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Master of Science in Business Administration

Knowledge inflows and business model innovation: the moderating effects of senior team attributes

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Preface

Acknowledgements

What an amazing journey the past two years have been. Sometimes with a bit of stress and with a few hectic weeks of only studying, working, eating and sleeping, but always full of energy and with loads of new insights and experiences. I would like to thank all the professors and lecturers for their enthusiasm during the different courses, and my fellow students for their support and insights into other businesses. The courses and projects during the first year and a half have proven to be an indispensable experience.

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Ruud Verstegen

Executive summary

The capacity to reinvent your business model before you are being outpaced by your competitors is argued to be a critical source of competitive advantage. Business model innovation aims to do so. While there is a reasonable understanding of the drivers, prerequisites and barriers to business model innovation, we know little of the enablers of business model innovation and even less on where the knowledge used to innovate a business model originates from. A better understanding of this topic is of importance, as most innovations in organisations result from borrowing rather than invention. In this, I specifically target the unit's senior team, because research has shown that company or unit level exploration is largely influenced by the activities of their senior teams. As the senior team is an extensive phenomenon to study, I curtail this to two attributes which are argued to moderate the effectiveness of senior teams, being senior team heterogeneity and senior team social integration. This research contributes to the following question: "How do knowledge inflows contribute to business model innovation and how is this affected by senior team attributes?". With that, I progress current scientific knowledge regarding top-down, bottom-up and horizontal knowledge inflows as sources of business model innovation. Moreover, I add new insights on the moderating role of senior team heterogeneity and senior team social integration to the existing literature on senior team attributes.

I build upon the organisational learning theory and the absorptive capacity framework as these provide valuable insights into innovation in general. These theories centre around the idea that innovations originate from recognising, acquiring, and exploiting knowledge from outside the organisation, by combining this knowledge with the organisation's existing knowledge stocks. I provide a quantitative research into the concept of business model innovation, using data gathered from 104 senior team members in 55 different organisational units of a large, European, multi-unit construction company. The findings indicate that there is no significant relationship between top-down, bottom-up or horizontal knowledge inflows and business model innovation, and these relationships are in most cases not moderated by either senior team heterogeneity or senior team social integration. However, there is a significant relationship between horizontal knowledge inflows and value creation innovation. Senior teams should therefore seek for knowledge of peers within the organisation if they want to innovate on value creation, instead of knowledge originating from higher or lower levels in the organisation. Senior team heterogeneity has a direct and significant positive effect on business model innovation and a direct and marginally significant positive effect on value proposition innovation. Management of multi-unit companies should therefore put effort into composing a diverse senior team for the unit in which they want business model innovation or value proposition innovation to take place and should take demographic, functional, and background

dimensions into account when selecting new team members. Senior team social integration does marginally significant moderate the relationship between bottom-up knowledge inflows on one side and business model innovation or value proposition innovation on the other side. This is a cross-over interaction, which means that more bottom-up knowledge inflows will only lead to higher levels of business model innovation or value proposition innovation when the unit's senior team is highly socially integrated. When the unit's senior team is not socially integrated, will more bottom-up knowledge inflows actually have a negative effect on business model innovation or value proposition innovation.

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1 Introduction

In current dynamic and volatile environments, even a tried and proven business model does not guarantee long-term success (Chesbrough, 2010; Lindgardt, Reeves, Stalk, & Deimler, 2009). Questions such as “how can companies avoid becoming victims of their own success?” and “how can companies do more with the resources and capabilities they have?” arise frequently (Schneider & Spieth, 2013). A response could be to adapt the current business model by exploring into new possibilities (Schneider & Spieth, 2013). The capacity to reinvent your business model before you are being outpaced by your competitors is argued to be a critical source of competitive advantage (Schneider & Spieth, 2013). Unique and differentiated business models give companies the possibility to achieve such competitive advantage (Casadesus-Masanell & Zhu, 2013), not only in developing markets but also in mature ones (Sosna, Trevinyo-Rodriguez, & Velamuri, 2010). Scholars in different fields of research have targeted the business model as the unit of analysis, such as studies in the field of entrepreneurship (George & Bock, 2011; Malmström, Johansson, & Wincent, 2014), strategic management (Zott & Amit, 2008), innovation management (Chesbrough & Rosenbloom, 2002; Bucherer, Eisert, & Gassmann, 2012), and marketing (Storbacka, Windahl, Nenonen, & Salonen, 2013). While you would expect business model innovation to take place at company level, it can also occur in individual subunits of multi-unit organisations (Foss & Saebi, 2017), as long as the unit operates on a secluded business model and is permitted to make decisions regarding business model innovation fairly autonomously. Business model innovation at unit level is the target of this study. Whether at company or unit level and as sublimely stated by Lindgardt et al. (2009), “business model innovation means more than a brilliant insight coming at the right place and the right time. To attain a reliable competitive advantage, business model innovation must be systematically cultivated, sufficiently supported, and explicitly managed”.

