Form Approach to Measuring Technology Acceptance and Other Constructs. *MIS Quarterly*, *32*(4), 687–703.

Curran-Bauer Analytics. (2019). Can I estimate an SEM if the sample data are not normally distributed? Retrieved April 21, 2020, from https://curranbauer.org/can-i-estimate-an-sem-if-the-sample-data-are-not-normally-distributed/

Daly, A., Dekker, T., & Hess, S. (2016). Dummy coding vs effects coding for categorical variables: Clarifications and extensions. *Journal of Choice Modelling*, *21*, 36–41. https://doi.org/10.1016/j.jocm.2016.09.005

Damanpour, F. (1992). Organizational Size and Innovation. *Organization Studies*, *13*(3), 375–402. https://doi.org/10.1177/017084069201300304

Dancey, C. P., & Reidy, J. (2011). *Statistics without maths for psychology* (5th ed.). Pearson Education Limited.

Darko, A., Chan, A. P. C., Owusu-Manu, D. G., & Ameyaw, E. E. (2017). Drivers for implementing green building technologies: An international survey of experts. *Journal of Cleaner Production*. https://doi.org/10.1016/j.jclepro.2017.01.043

Davis, F. D. (1986). *A TECHNOLOGY ACCEPTANCE MODEL FOR EMPIRICALLY TESTING NEW END-USER INFORMATION SYSTEMS: THEORY AND RESULTS*. MIT.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly: Management Information Systems*, *13*(3), 319–339. https://doi.org/10.2307/249008

de Bruijn, H. (2019). *The art of political framing : how politicians convince us that they are right*. Retrieved from https://www.aup.nl/en/book/9789463721127/the-art-of-political-framing

De Jaegher, K. (2019). Strategic framing to influence clients' risky decisions. *Theory and Decision*, *86*, 437–462. https://doi.org/10.1007/s11238-019-09691-x

de Vries, G. (2017). How Positive Framing May Fuel Opposition to Low-Carbon Technologies: The Boomerang Model. *Journal of Language and Social Psychology*, *36*(1), 28–44. https://doi.org/10.1177/0261927X16663590

de Vries, G. (2020). Public Communication as a Tool to Implement Environmental Policies. *Social Issues and Policy Review*, *14*(1), 244–272. https://doi.org/10.1111/sipr.12061

de Vries, G., Rietkerk, M., & Kooger, R. (2019). The Hassle Factor as a Psychological Barrier to a Green Home. *Journal of Consumer Policy*. https://doi.org/10.1007/s10603-019-09410-7

de Vries, G., Terwel, B. W., & Ellemers, N. (2014). Spare the details, share the relevance: The dilution effect in communications about carbon dioxide capture and storage. *Journal of Environmental Psychology*, *38*, 116–123. https://doi.org/10.1016/j.jenvp.2014.01.003

de Vries, G., Terwel, B. W., Ellemers, N., & Daamen, D. D. L. (2015). Sustainability or profitability? How communicated motives for environmental policy affect public perceptions of corporate greenwashing. *Corporate Social Responsibility and Environmental Management*, *22*(3), 142–154. https://doi.org/10.1002/csr.1327

Debruyne, M., Moenaertb, R., Griffinc, A., Hartd, S., Hultinke, E. J., & Robben, H. (2002). The impact of new product launch strategies on competitive reaction in industrial markets. *Journal of Product Innovation Management*, *19*(2), 159–170.

Deutskens, E., De Ruyter, K., Wetzels, M., & Oosterveld, P. (2004). Response Rate and Response Quality of Internet-Based Surveys: An Experimental Study. *Marketing Letters*, *15*(1), 21–36.

Dodd, N., Cordella, M., Traverso, M., & Donatello, S. (2017a). *Level(s)-A common EU framework of core sustainability indicators for office and residential buildings Part 3: How to make performance assessments using Level(s) (Draft Beta v1.0)*.

Dodd, N., Cordella, M., Traverso, M., & Donatello, S. (2017b). *Level(s)-A common EU framework of core sustainability indicators for office and residential buildings Parts 1 and 2: Introduction to Level(s) and how it works (Draft Beta v1.0)*.

Dwivedi, Y. K., Rana, N. P., Chen, H., & Williams, M. D. (2011). A Meta-analysis of the Unified Theory of Acceptance and Use of Technology (UTAUT). In *IFIP international working conference on governance and sustainability in information systems-managing the transfer and diffusion of it* (pp. 155–170). Springer, Berlin, Heidelberg.

European Commission. (2003). What is an SME? Retrieved April 15, 2020, from https://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_en

European Commission. (2011). *Roadmap to a resource efficient europe*.

European Commission. (2016a). *Accelerating Clean Energy Innovation*.

European Commission. (2016b). *EU GPP Criteria for Office Building Design, Construction and Management*.

European Commission. (2018). *Development and implementation of initiatives fostering investment and innovation in construction and demolition waste recycling infrastructure*.

European Commission. (2019a). Building sustainability performance - Level(s). Retrieved March 5, 2020, from https://ec.europa.eu/environment/eussd/buildings.htm

European Commission. (2019b). Circular Economy Strategy. Retrieved March 5, 2020, from https://ec.europa.eu/environment/circular-economy/

European Commission. (2019c). Construction and demolition waste. Retrieved March 5, 2020, from https://ec.europa.eu/environment/waste/construction_demolition.htm

European Commission. (2019d). *Corporate social responsibility, responsible business conduct, and business & human rights: Overview of progress*. Retrieved from https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:52011DC0681&from=DE

European Commission. (2019e). EU approach to sustainable development. Retrieved March 3, 2020, from https://ec.europa.eu/info/strategy/international-strategies/sustainable-development-goals/eu-approach-sustainable-development-0_en

European Commission. (2019f). Low-carbon economy. Retrieved March 6, 2020, from https://ec.europa.eu/regional_policy/en/policy/themes/low-carbon-economy/

European Commission. (2019g). *On the implementation of the Circular Economy Action Plan*. Retrieved from https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=cei_srm030&plugin=1

European Union. (2013). *REGULATION (EU) No 525/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL*.

