Wood We Change?

Business Model Innovation Towards Sustainability Transitions: Studying the Wood Construction Industry

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Business Administration

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Abstract

Innovations based on sustainable technologies have been widely considered as a remedy for addressing societal and environmental problems in many industries. However, the large-scale adoption of such innovations goes beyond technology and requires organizing the business in a way that drive industrial transformations across actors and system layers, such as market structures, institutional frames, consumer behavior, and business values.

The aim of this dissertation is to understand how industrial firms organize for system change towards sustainability. The study is a compilation of two papers within the same research context: the development of sustainable technology in the construction industry. The overlapping unit of analysis for both papers is business model innovation. Paper I examines how industry firms combine and complement business models with different innovation types to accelerate sustainable technology. Paper II identifies how a change in the business model and value creation logic that occur on a firm level accelerate sustainable technology and shape the socio-technical system. Together, both papers help paint a more complete picture of the business model role in transitions towards sustainability. The theoretical frame of this dissertation spans several domains: business model, innovation management, and sustainability transitions. Building on a multi-disciplinary premise, the study takes into account the organizational and the systemic parts of the change process by linking the company perspective (business models) to the wider governance of sustainability transitions.

The findings underline the importance of business models that combine production efficiency with higher customer engagement and more collective value creation for driving larger-scale transitions toward sustainability. Moreover, business models in combination with different innovation types, such as product, process and positioning, act together and complement each other to achieve high sustainability and business outcomes.

Keywords: Business model, Innovation types, Sustainability transitions, Sustainable technology, Construction industry.

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Karlstad, October 2021

Andrey Abadzhiev

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List of Abbreviations

BM	Business model
BMI	Business model innovation
CO2	Carbon dioxide
CLT	Cross-laminated timber
CVC	Construction value chain
GDP	Gross domestic product
SBM	Sustainable business model
SDGs	Sustainable development goals
TBL	Triple bottom line

> "… if there was a button I would press to stop all hydrocarbon usage today I would not press it. It will cause the whole human civilization to come to a halt. It would be irresponsible to press that button. What does need to happen is to accelerate the transition towards renewables. That's the sensible things to do."

Elon Musk

1. Introduction

Through its economic activities, our modern civilization heavily contributes to climate change. The sixth consecutive assessment report of the IPCC warns of dramatic climate scenarios if we do not take immediate actions to drastically reduce global greenhouse gas emissions (IPCC, 2021). Such alerts raise public awareness of sustainability and create an imperative for change towards finding alternative development paths that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987, p 6). The corporate response to such imperatives has been to link sustainability with business strategy by adopting sustainable practices into the established models and structures (Hoffman, 2018). Consequently, businesses have been "greening" their existing offerings without deeply engaging with industry transformations and core organizational values (Roberts, 2001). However, the implementation of sustainable business practices into unsustainable models is reaching the limits of what it can accomplish (Milne and Gray, 2013). Although business has shown commitments to sustainability with some self-regulation initiatives (such as corporate social responsibility) (Brown et al., 2009), whole sectors of our economy maintain the dominance of unsustainable technologies and business models that no longer reflect the dynamic reality. For example, the contribution to air and water pollution from critical sectors such as transportation and construction is at an all-time high (Renz et al., 2016). The examined sectors are continuing exploiting finite resources, applying unsustainable technologies, and mainly focusing on profit and shareholder value maximization (Bocken and Short, 2021). Rather than changing the unsustainable system, business continues finding innovative ways to exploit it.

Sustainable development paths in many industries goes beyond the implementation of sustainability into "business as usual". The corporate potential to meet the grand societal challenges is rooted in its ability to transform such industries and make them more sustainable

(Loorbach et al., 2017). Such transformations require key players to take a proactive role in “creating sustainability” (Ehrenfeld, 2009) and changing the established system (Lütkenhorst et al., 2014). The proactive mindset and sustainability commitment discards traditional strategy notions that companies must find their best fit with the existing environment (Porter, 1979). Instead of perceiving the established market and industry rules as standard-setting, companies must find ways to transform them.

Realizing the need for larger-scale changes, some actors take the frontlines of transitioning whole industries towards sustainability. Such transitions are seen as systemic shifts from unsustainable path-dependency that capture our hopes of making a lasting impact at scale (Markard et al., 2012). Examples of transformative businesses like Tesla (automotive), Siemens (industrial engineering), and Michael Green Architecture (construction) enable deeper changes both within organizations and in the industries in which they operate. The success of those examples is often related to autonomous innovations (Chesbrough and Teece, 1998), such as sustainable vehicles, engineering, or construction technology. However, it is virtually impossible for an autonomous sustainable innovation by itself to bring about such systemic transformations (Waddock et al., 2015). Addressing sustainability problems should ultimately target systemic changes of whole industries (Aagaard et al., 2021), including the structures, paradigm shifts, and values that govern the business. Thus, the potential of sustainable technologies to provide real societal implications is locked in such systemic transformations. Built on this premise, successful scaling and market adaptation of sustainable innovations requires innovative models for organizing the business in a way that drives deep transformations across actors and system levels (Loorbach, 2010).

This thesis is about *organizing for system change* and focuses on the transformative power of business models in accelerating sustainable technologies and shaping the system within which they operate. Organizing for system change is a highly complex process and, as such, it needs to utilize the experience from different disciplines to understand the issue under study. A single theoretical angle is also insufficient to serve as a backbone of sustainable development, which usually combines multiple theoretical perspectives from different research fields (Lüdeke-Freund et al., 2020). The multi-disciplinary approach provides opportunities to combine different arguments in support of sustainable development. Recently, scholars have synthesized insights from multiple research disciplines such as *sustainability transitions* (STs) and *business models* (BMs) in addressing the sustainability of large-scale industrial contexts (e.g. Hannon et al., 2013, Bolton and Hannon, 2016, Huijben et al., 2016, Schaltegger et al., 2016, Wainstein and Bumpus, 2016, Sarasini and Linder, 2018, Jonker and Faber, 2019). STs are perceived as processes that transform the existing socio-technical system to another, more in line with the sustainability goals (Geels, 2010) while a BM is understood as a firm architecture of value creation, delivery, and capturing (Teece, 2010). Building on a multi-disciplinary premise, scholars study *organizational* and the *systemic* parts of the change process by linking the company perspective (business models) to the wider governance of sustainability transitions (Gorissen et al., 2016).

While previous research has improved our understanding of the transformative properties of business models (i.e. Proka et al., 2018, Gorissen et al., 2014), it also has certain limitations. First, previous studies depart from either product or business model innovation perspectives. They have not taken into consideration the complementarity power of other innovation types such as process and positioning (Francis and Bessant, 2005). However, individual innovation types (such as business model innovation) can be truly understood only in relationship with the other innovations (Damanpour and Gopalakrishnan, 2001). Second, most transitions studies have neglected the business logic and value creation mechanisms by "niche" innovation firms. However, the environmental dynamic requires changing the business logic rather than merely improving how business is currently being conducted (Fjeldstad and

Snow, 2018). There is an inherent link between value configurations and the business model, which in the transitions studies suffers from ambiguities.

To summarize, previous research on business models and sustainability transitions has not examined the complementarity power of various innovation types and the business logic of different value configurations in depth. In addressing these research gaps, and in responding to the calls of Geels (2011) and Boons and Lüdeke-Freund (2013) for further research on the role of business models in sustainability transition, I make two main contributions in this thesis. First, I show that business model innovation acts with and complements different innovation types to achieve high sustainability and business value outcomes. Second, I provide an in-depth case analysis of a configuration of value creation that unlocks the potential of novel technology and shapes the entire industry towards more sustainable development.

The thesis consists of two appended papers, along with an overarching line of arguments that are developed based on the findings of the appended papers (referred to in this study as the kappa). The following chapters of the kappa continue with a discussion about the theory, method, and results of the thesis.

1.1.Research aim and research questions

The overall aim of the thesis is to understand how business models drive system-level changes towards sustainability. The thesis departs from the traditional BM literature that has primarily limited its attention to how innovation can better capture value for the organization and benefit its own business (Tidd and Bessant, 2018). The present thesis is built on the premise that a firm's operations can have consequences at the system level (Norman and MacDonald, 2004) and a more profound impact on economic, environmental, and social development (Boons and Ludeke-Freund, 2013). Therefore, the extant research perspectives see innovation performance beyond mere firm survival and profitability and link it to the up-to-date challenges faced by organizations and sustainability goals and the inseparability of the triple-bottom-line

(TBL) principles (Kramer and Porter, 2011, Isaksson et al., 2015). The empirical context is based on novel engineering technology in wood construction that can be described as "niche" innovations with the potential for industry transitions towards sustainability. The formulated research aim leads to two research questions that guide this research.

The first research questions study the business model as part of a wider innovation space together with other innovation types (for example, product, process, and positioning) and take into consideration their complementarity that leads to high sustainability and business performance. Previous research has a shared understanding that innovation is a complex phenomenon. However, literature has often overlooked the relationship between different innovations on performance (Fagerberg, 2004), emphasizing the effects of autonomous innovations (Damanpour, 2010). Considering the overall research aim, my first research question (RQ1) is: *How do firms innovate and act upon sustainable technology?*

The second research question deepens the focus on the actual innovation of the business model and links it to different logics of value creation. The dynamic environment and the growing sustainability concerns require "changing the logic of doing business rather than merely improving how it is currently being conducted" (Fjeldstad and Snow, 2018, p. 34). Since there is considerable ambiguity regarding the value creation logic behind transformative business models, the second research question (RQ2) is: *How do firms' value creation logic influence the transformative power of their business model?*

Finding the answers to these questions sheds more light on the role of the business models in changes with wider socio-technical consequences. In examining the business initiatives that pursue sustainability transitions in the construction industry, it becomes possible to understand what constitutes *organizing for system change*.

Paper I addresses RQ1 and aims to improve the understanding of the integrative view of innovation and how different innovation types act in combination and complement each other to accelerate sustainable wood technology in the construction sector. Paper II address RQ2 and aims to improve our understanding of how value creation logic and business activities that occur at the firm level influence broader societal and sustainability changes. Both papers look at the systems change from different perspectives (individual firm and value chain perspectives) to identify certain elements (innovation patterns, value creation logic, business activities, actor roles, and landscape forces) that trigger such changes. The research outcomes provide knowledge about how organization for system change occurs in relation to the identified elements.

1.2. Empirical context of the thesis

The empirical context of the thesis is in the construction industry. The construction industry is one of the world's largest and most socially important industries, accounting for 13 percent of global GDP, annually expanding by 3.4 percent, and performing core and basic functions for society: the needs for housing and infrastructure (CIC, 2015). Global megatrends such as ongoing urbanization, population growth, and climate change underpin the pressure on construction companies to provide healthy and affordable housing while focusing on sustainability at the same time as staying profitable.

In the next 30 years, the world's population is projected to reach 10 billion people, 68 percent of whom will live in urban areas, which means more homes, roads, and other infrastructure (DESA, 2018). Identifying the critical trends in urbanization is important for implementing the 2030 Agenda for Sustainable Development, including efforts to shape a new framework of urban growth (DESA, 2016). Since urban space is a sacred commodity, high-rise construction is the ultimate way forward for city development. However, the solid mineral-based materials that are currently used to build high-rise buildings, such as concrete and steel, have a large environmental footprint in terms of high levels of CO_2 emissions and direct destruction of ecosystems (Gibbs and O'Neill, 2014). Challenged by both urbanization and climate change problems, cities need to find ways to expand and become greener at the same time.

One possible solution could rest in the natural wood material, which has been used throughout our entire history of building. Sustainably harvested wood is perceived as renewable, recyclable, and a carbon sink material, but regular timber is not strong enough to build high. The forest-based sector has come up with an innovative solution called "engineered wood" (or engineered construction wood, ECW). ECW as a technology indicates the beginning of a radical change in construction by introducing the first new way of building high-rise structures following more than a century of steel and concrete domination (Green and Taggart, 2020). Due to its robust technical properties, ECW offers sustainable and resource-efficient construction, which significantly contributes to the decarbonization of the sector. The increasing development and adoption of novel technologies based on forest biomass in high-rise buildings has enabled the construction industry to sustain economic prosperity and satisfy growing demand while reducing its environmental footprint (Näyhä et al., 2015). Therefore, the development of construction wood technology has emerged as a promising approach for tackling sustainability problems of buildings (Toppinen et al., 2013). The dynamic changes in forest-based and construction sectors have become an interesting context for understanding the role of business models in the development of sustainable technologies.