While there is a reasonable understanding of the drivers, prerequisites and barriers to business model innovation, little is known of the enablers of business model innovation (Foss & Saebi, 2017). Prior research on the enablers of business model innovation focus mostly on constructs that are of use during the innovation process. For example, Doz and Kosonen (2008; 2010) highlight strategic sensitivity, leadership unity, and resource fluidity as important capabilities in order to achieve this strategic agility, Aspara et al. (2013) argue that managers use their understanding of inter-organisational cognition as input for the decision on changing the elements of the business model and the links between them, and Khanagha et al. (2014) indicate that switching between structural separation and integration gives a company the possibility to explore into the new business model and it initiates a collective learning process needed to reshape the strategy. Three studies have their focus earlier in this process. Malhotra (2000) suggests that a sense-making knowledge

management model, which centralises around the creation of meaning, will support business model innovation, Eppler et al. (2011) assess different techniques for collaborative idea generation, and Björk (2012) investigates into the influence spanning different knowledge domains has on an individual's ideation performance. However, there is little attention to the origin of knowledge necessary to create these new ideas and support business model innovation. A better understanding of where knowledge originates from with regard to business model innovation is of importance, as most innovations in organisations result from borrowing rather than invention (Hippel, 1988). I therefore advance the growing body of literature and take top-down, bottom-up and horizontal knowledge inflows as possible sources of business model innovation. This is based on the notion that these knowledge inflows can bring considerable advantages to multi-unit organisations as they support an organisation-wide exchange of knowledge, which would otherwise stay concealed in each individual subunit (Bartlett & Ghoshal, 1989).

Knowledge inflows can enter a unit at different levels, ranging from operational to senior team level. Where studies which have their focus on early phases in the business model innovation process don't target a specific level, I look at knowledge inflows into the unit's senior team. Research has shown that company or unit level exploration, which can be defined with terms such as "search, variation, risk taking, experimentation, play, flexibility, discovery, innovation" (March, 1991), is largely influenced by the activities of their senior teams (Mom, Van den Bosch, & Volberda, 2007). In addition, senior team members are in the best place to pick up signals that may call for business model innovation and they often have the authority to transform the business model when necessary, which makes their perception regarding the necessary changes of great importance (Foss & Saebi, 2017). As the senior team is an extensive phenomenon to study, I curtail it to two attributes which are argued to moderate the effectiveness of senior teams, namely senior team heterogeneity (Alexiev, Jansen, Van den Bosch, & Volberda, 2010) and senior team social integration (Jansen, George, Van den Bosch, & Volberda, 2008). To substantiate this, I build upon the organisational learning theory and the absorptive capacity framework as these provide valuable insights into innovation in general (Colakoglu, Yamao, & Lepak, 2014). These theories centre around the idea that innovations originate from recognising, acquiring, and exploiting knowledge from outside the organisation, by combining this knowledge with the organisation's existing knowledge stocks (Cohen & Levinthal, 1990).

Finally, where previous studies on business model innovation are typically case studies of individual companies and have a conceptual focus (Markides, 2013; Clauβ, 2017), I provide a quantitative research into the concept of business model innovation. I test the posed hypotheses using data

gathered from 104 senior team members in 55 different organisational units of a large, European, multi-unit construction company, in which each unit has a geographically distinct client base and operates on a secluded business model, with its own profit and loss account.

In summary, this research contributes to the following question: “How do knowledge inflows contribute to business model innovation and how is this affected by senior team attributes?”. This study poses that three distinct knowledge inflows have a different impact on business model innovation. Subsequent and from a theoretical perspective, it provides a better understanding on how these knowledge inflows influence a unit’s business model innovation levels. With that, I advance the growing body of literature on the enablers business model innovation. From a managerial perspective, it gives direction on how to use the companies different knowledge stocks to innovate an individual unit’s business model. Further, this study examines how the impact of top-down, bottom-up and horizontal knowledge inflows is moderated by senior team heterogeneity and senior team social integration. From a theoretical perspective, it progresses our knowledge on the impact of a senior team on a unit’s innovation efforts and from a managerial perspective, it gives insights into how to influence a senior team’s effectiveness with regard to their unit’s business model innovation levels.

In the following sections, I first present the theory to date to build my hypotheses on, in which I examine the relationships between knowledge inflows, business model innovation and senior team heterogeneity and senior team social integration as moderators. Subsequent, I describe the research method used and present the empirical findings. Finally, I end with a conclusion and discussion of the results, implications and limitations of this study and directions for future research.

2 Theory and hypotheses

2.1 Business models and business model innovation

The notion of business models originates from the late ‘40s and ‘50s (Bellman, Clark, Malcolm, Craft, & Ricciardi, 1957; Lang, 1947). A business model was first defined as “an operative activity for system modelling in the context of information technology” (Foss & Saebi, 2017). During the 1990s, scholars in the field of entrepreneurship and strategy understood a business model as an integrated model of the key business processes of a company and the links between these processes (Zott, Amit, & Massa, 2011). Although many studies apply different definitions of a business model (Foss & Saebi, 2017), the most currently used definitions are in line with the definition by Teece (2010) as “the design or architecture of the value creation, delivery and capture mechanisms of a company”. Thus, the elements of a company’s business model are value creation, value proposition and value capture (Morris, Schindehutte, & Allen, 2005; Johnson, Christensen, & Kagermann, 2008; Zott & Amit, 2008). Value creation consists of the way a company creates value for their customers using the resources and capabilities available along their value chain via intra- and interorganisational processes (Achtenhagen, Melin, & Naldi, 2013). Value proposition encompasses all the solutions offered to customers, including the channels used to deliver them (Johnson, Christensen, & Kagermann, 2008; Morris, Schindehutte, & Allen, 2005). Value capture contains the means by which the company’s value propositions are converted into revenues and it includes the ways a company generates revenues that cover costs and achieves short-term and long-term profits (Baden-Fuller & Haefliger, 2013; Johnson, Christensen, & Kagermann, 2008; Teece, 2010). A company’s business model is embodied by the composition of these elements (Shafer, Smith, & Linder, 2005).