Evans, J. R., & Mathur, A. (2005). The Value of Online Surveys. *Internet Research*. https://doi.org/10.1108/10662240510590360

Frederick, S. (2006). Valuing future life and future lives: A framework for understanding discounting. *Journal of Economic Psychology*, *27*(5), 667–680. https://doi.org/10.1016/j.joep.2006.05.007

Frederick, S., Loewenstein, G., & O'Donoghue, T. (2002). *Time Discounting and Time Preference: A Critical Review*. *Time Discounting Journal of Economic Literature* (Vol. XL).

Frederiks, E. R., Stenner, K., & Hobman, E. V. (2015). Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour. *Renewable and Sustainable Energy Reviews*, *41*, 1385–1394. https://doi.org/10.1016/j.rser.2014.09.026

Gifford, R. (2011). The Dragons of Inaction Psychological Barriers That Limit Climate Change Mitigation and Adaptation. *American Psychologist*, *66*(4), 290–302. https://doi.org/10.1037/a0023566

Goldman, M. (2008). *Statistics for Bioinformatics*.

González-Ramos, M. I., Donate, M. J., & Guadamillas, F. (2014). Technological posture and corporate social responsibility: effects on innovation performance. *Environmental Engineering and Management Journal*, *13*(10), 2497–2505. Retrieved from http://omicron.ch.tuiasi.ro/EEMJ/

Grotenhuis, M. te, & Thijs, P. (2015). *Dummy variables and their interactions in regression analysis: examples from research on body mass index*. Retrieved from http://arxiv.org/abs/1511.05728

Häkkinen, T., & Belloni, K. (2011). Barriers and drivers for sustainable building Barriers and drivers for sustainable building. *Building Research & Information*, *39*(3), 239–255. https://doi.org/10.1080/09613218.2011.561948

Hannan, M. T., & Freeman, J. (1984). *Structural Inertia and Organizational Change*. *Source: American Sociological Review* (Vol. 49).

Harker Martin, B. (2017). Unsticking the status quo Strategic framing effects on managerial mindset, status quo bias and systematic resistance to change. *Management Research Review*, *40*(2), 122–141. https://doi.org/10.1108/MRR-08-2015-0183

Harris, N., Shealy, T., Parrish, K., & Granderson, J. (2019). Cognitive barriers during monitoring-based commissioning of buildings. https://doi.org/10.1016/j.scs.2018.12.017

Haws, K. L., Winterich, K. P., & Naylor, R. W. (2010). Seeing the world through GREEN-tinted glasses: Green consumption values and responses to environmentally friendly products. *Journal of Macromarketing*, *5*(2), 18–39. https://doi.org/10.1016/j.jcps.2013.11.002

Hayes, A. F. (2012). PROCESS: A versatile computational tool for observed variable moderation, mediation, and conditional process modeling. *Manuscript Submitted for Publication*, (January), 1–39. Retrieved from http://www.afhayes.com/public/process2012.pdf

Hernandez, I., & Preston, J. L. (2013). Disfluency disrupts the confirmation bias. *Journal of Experimental Social Psychology*, *49*(1), 178–182. https://doi.org/10.1016/j.jesp.2012.08.010

Hobman, E. V, Frederiks, E. R., Stenner, K., & Meikle, S. (2016). Uptake and usage of cost-reflective electricity pricing: Insights from psychology and behavioural economics. *Renewable and*

Sustainable Energy Review, *57*, 455–467. https://doi.org/10.1016/j.rser.2015.12.144

Hoffman, A. J., & Henn, R. (2008). Overcoming the social and psychological barriers to green building. *Organization and Environment*, *21*(4), 390–419. https://doi.org/10.1177/1086026608326129

Huang, H.-C., Lai, M.-C., Lin, L.-H., & Chen, C.-T. (2013). Overcoming organizational inertia to strengthen business model innovation An open innovation perspective. *Journal of Organizational Change Management*, *26*(6), 977–1002. https://doi.org/10.1108/JOCM-04-2012-0047

Huang, H.-H., Hsu, J. S.-C., & Ku, C.-Y. (2012). Understanding the role of computer-mediated counter-argument in countering confirmation bias. *Decision Support Systems*, *53*(3), 438–447. https://doi.org/10.1016/j.dss.2012.03.009

Im, I., Hong, S., & Kang, M. S. (2011). An international comparison of technology adoption: Testing the UTAUT model. *Information and Management*, *48*(1), 1–8. https://doi.org/10.1016/j.im.2010.09.001

Kahneman, D., & Tversky, A. (1984). *Choices, Values, and Frames* (Vol. 39).

Kahnemann, D. (2011). *Thinking fast and slow*. MacMillan.

Kanner, A. D., Coyne, J. C., Schaefer, C., & Lazarus, R. S. (1981). *Comparison of Two Modes of Stress Measurement: Daily Hassles and Uplifts Versus Major Life Events*. *Journal of Behavioral Medicine* (Vol. 4).

Kats, G., & Alevantis, L. (2003). *The Costs and Financial Benefits of Green Buildings A Report to California's Sustainable Building Task Force*.