1.3. Contribution of the appended papers

This thesis contains two studies (Paper I and Paper II), which are in a submission stage for peer-reviewed journals (paper I to *Management Decision* and Paper II to *Creativity and Innovation Management*). The research questions are positioned in the domains of "business model", "innovation management" and "sustainability transitions" research. The two distinct empirical settings are outlined as "focal firm" and "value chain" perspectives (see Fig. 1.1.). The *focal* *firm* perspective includes business logic and activities that a focal firm perform in order to create value, while the *value chain* perspective at the industry level represents a larger stream of activities (starting the process with raw materials and ending with the delivered product/services) carried out by various firm actors (Porter, 1985, Brown, 1997). Since the theoretical domains are interlinked, the articles overlap them. Paper I identifies how various actors in the construction value chain combine and complement different innovation types to accelerate sustainable wood technology. The dominant theoretical domain of the paper is innovation management, which partially overlaps with the business model and sustainability research. Paper II identifies how value creation logic and business model decisions that occur on a firm-level accelerate sustainable niche innovation and comprise different levels of the social systems towards sustainability transition. The boundaries between the dominant theoretical domains are blurred and the article actively involves the three of them when studying the research questions. The key findings that address the research questions are summarized below.

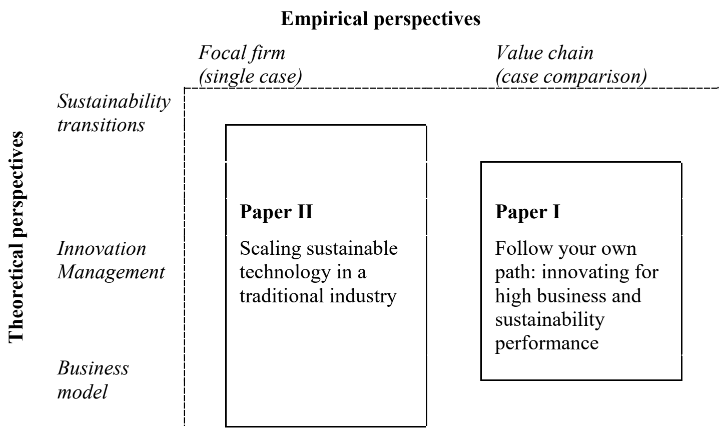

Figure 1.1. Theoretical and empirical perspective of the appended papers

Research question (1). How do firms innovate and act upon sustainable technology?

The successful implementation of novel and sustainable technology, studied in the context of the construction value chain, is possible when the actors find their own approach to innovation, combining a wide range of innovation activities. Four innovation activity types are outlined in this paper (product, process, positioning, and business model innovation), underlining the importance of understanding them holistically. By considering an integrative view on innovation, the four different innovation types are brought together to identify the complementarity between each other in practice. It also highlights the tight connection between the novel and sustainable technology and innovation. In the context of the research, sustainable technology accelerates different types of innovation, leading to changes in firms' market offerings and organizational processes, as well as their logic when it comes to approaching the market. The research question required linking innovation management and sustainability literature in an attempt to advance our understanding of how different innovation types complement each other in different ways and from different actors across the entire value chain, which speeds up the spread of new sustainable technology.

Research question (2). How do firms' value creation logics influence the transformative power of their business model?

Industrial firms can search for new ways of creating customer value by combining multiple value creation logic (see the chain-shop-network typology of value configuration). The business model performs the value logic of the company. A shift in the value creation logic influences a firm's strategic choices of the business model elements and their linkages, and determines the way the company configures and engage resources, customers, and partners in the value creation process. A business model that triggers larger-scale changes can be built upon the traditional industrial way of doing business (value chain) and extend it by increasing customer engagement (value shop) and network openness (value network).

The firm can build mechanisms to increase customer engagement by joint value creation in the context of services. The network openness can be created on a partnership between multiple organizations that goes beyond the scope of individual construction projects and provides the possibility to create value by building a core technology, which connects multiple actors in an ecosystem by applying “platform business” principles. Customer engagement and network openness can accelerate the development of sustainable technologies and give birth to a new economic, social, and technical structure in which industry-spanning actors collaborate in loosely coupled principles. The contribution of the research question is featured in bridging the business models literature with that of sustainability transitions by advancing our understanding of how different combinations of value creation can contribute to sustainability transitions and how a change in the business logic may foster the transformative potential of business models. Empowered by the innovative business model, combining multiple value creation logic, companies can change the mechanisms by which activities and resources are integrated beyond the scope of the value chain and co-create a part of their environment for driving sustainability transitions. The company can also transform the way it creates and delivers lifetime value for its customers and partners.

1.4.Structure of the dissertation

Chapter 1 – Introduction: The first chapter introduces the background of the current research by providing the empirical context, the overall purpose, the empirical and the theoretical problems, and the research questions. This is followed by an overview of the overall contribution of the thesis, followed by a structural framework of the dissertation.

Chapter 2 – Theoretical framework: This chapter provides the theoretical groundwork of the dissertation, combining previous research on business models, innovation management, and sustainability transitions, as well as overlapping research areas of those three fields.

Chapter 3 – Methodology: Chapter 3 describes the research process, the applied methods, and the design of the empirical studies.

Chapter 4 – Summary of the appended articles: This chapter shows the contribution of the appended papers that constitute this dissertation, with emphasis on the findings related to the research questions.

Chapter 5 – Discussion: This chapter reflects on the way this paper addresses the research questions and elaborates on the theoretical framework.

Chapter 6 – Limitations and further research: Chapter 6 presents the overall theoretical and managerial contribution of the thesis and suggestions for further research.

Chapter 7 – Conclusion: This chapter provides the conclusions of the thesis.

2. Theoretical framework

The theoretical framework of this thesis is built on three broad research areas (see Fig. 2.1). The first domain is the concept of *business model,* which is recognized as a core unit of analysis in the study. The second dimension is *innovation management* and the third one is *sustainability transitions*. These three research areas overlap and the three intersections are *business model innovation, sustainable business model, sustainable innovation,* and *business model innovation for sustainability transitions.*

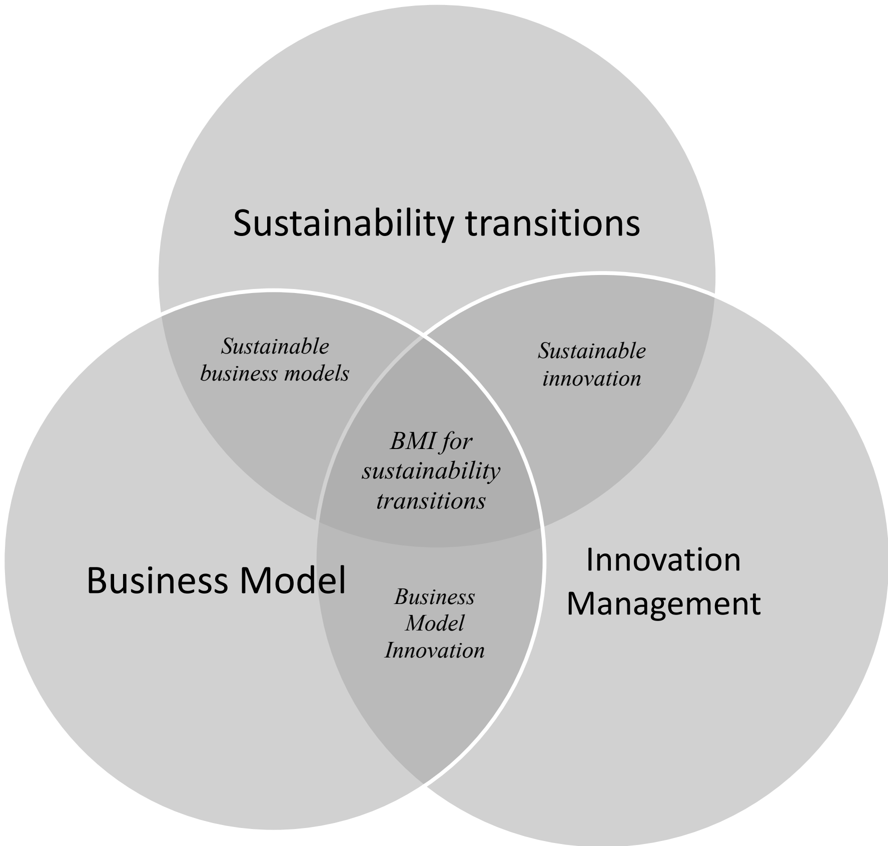

Figure 2.1. Dominant research areas in this thesis

In this thesis, the presented theoretical domains and their intersections are perceived as key theoretical viewpoints. The business model perspective helps to understand the architecture and organization of the business, innovation management contributes by understanding various innovation types and their complementarity, and sustainability transitions allow to understand the process of change on a system level. In the overlaps between these perspectives, some other distinct core concepts are identified. Ultimately, the thesis is situated on the phenomenon where they all play a role and help study business model innovation (BMI) for sustainability – or how BMI facilitates novel technology and drives large-scale system transitions towards sustainability.

2.1. Business model

A business model (BM) as a concept is polyphonic. In the art of music, polyphony consists of two or more simultaneous lines of independent melody in a single musical texture. The state of the art in BM research expresses polyphony as the property of the concept to have several meanings and different lines of research inquiry. A few things predetermine the polyphony of BM. The complex and systemic nature of BM (Massa et al., 2017, Berglund and Sandström, 2013) accepts the existence of many points of research departure, as the phenomenon encompasses multiple building blocks that go beyond the focal firm perspective. The complexity is also characterized by high-order interconnections within the BM elements and between them and the environment. Another factor that drives the polyphonic meaning of the term is the multiple disciplines from which BM scholars originate (such as strategic management, innovation management, strategic corporate entrepreneurship, marketing management, and sustainability). The variety of scientific disciplines enriches the knowledge base, but also connotes different meanings to the term, which complicates the constructive dialogue on the topic. The multiple viewpoints lead to disagreements, which could sharpen the criticism between the formed groups and leave little evidence of bridging and establishing a common research ground. Accordingly, the BM research is not developed based on a common and widely recognized language that allows a cumulative dialectic (Zott et al., 2011). A degree of cumulativeness would allow researchers to work more effectively on each other’s research.

The different points of departure in researching BMs predetermine the variances in the applied theories and generated definitions. The variety of research angles have associated BMs with “activity system” (Zott and Amit, 2010), “architecture” (Teece, 2010), “market device” (Doganova and Eyquem-Renault, 2009), “logic” (Magretta, 2002), “recipe” (Baden-Fuller and Morgan, 2010), and “canvas” (Osterwalder and Pigneur, 2010).

Some scholars (Wirtz et al., 2016, Gassmann et al., 2016, Massa et al., 2017, Foss and Saebi, 2017) have systematized the spectrum of different BM conceptualizations. There are several common themes in the identified distinct scientific discussions. The strategy literature observes BM as a source of competitive advantage (Demil and Lecocq, 2010, Casadesus-Masanell and Ricart, 2010). The innovation management perspective sees BMs as a bridge that links new technology with the markets (Chesbrough and Rosenbloom, 2002, Teece, 2010). Organizational perspectives forward BMs as artefacts that represent a company’s architecture and organizational reality, and this representation can be interpreted as an abstract cognitive model (Doganova and Eyquem-Renault, 2009, Magretta, 2002) or a more formal blueprint that simplifies the way the business function (Osterwalder and Pigneur, 2010, Baden-Fuller and Morgan, 2010, Zott and Amit, 2007). Marketing scholars see BMs as a service strategy (Wieland et al., 2017, Witell and Löfgren, 2013), while sustainability scholars put the social and environmental effects of the BM at the center, in line with the economic one (Lüdeke-Freund, 2010, Bocken et al., 2014). The identified boundaries between the themes are not clearly defined. Some scholars blur them by linking different viewpoints when researching BMs and casting light from multiple research angles, with the explicit goal of rendering a more comprehensive picture. Unfortunately, conceptual converging is currently less evident among all the themes due to the inconsistent use of terminology (Wirtz et al., 2016). Despite the progressive research development and high interest among practitioners, very few steps have been made to unify the terminology in all different themes and filter a generally accepted understanding of BMs. Different groups use the same conceptions with different meanings. However, some of the definitional convergences among scholars are now traceable. They outline the concept of the business model as "architecture of value creation, delivery and capture mechanisms" (Teece, 2010, p. 172) that "span firm boundaries" (Zott and Amit, 2010, p. 216) and "encourages systemic and holistic thinking" (Zott and Amit, 2010, p. 223).

In an attempt to position the current study in relation to the listed themes, I define the business model as it "articulates the logic and provides data and other evidence that demonstrates how a business creates and delivers value to customers" (Teece, 2010, p. 173). This definition frames BM as an imprint of the business logic and the means of realizing it. The conceptualization also embodies "the organizational and financial architecture of the business" (Teece, 2010, p. 173). The current interplay is between two spaces: (1) BM as a bridge of new technologies with their market expression; and (2) BM as a scaled-down, simplified, and formal blueprint that takes the shape of a graphical framework composed of elements and their interdependence.