Every organisation has a business model (Teece, 2010), whether shaped and constructed intentionally or not. The ability to innovate a business model is increasingly important in today’s rapidly changing environments (Amit & Zott, 2001; Schneider & Spieth, 2013). Many scholars use different definitions of business model innovation, refer to table 1. The unclarity on the definition and nature of business model innovation has been pointed out by many (Foss & Saebi, 2017; Markides, 2013; Schneider & Spieth, 2013). In this study, I apply the definition of Casadesus-Masanell and Zhu (2013), as it is the most cited definition and it captures all elements of the business model as defined by Teece (2010). Casadesus-Masanell and Zhu (2013) define business model innovation as follows: “at the root, business model innovation refers to the search for new logics of the company and new ways to create and capture value for its stakeholders; it focuses primarily on finding new ways to generate revenues and define value propositions for customers, suppliers, and partners”.

Authors	*Definition*
Mitchel and Coles (2004a)	"By business model innovation, we mean business model replacements that provide product or service offerings to customers and end users that were not previously available. We also refer to the process of developing these novel replacements as business model innovation."
Markides (2006)	"Business model innovation is the discovery of a fundamentally different business model in an existing business."
Santos et al. (2009)	"Business model innovation is a reconfiguration of activities in the existing business model of a company that is new to the product service market in which the company competes."
Aspara et al. (2010)	"Initiatives to create novel value by challenging existing industry-specific business models, roles and relations in certain geographical market areas."
Yunus et al. (2010)	"Business model innovation is about generating new sources of profit by finding novel value proposition/value constellation combinations."
Sorescu et al. (2011)	"As a change beyond current practice in one or more elements of a retailing business model (i.e., retailing format, activities, and governance) and their interdependencies, thereby modifying the retailer's organising logic for value creation and appropriation."
Amit and Zott (2012)	"Innovate business model by redefining (a) content (adding new activities), (b) structure (linking activities differently), and (c) governance (changing parties that do the activities)."
Bucherer et al. (2012)	"We define business model innovation as a process that deliberately changes the core elements of a company and its business logic."
Aspara et al. (2013)	"A change in the perceived logic of how value is created by the corporation, when it comes to the value-creating links among the corporation's portfolio of businesses, from one point of time to another."
Berglund and Sandström (2013)	"A business model innovation can thus be thought of as the introduction of a new business model aimed to create commercial value."
Casadesus- Masanell and Zhu (2013)	"At root, business model innovation refers to the search for new logics of the company and new ways to create and capture value for its stakeholders; it focuses primarily on finding new ways to generate revenues and define value propositions for customers, suppliers, and partners."
Khanagha et al. (2014)	"Business model innovation activities can range from incremental changes in individual components of business models, extension of the existing business model, introduction of parallel business models, right through to disruption of the business model, which may potentially entail replacing the existing model with a fundamentally different one."

Table 1: Definitions of business model innovation (ordered chronologically) (Foss & Saebi, 2017)

Regardless of which specific definition, business model innovation looks at innovating a company's business model, instead of its products or its processes (Baden-Fuller & Haefliger, 2013). With this, it aims to purposely renew a company's core business logic rather than focussing on innovation of a single product or service (Schneider & Spieth, 2013). Scholars argue that business model innovation drives significant competitive advantage (Zott, Amit, & Massa, 2011). Interestingly, it generally is the third option on the innovation agenda of companies, surpassed by innovation on new products and services and innovation on technologies (Mitchell & Coles, 2003). Business model innovation can be complex and risky, and its outcomes are unpredictable (Chesbrough, 2010), because it requires experimentation on the companies key value delivering activities (McGrath, 2010). In addition, as the performance of a business model depends heavily on the links between its elements, changing the elements or its links adds another layer of complexity (Berends, Smits,

Reymen, & Podoynitsyna, 2016). Business model innovation is also known as business model dynamics (Reuver, Bouwman, & MacInnes, 2009), business model evolution (Demil & Lecocq, 2010), business model reconfiguration (Calia, Guerrini, & Moura, 2007), business model reinvention (Johnson, Christensen, & Kagermann, 2008), business model renewal (Doz & Kosonen, 2010), or business model transformation (Aspara, Lamberg, Laukia, & Tikkanen, 2013).

Mitchell and Coles (2003; 2004a; 2004b) argue that before the '90s, it was standard practice for a company that found a successful business model to replicate that model in other markets, which allowed these companies to reduce costs and improve efficiency. Business model innovations where hardly introduced by market leaders, instead mostly by new entrants. Established companies reacted by either copying the business model introduced by new entrants or by acquiring the entrants before they could establish successful relationships with customers (Casadesus-Masanell & Zhu, 2013).

Publications on business model innovation have expanded to such a level that business model innovation is nowadays seen as a distinct field of research, even though it is a spinoff of and there are close connections to research on the business model as a concept (Foss & Saebi, 2017). Based on an extensive literature review, Foss and Saebi (2017) distinguish between four streams of research on business model innovation. First, they distinguish the stream on conceptualising business model innovation, which highlights the phenomenon itself and offers definitions and conceptualisations of business model innovation. This research stream tries to find a commonly accepted definition of business model innovation and investigates into which extent a business model can be innovated (Amit & Zott, 2012; Santos, Spector, & Van der Heyden, 2009). The second stream investigates into business model innovation as an organisational change process, which some argue is an evolutionary process (Dunford, Palmer, & Benviste, 2010), an ongoing adaptation to environmental dynamism (Demil & Lecocq, 2010), a continuous learning process (McGrath, 2010) with the compulsory double-loop learning process (Moingeon & Lehmann-Ortega, 2010), or a process focused on experimentation and invention (Sosna, Trevinyo-Rodriguez, & Velamuri, 2010). In addition, this stream emphasises the organisational capabilities and leadership required for successful business model innovation and highlight the different stages of the business model innovation process (Achtenhagen, Melin, & Naldi, 2013; Doz & Kosonen, 2010; Reuver, Bouwman, & Haaker, 2013), proposes practical tools for managing this process (Evans & Johnson, 2013), and cites the importance of experimentation and learning (Sosna, Trevinyo-Rodriguez, & Velamuri, 2010). Thirdly, Foss and Saebi (2017) distinguish the research stream on business model innovation as an outcome. This stream focusses on the rise of new business models in a particular industry,

