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# Sustainable Business Through Innovation: Qualitative Comparative Analysis of a Construction Value Chain

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# Sustainable business through innovation: Qualitative Comparative Analysis of a construction value chain

**Abstract**

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## 1. Introduction

Innovation plays a crucial role in firms' successful performance in a competitive market (Siguaw et al., 2006, Tidd, 2001). In practice, organizations apply innovation strategies as a means of developing and implementing new technologies so that they can make significant business improvements (OECD. et al., 2005). Innovation has been outlined as a vital ingredient of improving firms' performance and their abilities to adapt to market changes, including consumer demands for sustainable consumption, demonstrating the importance of innovation to the automotive, manufacturing, and IT industries (e.g. Wischnevsky et al., 2011, Zapata and Nieuwenhuis, 2010).

Besides the widely-acknowledged importance of innovation, organizations also frequently struggle with managing innovation due to its complex nature (Tidd and Bessant, 2020). Scholars have developed certain typologies as a primary approach to reducing innovation complexity, enabling them to study the various factors that influence the effects of innovation on performance (Damanpour, 2010). Hence, the "type of innovation" has become a key concept applied to innovation research (Rowley et al., 2011), whereby common innovation types relate to product, process, positioning, and business model innovation (Francis and Bessant, 2005). However, despite the shared understanding that innovation is a complex phenomenon, whereby different types of innovation can complement each other (Fagerberg, 2004), the existing literature often overlooks the relationship between these (Wischnevsky et al., 2011). Most innovation studies tend to emphasize a single innovation type, e.g. product, process or business model innovation. Research focusing on innovation practices that include interdependence between two or more types of innovation is rare, with scholars mainly focusing on the factors and conditions that distinguish them individually (Damanpour, 2010). As a result, there is a void between how past research has approached and understood innovation (focusing on the effects of single innovation types) and the emerging body of literature that proposes an integrative perspective (focusing on how combinations of different innovation types result in successful innovation practices) (e.g. Damanpour and Gopalakrishnan, 2001, Damanpour et al., 2009, Wischnevsky et al., 2011).

In this article, we study how senior managers in the construction sector value chain assess the relevance and importance of different innovation types as regards their firm's performance in terms of its sustainability and business values. This helps us to understand how different innovation types can be combined in order to result in successful practices. Specifically, we outline the innovation activities that relate 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 (i.e. have a large market share, stable growth, and generate sufficient revenue). In doing so, we provide explanations for how firms can be more sustainable and have high business value through innovation. To study this, we apply the innovation typology of Francis and Bessant (2005), embracing the integrative view of innovation suggested by (Damanpour et al., 2009). The data was collected using a mixed-methods approach where we gathered quantitative data by surveying 24 senior managers and CEOs in a construction value chain, managers and CEOs who have recently implemented engineered wood technology at their firms, and we supplemented this with qualitative data from interviews with 8 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 findings expand our understanding of the role of innovation in the construction value chain in three ways. First, we show 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, we found that the role of an actor in the construction value chain influences that actor's approach to innovation, with the materials producer acting mainly as a catalyst in accelerating the spread of new and sustainable technology through their product and process innovation. Finally, we provide 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, we propose that future research approach innovation as a complex phenomenon that is both contextual and holistic.

This article is structured as follows: It begins with an overview of the literature describing different innovation types, then introducing different views on innovation and explaining the different dimensions of firm performance. The following section explains innovation in the construction value chain and outlines our methods of data collection and analysis. Next, the findings section reports on the results of our analysis and provides our interpretations of the findings in light of the interviews with the experts. This is followed by a discussion and conclusion section, outlining limitations and recommendations for future research.

## 2. Theoretical framework

Innovation is a multidimensional construct (Damanpour, 1996). Research in innovation management aims to obtain a broader understanding of innovation's meaning and implications for organizations "going beyond that of changing technology" (Alves et al., 2018). This is done by categorizing innovation into different types, studying the existence of these through the firm's value chain, and outlining the different outcomes from innovation activities (Siguaw et al., 2006). Through the years, research efforts have resulted in innovation being classified in different ways (Damanpour et al., 2009). These classifications mainly involve the improvement or development of new products and services; they also involve the creation or improvement of production and administration processes, the changing of how products and services are perceived due to their repositioning on the market, and innovation of the organizing of the business model that embraces different management initiatives (Abernathy and Utterback, 1978, Jayanthi and Sinha, 1998, Khazanchi et al., 2007, Francis and Bessant, 2005). Recent frameworks that provide a more holistic and encompassing view of innovation (Francis and Bessant, 2005) suggest mapping an innovation space that consists of four innovation types orientated towards i) products/services, ii) processes, iii) positioning, and iv) business model innovation (see Table 1 for an overview of research on these innovation types). The following table provides a more detailed description of each innovation type and the innovation activities that these types involve within the Francis and Bessant (2005) framework.

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Insert Table 1 about here

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### *2.1.Product Innovation*

Product innovation is defined as "the commercialization of new goods or services to meet an external user need" (Damanpour, 2010 p. 997); this has been identified as one of the main drivers of value creation for firms in a competitive market (Visnjic et al., 2014). Working with product innovation means that firms can make changes to their existing market offerings, creating new and improved products that are desirable to their customers (Bessant and Tidd, 2007, Utterback and Abernathy, 1975). In practice, a firm can conduct activities such as implementing its product innovation strategy and allocating resources for structuring internal activities that help to transform new ideas into innovative new products and/or services (e.g. Cooper, 2014). The goal of this strategy is to systematize the continuous production of products that are either completely new to the market or viewed as new and innovative by the customers (Rowley et al., 2011). This requires that firms invest in the development of their own competencies, implement new technologies, and maintain their relationships with their customers (Danneels, 2002). Implementing and following a product innovation strategy has been found to improve overall business performance due to an increase in product offerings, the expansion of market share, and improved sales (Barczak et al., 2009, Lilien et al., 2002).

### *2.2.Process Innovation*

The literature defines process innovation in terms of 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). The main benefit of process innovation comes from enhancing a firm's organizational efficiency and responsiveness by means of shrinking costs, improving process quality, and delivering faster services (Damanpour and Gopalakrishnan, 2001). Consequently, process innovation has the power to change and improve the way organizations perform their activities through new ways of doing things. Applying process innovation means that the firm is primarily engaged with the internal operational changes that are less visible to its customers, but which might affect the final offering. Process innovation activities can consist of new types of input materials, task specifications, work and information flow mechanisms, and the equipment used to produce a product or render a service (Afuah and Utterback, 1997). In this regard, process innovations serve as a means of achieving a higher level of performance, by improving the way in which value is created and delivered (Gunday et al., 2011). Thus, process innovation is perceived as a new or significantly improved way of doing things, playing an important role in increasing productivity and gaining competitive advantage (Reichstein and Salter, 2006).

### *2.3.Position Innovation*

Position innovation characterizes a change in the context where products and services are introduced to customers (Bessant and Tidd, 2007). In other words, this type of innovation is orientated towards defining or re-defining the positioning of the product or service in the eyes of the customer (Francis and Bessant, 2005). Position innovation can target the shaping of the narrative slant, or the story told about the product or service, so that the customer perceives it in a particular way. This type of innovation has also been referred to as the 'innovation of meaning' (Verganti, 2017), whereby a firm strategically changes the meaning of a service by focusing on a specific element of a customer journey; changing the metaphor used for this element can change the perception of the whole customer experience (Artusi and Bellini, 2020). Position innovation also includes activities during the adaptation and development of a product or service intended for another market or customer group (Rowley et al., 2011). These activities do not significantly affect the functionality of the product or service, mainly the perception of the product or service in the eyes of the customer (Francis and Bessant, 2005). One application of position innovation occurs on an existing market, where the intention is to change the customer's perception or understanding of the product (Kim and Mauborgne, 1999). Another application of position innovation occurs when driving the creation of a market that does not yet exist (Francis and Bessant, 2005). Positional innovation is not mentioned often in the literature on innovation management, where product and process innovation dominate.

### *2.4.Business Model Innovation*

Business Model Innovation (BMI) has been 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). BMI is a highly-discussed research topic, its importance to firm performance and competitive advantage has been recognized in both research and practice (Zott et al., 2011, Spieth et al., 2014, Pohle and Chapman, 2006, Services, 2006). A business model can be a key vehicle for innovation by means of connecting innovative products and technologies to a realized market output (Massa and Tucci, 2013). However, it can also be a source of innovation (Zott et al., 2011, Schneider and Spieth, 2013) since a business model can complement the product and process innovation by developing novel value creation and value-capturing architectures (Zott et al., 2011, Teece, 2010). Hence, BMI represents a more holistic way of organizing innovation that goes beyond merely focusing on new products, services, processes or positioning. The choice of business model has the power to shape the other directions of the innovation space (Tidd and Bessant, 2020). BMI may require a change that spans the focal firm and encircles its clients, partners, and suppliers, and the other stakeholders involved in the process of creating value (Zott and Amit, 2007). Due to its complexity, BMI is difficult to achieve due to possibly requiring the fundamental transformation of the focal company, something which may affect the whole industry (Chesbrough, 2010, Girotra and Netessine, 2013).