In recent years, multiple scholars have studied the connections of BM with new technologies and filtered the generally accepted understanding that BM combines creativity and technology with customer satisfaction and financial sustainability (Chesbrough and Rosenbloom, 2002, Teece, 2010). BM becomes a bridge for many manufacturing firms that rely on technological innovations for improving their performance. BM answers key questions about how technologies become widely accepted and how firms monetize the value of their offering. Technological innovations and business models have a strong, two-fold connection (Baden-Fuller and Haefliger, 2013). On one hand, a BM can be a link that connects innovative technologies with the market realms. BMs mobilize technologies to improve company performance. On the other hand, the development of specific technology is dependent on the selected BM and its degree of openness (Chesbrough, 2010). Scaling up a technology often involves the inclusion of external technologies or services, and the level of BM openness determines the successful development of the complementarities network.

Since BM describes the value logic of an organization, scholars have been searching for an optimal frame that addresses the interrelated set of BM elements with regard to the customer, value proposition, organizational architecture, and economic dimensions (Fielt, 2014). In recent years, several proposals have been made for BM frameworks (for an exhaustive review, see, e.g., Zott and Amit, 2010; Chesbrough and Rosenbloom, 2002; Casadesus-Masanell and Ricart, 2010; Demil and Lecoq, 2010; Osterwalder and Pigneur, 2010; Teece, 2010; Fielt, 2013; Gassmann et al., 2014; Massa et al., 2017). The Gärtner and Schön (2016) modular framework is one means of categorizing different business model types. That framework describes three core dimensions: value proposition, value creation, and value capture (Fig. 2.2). The value proposition consists of the offered product/ service mix and the intended prices. The firm's core assets and capabilities, complemented by the partner network, define the value creation dimension. The value delivery and capture dimension include the different channels and the pricing structure (Gärtner and Schön, 2016; see also: Teece, 2018). The framework was preferred for the reason that it is based on the idea of building a complex BM system from smaller subsystems or modules. The modular system represents a specific set of choices about the six elements and their combination and coordination, which gives a powerful lens for analyzing and managing the transformation of business models.

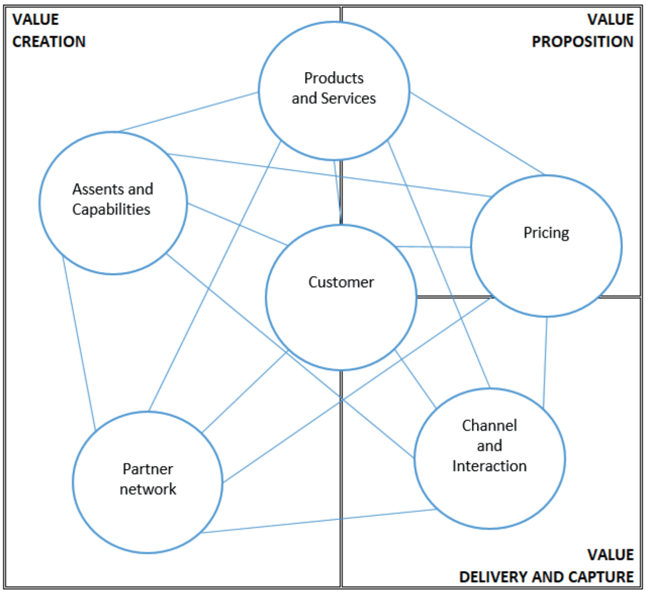

Figure 2. 2. The business model framework adapted from Gärtner and Schön (2016)

The development of new technologies requires alignment with a BM, which is subject to specific business logic, in order to extract the optimal market potential. The configuration of value (Stabell and Fjeldstad, 1998) represents the business logic, which is applied with the market recognition of a given technology. The applied business logic, in turn, predetermines a formal BM framework, including the BM elements, the involved activities, and their relationship. For example, if the commercialization of technology follows a pure manufacturing logic (Porter, 1985), it applies a property space where the respective BM will develop on cost efficiency and standardization, which largely excludes the active role of customers or a network beyond the value chain in the value creation process. On the other hand, the business logic can be extended with elements of servitization or integrating service activities to product offerings to increase customer value (Vandermerwe and Rada, 1988). Another direction to change the business logic is the value network, where the company can organize its activities beyond firm and industry boundaries by connecting various actors and structuring its business in cooperation and interdependence (Zott and Amit, 2009). Servitization and value network logic would dictate a different framework in which the respective BM will develop.

2.2. Innovation management

Innovation has a heterogeneous background that spans several research fields, including business, economics, engineering, and public administration. The literature on innovation traced by the various research fields is growing rapidly and it has become difficult to gain a thorough overview of the area (Fagerberg, 2004). Regardless of the increased literature volume, the way we study innovation today is primarily influenced by the work of Joseph Schumpeter. Considered the founder of modern innovation research in his fundamental writings, the Theory of Economic Development (1934) and Business Cycles (1939), Schumpeter defined innovation as the driving force behind economic and social change (Fagerberg, 2004, Hanusch and Pyka, 2007). Schumpeter (1939) considered innovations as novel combinations (of existing resources) that drive economic development. He further separated the process of innovation into four dimensions (invention, innovation, diffusion, and imitation) and made a distinction between invention (technical/scientific outputs) and innovation (economic exploitation) (Hanusch and Pyka, 2007, Fagerberg, 2003). Schumpeterian understanding of technological innovation as the driver of long-term change begins with a general equilibrium (grounded on well-defined fundamental technologies and preferences), followed by a shock (the entrepreneurial innovator introduces an unexpected innovation), which brings about “creative destruction” and then the economic system adapts via technological imitation and diffusion of the innovation (the system converges once more to a new equilibrium) (Dosi, 2013). Based on Schumpeter’s evolutionary ideas, researchers conceptualized innovation as a sequential process, including identification of problem/opportunity, development, production, commercialization, adoption, and implementation (Rogers, 2010). The innovation process can be further discerned between generation and adoption (Damanpour and Gopalakrishnan, 1998). Both processes of generation and adoption of innovation are prioritized and performed differently by different organizations (Van de Ven, 1996). For instance, many companies have focused on identifying and acquiring already generated new ideas in order to fulfil needs or solve problems (Damanpour and Wischnevsky, 2006). Schumpeter explained the temporal economic benefits of successful innovation with masses of imitators that gain markets by adopting innovations generated from other organizations (Fagerberg et al., 2013).

Schumpeter (1939) further called innovation "the creative destruction" that changes the economy and distinguished between radical and incremental innovation. Radical innovation is facilitated by independent entrepreneurial organizations that act as major agents of change in creating new industries and disrupting established ones (Sanidas, 2005). Thus, innovation in that sense concerns radical, discontinuous change mainly driven by technology push and productive revolutions (Damanpour and Wischnevsky, 2006). Following the Schumpeterian idea of "creative destruction" (Schumpeter, 1939), previous research has explained how novel technologies replace established ones (Abernathy and Clark, 1985) and are discontinuous from the dominant design (Anderson and Tushman, 1990). Discontinuous innovation research has primarily studied autonomous technologies that do not require systemic change for successful development and commercialization (Taylor and Levitt, 2004). However, innovations often require systemic change that cannot be facilitated with the efforts of a single firm (Bohnsack et al., 2014). The complexities involved with innovation are not always technology-based, as they can depend on markets, other actors, competition, or social elements (Dosi, 1982). Thus, some innovation can depend on a series of different interdependent innovations, which makes them "systemic" (Chesbrough and Teece, 1996). Therefore, organizations need dynamic boundaries as a means of responding to the complex environment (Roberts and Amit, 2003) by vertical integration of partners (Amit and Zott, 2001) or building an ecosystem of co-innovators and adopters (Adner, 2013).

Schumpeter (1932) took Karl Marx's idea for technology-driven competition and extended it by distinguishing between five different types of innovation: new product, new methods of production, new market, new sources of supply, and new organizational structure. The terms “product innovation” and “process innovation” have been mainly used in academic research of some issues, but as Fagerberg (2003) suggested, “the focus on product and process innovations, should not lead us to ignore other important aspects of innovation”. Aware of the complex nature of innovation (Damanpour, 1996), scholars have adapted and applied the multidimensional construct of innovation rooted in Schumpeter’s work, aiming to obtain a broader understanding of innovation’s meaning and implications for organizations “going beyond that of changing technology” (Alves et al., 2018). Through the years, research efforts have resulted in categorizing innovation into different types, outlining the different outcomes from innovation activities (Siguaw et al., 2006). Scholars developed a variety of taxonomies, most of which proposed models integrating product–process, administrative–technical, and incremental–radical innovations (Damanpour and Evan, 1984). These classifications involve incremental and radical improvement or development of new products and services, production and administration processes, and novel or improved business models that involve different ways of creating and capturing value (Abernathy and Utterback, 1978, Jayanthi and Sinha, 1998, Khazanchi et al., 2007, Francis and Bessant, 2005). Recent frameworks from Francis and Bessant (2005), applied in this thesis, suggest mapping innovation space that consists of four innovation types orientated towards:

(1) Product innovation – defined as “the commercialization of new goods or services to meet an external user need” (Damanpour, 2010 p. 997);
(2) Process innovation – outlined as new elements and methods introduced into a firm’s manufacturing or service operations to produce new products or services (Utterback and Abernathy, 1975, Damanpour, 1991);
(3) Position innovation – characterized as a change in the context where products and services are introduced to customers (Bessant and Tidd, 2007); and

(4) Business model innovation – defined as “designed, novel, and nontrivial changes to the key elements of a firm’s business model and architecture linking these elements” (Foss and Saebi, 2018 p. 216).

Extant research covers two approaches to innovations: a dominant one that perceives innovation as distinctive elements and studies them individually, and an integrative one that considers the simultaneous performance of different types of innovation and studies how they complement each other. Most studies focus on product and process innovations and research factors associated with one or two types of innovation (Damanpour, 2017). On the other hand, the “integrative” perspective proposes that an individual innovation type can only be truly understood by understanding its relationship with the other innovations (Damanpour and Gopalakrishnan, 2001). Thus, some scholars have suggested an innovation mix of strategies where the innovation types are synchronously pursued to achieve competitive advantage and improved performance (e.g., Damanpour et al., 2009, Wischnevsky et al., 2011, Baregheh et al., 2014, Guisado-Gonzáez and Coca Pérez, 2015, Snihur and Wiklund, 2018).

Studies of innovations can be conducted on multiple levels and embrace individuals, groups, organizations, industries, and economies as units of analysis (Damanpour, 2020). Schumpeter’s ideas are used as a foundation for linking the levels and understanding dynamics of change within firms and for the economy (Dekkers et al., 2014). Thus, organizational and economic innovation overlap as some entrepreneurs innovate and perform the function of the change on a larger system scale. Regardless of the level on which innovation is pursued, the primary driving force for individuals, firms, or the economy is productivity and profitability increase that leads to economic wealth and growth (Drucker, 2014). Thus, outcome values beyond profit and growth are overlooked by a prominent performance perspective of innovation.

The barriers to accomplishing the entrepreneurial function are not the lack of new ideas, but rather their successful implementation into the economic system (Fagerberg, 2003). The cumulative knowledge and existing institutions may cause path-dependency and locked-in behavior of the organizations. However, in his later work, Schumpeter outlined the role of the established firms, the incumbents, not only as a barrier for change, but also as a source of innovation for economic development (Fagerberg et al., 2005). In Schumpeter's corporate model of innovation, incumbents are seen as the vehicles for innovation because of their ability to drive efficiency and effectiveness through the process, easier entry to capital, and established market power (Damanpour and Wischnevsky, 2006).

2.3. Sustainability transitions

One of the biggest challenges in our times is coping with the environmental problems in terms of climate change, biodiversity loss, and decoupling of foil-based resources, which have persistent implications and interdependence with our economy and society. Addressing these challenges requires fundamental changes of individual actors, as well as networks of public organizations, business firms, established institutional norms, regulations, standards, good practices, and tacit knowledge (Markard et al., 2012). Such large-scale networks or systems that can encompass whole sectors (such as, energy supply, transportation, and construction), can be conceptualized as *socio-technical systems* (Geels, 2004, Markard, 2011). The socio-technical systems go beyond technological determinism (dominant in the 1980s), which study technological development separately from society (Bijker, 2006), by acknowledging that any change in the "technogram" of the innovation entails a change in its "sociogram", and vice versa (Latour, 1987). The systemic idea understands the various system elements as interrelated and interdependent (Simon, 1991). Thus, socio-technical systems in addition to the technological dimension include complementary non-technological innovations, shifts in user practices, institutional structures, and social domains (Markard et al., 2012).