for example in aviation (Schneider & Spieth, 2013), examines one particular type of business model, for example service oriented business models (Visnjic Kastalli & Looy, 2013), or describes a particular company's innovative business model, for example Nestlé's Nespresso (Matzler, Bailom, Eichen, & Kohler, 2013). The fourth and last stream targets the consequences of business model innovation. Research in this stream can be differentiated into the studies that connect the business model innovation process to its process outcomes (Aspara, Hietanen, & Tikkanen, 2010; Bock, Opsahl, George, & Gann, 2012), and studies that investigate how business models influence a company's performance (Wei, Yang, Sun, & Gu, 2014; Zott & Amit, 2008).

These four research streams give key insights into the ability of companies to change the design and composition of their business model (Foss & Saebi, 2017). In addition, the literature recognises that business model innovation can differ in at least two possible dimensions (Foss & Saebi, 2017). First, there is a differentiation in the amount of novelty of the business model innovation. Some studies state that the business model innovation can be novel to a company but it does not have to be novel to the industry (Bock, Opsahl, George, & Gann, 2012; Johnson, Christensen, & Kagermann, 2008), whereas others stress business model innovations that are novel to an industry (Santos, Spector, & Van der Heyden, 2009). For the purpose of this research, I do not distinguish between business model innovations which are novel to a company or novel to an industry as both degrees of novelty can bring a company advantage over their competitors (Johnson, Christensen, & Kagermann, 2008).

Another relevant dimension is the scope of the business model innovation, in other words which and how many elements of the business model are affected by the innovation (Foss & Saebi, 2017). Some scholars suggest that business model innovation may affect only a single component of a company's business model (Amit & Zott, 2012; Bock, Opsahl, George, & Gann, 2012). Others allow for one or more components in which a change may manifest (Sorescu, Frambach, Signh, Rangaswamy, & Bridges, 2011), or even for two or more components (Lindgardt, Reeves, Stalk, & Deimler, 2009). On the extreme end, some scholars insist that business model innovation must result in a completely new combination of all elements of a business model and the links between these elements (Velamuri, Bansemir, Neyer, & Moeslein, 2013). Independent of the degree of novelty and for the purpose of this research, I do not distinguish between the scope of the business model innovation, as changes in one or more of the three outlined elements of a business model can all lead to a competitive advantage (Winter & Szulanski, 2001; Johnson, Christensen, & Kagermann, 2008; Baden-Fuller & Haefliger, 2013).

While there are many advantages to business model innovation, as highlighted in the literature, are companies also confronted with substantial barriers and challenges when innovating their business model. Established companies may face two kind of barriers when innovating their business model, structural or organisational barriers and cognitive barriers (Chesbrough, 2010). Structural or organisational barriers can pose in four different forms. First, there is the tension of allocating sufficient resources to the new business model and the resistance towards changing the current business model because this may conflict with a company's existing assets or capabilities (Chesbrough & Rosenbloom, 2002). Second, adaptation to a new business model might be obstructed by lock-in and switching costs with regard to suppliers, customers, and other stakeholders (Amit & Zott, 2001). Third, there might be internal hostilities when developing a new business model in parallel with the current one, especially when the new business model cannibalises the existing one (Santos, Spector, & Van der Heyden, 2009). Lastly, there is the unpredictability of the effectiveness of the new business model because of the complex system of the business model elements and the links between the elements, and the difficulty in anticipating on these changes (Berends, Smits, Reymen, & Podoynitsyna, 2016; Lindgardt, Reeves, Stalk, & Deimler, 2009).

From a cognitive perspective, a business model closely resembles the notion of a dominant logic (Prahald & Bettis, 1986). A business model can therefore act as mental map and thereby influences the way new ideas are perceived by people operating in the business model (Massa & Tucci, 2014). Any information that misaligns with the current business model might be filtered out, which consequently creates a dominant logic trap over time (Chesbrough, 2010). In addition, cognitive barriers are also related to top management not being able to envision business model innovation, to identify the opportunities that arise with it (Chesbrough & Rosenbloom, 2002), and to unravel the appropriate structures and processes of the new business model and the organisational capabilities necessary to deliver the new business model successfully (Doz & Kosonen, 2010; Johnson, Christensen, & Kagermann, 2008). Realising the need for change of the business model is not only related to the senior team, but also depends on the allocation of authority and decision making rights within the organisation. Research shows that in companies where the authority to establish external cooperation rests with the middle managers, the prospect of recognising the necessity for change of the business model is higher (Foss & Saebi, 2015).

Previous research points to external shocks or crisis situations as drivers or prerequisites of business model innovation (Spieth & Schneider, 2016). Studies on external influences on business model innovation point at changing demands of stakeholders (Ferreire, Proenca, Spence, & Cavo,

2013), globalisation (Spieth & Schneider, 2016), alterations in the competitive environment (Reuver, Bouwman, & MacInnes, 2009), technological developments (Wirtz, Schilke, & Ullrich, 2010), and an increase regulatory control and changing demographics (Baden-Fuller & Haefliger, 2013). Saebi et al. (2017) argue that environmental changes can be framed in two ways, negative or threat-oriented and positive or opportunity-oriented, and their findings indicate that companies are more prone to innovate their business model when the company's management perceives these changes as threats rather than opportunities. Technological developments in particular have urged companies to look at other business model compositions (Casadesus-Masanell & Zhu, 2013), as this offers new ways to communicate for both companies and customers, and provide new ways of delivering value (Teece, 2010). Companies that have the ability to use these developments to their advantage and innovate their business model are more likely to achieve higher growth rates (Casadesus-Masanell & Ricart, 2010). Therefore, having the capability to innovate your business model is crucial for each company, especially when the environment is highly dynamic (Pohle & Chapman, 2006).