### *2.5. An integrative view of innovation*

Research studies have often focused on identifying the differences between the innovation types while overlooking their interdependence (Damanpour et al., 2009). Scholars differentiate between innovation types, both theoretically and empirically, in order to study their distinctive development (Snihur and Wiklund, 2018). Highly influenced by the seminal papers of Utterback and Abernathy (1975, 1987), which propose the sequential development of product and process innovation, mainstream innovation research focuses on distinguishing between and understanding successful innovation activities individually. For example, several researchers have studied singular product innovation as a means of identifying new knowledge, or its role in the success, survival, and renewal of the organization (e.g. Brown and Eisenhardt, 1995, Katila and Ahuja, 2002, Li et al., 2013). Other authors have focused on service innovation and its function of combining and exchanging knowledge (e.g. Smith et al., 2005). Furthermore, business model innovation is often viewed as the main driver of innovativeness or firm performance (e.g. Amit and Zott, 2001, Chesbrough, 2007, Teece, 2010). The relationships between these types of innovation have mainly been studied as *product* and *process* innovation (e.g. Utterback and Abernathy, 1975, Damanpour, 1991, Damanpour, 2010), or as *product* and *business model innovation* (e.g. Markides, 2006, Bucherer et al., 2012, Visnjic et al., 2016, Tavassoli and Bengtsson, 2018). Studies addressing these dualistic relationships between innovation types make the assumption that different innovation types contribute differently to company performance (Damanpour, 2010). For instance, the goal of product innovation is to meet some of the customer demand for new or improved products, while process innovation aims to decrease operational costs.

The boundaries between these four innovation types are often blurred (see Table 1 for an overview), raising the question of whether or not they should be understood more holistically. For example, launching a new product might be simultaneously influenced by a change in the business model or the introduction of new processes. The interdependence of innovation types is recognized by some researchers, who take an integrative view of and approach to them as complex phenomena consisting of many different and interconnected parts (e.g. Damanpour et al., 2009, Wischnevsky et al., 2011, Baregheh et al., 2014, Guisado-Gonzáez and Coca Pérez, 2015, Snihur and Wiklund, 2018). The integrative view proposes that the different types of innovation be seen as interdependent activities, whose simultaneous implementation has a synergistic effect on firm performance and achieves greater competitive advantage (Pisano and Wheelright, 1995, Damanpour et al., 2009, Damanpour, 2010). The theoretical perspectives upon which the integrative view of research into innovation reflects are broad and include product life-cycle theory (Abernathy and Utterback, 1978), the market orientation perspective (Narver and Slater, 1990), and resource- and knowledge-based views (Barney, 1991, Grant, 1996). Overall, the integrative perspective advocates the notion that innovation types complement each other and influence organizations jointly (Damanpour et al., 2009). Thus, future research on the typologies of innovation should focus on understanding these more holistically, as interdependent practices (Damanpour, 2010). In this regard, the focus of our investigation is the simultaneous integration of different types of innovation as a means of transforming the value of sustainable technology into increased organizational performance and environmental improvement for firms in the construction industry.

### *2.6. Different dimensions of firm performance*

In response to environmental pressures and changing societal expectations, companies are broadening the basis of their performance beyond the economic dimension alone (Robinson, 2000). Together with financially-viable business objectives, corporations are today generally more inclined to follow the triple bottom line (TBL) approach (Elkington, 1994, Elkington, 2004) by applying environmental and social dimensions to their performance outcomes. In integrating the TBL, companies are still focusing on profit (Kramer and Porter, 2011), while also accounting for the impact on social systems and natural resources (Isaksson et al., 2015). Hence, the TBL concept paves the way for the ability to acknowledge the consequences of a firm's operations on the system level, including People and the Planet (Norman and MacDonald, 2004, Pava, 2007).

Multiple drivers motivate companies to embrace sustainability, with rising pressures from various stakeholders (e.g. customers, regulatory, media) (Dangelico and Pujari, 2010), emerging opportunities of improving economic performance (Porter and Vanderlinde, 1995), and shifts in core values and beliefs (Enquist et al., 2006) being among the key forces causing organizations to evaluate their performance beyond mere profitability. While the external factors and 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), internal values-driven changes in a company's vision, beliefs and culture in line with

TBL thinking "transcend" the business logic towards a more sustainable society (Enquist et al., 2015) and the enhanced ability to facilitate end-user value in a trustworthy manner. Thus, in doing business that benefits all stakeholders, companies should not only integrate TBL principles into their strategy level but also apply them as a foundation for organizational core values.

In order to better understand how innovation activities can improve firms' performance, it is important to distinguish between sustainability and business outcomes, since these can represent different orientations and may require different ways of innovating in the construction sector. Therefore, this study focuses on identifying the innovation practices that lead to the high sustainability and high business value of various companies based on their role in the construction value chain.

## 3. Methodology

### *3.1.Research context – the construction value chain*

The construction sector, which is one of the largest and most socially-important industries, accounting for six percent of global GDP and having an annual expansion pace of 3.4 percent (CIC, 2015), has been a late adopter of innovation, maintaining its traditional use of materials, products, and practices. The construction value chain (CVC) consists mainly of project-based organizations using temporal collaboration patterns (Chinowsky et al., 2011). Few processes are standardized and few projects are repeated due to teams usually being disbanded after project completion (Bower, 2003). The fragmented nature of CVC discontinues knowledge flows and limits the allocation of valuable experience (Eriksson, 2013). A typical construction value chain structure is illustrated in Figure 1.

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Insert Figure 1 about here

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The CVC consists of various actors, including material and equipment producers, architects, engineers, contractors, installers, suppliers and regulators. The involvement of these actors is not consistently the same in every construction project and can vary with factors such as the scale and delivery method of the project and buyer/owner preferences (De Groote and Lefever, 2016). The value chain itself is responsible for creating and sustaining the built environment, representing the transformation of raw materials into a final product via manufactured materials (Foulkes and Ruddock, 2007). This transformation can be simplified using four distinct stages: design; the production and conversion of the raw materials into manufactured products; on-site construction; and operation and maintenance (De Groote and Lefever, 2016). The design stage involves the building's buyers (or owners), its architects, and its engineers. The material production stage includes building materials producers of various kinds, e.g. manufacturers of concrete, steel, bricks, glass and timber. The construction stage engages contractors, sub-contractors, architects and engineers, as well as material and equipment suppliers. The final stage involves maintenance firms, building residents and owners. The whole process is supported by various service organizations (e.g. financial, legal and insurance), and is highly regulated by local authorities.

Although the CVC has been regarded as low-tech and less innovative than other industries (Jones et al., 2016), this sector still generates and adopts multiple types of innovation in order to adjust to dynamic global change (Peace et al., 2010). Industry-specific innovations have to be prioritized when working towards the challenges of climate change (Field, 2014, IPCC, 2014). Actions aimed at more sustainable CVCs involve innovative ways of creating the built environment (WEF, 2016). The increasing development of innovative material solutions based on forest biomass, e.g. "Engineered Wood Products", allow the CVC to sustain economic prosperity while reducing its environmental footprint (Näyhä et al., 2015). Engineered wood currently comes under the umbrella of the “forest-based sector” (FBS) or the “bioeconomy”. The environmental benefits of bioeconomy materials for the CVC are mainly related to the “defossilisation” or decoupling from non-renewable building materials, e.g. steel and concrete, while replacing them with renewable and degradable biomaterials, e.g. timber. Engineered wood products, also known as manufactured wood, have consistent properties that allow them to directly compete with solid-mineral-based building materials (e.g. sheets and concrete) (McKeever, 1997).

### *3.2.Research method*

In order to examine how firms in the CVC innovate so as to successfully implement new sustainable technology, we used a configurational approach (Fiss, 2011; Furnari et al., 2020; Ragin, 2000; 2008; 2014). In this context, using a configurational approach enabled us to study the configurations of conditions (i.e. combinations of different innovation activities) leading to the outcomes of high sustainability and high business value in the CVC since these outcomes are likely to be the result of multiple interconnected innovation types that are mutually dependent. Specifically, we used fuzzy set Qualitative Comparative Analysis (fsQCA) (Ragin, 2008; Rihoux and Ragin, 2008), as well as the fsQCA 3.0 software for our data analysis (Ragin and Davey, 2016). This method is grounded on Boolean algebra and case comparison and allows the researcher to identify the configurations of conditions leading to specific outcomes (Ragin, 2000, see also Sukhov et al., 2021). Implementing this approach allows one to account for: 1) *conjunctural causation*, which suggests that case-specific conditions affect outcomes in combination with each other rather than in isolation from each other; 2) *equifinality*, which suggests that there can be multiple paths to the same outcome, and 3) *causal asymmetry*, which means that the set of factors bringing about an outcome may differ from the set of factors associated with the absence of that outcome (Fiss, 2011; Schneider and Wagemann, 2012;

Misangyi et al., 2017; Sihvonen and Pajunen, 2019; Sukhov et al., 2021). This makes fsQCA especially suitable for studying how construction firms innovate when implementing new technology as *i)* it captures how different types of innovation can be combined together since, in practice, *ii)* there can be different configurations of innovation types resulting in high sustainability and high business value, and *iii)* that innovation practices should be understood as wholes where the absence of some types of activities that relate to specific innovation types may be compensated for by the presence of others.