Scholars in the field of sustainability transitions are engaged with fundamental processes through which established systems shift towards a more sustainable future (Chatterton, 2016). In that sense, the transition is a set of processes that lead to underlying changes of various system elements, such as technological, organizational, institutional, cultural, and socio-economic (Geels, 2010, Markard et al., 2012) and replace one dynamic equilibrium with another (Loorbach et al., 2017). The need to change from one socio-technical system to another (Bitmon and Knab, 2018) corresponds to the fact that many economic sectors, in practice, are the main contributors to the sustainability challenges. For instance, industries based on fossil fuels (such as transportation, energy and construction sectors) need to overcome their fossil dependency by shifting to technologies based on renewable sources. However, these transitions overstep the domain of technology and encompass the interactions with the economic and social spaces (Murphy, 2015). Thus, sustainability transitions refer to the large-scale system changes that are necessary to solve grand societal challenges (Loorbach et al., 2017). Moreover, achieving transitions require the disruption of existing systems and creation of space for the emergence of new products, services, business models, and organizations that complement and substitute existing ones (Markard et al., 2012), which for a large-scale system usually takes decades. The long time period of transitions is determined by the path dependencies (Loorbach et al., 2017) and lock-ins (Deleye et al., 2019) to technologies, infrastructure, and user practice of the established system (Unruh, 2000). The desired outcome of the transitions is to achieve structural qualitative shifts from persistent unsustainability towards a more sustainable state (Loorbach et al., 2017).

The multi-level perspective (MLP) framework has been considered central for the theoretical framing of sustainability transitions (Smith et al., 2010). Acknowledging that technologies are socially embedded, the process of changes should be viewed on multiple levels by intertwining different elements of the socio-technical system (Geels, 2005). As a process theory, the MLP is based on three analytical levels – niche, regime, and landscape (see Fig. 2.3) (Geels, 2002). The socio-technical regime (meso-level) represents directions of incremental change along the established pathway of development, following traditional business and institutional logic. Geels (2011, p. 26) defined it as "the locus of established practices and associated rules that stabilize existing systems". Informed by evolutionary economics, the regime level is further characterized as a slowly evolving system in which economic and non-economic agents learn and create, exploit, and share knowledge within a limited trajectory of the dominant paradigm (Dosi, 2013). The elements that comprise the socio-technical regime are existing technologies, industry, markets, science, and cultural discourses (Rip and Kemp, 1998, Geels, 2002).

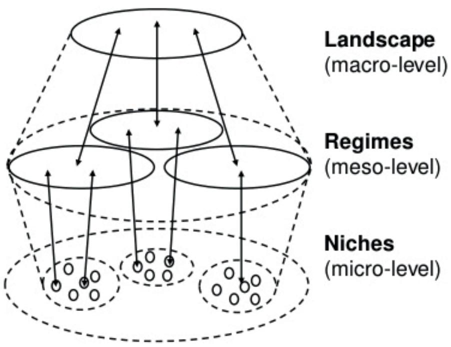

Figure 2.3 The multi-level perspective. Source: Geels, 2002.

A representation of novelty in the MLP model is the socio-technical niche, the micro-level, which represents a small and more protected space where radical innovation can originate. The niche space represents small niche markets or R&D laboratories where innovations are protected from the hostile regime environment (Rip and Kemp, 1998). Successful innovations take advantage of the sheltered niche spaces to gain sufficient scale and get a "window of opportunity", opened by broader and deeper landscape trends for changing the dominant socio-technical regime (Geels and Schot, 2007). A successful niche innovation can affect the current regime if it "fits and conforms" to a relatively unchanged selection environment or by "stretch and transform" to mainstream selection environments in ways favorable to the niche (Smith and Raven, 2012 p. 1025).

2.4. Interplay of the main theoretical building blocks

2.4.1. Business model innovation

In the last decade, business model research has evolved from static descriptions to a more dynamic perspective, focusing on the development and innovation of business models (see, e.g., Chesbrough 2010; Demil and Lecocq 2010; Teece 2010). Business model innovation (BMI) has become a highly discussed research area and its importance for firm performance and competitive advantage has become recognized in both entrepreneurial practice and academia (Zott et al., 2011, Spieth et al., 2014, IBM Global Services, 2006).

A change in the business logic (Fjeldstad and Snow, 2018), structural changes in industries (Hacklin et al., 2018), or technology innovation (Chesbrough, 2010) calls for changes in the business model. A business model can be a vehicle as well as a subject of innovation (Zott et al., 2011, Schneider and Spieth, 2013). Performing as a subject to change, BMI complements the traditional product and process innovation (Zott et al., 2011) by developing novel value creation and value-capturing architectures (Tidd and Bessant, 2018). Hence, BMI represents a more holistic way of organizational innovation than focusing solely on new products, services, or processes. Foss and Saebi (2018) outlined BMI as "designed, novel, and nontrivial changes to the key elements of a firm's business model and architecture linking these elements" (Foss and Saebi, 2018; p.216). Acknowledged as a source of competitive advantage (Pohle and Chapman, 2006), BMI is crucial when launching significantly different products (Björkdahl, 2009).

BMI is difficult to achieve because it might require a fundamental change for the focal company and/or the whole industry (Chesbrough, 2010, Girotra and Netessine, 2013). The dimensions of BM change in terms of novelty and industry scope represent an important step in framing the concept. Foss and Saebi (2017) developed a comprehensive typology matrix that can help organize the different kinds of observed BMI (Fig 2.4). While evolutionary BMI refers to naturally occurring changes to the individual components of the BM over time, adaptive BMI involves changes in the overall BM that are new to the firm, but not new to the industry. Focused and complex BMI can be defined as the process by which management actively engages in modular or architectural changes in the BMI to disrupt market conditions (Foss and Saebi, 2018).

	Scope		
		Modular	**Architectural**
Novelty	**New to firm**	Evolutionary BMI	Adaptive BMI
	New to Industry	Focused BMI	Complex BMI

Figure 2.4. BMI topology (adapted from Foss and Saebi, 2017).

Innovation processes are enabled and challenged by a dynamic environment, which necessitates a widening of the narrow firm-level view in studying BMI. Broadening the lens to see and understand how BMI success and failure depends on other actors considering the entire ecosystem and their full set of dependencies (Adner, 2013). The shift from a firm-centric view of BMIs to a system-centric view changes how the environment is perceived (Berglund and Sandström, 2013). Success in a network requires firms to manage their dependence, but they must first see and understand it (Adner, 2013). Choosing to focus on the ecosystem, rather than merely on the instant business network, provides a promising framework for understanding the interdependence (Moore, 1993, Iansiti and Levien, 2004, Teece, 2018, Jacobides et al., 2018, Adner, 2006). Scholars from different business fields have taken the "ecosystem" approach to studying the interdependence and co-evolution of firm business activities and the external surrounding. The ecosystem structure delivers value by seeing a system of interdependent organizations rather than individual firms (Clarysse et al., 2014). Such a structure recognizes the role of a central firm in the orchestration processes that coordinate, influence, and direct other actors in the ecosystem network by providing system stability and shaping its configuration (Moore, 1993, Teece, 2007).

BMI may complement the traditional product and process innovation (Zott et al., 2011) by developing novel value creation and value capturing architectures (Teece, 2010). Moreover, relying on the notion of low- and high-order systems (Boulding, 1956), BMI is distinguished as high-order innovation that might embody other innovation types (such as a product or process) as subunits or parts. Hence, BMI represents a more holistic way of organizational innovation instead of just focusing on new products, services, or processes.

2.4.2. Sustainable business models

Rising sustainability problems, such as population growth, carbon emissions, social inequality, and destruction of natural ecosystems, are making various stakeholders (customers, regulators, media, etc.) more active in terms of pressuring business entities towards sustainability (Dangelico and Pujari, 2010). Business as usual is not an option for a sustainable future, and a growing school of thought has emerged known as "sustainable business models" (SBMs), which links BM with sustainability research (i.e. Boons and Lüdeke-Freund, 2013, Bocken et al., 2014, Evans et al., 2017, Geissdoerfer et al., 2018). The research group around SBM recognizes BMs as critical for delivering social and environmental sustainability in the industrial context (Lüdeke-Freund, 2010), providing mechanisms to enhance sustainable solutions (Rashid et al., 2013), and can be itself a source of sustainable innovations (Schaltegger et al., 2012). The value logic of SBMs extends the commercial aspect of the traditional BM and encompasses sustainability, consistent with the TBL principles (Bocken et al., 2013). In that sense, SBMs differ from traditional BMs in four ways: (i) the ecological and/or social value measures of the value proposition; (ii) the level of responsibility in the involved supply chain;

(iii) the level of consumption responsibility of the customers; and (iv) the appropriate distribution of economic costs and benefits of the involved stakeholders (Boons and Lüdeke-Freund, 2013). Thus, SBMs are about creating customer and firm value by addressing societal and environmental needs (Boons and Lüdeke-Freund, 2013).

An SBM can be defined as a mechanism that “creates, delivers, and captures value for all its stakeholders without depleting the natural, economic, and social capital it relies on” (Breuer and Lüdeke-Freund, 2014) and “a vehicle to coordinate technological and social innovations with system-level sustainability (Bocken et al., 2014). An SBM involves various stakeholders finding consensus about what impacts should be considered in terms of the TBL dimensions (Lüdeke-Freund and Dembek, 2017). Authors have also argued that SBMs can act as market devices that facilitate a fundamental organizational shift in the purpose of the firm, the value-creating logic, and the perceptions of value (Doganova, 2009, Bocken et al., 2014).

Perceived as a system-level concept, BM sees the organization as a sub-system of a larger inter-organizational network (Massa et al., 2018). The system perspective opens the way for collaboration opportunities and facilitates innovations, which can reach far beyond the boundaries of the focal firm (Aagaard et al., 2021). In recent years there has been growing interest in studying how business models catalyze larger system elements and play a role in sustainability transitions (Hannon et al., 2013, Bolton and Hannon, 2016, Gorissen et al., 2016). Bidmon and Knab (2018) systematically explored the links between innovative BMs and transition theory and identified three BM roles within societal transitions: (i) BMs as part of the socio-technical regime, where the BM hinders transitions; (ii) BMs as intermediates between the technological niche and the socio-technical regime, where the BM drives transitions by mediating the successful commercialization and institutionalization of technological innovation to regime level; and (iii) BMs as non-technological niche innovations, where the BM drives transitions without relying on technological innovation. The findings of Bitmon and Knab

(2018) concluded that a BM can act as an obstacle and a source of socio-technical transitions. Thus, SBM has been recognized as an important feature of transitions research (Schot and Geels, 2008) and market devices in finding ways to deal with “unpredictable wider societal changes and sustainability issues” (Loorbach and Wijsman, 2013, p. 20).

2.4.3. Sustainable innovations

Businesses today face complex challenges, given the fast-changing business environment and global sustainability challenges. Companies are pressured to implement sustainable practices, while also providing an affordable and persistent offering for their end customers, and at the same time remaining profitable for their own survival (Isaksson et al., 2015). In efforts to balance sustainability and profitability, some organizations have attempted to use sustainable innovations as a remedy for more balanced development (Kemp and Volpi, 2008). In the academic literature and among practitioners, sustainable innovations are primarily understood as innovations with an environmental sustainability focus (Carrillo-Hermosilla et al., 2010) and are often narrowed to green- and eco-technology advancements. Thus, the term *sustainable innovations* is most commonly used to refer to a novel product and processes, based on eco-friendly technology, which reduces the environmental footprint. Companies generate and/or adopt innovations based on green technologies, and tag technological development as the driving force towards improving environmental performance. Technological development, based on environmentally friendly technologies, represents the trajectory of multiple innovations that happen over time in an identical and differentiated technological domain (Barnett, 1990). The development synergy of complementary green technologies aims to reach the phase of a dominant design within a specific industry. In that sense, technological development based on green technologies aims for an industry change that reduces the environmental impact (for example, from fossil-based technologies to more ecological ones based on renewable sources). Technological development over time and the establishment of green technologies as a dominant design may lead to changes that go beyond the scope of the industry. There is a growing literature stream that studies technological change and social shifts when existing technology is challenged by novel sustainable technology (Geels, 2005). Technological change in that sense is the outcome of a series of (green) innovations in an industrial context that has a broader impact on macroeconomic, environmental and social development (Nelson, 1982, Damanpour, 2017). However, it is hard to foresee technological development, and green technologies often prove to be sustainable with hindsight. Many green technologies prove to be less sustainable over time due to unintended patterns of use and diffusion since the nature of the innovation processes is not linear and takes unpredictable turns (Kropp, 2018).

Another research stream on sustainable innovations has focused on social problems via the concept of social innovation (Van der Have and Rubalcaba, 2016). Social innovations are often referred to as a means of promoting sustainable development (Jaeger-Erben et al., 2015). For example, studies informed by practice theory have focused on social practices and the transition or transformation of routines (Brand, 2010). A growing body of literature has focused on initiatives and innovations to the so-called “bottom of the pyramid” (Yunus et al., 2010). Within this research stream, sustainable innovation is understood as social, both in its ends and its means (Murray et al., 2010). Sustainable development cannot be achieved through technological innovation alone and must be combined with social innovations, encompassing our lifestyles and cultures (Green and Vergragt, 2002).