While there is a reasonable understanding of the drivers, prerequisites and barriers to business model innovation, little is known of the enablers of business model innovation (Foss & Saebi, 2017). Schneider and Spieth (2013) highlight enablers of business model innovation as an important field of study, especially from the perspective of an individual company. Prior research on the enablers of business model innovation focus mostly on constructs that are of use during the innovation process. Strategic agility is argued to be an important enabler for companies who are required to innovate their business model (Doz & Kosonen, 2008; 2010), as this concept plays a big role for companies anticipating on changes in their environment (Li, Goldsby, & Holsapple, 2009; Arteta & Giachetti, 2004). More specific, Doz and Kosonen (2008; 2010) highlight strategic sensitivity, leadership unity, and resource fluidity as important capabilities in order to achieve this strategic agility. The findings of Aspara et al. (2013) indicate that managers use their understanding of inter-organisational cognition as input for the decision on changing the elements of the business model and the links between them. Khanagha's et al. (2014) study on a company's business model transition indicates that structural changes start off a learning process, which in turn feeds into the formulation of a strategy on the new business model. More specific, switching between structural separation and integration gives a company the possibility to explore into the new business model and it initiates a collective learning process needed to reshape the strategy. Three studies have their focus earlier in the process. Malhotra (2000) suggests that in an increasing volatile environment, knowledge management needs to be reconceptualised in order to be a facilitator of business model innovation. He argues that a sense-making knowledge management model, which centralises around the creation of meaning, will support business model innovation. In addition,

scholars have focussed on the generation of ideas. Two studies in particular look at the idea generation phase as the starting point in developing a new business model; Eppler et al. (2011) assess different techniques for collaborative idea generation, and Björk (2012) investigates into the influence spanning different knowledge domains has on an individual's ideation performance. Refer to table 2 for an overview of enablers of business model innovation. However, there is little attention to the origin of knowledge necessary to create these new ideas and support business model innovation. A better understanding of where knowledge originates from with regard to business model innovation is of importance, as most innovations in organisations result from borrowing rather than invention (Hippel, 1988). I therefore take a broader approach to knowledge acquisition as an enabler of business model innovation and investigate into three distinctive knowledge inflows as a source of business model innovation.

Authors	*Contribution*
Malhotra (2000)	Suggests that in an increasing volatile environment, knowledge management needs to be reconceptualised in order to be a facilitator of business model innovation. Argues that a sense-making knowledge management model, which centralises around the creation of meaning, will support business model innovation.
Doz and Kosonen (2008; 2010)	Identify strategic sensitivity, leadership unity, and resource fluidity as important capabilities in order to achieve strategic agility.
Eppler et al. (2011)	Assesses different techniques for collaborative idea generation, which is argued to be a starting point in developing a new business model.
Björk (2012)	Investigates into the influence spanning different knowledge domains has on an individual's ideation performance.
Aspara et al. (2013)	Their findings indicate that managers use their understanding of inter-organisational cognition as input for the decision on changing the elements of the business model and the links between them.
Khanagha et al. (2014)	Suggests that switching between structural separation and integration gives a company the possibility to explore into the new business model and initiates the collective learning process needed to reshape the strategy.

Table 2: Enablers of business model innovation (ordered chronologically)

2.2 Knowledge inflows

From a knowledge perspective, as proposed by Gupta and Govindarajan (2000), this research explores how a unit's business model innovation is influenced by their senior team's acquisition of knowledge generated in other parts of the organisation. I build upon the organisational learning theory and the absorptive capacity framework as these provide valuable insights into innovation in general (Colakoglu, Yamao, & Lepak, 2014). These theories centre around the idea that innovations originate from recognising, acquiring, and exploiting knowledge from outside the organisation, by combining this knowledge with the organisation's existing knowledge stocks (Cohen & Levinthal, 1990). Combining these two sources of knowledge is argued to lead to more creativity and new and improved ways of doing (Colakoglu, Yamao, & Lepak, 2014), in other words to result in exploration,

which can be defined with terms such as “search, variation, risk taking, experimentation, play, flexibility, discovery, innovation” (March, 1991). In addition, I specifically target senior teams, because research indicates that company or unit level exploration is largely influenced by the activities of their senior teams (Mom, Van den Bosch, & Volberda, 2007), and senior teams have important contributions in organising and managing strategic renewal (Tushman & Rosenkopf, 1996), new product launches (Boeker, 1997), and transformations of research and development strategies (Kor, 2006). Next to this, senior teams can influence organisational actions by setting up formal and informal coordinating mechanisms to contribute to exploratory innovation (Jansen, Van den Bosch, & Volberda, 2006). A better understanding of how a senior team’s exploration related activities can be influenced will benefit our insight into how to organise and initiate these activities within an organisation (Mom, Van den Bosch, & Volberda, 2007), and consequently how to increase innovation efforts (March, 1991).