### *3.3.Sample*

The sample used in this study consisted of 17 European firms in the construction sector which had recently implemented a new technology for building multi-storey wooden buildings (Engineered Wood Products). These firms represented a wide range of value-chain actors which had implemented this new technology in modern urban construction. In this sample, there was a clear distinction between two types of actors, i.e. between a large international firm which was helping to develop this new technology (the materials producer) and other firms in the value chain that were adopting this new technology for their business offerings. Furthermore, we also identified each firm's role in the CVC on the basis of the framework by Coalition (2018), labelling them as belonging to 5 categories: i.e. i) *materials producers*, ii) *product manufacturers*, iii) *material and equipment suppliers*, iv) *contractors*, and v) *architects* and *engineers*. Doing this allowed us to capture all the key actors in the CVC involved in implementing the same technology of *engineered wood products*. We provide a more detailed description of the sample in Table 2.

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Insert Table 2 about here

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*3.4.Data collection*

The data was collected between 2019 and 2020, in 2 steps. First, we interviewed the 8 experts (2 female and 6 male) who had previously worked across the CVC in different roles and who were able to provide us with insights regarding different the types of innovation activities occurring in the CVC (see Table 3). This provided us with a deeper understanding of how engineered wood technology functions, and how it contributes to sustainability and business value, from multiple perspectives, on the basis of the interviewees' roles and experience.

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Insert Table 3 about here

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Second, we sent out a survey to all of the main actors in the value chain who had implemented this new technology. We were interested in capturing the individual perspectives of practitioners with different management roles in their respective firms within the value chain (see Table 2 for more detail). The reason for this was that we wanted to capture the way in which practitioners view and apply innovation activities. This resulted in a total of 24 respondents, consisting of CEOs and senior managers representing different firms in the value chain. In this survey, we asked the respondents to evaluate the importance of the different innovation types necessary for them to implement this new technology, as well as the impact the implementation of this technology had on each firm's sustainability and business value. These steps enabled us to collect both qualitative and quantitative data and helped us to formulate better insights regarding how firms need to innovate in order to successfully implement new technology in the CVC.

*3.5.Data analysis using fsQCA*

The data was analyzed using fuzzy set qualitative comparative analysis (fsQCA), which enabled us to systematically compare cases with each other, to examine the necessary and sufficient conditions (i.e. the relevance of the different innovation types), and to outline the configurations of conditions resulting in the specific outcomes (i.e. the perception of high sustainability and high business value) (Ragin, 2014; Schneider and Wagemann, 2012). In our fsQCA, we followed the recommendations of Greckhamer et al., (2018), as well as the analytical steps described by Sukhov et al. (2021).

After deciding on our empirical sample, see Table 2, and defining our main concepts for investigation, see Table 3, we proceeded to calibrate the data. According to Ragin (2008), calibration should be based on substantial and theoretical knowledge in order to give meaningful qualitative interpretation to quantitative measures. This meant that we needed to define and calibrate all conditions (i.e. innovation types: *product innovation*, *process innovation*, *position innovation*, and *business model innovation*) and outcomes (*high sustainability* and *high business value*) and to assign them specific set-membership scores (see Table 4 for an overview of the calibration decisions made during this study). Since our data was obtained using a survey, where the respondents used a 7-point Likert scale, we used the direct calibration method (Ragin, 2008; Ragin and Rihoux, 2008). This meant that we determined three threshold values: i.e. *Full membership* (1), corresponding to the maximum point (7) on the Likert scale, indicating full agreement with the statement provided in the survey; *full non-membership* (0), corresponding to the minimum point reported on the Likert scale for each condition, indicating disagreement with the statement provided; the *cross-over point* (0.50), corresponding to the central tendency (average value) of each condition, entailing that scores above the crossover point indicated the degree to which the condition was above the average point, with the scores below the crossover point corresponding to the degree to which the condition was below the average point (Rubinson et al., 2019). Doing so allowed us to take into account asymmetrically-distributed responses, and to focus on the differences in kind between the high and low points on the scale. In addition to the responses obtained from the survey, we also coded the firms on the basis of their role in the value chain. Their role in the value chain constituted an additional condition which could be of relevance to the actors' approaches to innovation. We used crisp-sets whereby a condition is either *fully in* the set of being a *materials producer*, or *fully out* of the set of being a materials producer (i.e. *not being a materials producer*) (Ragin and Rihoux, 2008). Theoretically, the materials producer can push new technology onto the value chain and whose innovation practices might differ from the adopters of this technology.

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### *3.5.1. Necessity analysis*

Next, we performed a 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 results of the necessity analysis are presented in Table 5). Generally, if a condition is necessary, then there will be no outcome without that condition (Ragin and Rihoux, 2008). In order to understand whether or not a condition is necessary, it is important to examine the values of *consistency* and *coverage*, which are produced by the fsQCA 3.0 software when performing the necessity analysis. The *consistency* score, during the necessity analysis, indicates the extent to which the outcome is contained within the condition and, if this score is above the threshold value of 0.9, then the outcome can be considered a subset of the condition, and thus the condition will be necessary in order for the outcome to occur (Greckhamer et al., 2018; Schneider and Wagemann, 2012; Sukhov et al., 2021). The c*overage* score can be used to assess the importance or trivialness of the condition in relation to the outcome (Schneider and Wagemann, 2012). If the consistency and coverage scores are high, the condition will be both necessary and highly relevant to the outcome. If, however, the consistency score is high but the coverage score is low, then the condition will be considered necessary but simultaneously trivial as regards the outcome.

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Insert Table 5 about here

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### *3.5.2. Sufficiency analysis*

In the following step, we performed a *sufficiency* analysis in order to identify innovation practicies resulting in high sustainability and high business value. Given that our sample consisted of only 24 cases, we used a frequency threshold of 1 case and a consistency threshold of > 0.80 in order to find configurations that could result in these outcomes (Greckhamer et al. 2018). The results of the sufficiency analysis are presented in the form of a configurational chart, shown in Tables 6 and 7 and illustrating the parsimonious and intermediate solutions (the *truth tables* for each outcome are provided in the appendix). From Tables 6 and 7, we can see that there were several configurations of innovation types whose outcome was high sustainability, with several other configurations resulting in high business value. This indicated that there was *equifinality* in our sample and that different innovation practices, by different actors, can result in similar outcomes. Our analysis also revealed that configurations contained different combinations of conditions needing to be either present or absent in order to generate these outcomes, thus supporting the idea of *conjunctural causation*. Furthermore, we also observed that, in some cases, the absence or presence of great importance for certain innovation types could still result in high sustainability and high business value, indicating *causal* *asymmetry*, and that these different innovation practices should be viewed as wholes rather than as independent types of innovation influencing outcomes.

Examining the output of the sufficiency analysis in Tables 6 and 7 revealed that these configurations of innovation types had a high level of *solution consistency* above 0.88, meaning that they were in close proximity to the empirical data and demonstrating the high level of validity of the configurational model. Tables 6 and 7 also indicated a high level of *solution coverage* above 0.64, indicating that these configurations were able to explain a high proportion of the empirical cases and that they occurred frequently in the data (Ragin, 2008; Woodside et al., 2013). The configurational chart also provides values for each individual configuration, where *raw coverage* reveals the percentage of cases where a configuration covers the outcome, while *unique coverage* reveals how much of the outcome is covered by each unique configuration (Schneider and Wagemann, 2012; Sukhov et al., 2021).

### *3.5.3. Robustness of the results*

As the final step of our analysis, we conducted a robustness check of the results (see Sukhov et al. 2020). This meant varying the thresholds of calibration and consistency to see whether the fsQCA software produces similar or different results. In practice, we used more inclusive thresholds for the conditions and outcomes, defining “fully in” as point 6 and above on the Likert-scale, “fully out” as point 2 and below, and the cross-over point. These manipulations influenced the values for consistency and coverage; on some occasions also generating additional configurations. However, given that our supplementary qualitative analysis did not change our interpretation of the findings in any substantial way, we proceeded with the calibration thresholds indicated in Table 4. Furthermore, in line with the recommendations of Ragin (2000; 2008; 2014), as well as recent research promoting configurational theorizing (Furnari et al., 2020), we made qualitative interpretations of the configurations on the basis of our initial interviews with the 8 industry professionals, in addition to providing quotations that help to illustrate and explain these configurations of different innovation types (see e.g., Sukhov et al., 2021). This helped us to make better sense of the results produced during the sufficiency analysis (Sihvonen and Pajunen, 2019). These qualitative interpretations are supplemented in Tables 6 and 7, and further illustrated in the following sections.