There is growing acknowledgement that sustainable innovation is not just about the environment, and also includes interplay with economic and social goals (Boons et al., 2013). Sustainability innovation not only improves environmental performance, but also needs to maintain the balance between all sustainability dimensions. Thus, building on previous research, sustainable innovation can be defined more holistically as an innovation that improves sustainability performance, where performance is measured by ecological, social, and economic dimensions (Boons and Lüdeke-Freund, 2013). Innovations often go beyond technology and can include all different types of innovation, including products/services, processes, positioning, and business models (Francis and Bessant, 2005). The inclusion of different innovation types and their interplay is important in order to gain a more precise understanding of sustainability innovations and their potential to meet sustainability goals. Some scholars consider the radicalness of sustainable innovation important (Charter et al., 2008), while others have highlighted the large cumulative economic impact of incremental innovations, if not larger than more disruptive forms of the radical ones (Lundvall, 2010).

The efforts of some scholars to understand how innovation for sustainable development occurs bring them to the co-evolutionary perspective on changes in 'socio-technical systems' (Loorbach and Wijsman, 2013). The focus of this literature stream is how sustainable innovations drive system-level changes and necessary conditions for transitions towards sustainability. Traditionally, sustainable innovation in socio-technical transitions was mainly covered by technological niches, developed within commercial markets. However, a growing number of studies consider is given to changes in social practices (Gill et al., 2011) and business model innovations (Loorbach, 2010). In light of the transitions theory, sustainable innovations can achieve the scale necessary to contribute to transition by orchestrating and simultaneously taking steps to change and innovate actors from different levels of the system (e.g. industry, government, research) (Jonker et al., 2020).

2.4.4. Business model innovation for sustainability transitions

The central overlapping section of the theoretical model (Fig 2.1), which is labelled *BMI for Sustainability Transitions*, involves individual organizations that proactively innovate their business model and drive change towards more sustainable forms of economic development.

Such agents of change (Waddok et al., 2016) design transformative BM with the potential to shape the system within which they operate (Proka et al., 2018) and balance profit with sustainability challenges (Jonker et al., 2020). The assumption is that BMIs for sustainability transitions have the potential to contribute to economic and social transformations (Aagaard et al., 2021). The function of such transformative BMs and their ability to orchestrate systemic changes have an important role for organizations in developing sustainable innovations. Some scholars have taken a more integrative view by connecting the different aspects of business models and socio-technical change (e.g., Bolton and Hannon, 2016, Hannon et al., 2013, Huijben et al., 2016, Sarasini and Lindner, 2017, Schaltegger et al., 2016b, Tongur and Engwall, 2014, Wainstein and Bumpus, 2016). In this perspective, the diffusion of innovation is seen as socially embedded, where business models take an important part (Geels and Johnson, 2018).

The design of the BM toward sustainability goes beyond the focal company and embraces a broader value orientation that takes responsibility towards society and the environment. Such transformative BM also takes a wider stakeholder network perspective, where the value creation takes a more *community-centric* approach (Jonker and Faber, 2019) through collaborations with and for all stakeholders of a company (Freeman, 2010). BMI can further change the dominant business logic (Gorissen et al., 2016) with sensemaking activities and different framing of new ideas (Chesbrough and Rosenbloom, 2002, Zott et al., 2011). The BMs become a bridge of new perspectives, practices, and power roles with the existing network of actors and their institutional and business logic framework (Geels, 2004, Waddock, 2020). In summary, BMI towards sustainability has the power to transform the business landscape by shaping the context that surrounds it through reorganizing the value creation process (structure), sensemaking (cognition), and technological norms and industry regulations (institutions). Such BM understands value creation as part of a larger system and builds a sense of balancing values with the needs and interests of various stakeholders.

3. Methodology

In this section, I briefly present the research process that clarifies the decisions that I made for the conducted studies and provides rationales for the empiric scope of the thesis. The chapter also informs on the processes of data collection and analysis and concludes with a reflection on the methodological trustworthiness.

3.1. Research process

In the summer of 2018, I started as a PhD student at CTF, Karlstad Business School, Sweden. My PhD is co-financed by Vinnova, Vinnväxt Project and IndBygg Project, in cooperation with Paper Province, a world-leading business cluster within the forest bio-economy, based in Karlstad. The focus of the Vinnväxt Project is the research, development, and commercialization of new forest industry products and services. The IndBygg Project aims to increase competence in building high-rise structures in a sustainable way by applying wood-based technologies. The overlay of the two projects is the idea of connecting sustainability to living spaces. They focus on building smarter, more efficient and environmentally friendly modern constructions by developing and adopting novel engineering wood technologies. ECW is believed to be one of the most promising innovations of the century in the field of construction (Green and Taggart, 2020). Due to its technical properties, ECW enters the multi-story building market traditionally dominated by concrete and steel and offer extensive business.

The concept of business model has received considerable attention in the literature and among practitioners and I was curious to explore the relation of business models with other types of innovations. In a research project initiative together with Paper Province, we sent out a survey to various actors, part of their network, which develops and/or adopt ECW. The survey captured all types of actors in the construction value chain, such as material and equipment producers, architectural firms, contractors, and consultants, all of which are involved in implementing the technology. The survey studied the role of different innovation types in the construction value chain and how companies perceive the benefit of the product, process, positioning, and BMI in yielding high sustainability and high business value. Since there had been few studies of the integrative view of innovation, where innovation types are seen as complementary, synchronous, and interdependent, I applied this empirical and research context in writing Paper I.

With the support of Paper Province, I managed to establish contacts with key actors in the wood construction value chain for collecting data. In the initial phase of the project, Paper Province facilitated several business meetings where I had the chance to approach Stora Enso, one of the largest producers of ECW products worldwide. My goal was to study how Stora Enso changed its business model from traditional and engineered construction wood. My key focus was on how the company configures its value creation and innovates the business model of ECW that drives system-level changes in the construction industry, where neither technology nor sustainability itself has been the most critical factor for change. Since the underlining logic of value creation for bringing novel sustainable technology on the B2B market suffers from inherent ambiguities, I constructed Paper II in this direction. However, when attempting to study how sustainable technology can drive transitions in large-scale industry, the business model perspective becomes insufficient. Therefore, I focused on the relationship between socio-technical change and business models in order to better understand the dynamics of the processes on multiple system levels.

As a doctoral student, my PhD journey is a learning process full of trials and errors. By going through the stages of the research process, I was searching for a more inclusive epistemological approach. My perspective gradually lined up with that of pragmatism, which becomes the philosophical base and overarching umbrella of this thesis. The main motive behind adopting pragmatism was one of its fundamental principles: the way pragmatism interprets the environment. For pragmatists, the reality is ever-changing, based on our actions (Morgan, 2014). Thus, the firm environment is not deterministic, but is experienced by organizations during action (Lorino, 2018). The pragmatism perspective of this thesis resides in *organizing for system change* in an attempt to understand how the environment can be changed (performed) through mutual interaction with the company's BM. In the organizational context, the firm co-creates the system by designing or changing the elements of the BM and therefore brings the notion of evolution (Demil et al., 2018). Another reason for the pragmatism standpoint in this thesis is the principle of integration or the synthesis of quantitative and qualitative perspectives (Morgan, 2014). The multiphase designs of mixed methods studies benefit from the eclectic nature of pragmatism, by having the flexibility to apply qualitative and quantitative data along with the different research phases (Johnson et al., 2007).

3.2. Research design

Based on the overall purpose of the thesis (which is to extend the knowledge on business models and understand its impact on a larger system scale that aims transitions towards sustainability), I applied a research structure of two studies, which focus on the two specific research questions (see Table 3.1).

	Study 1	**Study 2**
Motivation	Understanding BMI as part of a wider innovation space together with other innovation types (e.g., product, process and positioning) in accelerating sustainable technology	Uncovering how a change in the value creation logic unfolds BMI with the potential to scale niche sustainable technologies.
Research method	Mixed method/fsQCA	Qualitative single-case study
Data	Quantitative – survey Qualitative – interviews	Qualitative – interviews, participant observations, secondary sources
Research papers	Paper I	Paper II
Research questions	RQ (1)	RQ (2)
Research focus	Examines the relationship between BMI and other types of innovation	Examines how BMs change for linking niche and regime levels and driving socio-technical transitions towards sustainability
Empirical context	Wood construction value chain	Manufacturer of sustainable technology in the construction value chain

Table 3. 1. Research design of the thesis

Study 1

Study 1 is focused on BMI as part of a wider innovation space together with other innovation types (product, process, positioning, etc.). In this phase, I studied how various actors in the construction value chain combine and complement different innovation types to accelerate sustainable wood technology. More precisely, I analyzed how the wide range of innovation types can be combined in order to result in successful practices. Innovation activities were related to each of the innovation types, showing how these activities manifest themselves in practice in order for firms to become highly sustainable and to have high business value (that is, have a large market share, stable growth, and generate sufficient revenue). To study this, I applied the innovation typology of Francis and Bessant (2005), embracing the integrative view of innovation suggested by (Damanpour et al., 2009). The applied method for this study was a *configurational approach* (Fiss, 2011, Furnari et al., 2020, Ragin, 2000, Ragin, 2008, Ragin, 2014). Implementing fsQCA allows combining qualitative and quantitative data in examining causal complexity (Misangyi et al., 2017), which is guided by the principles of: (i) *conjunction*, which suggests that outcomes occur from the interdependence of multiple conditions (different types of innovation can be combined together); (ii) *equifinality*, which suggests that multiple paths can lead to the same outcome (different configurations of innovation types resulting in high sustainability and high business outcome values); and (3) *asymmetry*, which means that the set of factors found to be related in one configuration may differ or be unrelated in another (the absence of some innovation types may be compensated for by the presence of others) (Gresov and Drazin, 1997, Fiss, 2011, Schneider and Wagemann, 2012, Misangyi et al., 2017, Sihvonen and Pajunen, 2019, Sukhov et al., 2021). In that sense, using a configurational approach made it possible to study the combinations of different innovation types (configurations of conditions) such as product, process, positioning, and BMI, leading to the outcomes of high sustainability and high business value in the CVC.

The fsQCA method approach in Study 1 was selected to provide a more complete and comprehensive picture of the study phenomenon (innovation types) by combining qualitative and quantitative data (Greene et al., 1989, Bryman, 2006). The philosophical view of pragmatism, supports the mixed method approach and advances the notion that the consequences are more important than the process (Hanson et al., 2005). Researchers are free to determine what methods and combination of data to apply in addressing a complex phenomenon, regardless of *quantitative versus qualitative* arguments. Thus, the mixed method allows a combination of both approaches for maximizing the strengths and minimizing the weaknesses of each other (Morgan, 2007).

Study 2

Study 2 identified the role of the BMI in commercializing niche technologies and driving sustainable transitions in the construction sector. In this phase, I delineated BMI as a higher-order innovation that embodies the other innovation types as subunits or parts. I deepened the focus on the value creation processes and business model decisions that occur at the firm level for accelerating sustainable technologies in multiple levels of the social systems. For that purpose, I applied a qualitative single-case study of a leading manufacturer of renewable solutions for wood construction, Stora Enso. The case-study approach made it possible to explore the complex and multi-layered organizational dynamics that occur when a firm seeks to disrupt the ruling order of an industry in-depth (Eisenhardt and Graebner, 2007). The case study applied two “embedded” units of analysis (Yin, 2018) – (i) traditional construction wood (TCW) and (ii) engineered construction wood (ECW) – with the overall aim of comparing the different business logics and business models employed at the firm level and the interactions with the established industry environment. The theoretical lenses used to uncover the structures that drive sustainable transition under the studied context are BMI

(Baden-Fuller and Morgan, 2010; Foss and Saebi, 2017), value configuration (Stabell and Fjeldstad, 1998), and sustainability transitions (Markard et al., 2012).

A qualitative case study approach was chosen in order to develop a deep understanding of the phenomenon under study (BMI), acknowledging its contextual uniqueness and complexity (Eisenhardt et al., 2016, Stake, 2005). The applied study design allows extensive analysis of holistic, nuanced and empirically rich data (Eckstein, 2000), and enhancing the insights into the single case (Yin, 2018). Moreover, the single-case study selection helps to explore the collected rich data in a real-life environment and explain the complexities of an actual situation that might not be captured through other research approaches (Zainal, 2007). Hence, the strong points of this study are the rich contextual data and an in-depth understanding of the phenomenon under research.

The premise of this method is based on the presumption that reality is socially constructed by people through actions and interactions with their environment (Gioia et al., 2013). Thus, research within this perspective focused not only on human actions and experience but also on the context of these actions (Schwandt, 2007).