Members of an organisation rely on interaction to generate meaning and knowledge out of cause-and-effect relationships (Brown & Duguid, 1991), which makes organisational learning a social process. Organisational learning happens in a social context between individuals and is based on prior learning and collected knowledge of that context, which means that organisational learning is more than the sum of what members of an organisation know and learn individually (Cohen & Levinthal, 1990). It endures long after a member has left the organisation, as it can be captured in explicit policies and information collection systems (Argote, 2013), or in more intangible forms such as informal communication channels, the organisation’s culture and behavioural norms (Brown & Duguid, 1991).

While all organisations are likely to learn through the build-up of experience, there is a variation in their learning effectiveness. This is due to different learning rates of organisations, the way they learn, and the resources they have available, in other words their learning capacity (Argote, 2013). To understand this variation in learning effectiveness, researchers distinguish between three types of organisational learning. First, the most dominant mode of learning is single-loop learning, in which corrective actions purely focus on improving existing routines in response to failures or defects (Argyris, 2003). This mode of learning works best for organisations that operate in a stable and constant environment (Berta, et al., 2015). Second, double-loop learning occurs when an organisation responds to failures or defects by questioning the existing routines and the goals, assumptions and values associated with it (Argyris, 2003). By doing so, double-loop learning can lead to significant changes in existing routines. The capability to engage in double-loop learning is vital to organisations operating in volatile, uncertain environments (Argyris, 2003). Double-loop

learning is of particular importance in relation to business model innovation and having the capacity to reinvent your business model before other circumstances force you to, as this type of learning drives creativity and innovation (Argote, 2013).Third, the highest order of learning is triple-loop learning, in which the organisation reflects on the learning process itself (Tosey, Visser, & Saunders, 2012). Triple-loop learning thereby focusses on learning that improves learning processes and optimises behaviour. Unlocking higher-order learning helps an organisation to perform as close to their aspiration levels as possible (Argyris, 2003).

Learning capacity, or absorptive capacity, is defined as the capability to "recognise the value of new knowledge, assimilate it, and apply it to commercial ends", and can be both a precondition for and an outcome of organisational learning (Cohen & Levinthal, 1990). Research has shown that absorptive capacity plays a key role in innovation and performance of business units in multi-unit organisations (Tsai, 2001), and in knowledge transfers in multinational organisations (Gupta & Govindarajan, 2000). Zahra and George (2002) distinguish between potential absorptive capacity and realised absorptive capacity. Potential absorptive capacity contains knowledge acquisition capability, defined as "the capability to identify and acquire externally generated knowledge that is critical to an organisation's operations", and knowledge assimilation capability, defined as "the routines and processes that allow an organisation to analyse, process, interpret and understand the information obtained from external sources" (Zahra & George, 2002). Realised absorptive capacity is made up of knowledge transformation capability, defined as "the capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge", and knowledge exploitation capability, defined as "the routines that allow an organisation to refine, extend, and leverage existing competencies or to create new ones by incorporating acquired and transformed knowledge into its operations" (Zahra & George, 2002). Both potential absorptive capacity and realised absorptive capacity need to be managed in order to obtain superior performance. A sole focus on potential absorptive capacity will enable a company to expand and renew their knowledge stock, but may prevent the company to reap the benefits by exploiting that knowledge (Jansen, Van den Bosch, & Volberda, 2005). In contrast, a sole focus on realised absorptive capacity will enable short-term profits via knowledge exploitation, but entails the risk the company will create their own competence trap (Ahuja & Lampert, 2001).

Thus, absorptive capacity and organisational learning theories illustrate how the acquisition and exploitation of externally generated knowledge helps a unit in creating new knowledge (Cohen & Levinthal, 1990; Todorova & Durisin, 2007). To do so, units can integrate externally generated and sourced knowledge with their existing knowledge stocks, make new combinations out of the two,

and subsequently create new or improved offerings, systems, processes or organisational structures (Colakoglu, Yamao, & Lepak, 2014). The question arises where external knowledge is sourced from, which brings us to the concept of knowledge flows and their link to absorptive capacity.

Some studies use comparable concepts such as knowledge exchange, knowledge acquisitions, knowledge sharing, and knowledge flows (Schulz, 2001). The concepts of knowledge exchange, knowledge acquisitions, and knowledge sharing imply a mutual transaction between a donor and a recipient, while the concept of knowledge outflows and inflows give the ability to pinpoint the direction of the knowledge flow (Mom, Van den Bosch, & Volberda, 2007). Knowledge outflows focus on the donor in a knowledge flow, while knowledge inflows have their focus on the recipient in this flow (Gupta & Govindarajan, 2000). Since I am interested in how a unit's business model innovation is influenced by their senior team's acquisition of knowledge generated in other parts of the organisation, this research limits to knowledge inflows. Herein, both the donor and the recipient can initiate a knowledge flow. Knowledge inflows link to absorptive capacity because of the following; as acquiring knowledge from outside the unit increases the breadth and depth of a unit's competencies (Cohen & Levinthal, 1990; March, 1991), knowledge inflows contribute to the unit's absorptive capacity as the enhanced breadth and depth of the unit's competencies enables the unit to better understand and exploit externally sourced knowledge (Zahra & George, 2002).

Knowledge transfers within multi-unit organisations occur within the interorganisational network between the differentiated units (Ghoshal & Bartlett, 1990; Gupta & Govindarajan, 1991). Therefore, there are three possible levels of analysis to study knowledge flows within this network (Gupta & Govindarajan, 2000). First, from the nodal level, which focusses on the behaviour of individual units. Second, from the dyadic level, which focusses on the joint behaviour of two units. Third, from the systemic level, which focusses on the behaviour of the entire network. Due to the complexity of knowledge flows, and in line with Gupta and Govindarajan (2000), I limit my research to the nodal level, in particular to the senior team of the individual units.