Kekic, M., McClelland, J., Bartholdy, S., Chamali, R., Campbell, I. C., & Schmidt, U. (2020). Bad Things Come to Those Who Do Not Wait: Temporal Discounting Is Associated With Compulsive Overeating, Eating Disorder Psychopathology and Food Addiction. *Frontiers in Psychiatry*, *10*(January), 1–9. https://doi.org/10.3389/fpsyt.2019.00978

Kelly, D., & Amburgey, T. L. (1991). *Organizational Inertia and Momentum: A Dynamic Model of Strategic Change*. *The Academy of Management Journal* (Vol. 34). Retrieved from https://about.jstor.org/terms

Kenny, D. A. (2015). Measuring model fit. Retrieved April 21, 2020, from http://davidakenny.net/cm/fit.htm

Khechine, H., Lakhal, S., & Ndjambou, P. (2016). A meta-analysis of the UTAUT model: Eleven years later. *Canadian Journal of Administrative Sciences*, *33*(2), 138–152. https://doi.org/10.1002/cjas.1381

Kim, H.-W., & Kankanhalli, A. (2009). INVESTIGATING USER RESISTANCE TO INFORMATION SYSTEMS IMPLEMENTATION: A STATUS QUO BIAS PERSPECTIVE. *MIS Quarterly: Management Information Systems*, *33*(3), 567–582.

King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. *Information and Management*, *43*(6), 740–755. https://doi.org/10.1016/j.im.2006.05.003

Koehler, D. J. (1991). Explanation, Imagination, and Confidence in Judgment. *Psychological Bulletin*, *110*(3), 499–519. https://doi.org/10.1037/0033-2909.110.3.499

Kucuk, U., Eyuboglu, M., Kucuk, H. O., & Degirmencioglu, G. (2016). Importance of using proper post hoc test with ANOVA. *International Journal of Cardiology*, *209*, 346. https://doi.org/10.1016/j.ijcard.2015.11.061

Laber-Warren, E. (2012). Calling a Truce in the Political Wars. *Scientific American Mind*, *23*(4), 22–23. https://doi.org/10.1038/scientificamericanmind0912-22

Lee, G., & Xia, W. (2006). Organizational size and IT innovation adoption: A meta-analysis. *Information and Management*, *43*, 975–985. https://doi.org/10.1016/j.im.2006.09.003

Lee, Y.-H., Hsieh, Y.-Ch., & Hsu, C.-N. (2011). Adding innovation diffusion theory to the technology acceptance model: Supporting employees intentions to use E-learning systems. *Educational Technology & Society*, *14*(4), 124–137. Retrieved from http://www.ifets.info/

Levin, K., Cashore, B., Bernstein, S., & Auld, G. (2007). Playing it Forward: Path Dependency, Progressive Incrementalism, and the "Super Wicked" Problem of Global Climate Change. In *International Studies Association 48th Annual Convention*.

Little, T. D., Slegers, D. W., & Card, N. A. (2006). *A Non-arbitrary Method of Identifying and Scaling Latent Variables in SEM and MACS Models*.

MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods*, *1*(2), 130–149. https://doi.org/10.1037/1082-989X.1.2.130

Madden, T. J., Ellen, P. S., & Ajzen, I. (1992). A Comparison of the Theory of Planned Behavior and the Theory of Reasoned Action. *Personality and Social Psychology Bulletin*, *18*(1), 3–9. https://doi.org/10.1177/0146167292181001

Milbrath, L. W. (1995). Psychological, Cultural, and Informational Barriers to Sustainability. *Journal of Social Issues*, *51*(4), 101–120. https://doi.org/10.1111/j.1540-4560.1995.tb01350.x

Mills, F. T., & Glass, J. (2009). Architectural Engineering and Design Management The Construction Design Manager's Role in Delivering Sustainable Buildings. *Architectural Engineering and Design Management*, *5*(1–2), 75–90. https://doi.org/10.3763/aedm.2009.0908

Moore, G. A. (2002). *Crossing the Chasm: Marketing and Selling Disruptive Products to Mainstream Customers*. [New York, N.Y.] : HarperBusiness. Retrieved from http://www.amazon.co.uk/Crossing-Chasm-Marketing-Apprehensive-Customers/dp/0887305199

Nickerson, R. S. (1998). *Confirmation Bias: A Ubiquitous Phenomenon in Many Guises*. *Review of General Psychology* (Vol. 2).

O'Reilly 3rd, C. A., & Thusman, M. L. (2004). The ambidextrous organization. *Harvard Business Review*, *82*(4), 74–81. https://doi.org/10.1136/bmj.320.7235.642

Ortt, J. R. (2020a). MOT2421 - Actors and factors during the pattern. Retrieved from https://brightspace.tudelft.nl/d2l/le/content/194733/viewContent/1414148/View

Ortt, J. R. (2020b). MOT2421 - Strategies during the adaptation phase. Retrieved from https://brightspace.tudelft.nl/d2l/le/content/194733/viewContent/1672672/View

Ortt, J. R. (2020c). MOT2421 - The pattern of development and diffusion. Retrieved from https://brightspace.tudelft.nl/d2l/le/content/194733/viewContent/1661587/View

Ortt, J. R., Dedehayir, O., Miralles, F., & Riverola, C. (2017). Innovators and early adopters in the diffusion of innovations : A literature review. In *XXVIII ISPIM Innovation Conference*.

Ortt, J. R., Langley, D. J., & Pals, N. (2013). Ten niche strategies to commercialize new high-tech products. In *2013 International Conference on Engineering, Technology and Innovation, ICE 2013 and IEEE International Technology Management Conference, ITMC 2013*. https://doi.org/10.1109/ITMC.2013.7352687

Ortt, J. R., & Schoormans, J. P. L. (2004). The pattern of development and diffusion of breakthrough communication technologies. *European Journal of Innovation Management*, *7*(4), 292–302. https://doi.org/10.1108/14601060410565047

Pakhuis de Zwijger. (2020). Gebiedsontwikkeling in tijden van crisis. Retrieved from

https://dezwijger.nl/programma/gebiedsontwikkeling-in-tijden-van-crisis

Parry, M. (1990). *Climate change and world agriculture*. Earthscan publications Ltd.