3.2. Data collection

The data from multiple data sources were collected in three steps: Step 1, Interviews; Step 2, survey; and Step 3, participant observations (see Table 3.2.).

Data collection	*Data type*	*Papers applied the data*	*Data source*	*Respondents*	*Data collecting technique*	*Details*
Step 1: Interviews	QUAL	Papers I & II	Stora Enso	Top-and-middle-level managers of Stora Enso	Audio recording, notes	Duration: 7.2 h No. of people: 8 No. of organizations: 1
Step 2: Survey	QUANT	Paper I	Stora Enso, Large cluster organization	Managers of multiple industry organizations	Online questionnaire	No. of people: 24 No. of firms: 17
Step 3: Participant observations	QUAL	Paper II	Stora Enso, Large cluster organization	Managers of multiple industry organizations (public and private)	Audio recording, notes	Duration: 18 h No. of people: 16 No. of organizations: 18

Table 3. 2. Data collection of the thesis

Step 1: Interviews

I conducted in-depth interviews with eight senior managers (two female and six male) from Stora Enso, one of the largest material producers worldwide and developers of ECW technology. The interviewees worked in multiple international markets and were responsible for the production, sales, marketing, and digitalizing of wood construction products (see Table 3.3.). The interviews were conducted in English and took place between December 2018 and October 2019. The interviews were partly conducted face-to-face and partly digital (via an online meeting platform). The interview questions were semi-structured and arranged in a protocol. The interviews ranged between 40 and 85 minutes. All interview sessions were audio-recorded and carefully transcribed into written protocols. Meeting notes were taken in parallel.

Interview #	*Date*	*Respondent's position*	*Country*	*Working experience in Stora Enso*	*Interview type*	*Duration*	*Place*
1	6/17/2019	VP strategy	Finland	1 year	Onsite	45 min	Stora Enso HQ
2	6/18/2019	Program manager	Finland	18 years	Onsite	85 min	Stora Enso HQ
3	6/27/2019	Business developer	Sweden	3 years	Onsite	56 min	Karlstad University
4	8/12/2019	Product manager	Germany	11 years	Online	58 min	Online
5	8/19/2019	Director of business line	Austria	11 years	Online	54 min	Online
6	9/9/2019	Head of wood products	Austria	25 years	Online	40 min	Online
7	9/25/2019	Director of business line	Finland	16 years	Online	40 min	Online
8	10/2/2019	Digital advisor	Sweden	1 year	Online	60 min	Online
Total						**437 min**	

Table 3. 3. Log of the research interviews

Step 2: Survey

In collaboration with a world-leading business cluster within the forest bio-economy, Paper Province (based in Karlstad, Sweden), I sent out a survey to various actors in the construction value chain. The sample consisted of firms in the construction sector part of the cluster organization. The companies are at different stages in developing and adopting the new sustainable technology for building multi-story wooden buildings (ECW). The survey involved 24 respondents, consisting of CEOs and senior managers representing different firms in the value chain (for more details see Table 3.4.). In the survey, I asked the respondents to evaluate the importance of the different innovation types that were necessary for them to implement this new technology, as well as the impact that the implementation of this technology had on each firm's sustainability and business value.

#	Respondent's position	Firm's type in the CVC	Market exposure	Firm size (employees)
1	Vice-president strategy	Materials producer	International	26,000
2	Business developer	Materials producer	International	26,000
3	Program manager	Materials producer	International	26,000
4	Product manager	Materials producer	International	26,000
5	Head of a business line	Materials producer	International	26,000
6	Senior vice-president supply chain	Materials producer	International	26,000
7	Digital advisor	Materials producer	International	26,000
8	CEO	Architects & engineers	Domestic	5
9	CEO	Manufactured products	Domestic	61
10	CEO	Contractors	Domestic	14
11	Co-owner	Contractors	Domestic	30
12	CEO	Manufactured products	Domestic	491
13	Head of department	Contractors	International	6,447
14	CEO	Contractors	Domestic	85
15	CEO	Service provider	Domestic	4
16	Head of HR and finances	Contractors	Domestic	20
17	Chief architect	Architects & engineers	International	605
18	Operations manager	Architects & engineers	International	605
19	Project manager	Architects & engineers	Domestic	25
20	CEO	Materials & equipment suppliers	Domestic	50
21	CEO	Service provider	Domestic	18
22	Section manager	Contractors	Domestic	179
23	CEO/co-owner	Contractors	Domestic	23
24	CEO/owner	Manufactured products	Domestic	n/a

Table 3. 4. Survey sample (Paper II)

Step 3: Participant observations

I conduct participant observations at formal and informal meetings. During an industry event organized in Karlstad (Sweden) in September 2019, I had the opportunity to directly observe one round table and eight workshops where Stora Enso and multiple industry organizations discussed the challenges and opportunities of wood construction (see Table 3.5.). The discussions covered the current industry challenges during the design, production, and management phases of the construction process and how timber technologies might address them.

# people (n = 18)	Organizations (n = 16)
1	Stora Enso
5	Local municipalities
2	Local business cluster
2	Investment hubs
2	Universities
2	Consulting companies
2	Building companies
2	Complementary providers

Table 3. 5. Overview of the participant to the round table and the workshops

3.4. Data analysis

Analysis of the survey data (Paper I)

In Paper I, the survey data was analyzed using fuzzy set qualitative comparative analysis (fsQCA) (Ragin, 2008, Rihoux and Ragin, 2008), as well as the fsQCA 3.0 software (Ragin and Davey, 2016). QCA understands interactions of set memberships that consider each case as a configuration or conditions leading to specific outcomes (Ragin, 2008), which enables systematic comparison of cases. By applying fsQCA in our empirical context, we examine the necessary and sufficient conditions or the relevance of different innovation types, and the configurations that result in specific outcomes, such as high sustainability and high business value (Ragin, 2014, Schneider and Wagemann, 2012). The steps in this analysis included defining the main concept for investigation, calibrating the data, performing a necessity and sufficiency analysis, and, at the end, conducting a robustness check of the results (Sukhov et al., 2021). In the first step, we clearly *define our main concepts for investigation*, so their presence or absence can be determined. In the following step we applied the *direct calibration method* since our survey applied a seven-point Likert scale (Ragin, 2008; Rihoux and Ragin, 2008). Within this step, we defined and calibrated all conditions (innovation types: product innovation, process innovation, position innovation, and business model innovation) and outcomes (high sustainability and high business value), and assigned them specific set-membership scores. In the third step, we applied *necessity analysis,* where we investigated whether the presence or absence of a single condition will be necessary in order for the outcome to occur. The next analytical step was to perform *sufficiency analysis* in order to identify sufficient conditions or configurations of innovation patterns that resulted in high sustainability and high business value. As the final step of our analysis, we conducted a *robustness check* of the results (see Sukhov et al., 2021). This meant varying the thresholds of calibration and consistency to determine whether the fsQCA software produces similar or different results.

Analysis of qualitative data (Paper I & II):

The qualitative data consisted of in-depth interviews and participant observations. Directly after each interview, the audio records were transcribed and coded and the field notes from the participant observations were analyzed and thematically clustered similarly to the interviews. A backup audio record was also available for refining the notes. Coding was performed via NVivo software.

In Paper I, based on the initial interviews, we made qualitative interpretations of the configurations from the fsQCA, performed with the quantitative data. That helped illustrate and explain these configurations of different innovation types (see, e.g., Sukhov et al., 2021) and make better sense of the results produced during the sufficiency analysis (Sihvonen and Pajunen, 2019). This research process was in line with the recommendations of Ragin (2000; 2008; 2014), as well as recent research promoting configurational theorizing (Furnari et al., 2020).

In Paper II, for each unit of analysis, I traced differences in value creation and BM components. For each of the BM components I developed sub-level coding elements applying the framework of Gärtner and Schön (2016) and the value configuration model of Stabel and Fjeldstad (1998). The coding elements were extended and refined as data analysis progressed and compared with data from participant observations and documents for coherence. As a result, each business model was assigned to a particular value configuration archetype. The outcome of each value configuration was assessed by investigating the impact on the business model and the firm's ability to establish onto the market technological innovation.

3.5. Trustworthiness of the research

Demonstrating that the design of the study responds to the criteria of good research practice is critical in developing methodologies (Marshall and Rossman, 2016). In the world of social science, there is no single supreme research or data collection method since each of them has intrinsic strong and weak merits. Regardless of being qualitative or quantitative, each method has particular problems of validity and reliability. Thus, despite the selected research approach (that is, using one or a combination of methods), the researchers need to be aware of the constraints and opportunities behind the methodological choices they make. There is a wide range of conducts to communicate trustworthiness (or validity). In the following text, I focus on some key research validity dimensions, guided by the framework of Abowitz and Toole (2010) for assessing design, validity, and reliability issues in mixed method studies and the construct of Lincoln and Guba (1986) for qualitative studies.

Clear definition and operationalization of the theoretical concepts

Critical validity factors of the research process are the clarity about the level of analysis and the rigor in defining and operationalizing the concepts before they can be measured (Abowitz and Toole, 2010). Concerning the level of analysis, Papers I and II were based on firm-level characteristics. However, Paper II applied a theoretical construct (the role of BMI in sustainability transitions), which described organizational behavior at multiple levels, encompassing micro- and macro-characteristics of the social system. In both papers, the studied theoretical concepts (that is, innovation types, business model, sustainability transitions, configurations of value creation) were carefully defined with the help of previous research and further used as a lens to study social constructs, improve our understanding, and gain new knowledge. The thorough attention to conceptualization was even more critical when using fsQCA analysis and defining the conditions, outcomes, and their relationships. Once defined, the key concepts were also operationalized by selecting the empirical indicators and providing transparency regarding how each construct was measured. Thus, defining the level of analysis and careful conceptualization and operationalization of the theoretical constructs provided the feasibility of the studies in this thesis by improving measurement validity and reliability (Lincoln and Guba, 1985, Abowitz and Toole, 2010).

As part of the research design process, I reflected on the way the theoretical concepts (presented in Chapter 2) are applied in the studied context (summarized in Table 3.6). By presenting these distinctive concepts, I was not aiming to synthesize the different approaches into a more integrative framework; instead, I employed them to better understand business models and the relationship with sustainable innovations and socio-technical systems. The theoretical concepts are my magnifying glass and cutting tool applied as a means to reduce the level of complexity and confusion around the studied phenomenon. On one hand, the magnifying glass allows me to observe objects and relationships that are invisible to the naked eye. On the other hand, conceptual tools act as cutters for shearing deformations (simplification) to the rich and vivid real-life context, which allows me to overcome my bounded rationality in studying and understanding the phenomenon. Thus, as part of the research process, I tried to carefully define and apply the concepts (that is, polishing the magnifying glass and sharpening the cutters) in studying how organizations can shape their environment towards more sustainable development.

Concepts	Definitions	Research context
Business model	"BM articulates the logic and provides data and other evidence that demonstrates how a business creates and delivers value to customers." (Teece, 2010, p. 173)	A framework including three core dimensions (value proposition, value creation, value capture) of MCW and ECW (Papers I and II).
Business model innovation	"Designed, novel, and nontrivial changes to the key elements of a firm's business model and architecture linking these elements." (Foss and Saebi, 2018; p. 216)	BMI was studied as part of a wider innovation space together with other innovation types, such as product, process, and positioning (Paper I). BM changes, based on multi-actors collaboration and higher customer engagement, accelerate the development of sustainable technologies (Paper II).
Value configuration	The configurations of value creation represent the business logic and mechanisms that combine activities and resources across the firm's boundaries (Stabell and Fjeldstad, 1998).	The value configuration framework is applied in studying the business logic of traditional and ECW. The two business units have distinct generic value configurations that lead to different drivers of firm performance and system change (Paper II).
Sustainability transitions	Achieving structural qualitative shifts from persistent unsustainability towards a more sustainable state (Loorbach et al., 2017).	The construction industry sustains economic prosperity and satisfies the growing demand while reducing its environmental footprint (Papers I and II).
Sustainable innovation	Innovation that improves sustainability performance, where performance is measured by ecological, social and economic dimensions (Boon et al., 2013)	Novel technologies based on forest biomass (such as ECW) offer more sustainable and resource-efficient construction, which significantly contribute to the decarbonization of the sector (Papers I and II).
Innovation types	Innovation space consists of four innovation types orientated towards: product, processes, position and business model innovation (Francis and Bessant, 2005).	All innovation types act in combination and complement each other to accelerate sustainable wood technology in the construction sector (Paper I).
Technology	Tools, devices, and knowledge create new products or services (product technology) and mediate between inputs and outputs (process technology) (Anderson and Tushman, 1986, p. 440).	ECW is a robust technology that introduces the first new way to build high-rise structures since more than a century of steel and concrete domination (Paper I & II).
Technological development	The development trajectory of novel technology over time (Damanpour, 2018).	The development synergy of various ECW innovations aims to reach the phase of a dominant design within the CVC (Paper I & II).
Socio-technical change	Changes on the level of industry, society, and natural environment due to the establishment of novel technology as a dominant design (Geels, 2002).	The ECW development over time and the establishment as a dominant design may lead to changes that go beyond the scope of the market niche and shape the whole industry (and society). Socio-technical change becomes the outcome of a series of innovations (technical and non-technical) that has a broader impact on economic, institutional, environmental and social development (Paper II).