Knowledge inflows are influenced by the perception of the recipient's capabilities (Monteiro, Arvidson, & Birkinshaw, 2008). Chew et al. (1990) argue that the flow of a best practices originates from the most capable units in an organisation into the less capable ones, which would make it likely that low self-ratings turn to higher knowledge inflows. This would mean that senior teams with high self-ratings engage in fewer knowledge inflows because they assume they possess all knowledge necessary. Monteiro et al. (2008) however show that this is exactly opposite, where senior teams

that rate their own capabilities as high are associated with high knowledge inflows. They argue that this is because group efficacy, which can be defined as “a group’s belief in its capability to perform a task” (Gibson, 1999), is positively related to information seeking. Senior teams with high levels of group efficacy are less affected by performance anxiety and better able to focus on the task at hand, which gives them greater ability and motivation to seek, integrate, and interpret information (Brown, Ganesan, & Challagalla, 2001). In addition, a senior team with high self-ratings will recognise the value of externally generated knowledge and believe in its own capacity to assimilate that knowledge, due to their high level of absorptive capacity (Monteiro, Arvidson, & Birkinshaw, 2008).

Previous research on strategy argues that exploration related activities of senior teams are supported by top-down or bottom-up knowledge inflows (Floyd & Lane, 2000; Rivkin & Siggelkow, 2003). Other researchers highlight the importance of horizontal knowledge inflows within an organisation (Gupta & Govindarajan, 2000; Schulz, 2003). These three kind of knowledge inflows bring considerable advantages to multi-unit organisations as they support an organisation-wide exchange of knowledge, which would otherwise stay concealed in each individual subunit (Bartlett & Ghoshal, 1989). As there is a clear distinction between top-down, bottom-up, and horizontal knowledge inflows, which is discussed in more detail below, I explore these knowledge inflows separately and explore whether their influence on business model innovation differs.

Top-down knowledge inflows of a senior team can be defined as “knowledge coming from persons or units at higher hierarchical levels than the senior team” (Mom, Van den Bosch, & Volberda, 2007). Top-down knowledge inflows poses in most cases clear and explicit information with a direct cause-effect relationship (Egelhoff, 1991), and they have a clear link to improving a recipient’s current activities (Schulz, 2003). Top-down knowledge inflows therefore contribute to exploitation related activities instead of exploration related activities, which will lead to lower levels of innovation. In addition, top-down knowledge inflows within large multi-unit organisations have a close relation to the organisational hierarchy of units operating in distinct functional, geographical, technical, or product-market areas (Gupta & Govindarajan, 1991). The scope of these flows is therefore expected to be narrow and they will thus increase the depth of the recipient’s current knowledge base and not its breadth (Winter & Szulanski, 2001). Furthermore, top-down knowledge inflows in large, multi-unit organisations are likely targeted at reducing costs and increasing revenues. Hence, they are restricted to the unit’s cost structures and revenue streams, the bottom part of Osterwalder’s et al. (2010) composition of the elements of a business model, refer to appendix 1. As business model innovation is considered to be complex (Chesbrough, 2010) and requires experimentation on the

units key value delivering activities (McGrath, 2010), a senior team will be limited by a deep but narrow knowledge base in tackling this complexity and experimenting on these activities.
Moreover, focussing on one side of knowledge building, as Cohen and Levinthal (1990) have argued, can reduce the diversity of an individual's knowledge base. Top-down knowledge inflows will therefore decrease the level of absorptive capacity of the senior team (Cohen & Levinthal, 1990), which will make it even more difficult for the senior team to search for new possibilities to create, propose, and capture value for the unit's stakeholders. Finally, top-down knowledge inflows compel the senior team to tackle problems in familiar ways and it increases and refines their ability to perform activities they are familiar with (Galunic & Rodan, 1998). In other words, these knowledge inflows "will increase the recipient's reliability in experience rather than variety" (Mom, Van den Bosch, & Volberda, 2007). Thus, when facing problems occurring in the business model, top-down knowledge inflows will contribute to improving the current business model instead of innovating the unit's business model.

Where product and process innovations only affect a small part of the unit business, does business model innovation affect the full logics of the unit's business model (Casadesus-Masanell & Zhu, 2013). Business model innovation therefore involves multiple divisions of a unit, even if the scope of the business model innovation is limited to a single component of the unit's business model (Bock, Opsahl, George, & Gann, 2012). For example, introducing a new delivery channel requires changes in the way a value proposition is delivered to the client, but also in the cost structure of the unit and in the key partners and key activities associated with the delivery. The knowledge received on reducing costs and increasing revenues via top-down inflows will not help them to innovate the other elements of the business model. Moreover, with a narrow knowledge base and an increased ability to perform existing activities, both enhanced by top-down knowledge inflows (Winter & Szulanski, 2001; Galunic & Rodan, 1998), the senior team will be more likely to adhere to what they are familiar with because they simply lack the knowledge base needed to implement the necessary changes regarding a business model innovation in all related divisions. This all leads to the following hypothesis:

> *Hypothesis 1: Top-down knowledge inflows influence business model innovation in such a way that more top-down knowledge inflows lead to less business model innovation.*

Bottom-up knowledge inflows of a senior team can be defined as "knowledge coming from persons and units at lower hierarchical levels than the senior team" (Mom, Van den Bosch, & Volberda, 2007). Bottom-up inflows of knowledge do not come in a standardised and formalised way, but they

follow ad hoc, random, and unpredictable paths in the organisation (Mom, Van den Bosch, & Volberda, 2007). As bottom-up knowledge inflows come from people in the organisation who are close to the customers and markets, they will increase the senior team's understanding of the evolution of customer needs and requests and market developments (Brady & Davies, 2004). With regard to the model by Osterwalder et al. (2010), refer to appendix 1, bottom-up knowledge inflows therefore contain knowledge which is mostly related to customer relationships, channels and customers segments. It is the increased understanding of the evolution of these elements that can urge the senior team to reconsider strategic decisions (Floyd & Lane, 2000; Ghoshal & Bartlett, 1994). In addition, senior teams need this understanding in order to explore new value propositions and revenue generating possibilities, which is a primary focus of business model innovation (Casadesus-Masanell & Zhu, 2013).