Pecl, G. T., Araújo, M. B., Bell, J. D., Blanchard, J., Bonebrake, T. C., Chen, I.-C., … Williams, S. E. (2017). Biodiversity redistribution under climate change: Impacts on ecosystems and human well-being. *Science*, *355*(6332). https://doi.org/10.1126/science.aai9214

Peloza, J. (2011). How can corporate social responsibility activities create value for stakeholders? A systematic review. *Article in Journal of the Academy of Marketing Science*, *39*, 117–135. https://doi.org/10.1007/s11747-010-0213-6

PHYSEE. (2020). Physee - Home. Retrieved March 9, 2020, from https://www.physee.eu/

Ram, S., & Sheth, J. N. (1989). Consumer resistance to innovations: The marketing problem and its solutions. *Journal of Consumer Marketing*, *6*(2), 5. https://doi.org/10.1108/EUM0000000002542

Rijksoverheid. (n.d.). Energielabel woning | Energielabel woningen en gebouwen. Retrieved June 1, 2020, from https://www.rijksoverheid.nl/onderwerpen/energielabel-woningen-en-gebouwen/energielabel-woning

Rijksoverheid. (2019). Voorstel voor het Klimaatplan, 62.

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, *4*(2), 155–169. https://doi.org/10.1007/BF01405730

Robb, A. (2004). Fear of Ebola Could Make People More Likely to Vote Conservative. Retrieved May 2, 2020, from https://newrepublic.com/article/119895/psychology-fear-increases-conservatism

Roberson, Q. M. (2019). Diversity in the Workplace: A Review, Synthesis, and Future Research Agenda. *Annual Review of Organizational Psychology and Organizational Behavior*, *6*, 69–88. https://doi.org/10.1146/annurev-orgpsych

Rogers, E. M. (1962). *DIFFUSION OF INNOVATIONS*. The Free Press.

Sääksjärvi, M., & Morel, K. P. (2010). The development of a scale to measure consumer doubt toward new products. *European Journal of Innovation Management*, *13*(3), 1460–1060. https://doi.org/10.1108/14601061011060120

Salkeld, G., Ryan, M., & Short, L. (2000). The veil of experience: do consumers prefer what they know best? *Health Economics*, *9*(3), 267–270. https://doi.org/10.1002/(SICI)1099-1050(200004)9:3<267::AID-HEC511>3.0.CO;2-H

Samuelson, W., & Zeckhauser, R. (1988). *Status Quo Bias in Decision Making*. *Journal of Risk and Uncertainty* (Vol. 1).

Satorra, A., & Bentler, P. (1999). A Scaled Difference Chi-square Test Statistic for Moment Structure Analysis. *UCLA Department of Statistics Paper*.

Sayce, S., Ellison, L., & Parnell, P. (2007). Understanding investment drivers for UK sustainable property. *Building Research & Information*, *35*(6), 629–643. https://doi.org/10.1080/09613210701559515

Schilling, M. A. (2013). *Strategic management of technological innovation* (4th ed.). McGraw-Hill Irwin.

Scholten, H., Scheres, A., De Water, E., Graf, U., Granic, I., & Luijten, M. (2019). Behavioral trainings and manipulations to reduce delay discounting: A systematic review. *Psychonomic Bulletin & Review*, *26*, 1803–1849. https://doi.org/10.3758/s13423-019-01629-2

Scholten, V. (2019). MOT1435 - Organizing for innovation opportunity development and NPD. Retrieved from https://brightspace.tudelft.nl/d2l/le/content/194715/viewContent/1628877/View

Schumpeter, J. A. (1942). Capitalism, Socialism, and Democracy.

Schwind, C., & Buder, J. (2012). Reducing confirmation bias and evaluation bias: When are preference-inconsistent recommendations effective - And when not? *Computers in Human Behavior*, *28*(6), 2280–2290. https://doi.org/10.1016/j.chb.2012.06.035

Sedera, D. (2016). Does Size Matter? The Implications of Firm Size on Enterprise Systems Success. *Australasian Journal of Information Systems*, *20*, 1–25. https://doi.org/10.3127/ajis.v20i0.1224

Sekaran, U., & Bougie, R. (2016). *Research methods for business: A skill building approach* (7th ed.). John Wiley & Sons, Ltd.

Servaes, H., & Tamayo, A. (2013). The Impact of Corporate Social Responsibility on Firm Value: The Role of Customer Awareness. *MANAGEMENT SCIENCE*, *59*(5), 1045–1061. https://doi.org/10.1287/mnsc.1120.1630

Shefer, D., & Frenkel, A. (2005). R&D, firm size and innovation: an empirical analysis. *Technovation*, *25*, 25–32. https://doi.org/10.1016/S0166-4972(03)00152-4

Sodagar, B., & Fieldson, R. (2008). Towards a sustainable construction practice. *Construction Information Quarterly*, *10*(3), 101–108.

Thaler, R. H., & Sunstein, C. R. (2009). *Nudge: Improving decisions about health, wealth, and happiness*. Penguin.

Tversky, A., & Kahneman, D. (1981). The Framing of Decisions and the Psychology of Choice. *Science*, *211*, 453–458. Retrieved from http://science.sciencemag.org/

Tversky, A., & Kahneman, D. (1992). *Advances in Prospect Theory: Cumulative Representation of Uncertainty*. *Journal of Risk and Uncertainty* (Vol. 5).

Udayasankar, K. (2008). *Corporate Social Responsibility and Firm Size*. *Source: Journal of Business Ethics* (Vol. 83). Retrieved from https://www.jstor.org/stable/25482364

Ullman, J. B., & Bentler, P. M. (2003). Structural equation modeling. In *Handbook of Psychology* (pp. 607–634). https://doi.org/10.1007/978-1-4939-7274-6_28

UN. (2019). Sustainable Development Goals. Retrieved March 3, 2020, from https://sustainabledevelopment.un.org/?menu=1300

UN General Assembly. (2015). *Transforming our world: the 2030 Agenda for Sustainable Development*. https://doi.org/10.1163/157180910X12665776638740

van de Kaa, G. (2019). MOT1435 - Lecture 2. Retrieved from https://brightspace.tudelft.nl/d2l/le/content/194715/viewContent/1617353/View

Van Witteloostuijn, A. (1998). Bridging Behavioral and Economic Theories of Decline: Organizational Inertia, Strategic Competition, and Chronic Failure. *Management Science*, *44*(4), 501–519. https://doi.org/10.1287/mnsc.44.4.501

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, *27*(3), 425–478.