Table 3. 6. Summary of the applied concepts

Select appropriate analysis approaches

In this thesis, I combine quantitative and qualitative approaches in research design and data collection. One of the main benefits of using a mixed method is the ability to triangulate the results by having multiple measures (in multiple research phases) within a single methodological approach (Sukhov et al., 2018, Sukhov et al., 2021). In Paper I, I sequentially apply more than one method, which provided richer, more comprehensive data (Neuman, 1991). However, mixed methods per se do not automatically improve the validity and reliability of the resulting data. The method can create additional noise in the data if there is a lack of careful operationalization during the design process (Abowitz and Toole, 2010). The reliability of the qualitative data analysis was also improved by the offered transparency of the data collection (providing detailed information in every step of the process) and by citing direct quotations from transcribed interviews in the papers (Eisenhardt, 1989).

The multiple data sources applied and multiple methods in the thesis allowed for triangulation (Lincoln and Guba, 1985, Yin, 2018), which increased the validity of the findings. The interview data was validated and triangulated with participant observation data (seminars and workshops) and other secondary materials, including publicly available data (press publications, company brochures, newsletters, industry reports, and podcasts), which helps us to cross-check and process the data in the analysis phases (Gibbert et al., 2008). Moreover, the survey data was validated with in-deep interview data in fsQCA (Sikhov et al., 2021).

4. Summary of the appended papers

The two papers that are the building blocks of the dissertation are summarized here. Complete versions of the papers are found appended in this thesis.

4.1. Paper I

Abadzhiev, A., Sukhov, A., Johnson, M. "Follow your own path: innovating for high business and sustainability performance". At the submission stage to "*Management Decisions"*.

Purpose – To investigate how firms in a construction value chain combine different innovation types such as product, process, positioning, and business model innovation in order to implement new and sustainable technology.

Methodology – The paper uses a mixed-method approach. The data were collected using interviews and questionnaires. We gathered quantitative data by surveying 24 senior managers and CEOs in a construction value chain, managers, and CEOs who have recently implemented ECW technology at their firms, and supplemented this with qualitative data from interviews with eight expert practitioners. We then analyzed the survey data using fuzzy set Qualitative Comparative Analysis (Fiss, 2011, Ragin, 2000, 2008, 2014), together with the interview data, to both gain an understanding of specific innovation activities and provide more coherent explanations for our findings. The paper was based on the literature on the innovation typology of Francis and Bessant (2005) and the integrative view of innovation suggested by Damanpour et al. (2009).

Context – By introducing the ECW technology to the market, materials producers are taking the lead in pushing that technology into the value chain. The other actors in the value chain that choose to develop their business around this new technology, and to integrate it into their market offerings, then become adopters of this technology. However, the process of technology diffusion within the value chain is neither purely sequential nor linear since different actors are working together and co-developing the technology. Thus, developing timber innovations in the construction value chain (CVC) requires a move away from considering innovation as an isolated and shielded activity towards perceiving it as a collaborative and multidimensional process.

Findings – The findings expand our understanding of the role of innovation in the construction value chain, in three ways. First, the paper shows how practitioners perceive the benefit of the different innovation types used in the construction value chain, and how these innovation types translate into activities leading to successful practices yielding high sustainability and high business value. Second, the study found that the role of an actor in the construction value chain influences the innovation approach, with the materials producer acting mainly as an orchestrator in accelerating the spread of new and sustainable technology through their product and process innovation. Finally, the paper provides an empirical basis and find support for the integrative view of innovation (Damanpour et al., 2009) in the construction sector, by showing that different innovation types are combined together, as well as how these complement each other in practice. Thus, the paper proposes that future research approach innovation is a complex phenomenon that is both contextual and holistic.

Research implications – A key contribution of this study is that it shows how four different innovation types are brought together in the context of the CVC, as well as how these complement each other in practice. This research also highlights the tight connection between novel and sustainable technology and innovation.

Contribution to the thesis – This paper contributes to the analysis of BMI in relation to other innovation types. BMI was studied as part of a wider innovation space together with other innovation types (such as product, process, and positioning). By taking an integrative view, the paper connects different innovation types and applies a more parsimonious and complexity accommodating perspective on how innovation types are related.

Previous versions of this paper – The paper was accepted and published at the COMPASSS WP Series (Comparative Methods for Systematic Cross-Case Analysis, https://compasss.org), where three anonymous reviewers approved our use of the fsQCA method.

Authorship contribution statement

Andrey Abadzhiev – Main author, planning, data collection, shared data analysis, shared writing.

4.2. Paper II

Abadzhiev, A., Johnson, M., Sukhov, A. "Scaling sustainable technology in a traditional industry". At the submission stage to a special issue of "*Creativity and Innovation Management".*

Purpose – To investigate the role of the BMI in enhancing technologies towards more sustainable large-scale system transitions.

Methodology – The paper is based on a qualitative single-case study of a leading provider of renewable solutions for wood construction, Stora Enso. Two "embedded" units of analysis (Yin, 2018) were chosen within the single case: (i) traditional construction wood (TCW) and (ii) engineered construction wood (ECW). The research closely traces the change of value creation logic and business model activities that occur in the organization with regard to the two different units of analysis, and shows how this logic affects the development of sustainable technology in the traditional construction sector. This study was based on multiple data sources. Data were collected through semi-structured interviews, participant observation, and secondary sources such as company documentation, corporate websites, and industry reports on the researched topic.

The context – The single case study was on Stora Enso, one of the world's largest producers of ECW technologies. The study briefly describes and compares the business models behind *traditional* and *engineered construction wood*. Building with *traditional construction wood* has a long tradition and in some countries it represents half of the housing stock. However, the presence of traditional wood in the construction market provides limited business opportunities due to its peripheral role in the dominant building technology in key market segments (for example, the multi-story building market). Critical limitations of the technology used with traditional wood (or light-frame technology) come from the fact that the construction elements are not robust enough to support high structures. However, due to its technical properties, ECW has entered the high-rise building markets traditionally dominated by concrete and steel. A key player in the group of ECW is cross-laminated timber (CLT), a material in which cross-laminated solid wood panels, glued together in layers in a crosswise pattern, serve as vertical or horizontal elements. CLT is believed to be one of the most promising innovations of the century in the field of construction.

Findings – The findings highlight a need for BMI, based on multi-actors collaboration and higher customer engagement, to accelerate the development of sustainable technologies. First, the paper shows how a change in the value creation logic (from a value chain to a mix of value creation logics) of the company influences the strategic choices related to the selected business model. Second, the study finds that the business model changes towards network openness and higher customer engagement that accelerates the spread of new sustainable technology at a large-scale industry level. Finally, the paper finds support for the role of the business model in linking the space between the niche innovation and the established regime (Bidmon and Knab, 2018, Jonker et al., 2020).

Research implications – The findings contribute to both BM and transitions research fields as the paper uncovers the responsiveness of BM choices toward different value configurations in the context of scaling technological innovation.

Contribution to the thesis – This paper contributes to our understanding of how value creation logic (that occurs on a firm-level) changes BM and its role in scaling niche sustainable technologies for driving socio-technical change.

Previous versions of this paper

DRUID PhD Academy Conference, Odense Denmark, January 2020

NBM Virtual Conference, Sweden, June 2021

ISDRS Virtual Conference, Sweden, July 2021

R&D Management Conference, Scotland, July 2021

Authorship contribution statement

Andrey Abadzhiev: Main author, planning, data collection, data analysis, shared writing.

5. Discussion

The aim of this thesis was to extend the knowledge on business models that drive system change towards sustainability. The aim took shape and direction by addressing the research questions, which apply the results from the appended papers and elaborate the theoretical model (presented in Chapter 2) from the value creation perspective. First, I investigated how firms innovate in order to implement new and sustainable technology. More precisely, the thesis examines BMI as part of a wider innovation space together with other innovation types (such as product, process, and positioning). Second, I hoped to identify new ways in which industrial firms can create value by combining multiple value creation logic (see the chain-shop-network typology of value configuration). Through the results, I sought to find the role of the BMI in commercializing niche technologies and driving sustainable transitions. Third, the theoretical framework of the thesis is used as a basis for discussion on different forms of value creation. Different perspectives are outlined (traditional and sustainable value creation) and their reflection on the transformative power of innovative business models towards sustainability.

5.1 Returning to the research questions

The way in which firms innovate often differs from the way the prevailing research studies innovation (by focusing on the effects of individual innovation types on firm performance). In reality, the boundaries between different innovation types are often blurred. *Research question (1)* took a more integrative view on innovation by showing how different innovation types are actor-specific and complement each other for high sustainability and business performance. The successful implementation of novel and sustainable technology, studied in the context of the construction value chain, is possible when the actors find their own approach to innovation, combining a wide range of innovation activities. Due to the complex interrelationships between different innovation types, senior managers from the construction sector do not apply a “one-size fits all”, approach. On the contrary, different configurations or patterns of innovation activities examine the fit between sustainable technology development and high firm performance. Hence, BMI is seen as part of a wider innovation space together with other innovation types (such as product, process, and positioning).

Research question (2) took the understanding of BMI one step further. BMI is delineated as a higher-order innovation that embodies the other innovation types as subunits or parts. With the purpose of accelerating niche technologies on a larger system scale and driving sustainability transitions (in the construction sector), actors integrated into their novel business model activities related to product, process, and positioning innovation. Changes in the underlying logic of how businesses go about their value creation processes shape the business model and help scale sustainable technologies. The study illustrates that the different configurations of value creation should not be considered as a strategic dilemma between either production, servitization, or platformization logic. Agents of change that accelerate sustainable technology should adopt elements from multiple logics to undergo transformation across the entire industry. Thus, BMI, based on collective value creation and higher customer engagement, enhances sustainable technologies and drives system-level transitions toward sustainability.

In general, the findings reported from the two papers support previous research focused on bridging business model discipline with innovation management (Chesbrough and Rosenbloom 2002, Teece, 2010, Chesbrough, 2010, Baden-fuller and Haefiger, 2013) and transitions studies (Rip and Kemp, 1998, Geels, 2002, Geels, 2005, Markard et al., 2012). The findings confirm that the development of sustainable technology depends on the selected business model and its degree of openness and customer engagement. Scaling up a technology often involves the inclusion of external technologies or services, and the level of business model openness determines the successful development of the complementarities network. Moreover, the papers' findings support the integrative view of innovation (Damanpour et al., 2009), the contingency effect of value configuration towards business model (Fjeldstad and Snow, 2018), and the role of the business model in linking the space between the niche technology and the established regime (Bolton and Hannon, 2016, Bidmon and Knab, 2018). The papers' results further identify the role of the transformative business model in creating value with multiple actors, influencing the institutional landscape with non-market strategies, and promoting collective sensemaking and legitimacy among key stakeholders with the purpose of accelerating niche technologies and driving sustainable transitions in the construction sector.

However, the inferences that can be drawn based on the findings of this thesis differ from most previous research, in two ways. First, the results show that successful implementation of novel and sustainable technology (studied in the context of the construction value chain) is possible when the actors find their own approach to innovation, combining a wide range of innovation activities. The thesis identifies, in practice, the complementarity among business model, product, process, and positioning innovation and the rationale for approaching them holistically. Second, the findings show empirically how the shift in the value creation logic changes the elements of the business model. In developing sustainable technology, a manufacturing company adds layers of different logics (chain-shop-network). BM based on a configuration of multiple value logic becomes a foundation for scaling the sustainable technology in a way that challenges the established industry regime. The company does not just substitute one logic to another (that is, switch from manufacturing to services), but builds them upon each other by adding *servitization* and *platformitization* on top of their core *production* logic. The business model of engineered wood, rooted in "cross-value-configuration" (Fjeldstad and Haanœs, 2001), is seen as a transformative one that co-create part of the environment towards more sustainable development.