## 4. Findings

The necessity analysis showed that no single innovation type was consistently associated with the outcomes of high sustainability or high business value. This meant that perceptions of high sustainability and high business value are likely to be the products of different innovation types, and therefore likely to vary from case to case. The results of the sufficiency analysis, for the outcome of high sustainability, are presented in the form of a configuration chart in Table 6, with the analysis for the outcome of high business value being presented in Table 7.

We found that different innovation types (i.e. product, process, positioning and business model innovation) involve specific innovation activities (see Table 3 for an overview of the innovation types, their definitions, key references, examples of the innovation activities found, and quotations from industry professionals). Furthermore, in order for the actors in the CVC to attain high sustainability and high business value, we also found that these innovation activities can be combined using different configurations and that the configurations explaining high sustainability can differ from the configurations explaining high business value (i.e. the configurations in Table 6 differ from those in Table 7). This means that innovation can serve different purposes and that the actors in the value chain may use different innovation strategies and practices to achieve different objectives. We also found both that the actor's role in the value chain (i.e. being a materials producer versus not being a materials producer) and the materials producer's innovation practices differ from the innovation practices of other actors in the value chain. There now follows a more detailed description of the configurations of innovation types, providing an explanation for how these innovation types are combined in practice. We first present the configurations with regard to the outcome of high sustainability and then with regard to the outcome of high business value. Next, we present a more detailed breakdown of the findings.

### *4.1.Sustainability through innovation*

Table 6 identifies the innovation practices (i.e. configurations of innovation types) that result in high sustainability (i.e. a reduction of the impact on the environment). Configuration 1a relates to the specific role of the materials producer in the CVC. Configurations 1b, 1c, 1d, and 1e relate to the innovation practices of actors other than the materials producer.

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Insert Table 6 about here

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#### *4.1.1. Product and process innovation in order to catalyze new sustainable technology*

Configuration 1a illustrates the fact that, in order to be highly sustainable, the materials producer mainly focuses on product and process innovation activities, where the business model does not require any further innovation. A quotation from one of the experts working for the materials producer reveals the connection between sustainability and the importance of products and their innovation:

> *"For our company, sustainability is a core value. For the whole of [name of company] as a group, and also for the wood products sector, it is highly important. One of the key drivers is that we think the end-users are interested in our products because we can provide a very good level of sustainability." Expert 8 (Vice-president Strategy, 16 years' experience)*

Since the materials producer comes from a forest-based industry, where harvested wood is perceived as renewable, recyclable and carbon sink material, sustainability lies at the core of that firm's business. Here, sustainability is described as one of the core values of the materials producer. Another expert points to the impact which the product innovations of the materials producer can create and which influence the entire value chain:

> *"I think that the construction industry as such will change quite dramatically over the next 10 years. […] I think that with [names of product innovations], we definitely have products that will change the construction industry. […] And we definitely see ourselves in the role of forerunner and consequently also, hopefully, in the role of game-changer. […] So we put a lot of effort into innovation and continuous product development, but also into the development of completely new products. I strongly believe in all of this!" – Expert 2 (Director of a Business Line, 11 years' experience)*

According to this expert, the construction industry will undergo major changes in the future due to new products being based on the new and sustainable technology of engineered wood. The role of the materials producer is perceived as 'game-changing', due to the key role it plays in the value chain and the products it creates. This insight helps us to understand that the materials producer acts as a catalyst for spreading, across the value chain, this new and sustainable technology in the form of different product innovations. Furthermore, the need to build for the future is also emphasised by the expert, relating to the goals of sustainable production and future demand. The lack of importance of the business model innovation in Configuration 1a is explained in the following quotation:

> *"I think it's still a very traditional business model in itself, when we're talking about [names of engineered wood products]. It's a bit different from saw timber sales, because you need a lot of planning before you can produce. We don't produce anything on stock, but still it's very traditional…there's a project and then the customer is asks for an offer. Once the customer says yes to your offer yes and you produce and deliver to the building site. ...I wouldn't call this in itself a very innovative business model. With [names of products], we sell in a very traditional way. We're not doing any online sales of [names of products], or anything like that at the moment." – Expert 6 (Programme Manager, 18 years' experience)*

Based on the interview with this expert, we found that a new business model had been introduced with the launch of the engineered wood products a few years prior, since then no further changes had been required. Thus, business model innovation is not the focus of the materials producer since his current business model functions and the products themselves are considered sustainable. The main focus of the materials producer is developing new products and services, as well as finding new processes for developing new products while simultaneously improving efficiency.

### *4.1.2. Innovation practices for adopting new and sustainable technology*

The actors in the value chain that are not materials producers show several approaches to different innovation practices aimed at making them highly sustainable. Configuration 1b shows that an actor that is not a materials producer requires product, process and business model innovation in order to adapt to the new technology of engineered wood, and in order to be more sustainable. The quotation below illustrates the importance of combining different innovation types and of these being interdependent.

> *"I think things will be happening in each of those categories. In the robotic and automation side for sure. Still, there are things like visual quality, things you can do like very automated stuff and very customized stuff. […] Then there's this prefabrication thing where you can add different things, not just wood. Then again there's the business models; what about selling directly to potential consumers, so they can make their own stuff. […] Then, finally, in the whole ecosystem as well, how do you work more closely together to make this chain leaner. […] Yes, I think there's a lot in all those fields that can be done." – Expert 6 (Programme Manager, 18 years' experience)*

This example shows that the implementation of new and sustainable technology, as well as product innovations based on engineered wood technology, create a new opportunity for manufacturing, as well as influencing the production process by creating a need for robotics, automation, and sensors that allow firms to prefabricate and customize their production at lower cost. Business model innovation is also viewed as important due to changes in how different actors interact with each other because of this new technology, which is catalysed by the materials producer, enabling new forms of customization and the development of new types of products. Furthermore, sustainability is also highlighted as a key goal, as well as the fact that it can be used to improve business:

> *"[Sustainability] is definitely a selling point that we use in our argumentation towards the market. Still, it isn't the key element of the decision-making process, but it's definitely growing. So this sustainability topic is becoming more and more important, for example when you're talking about real estate developers who have a big portfolio. There is a tendency that they would like to have a certain amount of ecological assets, they call them green assets, in their portfolios. Consequently, this environmental topic is becoming more and more important. It'll continue like this for the next 10 years, at least this is my expectation." – Expert 2 (Director of a Business Line, 11 years' experience)*

This importance of sustainability is closely connected to both the technology and the products being sold to end-customers, underlining the need to innovate in different ways in order to continue growing the business.

Configuration 1c shows that actors that are not materials producers can also be product-orientated firms, where the sustainability of the product itself translates into a high level of sustainability for the business. In the quotation below, an example of this kind of actor, whose products are multi-storey buildings, is presented:

> *"The construction [industry] wasn't able to build multi-storey buildings made of wood 10 or 15 years ago. With the development of [names of product innovations], all of a sudden we can build those multi-story buildings. Therefore, products are to some extent an innovation per se. […] We put a lot of effort into innovation and continuous product development, but also into the development of completely new products. I strongly believe in all of this!" – Expert 2 (Director of a Business Line, 11 years' experience)*

Here, the expert explains that the products are innovations in-themselves and that, if the new technology behind the product is sustainable, the end-products will also be considered sustainable. This means that, for a product-orientated business, product innovation alone becomes important in order to be perceived as a sustainable business.

#### *4.1.3. No need for innovations to be sustainable*

Configurations 1d and 1e indicate that a high level of sustainability can be achieved without actively engaging in innovation activities. Building with wood is one way of tackling global warming challenges by replacing the fossil-based materials used in construction, e.g. concrete and steel. Actors that have already started using wood products in construction consider themselves highly sustainable, without having to change their ways of doing things.

*"For our company, sustainability is a core value… one of the key drivers that we think make end-users interested in our products, because we can provide a very good level of sustainability." – Expert 7 (Product Manager, 11 years' experience)*

One possible explanation for the lack of any great involvement in innovation activities is the traditional context of the construction industry, where actors do not aspire to make any major changes in their ways of working, also being slow to change their business offerings, processes, positioning or even business functions. Nevertheless, sustainability is possible without innovation, if the actor is already working with sustainable materials.

*"It's one of the key foundations that we build on, so we're certainly not going to develop something which isn't sustainable." – Expert 4 (Director of a Business Line, 16 years' experience)*

### *4.2.Business value through innovation*

Table 7 identifies innovation practices leading to high business value, consisting of the increase in market share, stable growth, and a sufficient revenue stream. By comparing Tables 6 and 7, it is possible to see that there are certain innovation practices leading to both high sustainability and high business value, as well as certain practices only relating to each specific outcome.