Verburg, R. (2017). MOT 1524 - Lecture 3. Retrieved from https://brightspace.tudelft.nl/d2l/le/content/36805/viewContent/578772/View

Werker, C. (2018). MOT1412 - Lecture 2. Retrieved from https://brightspace.tudelft.nl/d2l/le/content/132590/viewContent/1140121/View

Wickert, C., Scherer, A. G., & Spence, L. J. (2016). Walking and Talking Corporate Social Responsibility: Implications of Firm Size and Organizational Cost. *Journal of Management Studies*, *53*(7), 1169–1196. https://doi.org/10.1111/joms.12209

Williams, K., & Dair, C. (2007). What Is Stopping Sustainable Building in England? Barriers Experienced by Stakeholders in Delivering Sustainable Developments. *Sustainable Development*, *15*, 135–147. https://doi.org/10.1002/sd

Wilson, E. J., & Sherrell, D. L. (1993). Source Effects in Communication and Persuasion Research: A Meta-Analysis of Effect Size. *Journal of the Academy of Marketing Science*, *21*(2), 101–112. https://doi.org/10.1007/BF02894421

Wolfe, M. T., & Patel, P. C. (2017). Instant gratification: temporal discounting and self-employment. *Small Business Economics*, *48*(4), 861–882. https://doi.org/10.1007/s11187-016-9823-9

World Bank. (2012). Total greenhouse gas emissions (kt of CO2 equivalent). Retrieved November 29, 2019, from https://data.worldbank.org/indicator/EN.ATM.GHGT.KT.CE

Wu, C.-C. (2016). Status quo bias in information system adoption: a meta-analytic review. *Online Information Review*, *40*(7), 998–1017. https://doi.org/10.1108/OIR-09-2015-0311

Yi, M. Y., Jackson, J. D., Park, J. S., & Probst, J. C. (2017). Understanding information technology acceptance by individual professionals: Toward an integrative view. https://doi.org/10.1016/j.im.2013.02.006

Appendix

Appendix A: Questionnaire

The questionnaire below includes all the questions that were presented to the respondents. Not all of the questions have been used in the analysis of the survey research. This is due to the fact that the research design has been changed over time. However, the questions that were not used in the analysis could still contribute to respondent fatigue. For this reason, I have chosen to include the questionnaire as presented to the respondent. This way, everyone that reads this thesis can make his own conclusions about the chance on respondent fatigue.

Onderzoek naar innovatie binnen de vastgoed sector

Heel erg bedankt voor het invullen van deze vragenlijst!

Deze vragenlijst is een belangrijk onderdeel van het onderzoek dat ik in samenwerking met PHYSEE uitvoer voor mijn Master Scriptie aan de TU Delft. Ik doe onderzoek naar mogelijke psychologische invloeden op de implementatie van nieuwe energie besparende technologieën in de vastgoedsector. De doelgroep van dit onderzoek is professionals werkzaam bij projectontwikkelaars. Het is belangrijk dat u de vragen erg goed leest en naar waarheid invult. Neem daar alstublieft de tijd voor. De vragenlijst zal niet meer dan 10 minuten in beslag nemen.

U zult vragen invullen die niet werkgerelateerd lijken te zijn. Deze vinden echter hun oorsprong in de literatuur en meten bepaalde voorkeuren die invloed hebben op investeringsgedrag. Deze vragen hebben als doel om vast e stellen of deze voorkeuren van invloed zijn in het implementatie proces van nieuwe energie besparende technologieën.

De antwoorden op deze vragenlijst worden volledig geanonimiseerd in mijn onderzoek. Vragen die aanwijzingen kunnen geven tot uw identiteit zullen nergens terug gevonden kunnen worden in mijn onderzoek. Die vragen zullen puur door mij gebruikt worden ter referentie om de antwoorden op de andere vragen in perspectief te plaatsen.

Mocht u een vraag hebben over het onderzoek, kunt u contact met mij opnemen via de mail: b.hofman@student.tudelft.nl

Nogmaals bedankt,

Björn Hofman

Als u nog geen kennis heeft gemaakt met de SmartSkin technologie van PHYSEE, lees dan alstublieft deze korte uitleg goed door!

PHYSEE biedt projectontwikkelaars in de vastgoedsector de optie aan om SmartSkin technologie toe te passen op hun projecten. SmartSkin is een slimme en flexibele gevel, waarbij PV-cellen en sensoren in ieder individueel raam zijn geïntegreerd. De sensoren meten temperatuur, lichtintensiteit, luchtvochtigheid en druk.

De data en de elektriciteit uit de ramen worden via een grid en het gebouwbeheerssysteem gekoppeld aan klimaatfuncties in de glasgevel, zoals zonwering en gevelventilatie. Dezen kunnen zo dynamisch lichtinval en temperatuur regelen, aan de hand van vooraf ingestelde comfort- en energiewaarden. Op deze manier wordt het comfort van de binnenruimte verhoogd en wordt er veel efficiënter gebruik gemaakt van energie, licht en lucht. Door verlaging van koel- en warmtelast van de binnenruimte kan de kostenbesparing op de energierekening oplopen tot wel 20%.

PHYSEE biedt maatoplossingen aan, inclusief de koppeling met juiste zonwering en ventilatiesystemen. Verder zal PHYSEE altijd eerst een haalbaarheidsstudie doen om te bepalen of SmartSkin toepasbaar is op een specifiek project.

b

Bent u werkzaam bij een projectontwikkelaar? *

- ○ Ja
- ○ Nee

Bij welk bedrijf bent u in dienst? *

Jouw antwoord

Wat is uw rol bij dit bedrijf?