5.2 Rethinking the theoretical framework with the value creation perspectives

The business model (innovation) and innovation management literature are multi-disciplinary, but have been mainly influenced by business and management research fields (Tidd and Bessant, 2018). Under the umbrella of traditional business and management disciplines, BM and innovation management apply a commercial logic of value exchange (Teece, 2010) and a value creation perspective that centers the firm–customer relationship along the value chain (Baden-Fuller and Teece, 2020). For example, the BM canvas of Osterwalder and Pigneur (2009) described how a company creates customer value and captures some back within the value chains. Innovation, on the other hand, is perceived as a combination of organizational capabilities and competencies that converges a firm's and customer's value creation (Bessant and Tidd, 2007). Within these perspectives, the success of the firm is measured by profits or quantitative economic growth. The value creation process is described as creating value for the customer, while the value capturing process implies catching back value for the company (Priem et al., 2018). Creating value is an important part of the model, but not enough for business success and the company need mechanisms to monetize or capture some of the value they created. Value creation and capturing have both been anchored to the traditional business and management theoretical roots, such as transaction costs economics, Schumpeterian innovation, resource-based theory, and strategic networks (Zott and Amit, 2013). The research under these domains applies both resource-focused approaches on value creation – centered around the supply side, upstream in the value chain (Teece et al., 1997, Amit and Zott, 2001) – and demand-side approaches that position consumers at the center of a firm's strategy (Massa et al., 2017; Priem, et al., 2018). While value from the supply-side perspective is mainly focused on a firm's capturing (organizational-centric), value from the demand-side perspective puts customer value at the center (customer-centric) (Johannessen and Olsen, 2010). In both the supply-side and demand-side perspectives of value creation, the two main actors remain as the company and the customer. The stakeholder involvement of value creation (beyond customers) is narrowed to business partners or capital investors (Zott and Amit, 2010). Their function is usually focused on how to create value with them but not for them (Freudenreich et al., 2020). In short, the traditional assumption of the value creation process includes fairly limited interpretations related to firm-customer perspectives and mainly financial parameters that do not involve sustainability.

Growing concern with sustainability and the business challenges to meet the higher social expectations pushes organizations to consider stakeholders and the natural environment in their value-creating activities (Lüdeke-Freund et al., 2020). Tidd and Bessant (2018) further argued that "managing innovation is not simply business" and existing innovation and BM research is narrowly focused on how firms capture value from innovation, rather than responding to fundamental economic and social challenges. The notion of value creation that reflects the needs and interests of various stakeholders is slowly finding its place in the innovation and business model literature (Green and Vergragt, 2002, Bocken et al., 2013). Commonly anchored with the triple-bottom-line principles, which includes the planet, people, and profit (Elkington, 1994), the literature extends the purely financial view of the business by integrating social and environmental concerns. Including sustainability as a line of reasoning in the value creation process requires a more holistic interpretation of value beyond the market perspective and accounts for the ecological and social performance of the company (Isaksson et al., 2015; Boons, 2013). Widening the stakeholder view and including social and environmental dimensions in the evaluation of value logically brings some tension. The business should take into account the negative impact on the environment and society (and vice versa), which requires finding the balance between different stakeholders. The balance often requires a trade-off between the actors, which extends the notion of value creation with value destruction (Lüdeke-Freund et al., 2020), and describes it as ratios of user value and harm (people value/planet harm and; people value/people harm) (Isaksson et al., 2015). In that sense, the value might take positive (creation) and negative (destruction) perspectives (Echeverri and

Skålén, 2011) and take into account the organizational, environmental, and social survival and wellbeing. In searching for balance, the creation of corporate good should not win over the destruction of the common good. Thus, the sustainability perspective of the value creation process goes beyond firm boundaries by incorporating a broader range of stakeholders and call for value pluralism, following the TBL approach.

By applying the notion of value creation to the theoretical framework of the thesis and extending the perception of value with the TBL approach, we can see that business models and innovation are not only intended to serve the economic benefits of a single organization (see Fig 5.1).

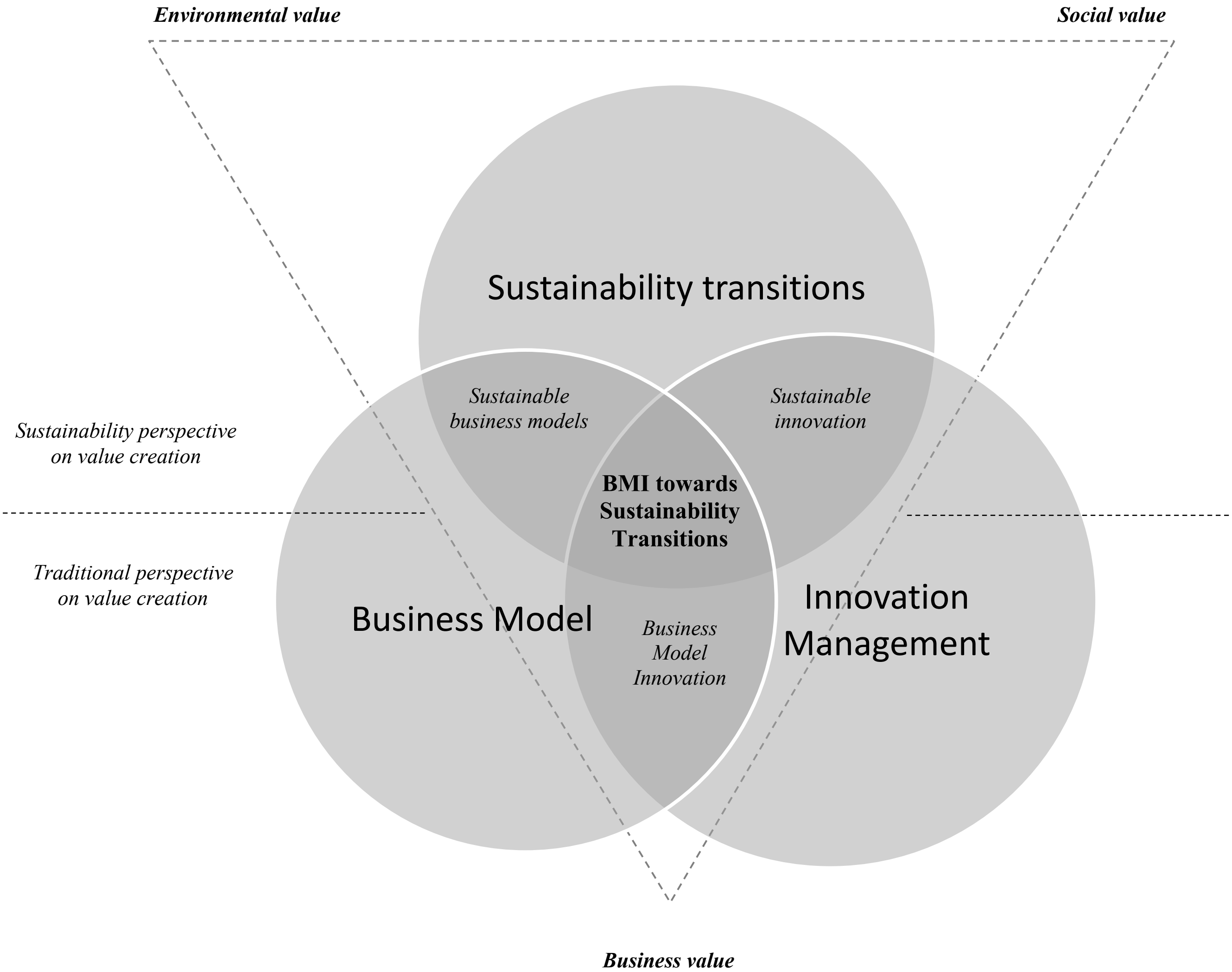

Figure 5. 1. Dominant research areas and value creation perspectives

In the lower part of the model, the traditional business model (innovation) and innovation management disciplines follow the perspective of value creation that is business-oriented. The definition of value implies a narrow interpretation, which is mainly financial. Accordingly, these disciplines primarily take into account the business part of the value triangle. However, with the broader concept of value, sustainable business models and sustainable innovations balance the business performance by addressing environmental and social objectives (Bocken et al., 2014).

Resolving the grand challenges and further developing sustainable society goes through business activities that prioritize social, environmental, and economic value. By vigorously pursuing sustainable innovations and organizing the business through collaborative creation with multiple stakeholders, companies can supply solutions that boost social value and adequately address the Sustainable Development Goals (SDGs) (United Nations, 2015). Hence, businesses have the power to greatly contribute to the SDGs through innovations and BMs balanced with social and natural realms (Waddock, 2020).

Nonetheless, if business is ever going to live in balance with the environment and the society, it will have to rethink the core values. Such rethinking does not mean downgrading the importance of business, but more realigning environmental and well-being values with the commercial benefits. If growth and profit maximization continue to be the main foundation of the business, true transformations towards sustainability become obsolete. The notion of sustainability needs to be grounded in company core values, which shift the value creation from profit to "value per harm" in order to create true value for society (Isaksson et al., 2015). Following sole financial opportunism might push firms towards finding new forms of "ethical visibility", without really affecting their way of doing business (Roberts, 2001, Milne and Gray, 2013). The lack of moral sensibility and the tendency to exploit others for achieving personal benefits make sustainability initiatives purely instrumental and narrow their effect down to minimizing the bad publicity or improving corporate image (Campbell et al., 2011). Organizational involvement in sustainability grounded in purely financial forms of accountability has been criticized as "ethics of narcissus" and linked with their destructive behavior (Roberts, 2001). Internal values-driven changes in a company's vision, beliefs, and culture in line with TBL thinking are needed to "transcend" the business logic towards a more sustainable society (Enquist et al., 2015) and the enhanced ability to facilitate social value in a trustworthy manner. The balance between business and sustainability excellence could boost organizational credibility or so-called social license to operate by its stakeholders and the general public (Isaksson, 2021). In doing business that truly benefits wider stakeholders, companies should not only integrate TBL principles into their strategy level, but also apply them as a foundation for organizational core values. Thus, organizing for system change needs to drive transformations on two layers: the individual organization and its core values, and the wider system layer that surrounds businesses.

6. Limitations and further research

The studies were carried out in the context of a CVC specializing in wood construction. The survey and the participant observation data collection were conducted in Sweden, and interview data were collected from a single multi-national company. The industry-specific context allowed me to understand more intricate details of how firms innovate and which business activities they consider important. However, the context also makes the findings more specific and gives them limited generalizability (Yin, 2018). Thus, findings should not be outlined literally as general recommendations for other industries. I also acknowledge that the research is based on the present development of the ECW technology and innovations in general, without extended and retrospective process tracing of the trajectories.

I propose that future research consider the integrative approach of innovation and conduct longitudinal studies for better capturing the performance outcomes of innovation. I also encourage scholars to initiate research within other industries, involving both B2B and B2C perspectives. Moreover, further empirical testing could enlighten the role of power (economic, institutional, political, market) in BMIs that connect niche technologies with an established regime. It will be also interesting for future transitions and BM research to study the interactions and relationships of value formation with its positive (value creation) and negative (value destruction) dimensions. Future research could also deal with creating and evolving the core organizational values and value-driven culture that is fully invested in the change agent's sustainable success. Another line of future studies is the individual and collective design actions and thinking that face the unknown and transform systems into a stage that do not yet exist. Thus, I encourage future research to pick up where I have left off.

7. Conclusion

If I had to conclude this thesis in three sentences, I would do so as follows: BMI represents a more holistic and higher-order innovation that includes other innovation types as sub-dimensions. For scaling niche sustainable technologies, manufacturing companies combine layers of different value creation logics (chain-shop-network) that change the elements of the business model and the surrounding environment. With such a transformative business model (combining production efficiency with higher customer engagement and more collective value creation), the firm can also transform the way they create and delivers lifetime value for their customers and partners.

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Wood We Change?

Innovations based on sustainable technologies have been widely considered as a remedy for addressing societal and environmental problems in many sectors of our economy. However, the large-scale adoption of such innovations goes beyond technology and requires organizing the business in a way that drives transformations across actors and industries.

This dissertation aims to understand how industrial firms organize for system change towards sustainability. The study is a compilation of two papers within the same research context: the development of sustainable wood technology in the construction industry. The overlapping unit of analysis for both papers is business model innovation. Paper I examines how industry firms combine and complement business models with different innovation types to accelerate sustainable technology. Paper II identifies how a change in the business model and value creation logic that occur on a firm level accelerate sustainable technology and shape the socio-technical system. Together, both papers help paint a more complete picture of the business model role in transitions towards sustainability. The theoretical frame of this thesis spans several domains: business model, innovation management, and sustainability transitions. Building on a multi-disciplinary premise, the thesis takes into account the organizational and the systemic parts of the change process by linking the company perspective to the wider governance of sustainability transitions.

The thesis outlines two main contributions. First, the results show that business model innovation acts with and complements different innovation types to achieve high sustainability and business value outcomes. Second, the results reveal that scaling sustainable technologies require combining production efficiency with higher customer engagement and more collective value creation. Combining layers of different value creation logics unlocks the potential of novel technology and shape the entire industry towards more sustainable development.

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