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Insert Table 7 about here

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#### *4.2.1. Materials producers' innovation for high business value*

Configuration 2a shows the same pattern as the previously presented Configuration 1a, entailing that high business value and high sustainability, for the materials producers, can be achieved by focusing on product and process innovation while keeping the existing business model. It is also made clear that product and process innovation are interlinked and that, in order to develop a new product, a change in processes is also required:

*"There's a plan that [firm's name], over the next 5 years, should double the products and services that are new for the company. So currently, 9 % of our turnover comes from new products and services. By 2024, we should have doubled that figure and reached 15 %, which is a huge change. This requires a lot of new stuff to happen and many things are going on now, like putting innovation processes in place, conducting change leadership programmes […]. Then there's also a lot going on in start-up engagements and there's a lot going on in different processes; how do you do open innovation and how do you get ideas from outside the company." – Expert 6 (Program Manager, 18 years' experience)*

What we are observing is that the experts are explaining a clear focus by the materials producers on product and process innovation, whose agenda is to double revenues from new products and services by 2024. It is also clear that, in order for a firm to innovate its products, it will also need to innovate its processes, by introducing new internal programmes, implementing open innovation in order to gain new ideas externally and bring them into the firm. This means that some product innovation also influences the processes occurring within the firm.

Configuration 2b reveals that the materials producer can also achieve high business value by focusing on both positioning and business model innovation while maintaining its existing products and processes. However, this innovation practice only works for high business value and not for high sustainability. In the following quotation, innovation is viewed as a way of differentiating actor from competition, something which does not necessarily relate to sustainability.

*"Innovation is important for the future and will become more important because it is one of the differentiation factors" – Expert 1 (Digital Advisor, 10 years' experience)*

### *4.2.2. Generic innovation practices in the CVC*

Configurations 2c and 2d showed innovation practices that were not actor specific, thus representing the generic innovation practices to be found across the CVC which result in high business value.

Configuration 2c consisted of a combination of product and process innovation, while not engaging in position and business model innovation. This means that, for the companies in the value chain which are product-orientated, this innovation practice is highly beneficial and results in high business value.

> *“…you need to have this innovation culture and that doesn’t come overnight, and we came from a very traditional industry in the sense that things have always started out with technology initially and not so much as regards what kinds of problems we need to solve. I can see a drift now, especially in the digital space we have now taken service designers in the company and people who really have methods how do you engage customers, and how do you design services from the beginning. We do not have such a big bunch of these yet. However, there is a kind of a change in thinking" – Expert 6 (Program Manager, 18 years’ experience)*

From this quotation, we see that innovation is slow, but still ongoing, in the construction sector. Experts describe innovation as starting with a technological push in the form of new and innovative products or services, with this influencing other parts of the firm and leading to the need to develop new processes and new ways of doing things. The absence of positioning and business model innovation in this configuration is also important since having a new type of product and process can be sufficient when it comes to being more sustainable and having high business value, due to this being a traditional industry with established business models and relationships between the actors. Furthermore, by comparing Configuration 2c with Configurations 1a, 1c and 2a, we can see that the emphasis on product and process innovation in the CVC can contribute to both high sustainability and high business value, making this innovation practice particularly interesting when it comes to having a sustainable business.

Configuration 2d indicated that high business value is also possible when all innovation types (product, process, position, and business model innovation) are present and interdependent. The following quotation illustrates the importance of conducting all 4 of these types of innovation:

> *"I really have to say that it's really those four [innovation types]. It's really hard to split them when you have such a wide range. Again, I think it's all 4 [innovation types] …" – Expert 7 (Product Manager, 11 years' experience)*

Moreover, the experts both highlight the importance of innovation, due to it leading to greater financial gains, and link it to a broad range of innovation activities spanning the entire organization, as shown in two following quotations:

> *"I think we managed to cover most of the areas you could imagine under this headline "innovation". It's a very broad range, but our definition is very clear; it [innovation] needs to lead to monetization and it's connected to results." – Expert 4 (Director of a Business Line, 16 years' experience)*

In sum, an innovation practice that involves a wide range of different types of innovation can be seen as helping different actors to adapt to the new sustainable technology, in their business offerings, and to intensify their collaboration with other actors in the value chain as and when they see new market opportunities. Combined, these activities can be viewed as practices that help to accelerate the implementation of new and sustainable technology across the value chain.

## 5. Discussion

Construction projects are commonly regarded as context-specific and risky, having established, over the years, a practice of having a dominant design that relies on low risk and low cost in order to deliver profitability to shareholders (Jones et al., 2016). Risk aversion and fragmentation both slow down innovation in the sector (Blanco et al., 2017), making most of the actors hesitant to innovate, and reluctant to adapt their competencies and practices to new conditions (Egbu, 2004). Consequently, the construction sector is perceived as conservative and often resistant to change as this might increase costs or uncertainty. However, in our analysis, we demonstrated that innovation practices within the sector occur in various forms, and across the entire value chain. We linked different innovation types with their activities and outlined the innovation practices that are perceived to result in high sustainability and high business value, as seen by senior managers in the CVC. Thus, a key part of our analysis of innovation types is an examination of their multiple practical materializations. Results show that innovation is performed through the choices made by organizations as regards their products, processes, positioning and business model innovations. In other words, investigating how practitioners innovate entails studying which innovation activities they perform, and how these activities are combined in practice.

Given that the actors in the CVC are encouraged to reduce their impact on the environment (Wackernagel et al., 1999), and to be more sustainable (Gibbs and O'Neill, 2014), while at the same needing to remain profitable (Jones et al., 2016), the innovation of sustainable technology has been identified as a key approach to addressing these challenges (Martin and Perry, 2019). Building on that, we found that actors in the CVC employ different innovation practices in order to implement new and sustainable technology. Specifically, our analysis shows that senior managers consider several different innovation practices to be critical when it comes to achieving high sustainability and high business value. Our findings reveal that pursuing a single type of innovation, in isolation from the others, is not common to the actors in the CVC. On the contrary, a successful innovation practice needs to consist of several innovation types which involve distinct innovation activities which act in conjunction with each other. Thus, our findings support the integrative view of innovation (Damanpour et al., 2009) and indicate that combinations of different innovation types should be taken into account when managing innovation.

Our findings revealed that among the important outcomes in the construction sector is the ability to build for the future, and for companies to be sustainable. According to previous research, in order to achieve sustainability, companies need to avoid greenwashing (Delmas and Burbano, 2011), to reduce their focus on personal gains (Roberts, 2001) and to abandon their single bottom line visions (Norman and MacDonald, 2004). This is for the benefit of developing business propositions resting on a broader vision statement capable of truly balancing the three dimensions of sustainability: i.e. economic, environmental and social (Elkington, 1998, Pruzan, 1998, Conroy and Berke, 2004). By having this focus, companies can do more than merely addressing consumer demand for responsible consumption (Fisk, 1973, Webb et al., 2008), instead having a wider vision of sustainability that can create value for more actors that are part of the same network (Jackson, 2003, Pava, 2007). These visions are related to the core of corporate citizenship (Waddock, 2004); to do well while doing good (Hamilton et al., 1993). This may act as a challenging obstacle to overcome in the case of old and established enterprises that have had a single bottom line approach for a long time; nevertheless, this is already observable in the CVC. Innovations in the value chain are of key importance as regards changing the vision and key values driving sustainable business.

Profitability and growth are perceived as fundamental objectives for the construction industry's development. However, business activities often go hand-in-hand with environmental hazards. The environmental footprint of the CVC is substantial, as the value chain requires the massive extraction of raw and non-renewable materials, and their disposal. The sector generates about one-third of all global waste and is responsible for 11% of all global CO2 emissions due to its high volume of unsustainable natural resource utilization and the significant environmental damage it causes for the sake of growth (Monier et al., 2011, Ding, 2008, Yılmaz and Bakış, 2015). Thus, the CVC faces significant challenges in harmonizing its economic and environmental goals and reducing its impact on global climate change. This study builds upon the sustainability discussion taking place in the sector and reveals that the organizations in the CVC which recognize the need for more environmentally-friendly building technologies could overcome their current sustainability shortcomings in the CVC through innovation. In other words, the successful implementation of new and sustainable technology is possible when it is profitable and, in order for it to be profitable, the actors in the CVC need to find their own approach to innovation, focusing on either products/processes or on a wider range of innovation activities. Furthermore, among the different types of actors in the CVC, the product and process innovations of the materials producer are literally the building blocks for the entire value chain, entailing that the materials producers, through their innovations, help to catalyse the spread of new and sustainable technology. Other actors, e.g. architects and engineers, contractors, manufacturers, service providers, materials and equipment suppliers, need to adapt to the materials producers' innovations and to innovate themselves, both internally and externally. This creates an additional push for the spread of new and sustainable technology in the value chain, opening up new business and market opportunities.