Jouw antwoord

Met welk gender identificeert u zich? *

- ○ Man
- ○ Vrouw
- ○ Non-binair
- ○ Zeg ik liever niet

Wat is uw hoogst behaalde opleidingsniveau? *

- ○ Basisschool
- ○ Middelbare school
- ○ MBO
- ○ HBO associate degree
- ○ HBO bachelor
- ○ HBO master
- ○ Universitaire bachelor
- ○ Universitaire master
- ○ PhD

Heeft u bevoegdheid om te beslissen over het toepassen van nieuwe technologieën in de projecten van het bedrijf waar u in dienst bent? *

- ○ Ja
- ○ Nee

d

Hoeveel nieuwe producten of services heeft het bedrijf waar u voor werkt gepromoot in de afgelopen 10 jaar? *

	1	2	3	4	5	
Geen nieuwe producten of services	○	○	○	○	○	Erg veel nieuwe producten of services

Hoe groot zijn de veranderingen in de producten of services geweest? *

	1	2	3	4	5	
De veranderingen waren over het algemeen op erg kleine schaal	○	○	○	○	○	De veranderingen waren over het algemeen erg drastisch

Over het algemeen geeft het top-level management in het bedrijf waar ik werk de voorkeur aan: *

	1	2	3	4	5	
Een sterke nadruk op het marketen van beproefde producten en services	○	○	○	○	○	Een sterke nadruk op R&D, technologisch leiderschap en innovatie

e

Het bedrijf waar ik voor werk: *

	Erg mee oneens	Mee oneens	Neutraal	Mee eens	Erg mee eens
Onderneemt actie om vervuiling, veroorzaakt door de activiteiten van het bedrijf, te verminderen	○	○	○	○	○
Meet de impact van de activiteiten van het bedrijf op het milieu	○	○	○	○	○
Investeert in groene technologieën en hernieuwbare energie	○	○	○	○	○
Draagt bij aan het besparen van grondstoffen en energie	○	○	○	○	○

f

In de projecten waar ik me mee bezig houd vind ik de SmartSkin technologie van PHYSEE: *

	Erg mee oneens	Mee oneens	Neutraal	Mee eens	Erg mee eens
Waarde toevoegen	○	○	○	○	○
Inefficiënt	○	○	○	○	○
Onbehulpzaam	○	○	○	○	○
Makkelijk te begrijpen	○	○	○	○	○
Onduidelijk om mee om te gaan	○	○	○	○	○
Vrij nuttig	○	○	○	○	○
Flexibel om mee om te gaan	○	○	○	○	○

g

Hoe interessant vindt u de SmartSkin technologie van PHYSEE? *

	1	2	3	4	5	
Erg oninteressant	○	○	○	○	○	Erg interessant

Hoe waarschijnlijk is het dat u de SmartSkin technologie van PHYSEE binnen nu en een jaar in een project toepast? *

	1	2	3	4	5	
Erg onwaarschijnlijk	○	○	○	○	○	Erg waarschijnlijk

Hoe positief of negatief denkt u over de SmartSkin technologie van PHYSEE? *

	1	2	3	4	5	
Erg negatief	○	○	○	○	○	Erg positief

Is er een bepaalde reden dat u wel of niet heeft gekozen voor het implementeren van de SmartSkin technologie van PHYSEE? Zo ja, wat was deze reden?

Jouw antwoord

Welke van de volgende opties zou u kiezen? *

- ○ Met zekerheid 1300 euro ontvangen op dit moment
- ○ Met zekerheid 1950 euro ontvangen over een jaar

h

Welke van de volgende opties zou u kiezen? *

- ○ Met zekerheid 1300 euro ontvangen op dit moment
- ○ Met zekerheid 2600 euro ontvangen over een jaar

Welke van de volgende opties zou u kiezen? *

- ○ Met zekerheid 1300 euro ontvangen op dit moment
- ○ Met zekerheid 1560 euro ontvangen over een jaar

	Erg mee oneens	Mee oneens	Neutraal	Mee eens	Erg mee eens
Ik verander mijn routines niet graag	○	○	○	○	○
Ik kan me overweldigd voelen door verandering	○	○	○	○	○
Ik vind het niet erg om op een andere manier te werken dan mijn collega's	○	○	○	○	○
Als ik ergens in heb geïnvesteerd, vind ik het niet erg om dit te vervangen door een nieuwer alternatief	○	○	○	○	○
Ik probeer altijd te blijven zoeken naar informatie over nieuwe technologieën	○	○	○	○	○

j

De meeste informatie die ik vind onderbouwt mijn huidige routines	○	○	○	○	○
Ik besteed veel tijd aan het zoeken van informatie over innovaties in mijn sector	○	○	○	○	○

	Erg mee oneens	Mee oneens	Neutraal	Mee eens	Erg mee eens
Ik neig ernaar om praten met vreemden te ontwijken	○	○	○	○	○
Ik geef de voorkeur aan een routinematig leven in plaats van een onvoorspelbaar leven met veel verandering	○	○	○	○	○
Ik zou mezelf niet beschrijven als een risico-nemer	○	○	○	○	○

Ik hou er niet van om teveel risico te nemen om een fout te voorkomen	○	○	○	○	○
Ik zou liever 100 euro met zekerheid verliezen, dan de gok aangaan dat ik 50% kans heb om niets te verliezen en 50% kans om 200 euro te verliezen	○	○	○	○	○
Als iemand me de kans zou aanbieden om met 50% kans 750 euro te verdienen en met 50% kans 500 euro te verliezen zou ik het aannemen	○	○	○	○	○
Ik neem liever geen kansen aan op werk als er de mogelijkheid bestaat dat er verlies gemaakt wordt	○	○	○	○	○