## 6. Conclusion

Consistent with the suggestion of Bessant and Tidd (2007), i.e. that research should reflect all four innovation types during the study of innovation management, the present study details the ways in which different innovation types can be connected, also underlining the importance of understanding innovation as a holistic organizational phenomenon. Moreover, this study also contributes to innovation research in the construction sector (Peace et al., 2010) by showing that, although the construction sector has been perceived as conservative, low-tech, and less innovative, compared to other sectors (Jones et al., 2016), innovation still takes place, occurring in multiple forms and spanning the entire value chain. Thus, a key contribution made by 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. In addition, this research also highlights the tight connection between novel and sustainable technology and innovation. As already discussed in the literature, technology is an antecedent of innovation (Damanpour and Aravind, 2006). In the context of our research, engineered wood technology propels and 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.

### *6.1.Managerial implications*

Innovation is a manageable activity which requires holistic thinking. The present study has revealed that innovation types can be configured in different ways for different actors, also involving different but interconnected activities. Based on our findings, we suggest that the actors in the CVC which adopt engineered wood technology have to acknowledge the importance of all innovation types and approach them accordingly. This means that managers should develop a strategy that combines different innovation types in order to better adapt to sustainable technologies which influence other actors in the CVC. The role of the wood materials producer acts as an agent for diffusing the new and sustainable technology via, primarily, product and process innovation, while the role of the other actors is to adapt to this using their own ways of innovating.

### *6.2.Limitations and suggestions for further research*

This study was carried out in the context of a CVC specializing in wood-based products, with data collection being carried out in Sweden. This makes the findings context-specific and thus they should not be viewed as attempts to outline general recommendations for other industries. However, having this specific focus allowed us to understand more intricate details of how firms innovate and which activities they consider important. We found that innovation is an integrated concept in which different types of innovation complement each other; thus, we propose that future research consider this and approach innovation in an integrative way, rather than focusing on the different types in isolation from each other.

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**Table 1**
**An overview of empirical studies of the different innovation types**

| Author(s) | Product (service) innovation | Process innovation | Position innovation | Business Model Innovation | Key focus/insights |
|---|---|---|---|---|---|
| Utterback and Albernathy (1975) | ✓ | ✓ | | | The article builds a dynamic model (the A-U model) of process and product innovation. The rates of adoption of product and process innovations differ during the stages of developing a business. The capabilities of a firm to innovate, to achieve efficient operations, etc. cannot be divorced from one another, instead being a matter of an overall strategy. |
| Damanpour (1991) | ✓ | ✓ | | | The distinction between types of innovation is not essential because organizations ultimately adopt administrative and technical, product and process, and radical and incremental innovations. Organizational performance may depend more on the congruency between innovations of different types than on each type alone. A primary contingency variable should not be the type of innovation but the organizational type (in terms of industry, sector, structure, strategy). |
| Amit and Zott (2001) | | | | ✓ | The Business Model (BM) is an integrated concept and a unit of analysis for value creation. BM is an important locus of innovation and a critical source of value creation, both for the firm and for its suppliers, partners and customers. |
| Katila and Ahuja (2002) | ✓ | | | | The pace of new product innovation is a function of the search for and the identification of new knowledge and information. |
| Smith et al. (2005) | ✓ | | | | The rate of new product and service introduction is a function of the organization members' ability to combine and exchange knowledge. |
| Markides 2006 | ✓ | | | ✓ | Technological, business-model, and new-to-the world product innovations should be treated as distinct phenomena. |

| | | | | | |
|---|---|---|---|---|---|
| Damanpour (2010) | ✓ | ✓ | | | Innovation types are complementary and influence organizations jointly; hence, each type cannot be truly understood without an understanding of its interrelationship with the other types. Innovation types are synchronously pursued in order to achieve competitive advantage, due to the firm’s innovative performance depending on how well they work together, not on how each one contributes independently. |
| Bucherer et al. (2012) | ✓ | | | ✓ | Systematic investigation of the similarities and differences between product and business model innovation. A more holistic management of innovation is needed, in which different types (e.g., product and Business Model Innovation) and the degrees of innovation (incremental and radical) are considered and integrated. BMI should not be treated as an isolated activity but aligned with the company’s innovation strategy. Contingency theory supports the need for a holistic approach to innovation management. |
| Li et al. (2013) | ✓ | | | | The location selection and intensity of the search both independently and jointly influence new product introductions. |
| Visnjic et al. (2014) | ✓ | | | ✓ | A study of the interplay between product and service Business Model Innovation. Combining service Business Model Innovation and product innovation results in long-term performance benefits coupled with a degree of short-term performance sacrifice. Service Business Model Innovation in isolation from product innovation results in short-term profit gains but long-term knowledge loss and, consequently, a decline in market performance. |

| | | | | | |
|---|---|---|---|---|---|
| Tavassoli and Bengtsson (2018) | ✓ | | | ✓ | There is a significant and positive association between BMI and product innovation performance. Product innovation has superior performance of BMI-firms compared to firms only introducing product innovations. Complementary innovations in processes, marketing and in the organization may act as an isolating mechanism in the case of competitive imitation. |
| Artusi and Bellini (2020) | | | ✓ | | The authors apply the Innovation of Meaning (IoM) framework which aims to innovate the “reason why” people use a product or service, and to study how to embody new meaning into a new solution. This study further presents a new conceptual method in line with the core principles of the IoM framework. |
| *Current study* | ✓ | ✓ | ✓ | ✓ | *Explains how different innovation types are manifested in innovation practices which result in high sustainability and/or high business value.* |

**Table 2**
**Details of the sample**

| Case | Firm's role in the CVC | Domestic or international business? | Firm size (employees) | Role of the respondent in the firm |
|---|---|---|---|---|
| 1 | Materials producer | International | 26,000 | Vice-president Strategy |
| 2 | Materials producer | International | 26,000 | Business Developer |
| 3 | Materials producer | International | 26,000 | Program Manager |
| 4 | Materials producer | International | 26,000 | Product Manager |
| 5 | Materials producer | International | 26,000 | Head of a business line |
| 6 | Materials producer | International | 26,000 | Senior vice-president Supply Chain |
| 7 | Materials producer | International | 26,000 | Digital Advisor |
| 8 | Architects & engineers | Domestic | 5 | CEO |
| 9 | Manufactured products | Domestic | 61 | CEO |
| 10 | Contractors | Domestic | 14 | CEO |
| 11 | Contractors | Domestic | 30 | Co-owner |
| 12 | Manufactured products | Domestic | 491 | CEO |
| 13 | Contractors | International | 6,447 | Head of Department |
| 14 | Contractors | Domestic | 85 | CEO |
| 15 | Service provider | Domestic | 4 | CEO |
| 16 | Contractors | Domestic | 20 | Head of HR and Finances |
| 17 | Architects & engineers | International | 605 | Chief Architect |
| 18 | Architects & engineers | International | 605 | Operations Manager |
| 19 | Architects & engineers | Domestic | 25 | Project Manager |
| 20 | Materials & equipment suppliers | Domestic | 50 | CEO |
| 21 | Service provider | Domestic | 18 | CEO |
| 22 | Contractors | Domestic | 179 | Section Manager |
| 23 | Contractors | Domestic | 23 | CEO/Co-owner |
| 24 | Manufactured products | Domestic | n/a | CEO/Owner |

**Table 3**
**Examples of innovation types and activities**

| Innovation type | Definition | Key references | Examples of innovation activities | Quotations from industry professionals |
|---|---|---|---|---|
| **Product** | New products or services introduced to meet an external user need | Knight (1967)<br><br>Utterback and Abernathy (1975)<br><br>Damanpour (1991) | New product development and moving towards pre-fabrication, servitization and customized solutions.<br><br>Continuous improvement of the existing offering | "Our key focus is product development, we're continuously improving our offering." - (Expert 3)<br><br>"There's still a lot of potential to make more customized pre-fabricated products, especially as regards technology and automation and what this digital new-thinking allows." – (Expert 6) |
| **Process** | New elements introduced into a firm's production or service operation to produce a product or render a service. | Knight (1967)<br><br>Utterback and Abernathy (1975)<br><br>Damanpour (1991) | Lean production, optimizing logistic processes, automation & digitalization in materials manufacturing.<br><br>A collaboration between different key value chain actors early on during the construction process to optimize the processes and improve the efficiency along the whole chain. | "I think the value lies in the time. Compare it to other traditional businesses, we apply a very lean process. It needs planning, but if you already know how it's being planned and how to do the drawings, then it's very straightforward. You get it done very quickly." – (Expert 6)<br><br>"Today, we see that the CVC is a little bit scattered and there's no optimization between the building process and the supply of materials and that's what we're going to change." (Expert 8) |
| **Position** | A product or service that is introduced into a new context. | Francis and Bessant (2005)<br><br>Tidd and Bessant (2007) | The positioning of engineered wood not only as a robust construction material but also as a means of achieving a sustainability transition in the construction industry.<br><br>Engineered wood resonates with the growing environmental concerns of society and with the awareness of climate change. | "Our target is to change how forest-based industry is connected to the construction industry by providing wood materials as sustainable solutions. That will be the change." (Expert 8)<br><br>"Very personal opinion, when we consider the environmental threat in the future. It starts with new thinking in society. There's more awareness of ecological issues, timber construction will benefit from these." – (Expert 7) |

| | | | | |
|---|---|---|---|---|
| **Business model** | A novel, and nontrivial changes to the key elements of a firm's business model and architecture linking these elements. | Foss and Saebi (2018)<br><br>Teece (2010) | Building up the market for engineered wood and the network of key actors in order to create and deliver customer value.<br><br>Greater customer and partner engagement in order to accelerate and complement the technological development of engineered wood in the CVC. | "I think 10 years ago, the value was completely different. Now we offer custom-made components of buildings, which we deliver directly to the construction site, on time." - (Expert 4)<br><br>"When we're moving more from volume business to customer service, then we also have to understand better what the customers actually want, what they need. We're not driven by volume, but more likely by the value we can provide… and it's still ongoing and we're not there yet." - (Expert 8) |

**Table 4**
**Calibration of conditions and outcomes as fuzzy sets**

| **Condition** | **Question/measure** *"In my organization, IEW products…"* | **Type** | **Min** (full non-membership) | **Max** (full membership) | **Mean** | **Crossover point calibration** | **Coding: fsQCA thresholds** |
|---|---|---|---|---|---|---|---|
| Product innovation | …requires innovation of the products themselves. | Condition | 3 | 7 | 5.29 | 5.3 | Full membership corresponded to the maximum point (7) on the Likert-scale, indicating full agreement with the provided statement, e.g. *In my organization, IEW products make a great contribution to sustainability and reduce the impact on the environment*;<br><br>The crossover point (0.5) corresponded to the point of central tendency (average value) in each of the conditions, indicating that a response is either above the average tendency or below the average tendency, e.g. *In my organization, IEW products make a slightly lower than average contribution to sustainability*;<br><br>Full non-membership (0.05) corresponded to the minimum point on the Likert-scale, indicating disagreement with the statement provided, e.g. *In my organization, IEW products do not make a great contribution to sustainability*. |
| Process innovation | …requires changes in the way in which we create and deliver them. | Condition | 3 | 7 | 5.16 | 5.1 | |
| Positioning innovation | …requires changes in customer perceptions of our offerings. | Condition | 2 | 7 | 5.00 | 5.1 | |
| Business Model Innovation | …requires innovation in the business model. | Condition | 2 | 7 | 4.00 | 4.1 | |
| Sustainability | …contributes to sustainability and reduces the impact on the environment. | Outcome | 4 | 7 | 5.91 | 5.9 | |
| Business value | …increases our market share.<br>…provides stable growth.<br>…generates sufficient revenues. | Outcome | 3 | 7 | 5.37 | 5.3 | |

**Table 5**
**Necessity analysis***

| | **High sustainability** | | **High business value** | |
|---|---|---|---|---|
| | Consistency | Coverage | Consistency | Coverage |
| Product innovation | 0.76 | 0.81 | 0.75 | 0.77 |
| ~Product innovation | 0.54 | 0.68 | 0.55 | 0.66 |
| Process innovation | 0.67 | 0.71 | 0.80 | 0.81 |
| ~Process innovation | 0.55 | 0.70 | 0.48 | 0.59 |
| Positioning innovation | 0.66 | 0.70 | 0.72 | 0.74 |
| ~Positioning innovation | 0.61 | 0.76 | 0.55 | 0.65 |
| Business Model Innovation | 0.55 | 0.64 | 0.64 | 0.73 |
| ~Business Model Innovation | 0.67 | 0.75 | 0.60 | 0.65 |
| Materials producer | 0.34 | 0.57 | 0.48 | 0.76 |
| ~Materials producer | 0.65 | 0.58 | 0.51 | 0.43 |

**Note*: The tilde symbol (~) indicates negation i.e., ~product innovation indicates the absence of product innovation.

## Table 6
## Configurational chart for the outcome of high sustainability*

| **Configurations** | **High sustainability** | | | | |
|---|---|---|---|---|---|
| | 1a | 1b | 1c | 1d | 1e |
| **Conditions** | | | | | |
| Materials producer | ● | ⨂ | ⊗ | ⨂ | ⨂ |
| Product innovation | ● | ● | ⬤ | ⊗ | ⊗ |
| Process innovation | ● | ● | | ⨂ | ⨂ |
| Position innovation | | | ⊗ | ⊗ | |
| Business Model Innovation | ⊗ | ⬤ | ⨂ | | ⊗ |
| *Qualitative interpretation of the configurations* | *Requires product and process innovation while pushing the new technology into a value chain* | *Requires innovation in all aspects of the business while adapting to a new technology* | *Requires product innovation while having an established market position and business offering* | *Does not require innovation activities in order to be sustainable* | *Does not require innovation activities in order to be sustainable* |
| **Consistency** | 1.00 | 0.87 | 0.90 | 0.84 | 0.85 |
| **Raw coverage** | 0.17 | 0.25 | 0.30 | 0.31 | 0.32 |
| **Unique coverage** | 0.17 | 0.07 | 0.09 | 0.03 | 0.04 |
| **Solution consistency** | | | 0.88 | | |
| **Solution coverage** | | | 0.71 | | |

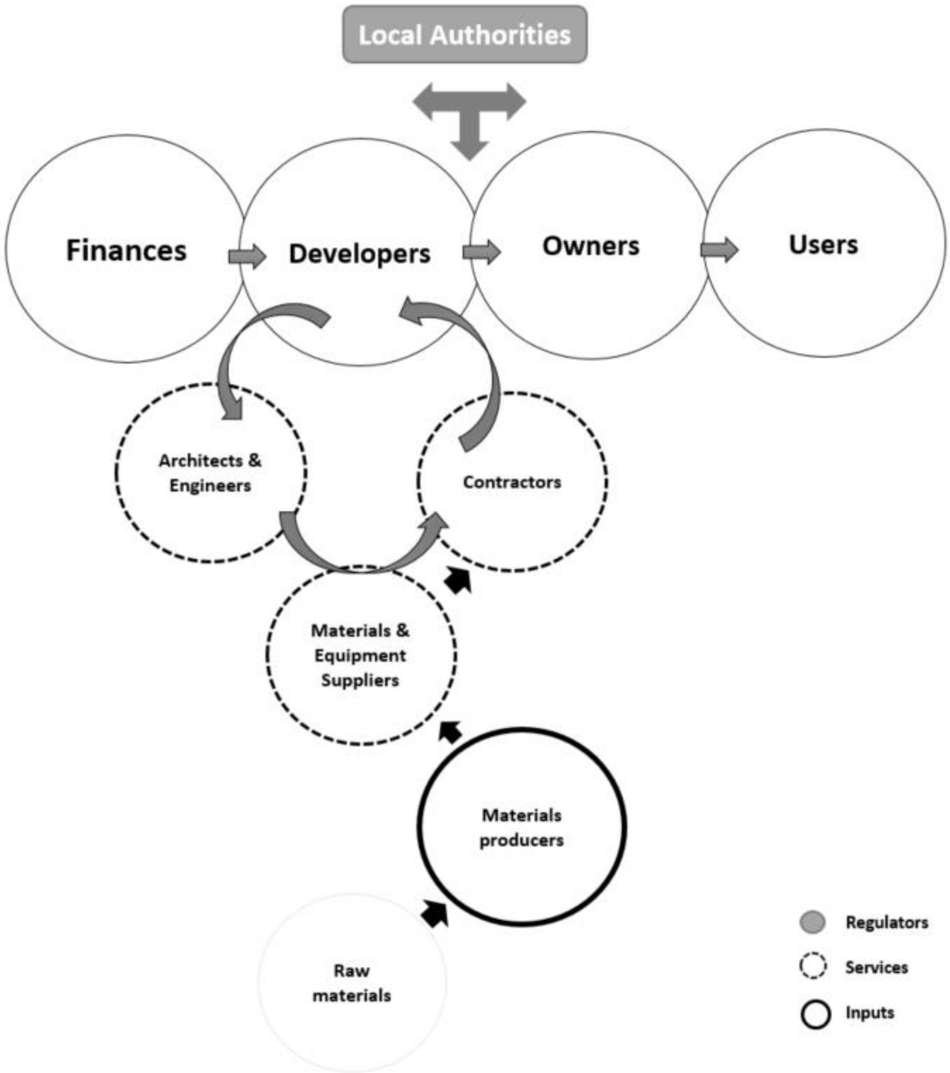
**Note*: Black circles indicate the presence of a condition, while circles containing an "X" indicate its absence and blank spaces indicate that the presence or absence of the condition does not matter to the configuration. Large circles indicate the core conditions of the parsimonious solution.