	Erg mee oneens	Mee oneens	Neutraal	Mee eens	Erg mee eens
Ik vind het makkelijk om de juiste informatie over een nieuwe technologie te vinden	○	○	○	○	○
De introductie van een technologie gaat meestal gepaard met een heleboel nieuwe informatie	○	○	○	○	○
Ik vind het verwerken van informatie over een nieuwe technologie gedoe	○	○	○	○	○

m

Figure 18: Questionnaire design (Author)

n

Appendix B: Model fitting code

```
> model <- '
+
+ # Confirmatory Factor Analysis
+
+ Size =~ Large
+ TEMP =~ TD_1_ST
+ SQB =~ SQB_1_ST + SQB_3_ST
+ CB =~ CB_1_ST + CB_3_ST
+ CH =~ CH_1_ST + CH_3_ST + CH_6_ST + CH_4_ST + CH_5_ST
+ PU =~ PU_1_ST + PU_2_ST + PU_3_ST + PU_4_ST
+ PEU =~ PEU_1_ST + PEU_2_ST + PEU_3_ST
+ BI =~ BI_1_ST + BI_2_ST + BI_3_ST
+
+ # Regression
+
+ PU ~ e*SQB + f*CB + g*TEMP + k*Size
+ PEU ~ h*CH + l*Size
+ BI ~ i*PU + j*PEU + m*Size
+ BI ~ a*SQB + b*CB + c*TEMP
+ BI ~ d*CH
+
+ # Residual Correlations
+
+ SQB ~~ CB
+ SQB ~~ CH
+ CH ~~ CB
+ SQB ~~ TEMP
+ CH ~~ TEMP
+ CB ~~ TEMP
+ Size ~~ TEMP
+ Size ~~ CH
+ Size ~~ CB
+ Size ~~ SQB
+
+ # Direct Effects
+
+ SQB_dir:=a
+ CB_dir:=b
+ TEMP_dir:=c
+ CH_dir:=d
+ Size_dir:=m
+
+ # Indirect Effects
+
+ SQB_ind:=e*i
+ CB_ind:=f*i
+ TEMP_ind:=g*i
+ CH_ind:=h*j
+ Size_ind_PU:= k*i
+ Size_ind_PEU:= l*j
+
+ # Total Effects
+
+ SQB_total:=a+(e*i)
+ CB_total:=b+(f*i)
+ TEMP_total:=c+(g*i)
+ CH_total:=d+(h*j)
+ Size_total:= m + (k*i) + (l*j)
+ '
> fit<- sem(model, data=Thesis_V1, estimator = "MLM" , test = "satorra,bentler", se = "robust.sem")
> summary(fit, standardized = TRUE, fit.measures = TRUE)
```

Figure 19: R code survey research model (Author)

Appendix C: Matrix display interview data

Table 5: Matrix display interview codes (Author)

Category	*Theme and codes*	*Amount of mentions*	*Mentioned in interview*
Institutional context			
	Conservative industry		
	No room for interpretation and innovation in contracts	1	2
	The right drivers for innovation not built into organizations	2	2
	Organizations that mean well get frustrated by the conservative market	1	2
	The industry is conservative	2	1
	Social pressures		
	Social pressure stimulating innovation	1	1
	Engaging in innovation that is more broadly being applied	2	1
	Waiting for others to innovate	1	1
	Regulations		

a

	Regulation as a stimulator of innovation	3	1
	No drive to innovate more than required by regulation	2	1
	Regulation as a barrier to innovation	3	1&2
People			
	Stakeholders & Supply-chain		
	Difficult to educate and convince all actors	2	2
	Many stakeholders that need convincing	1	2
	Supply chain issues as a barrier to innovation	1	2
	Social network as a stimulus of innovation	1	2
	Supply chain issues can be managed	1	2
	Important to create the same incentives for all parties	1	2
	Split incentive with client		
	End-user should be the one to take initiative	2	1
	The need to align incentives with client using a business model	10	1&2
	Need to be involved with the end-user to innovate	4	2
	Developers hiding behind the risks for the investors	2	2
	Investors will not buy the innovative projects that do not fit their portfolio requirements	2	2
	Organizations are not willing to share profits from green energy with end-user	4	2

b

Organizational context			
	Risk aversion		
	High risk in the industry due to large investments	1	2
	Risk aversion is seen as a positive trait within development organizations	2	2
	Risk-averse organizations and decision-makers	5	2
	Risk aversion as a barrier to innovation	3	2
	Guarantees needed for the clients to accept complex innovation	1	2
	Knowledge		
	Differences in background stimulates innovation	2	2
	A lack of knowledge in the industry	2	2
	To innovate, people are needed that can do and understand more than one thing	2	2
	Highly specialized teams are more efficient but less innovative	2	2
	Company size		
	Larger organizations have more resources than SME's	2	1
	SME's have more flexibility to innovate than large organizations	4	1&2
	Large organizations are more capable to innovate	1	1

c

	Larger organizations have more information and knowledge than SME's	2	1&2
	Large organizations are risk-averse and risk oriented	3	2
	Collaboration between large organizations and SME's as stimulus for innovation	1	1
	Commitment		
	Many building professionals do not have a passion for the industry	1	2
	Passion for the industry and project as a driver for innovation	6	2
	Not many organizations innovate because they want to do something special	1	2
	Be willing to be different is necessary for innovation	1	2
	Creating a sustainable corporate culture as a stimulus for innovation	3	1
Bias and Hassle			
	Status-quo bias		
	Using a known and trusted process as the base for projects	3	1
	Innovation gets compared to the status-quo (Confirmation bias?)	1	1
	There is resistance to do things that have not been done before	3	2
	If innovation gets difficult, the conservative way will be chosen	1	1
	Complex information hassle		
	In-house knowledge should negate the effects of complex information hassle	1	1