## Table 7
## Configurational chart for the outcome of high business value*

| **Configurations** | **High business value** | | | |
|---|---|---|---|---|
| | 2a | 2b | 2c | 2d |
| **Conditions** | | | | |
| Materials producer | ⬤ | ⬤ | | |
| Product innovation | ⬤ | | ⬤ | ⬤ |
| Process innovation | ⬤ | ⊗ | ⬤ | ⬤ |
| Position innovation | | ● | ⊗ | ● |
| Business Model Innovation | ⊗ | ● | ⊗ | ● |
| *Qualitative interpretation of the configurations* | *Requires product and process innovation while pushing the new technology into a value chain* | *Requires position and business model innovation while pushing the new technology into a value chain* | *Requires product and process innovation while having an established market position and business offering* | *Requires innovation in all aspects of the business* |
| **Consistency** | 0.85 | 1.00 | 0.84 | 0.90 |
| **Raw coverage** | 0.32 | 0.17 | 0.31 | 0.30 |
| **Unique coverage** | 0.04 | 0.17 | 0.03 | 0.09 |
| **Solution consistency** | | 0.90 | | |
| **Solution coverage** | | 0.64 | | |

**Note*: Black circles indicate the presence of a condition, while circles containing an "X" indicate its absence and blank spaces indicate that the presence or absence of the condition does not matter to the configuration. Large circles indicate the core conditions of the parsimonious solution.

**Figure 1**
**Illustration of a construction value chain (CVC) with key actors and interactions, adapted from Coalition (2018)**



# Appendix

**Table A1**
**Calibrated dataset for fsQCA**

| Case | Mat. prod. | Prod. | ProdFz | Proc. | ProcFz | Pos. | PosFz | Bmi | BmiFz | Sust. | SustFz | Bus. | BusFz |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1 | 6 | 0.77 | 6 | 0.81 | 2 | 0.05 | 4 | 0.46 | 7 | 0.95 | 6.33 | 0.86 |
| **2** | 1 | 7 | 0.95 | 7 | 0.95 | 6 | 0.81 | 4 | 0.46 | 7 | 0.95 | 7 | 0.95 |
| **3** | 1 | 5 | 0.40 | 5 | 0.46 | 6 | 0.81 | 7 | 0.95 | 5 | 0.19 | 6.33 | 0.86 |
| **4** | 1 | 7 | 0.95 | 5 | 0.46 | 7 | 0.95 | 6 | 0.88 | 5 | 0.19 | 6 | 0.77 |
| **5** | 1 | 7 | 0.95 | 7 | 0.95 | 7 | 0.95 | 5 | 0.72 | 7 | 0.95 | 5.67 | 0.66 |
| **6** | 1 | 6 | 0.77 | 6 | 0.81 | 6 | 0.81 | 5 | 0.72 | 6 | 0.57 | 6 | 0.77 |
| **7** | 1 | 5 | 0.40 | 5 | 0.46 | 6 | 0.81 | 6 | 0.88 | 5 | 0.19 | 5.33 | 0.51 |
| **8** | 0 | 5 | 0.40 | 3 | 0.05 | 6 | 0.81 | 4 | 0.46 | 6 | 0.57 | 3.67 | 0.08 |
| **9** | 0 | 4 | 0.16 | 4 | 0.17 | 5 | 0.48 | 2 | 0.05 | 7 | 0.95 | 6.33 | 0.86 |
| **10** | 0 | 3 | 0.05 | 6 | 0.81 | 5 | 0.48 | 2 | 0.05 | 6 | 0.57 | 6 | 0.77 |
| **11** | 0 | 5 | 0.40 | 5 | 0.46 | 5 | 0.48 | 5 | 0.72 | 6 | 0.57 | 5.67 | 0.66 |
| **12** | 0 | 5 | 0.40 | 6 | 0.81 | 3 | 0.12 | 3 | 0.17 | 6 | 0.57 | 6 | 0.77 |
| **13** | 0 | 5 | 0.40 | 3 | 0.05 | 4 | 0.26 | 5 | 0.72 | 6 | 0.57 | 4.67 | 0.28 |
| **14** | 0 | 6 | 0.77 | 6 | 0.81 | 4 | 0.26 | 3 | 0.17 | 6 | 0.57 | 6 | 0.77 |
| **15** | 0 | 6 | 0.77 | 4 | 0.17 | 6 | 0.81 | 5 | 0.72 | 7 | 0.95 | 4.67 | 0.28 |
| **16** | 0 | 4 | 0.16 | 5 | 0.46 | 4 | 0.26 | 3 | 0.17 | 4 | 0.05 | 4 | 0.12 |
| **17** | 0 | 4 | 0.16 | 6 | 0.81 | 4 | 0.26 | 4 | 0.46 | 4 | 0.05 | 3.33 | 0.05 |
| **18** | 0 | 6 | 0.77 | 5 | 0.46 | 4 | 0.26 | 2 | 0.05 | 7 | 0.95 | 3.67 | 0.08 |
| **19** | 0 | 5 | 0.40 | 4 | 0.17 | 4 | 0.26 | 2 | 0.05 | 6 | 0.57 | 4.67 | 0.28 |
| **20** | 0 | 6 | 0.77 | 6 | 0.81 | 6 | 0.81 | 6 | 0.88 | 6 | 0.57 | 5.67 | 0.66 |
| **21** | 0 | 4 | 0.16 | 5 | 0.46 | . | . | 2 | 0.05 | 5 | 0.19 | 6 | 0.77 |
| **22** | 0 | 5 | 0.40 | 4 | 0.17 | . | . | 2 | 0.05 | 5 | 0.19 | 3.33 | 0.05 |
| **23** | 0 | 6 | 0.77 | 6 | 0.81 | . | . | 4 | 0.46 | 7 | 0.95 | 7 | 0.95 |
| **24** | 0 | 5 | 0.40 | 5 | 0.46 | . | . | 5 | 0.72 | 6 | 0.57 | 5.67 | 0.66 |

## Table A2
## Truth table for the outcome of high sustainability

| Materials producer | Product innovation | Process innovation | Position innovation | BMI | Num. | High Sustain. | Raw consist. | PRI consist | SYM consist |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| **1** | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| **0** | 1 | 0 | 0 | 0 | 1 | 1 | 0.924399 | 0.770834 | 0.770833 |
| **0** | 1 | 0 | 1 | 1 | 1 | 1 | 0.920863 | 0.752809 | 0.752809 |
| **0** | 0 | 0 | 1 | 0 | 1 | 1 | 0.895522 | 0.72 | 0.72 |
| **0** | 0 | 0 | 0 | 1 | 2 | 1 | 0.888031 | 0.560606 | 0.587302 |
| **0** | 1 | 1 | 0 | 0 | 1 | 1 | 0.868687 | 0.666666 | 0.78 |
| **0** | 0 | 0 | 0 | 0 | 3 | 1 | 0.822102 | 0.584906 | 0.596154 |
| **0** | 1 | 1 | 1 | 1 | 1 | 1 | 0.813333 | 0.382353 | 0.541667 |
| **0** | 0 | 1 | 0 | 0 | 3 | 0 | 0.740947 | 0.411392 | 0.419355 |
| **1** | 1 | 1 | 1 | 1 | 2 | 0 | 0.738318 | 0.592233 | 0.638743 |
| **1** | 1 | 0 | 1 | 1 | 1 | 0 | 0.541667 | 0 | 0 |
| **1** | 0 | 0 | 1 | 1 | 2 | 0 | 0.52381 | 0 | 0 |

## Table A3
## Truth table for the outcome of high business value

| Materials producer | Product innovation | Process innovation | Position innovation | BMI | Num . | High business value | Raw consist. | PRI consist | SYM consist |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| **1** | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| **1** | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **1** | 1 | 1 | 1 | 1 | 2 | 1 | 0.981308 | 0.966102 | 1 |
| **1** | 0 | 0 | 1 | 1 | 2 | 1 | 0.979592 | 0.933333 | 1 |
| **0** | 1 | 1 | 1 | 1 | 1 | 1 | 0.884444 | 0.59375 | 0.716981 |
| **0** | 1 | 1 | 0 | 0 | 1 | 1 | 0.821549 | 0.569106 | 0.569106 |
| **0** | 0 | 0 | 0 | 1 | 2 | 0 | 0.760618 | 0.225 | 0.225 |
| **0** | 0 | 0 | 1 | 0 | 1 | 0 | 0.734328 | 0.276423 | 0.276423 |
| **0** | 0 | 1 | 0 | 0 | 3 | 0 | 0.727019 | 0.413173 | 0.413173 |
| **0** | 1 | 0 | 0 | 0 | 1 | 0 | 0.71134 | 0.0232558 | 0.0232558 |
| **0** | 0 | 0 | 0 | 0 | 3 | 0 | 0.692722 | 0.25 | 0.25 |
| **0** | 1 | 0 | 1 | 1 | 1 | 0 | 0.672662 | 0.0618558 | 0.0618558 |