d

	Complexity and information overload leads to ill-defined portfolio requirements	1	2
	Real estate developers are affected by the complexity of innovations	4	2
Decision-making considerations			
	Financials		
	Financial considerations as a barrier to innovation	3	1&2
	Financial considerations as a driver for innovation	2	1&2
	Decision-making is financially driven	4	1&2
	Sustainable solutions getting more profitable	1	1
	Strategic gains instead of financial gains as a driver for innovation	1	2
	Proven results		
	Proven results stimulating innovation	4	1&2
	Proven results needed for certification	1	1
	Lack of proven results as a barrier to innovation	7	1&2
	Certification		
	Certificates cannot be designed to fit every project	1	2
	Certification as barrier to innovation	3	1&2

e

Certification and sustainability are used as a marketing tool	5	1&2
Project complexity		
Changing teams and project requirements as barrier to innovation	1	1
Best practices are often used in the industry to reduce complexity	1	2
Similarity in projects stimulating innovation	1	1
Standardized products will not generate innovation	1	2

f

Appendix D: Validity and reliability survey research

Table 6: PCA bias towards conservatism (Author)

	1	*2*	*3*
SQB_1		.728	
SQB_2			.893
SQB_3		.804	
SQB_4			.620
CB_1	.855		
CB_2		.535	
CB_3	.853		

Table 7: PCA complex information hassle (Author)

	1	*2*
CIH_1	.617	
CIH_2		-.817
CIH_3	.710	.467
CIH_4	.795	

g

CIH_5	.732	
CIH_6	.431	.467

Table 8: PCA PU, PEU, and BI (Author)

	1	*2*	*3*
PU_1		.822	
PU_2	.631		
PU_3		.682	.506
PU_4	.643		
PEU_1			.729
PEU_2			.646
PEU_3	.734		
BI_1	.474	.548	
BI_2		.593	
BI_3	.722		

Table 9: Cronbach's alpha (Author)

	Status-Quo Bias	*Confirmation Bias*	*Complex Information Hassle*	*Perceived Usefulness*	*Perceived Ease of Use*	*Behavioral Intent*
Cronbach's alpha	0.57	0.69	0.73	0.75	0.45	0.69
Nr. of items in measure	2	2	5	4	3	3

h

The estimates that are denoted with ** are assumed to be statistically significant.

Table 10: CFA output (Author)

Latent variable	*Total standardized estimate*	*Latent variable*	*Total standardized estimate*
Status-quo bias		***Perceived usefulness***	
SQB_1	0.721**	*PU_1*	0.667**
SQB_3	0.565**	*PU_2*	0.651**
Confirmation bias		*PU_3*	0.690**
CB_1	0.717**	*PU_4*	0.624**
CB_3	0.727**	***Perceived ease of use***	
Complex information hassle		*PEU_1*	0.653**
CH_1	0.481**	*PEU_2*	0.331
CH_3	0.794**	*PEU_3*	0.447
CH_4	0.631**	***Behavioral intent***	
CH_5	0.478**	*BI_1*	0.688**
CH_6	0.595**	*BI_2*	0.655**
		BI_3	0.600**

Appendix E: Answer distribution survey

Table 11: Answer distribution survey (Author)

	TD_1	*SQB_1*	*SQB_3*	*CB_1*	*CB_3*	*CH_1*	*CH_3*	*CH_4*	*CH_5*	*CH_6*
Experienced	13.67%	16.51%	18.53%	7.34%	27.52%	29.36%	24.77%	15.60%	17.43%	40.37%
Neutral	-	14.68%	19.08%	12.84%	38.54%	35.80%	33.03%	33.02%	44.04%	12.84%
Not experienced	86.24%	68.81%	62.39%	79.82%	33.94%	34.86%	42.20%	51.38%	61.47%	46.79%

Table 12: Answer distribution survey (Author)

	PU_1	*PU_2*	*PU_3*	*PU_4*	*PEU_1*	*PEU_2*	*PEU_3*	*BI_2*	*BI_2*	*BI_3*
Positive	55.05%	33.94%	46.79%	46.79%	36.70%	18.35%	45.87%	68.81%	10.09%	49.54%
Neutral	32.11%	51.38%	42.20%	47.71%	46.79%	70.64%	49.54%	39.45%	37.62%	46.79%
Negative	12.84%	14.68%	11.01%	5.50%	16.51%	11.01%	4.59%	8.26%	52.29%	3.67%

j

Appendix F: SEM output

The estimates that are denoted with ** are assumed to be statistically significant, while the estimates denoted with * are assumed to be marginally significant.

The estimates that are denoted with [a] are correlations, while the estimates that are denoted with [b] are a covariance.

Table 13: Correlation and covariance matrix (Author)

Direct effect	*Temporal discounting*	*Status-quo bias*	*Confirmation bias*	*Complex information hassle*	*Company size*	*Perceived usefulness*	*Perceived ease of use*	*Behavioral intent*
Temporal discounting	-	-0.008[b]	-0.039[b]	-0.106[b]	-0.129[b]	-0.029[a]	-	-0.034[a]
Status-quo bias		-	0.152[b]	0.466[b]**	-0.347[b]**	0.229[a]	-	-0.411**
Confirmation bias			-	0.495[b]**	0.072[b]	-0.310[a]**	-	0.103[a]
Complex information hassle				-	-0.259[b]**	-	-0.251[a]	-0.012[a]
Company size					-	0.077[a]	-0.001[a]	-0.251[a]
Perceived usefulness						-	-	0.817[a]**
Perceived ease of use							-	0.090a
Behavioral intent								-

k

Table 14: Indirect and total effect on behavioral intent (Author)

Indirect and total effect	*Indirect effect mediated by perceived usefulness*	*Indirect effect mediated by perceived ease of use*	*Total effect*
Temporal discounting	-0.024[a]	-	-0.058[a]
Status-quo bias	0.187[a]	-	-0.224[a]
Confirmation bias	-0.253[a]*	-	-0.150[a]
Complex information hassle	-	-0.023[a]	-0.035[a]
Company size	0.063[a]	-0.000[a]	-0.152[a]

l