Schulz (2001) has found that vertical knowledge flows mainly transport new knowledge. Vertical flows that transport knowledge from persons or units upwards, bottom-up knowledge inflows, will expose it to different knowledge retrieved from other persons or units, which contributes to the identification of risks, threats, and opportunities by combining different knowledge sources (Schulz, 2001). This will give the senior team a better understanding into which innovations might prove valuable and which not, and will help them successfully innovate their unit's business model. In addition, bottom-up knowledge inflows will increase the senior team's variety in experience (Mom, Van den Bosch, & Volberda, 2007), and can consequently provide a learning opportunity by increasing the senior team's existing knowledge base (Brady & Davies, 2004). An increase of variety of experience will increase the level of absorptive capacity of the senior team, which in turn makes it easier to add new knowledge to their existing knowledge base (Cohen & Levinthal, 1990). This self-reinforcing effect will enable the senior team to search for new possibilities to create, propose and capture value for the unit's stakeholders and will increase the unit's level of business model innovation. I therefore hypothesise the following:

> *Hypothesis 2: Bottom-up knowledge inflows influence business model innovation in such a way that more bottom-up knowledge inflows lead to more business model innovation.*

Horizontal knowledge inflows of a senior team can be defined as "knowledge coming from persons or units at the same hierarchical levels as the senior team" (Mom, Van den Bosch, & Volberda, 2007). In multi-unit organisations, the knowledge acquired from elsewhere in the organisation by a unit's senior team is in most cases ambiguous, tacit and complex (Daft & Lengel, 1986). This requires a senior team to engage in personal and reciprocal interactions, which supports them to

comprehend this newly acquired knowledge (Daft & Lengel, 1986; Jansen, Van den Bosch, & Volberda, 2005). In contrast to vertical flows, facilitate horizontal flows the transportation of incremental knowledge (Schulz, 2001), that is knowledge which is imported from different parts of the organisation to generate new knowledge from it. Incremental knowledge is exchanged directly and unmediated between the relevant professionals due to the high level of detail involved in this exchange (Schulz, 2001). With regard to architectural innovation, which can be defined as "innovations that change the architecture of a product without changing its components" (Henderson & Clark, 1990) and closely resembles business model innovation, Grant (1996) has shown that by stimulating cross-fertilisation and combining different kinds of knowledge, horizontal knowledge inflows are linked to increased architectural innovation. As horizontal knowledge inflows might cross different functions, divisions, or disciplines (Grant, 1996), these inflows have a broad scope (Winter & Szulanski, 2001). Subsequently, horizontal knowledge inflows can contain knowledge regarding all elements of the business model as defined in the model by Osterwalder et al. (2010), refer to appendix 1. They are fairly unrelated to the senior team's current knowledge base and thereby increase the breadth of their knowledge base (Mom, Van den Bosch, & Volberda, 2007). Opposite to top-down knowledge inflows, where a deep but narrow knowledge base limits the senior team, will a broad knowledge base enable the senior team to tackle the complexity related to business model innovation (Chesbrough, 2010) and help them experiment on the units key value delivering activities (McGrath, 2010). The senior team will more likely poses the knowledge base needed to implement the necessary changes regarding a business model innovation in all related divisions, even when the scope of the business model innovation is limited to a single component of the unit's business model. Back to example used earlier, a broad knowledge base will make it more likely that the senior team will know what changes are necessary to the cost structure of the unit and the key partners and key activities associated with the delivery of the value proposition when introducing a new deliver channel. This will help them successfully implement an innovation regarding the unit's business model. Finally, as Cohen and Levinthal (1990) have argued, a broader knowledge base leads to higher levels of absorptive capacity of the senior team. As argued before, this will in turn make it easier for the senior team to add new knowledge to their existing knowledge base and helps them to search for new possibilities to create, propose and capture value. The self-reinforcing effect also applies here. This leads all to the following hypothesis:

> *Hypothesis 3: Horizontal knowledge inflows influence business model innovation in such a way that more horizontal knowledge inflows lead to more business model innovation.*

2.3 Senior team attributes, knowledge inflows and business model innovation

Senior team attributes may represent particular important microlevel moderators in business model innovation (Foss & Saebi, 2017). First, senior team members are in the best place to pick up signals that may call for business model innovation, and second, they often have the authority to transform the business model when necessary, which makes their perception regarding the necessary changes of great importance (Foss & Saebi, 2017). Scholars have argued that the effectiveness of senior teams is moderated by senior team heterogeneity (Alexiev, Jansen, Van den Bosch, & Volberda, 2010) and senior team social integration (Jansen, George, Van den Bosch, & Volberda, 2008). However, just exposing a senior team to related knowledge will not ensure they will internalise it successfully (Pennings & Harianto, 1992), and can subsequently exploit it to the unit's benefit (Cohen & Levinthal, 1990). Therefore, it is necessary to understand how the senior team processes the acquired knowledge (Alexiev, Jansen, Van den Bosch, & Volberda, 2010), which is where the notions of potential and realised absorptive capacity come into play as a further refinement of absorptive capacity (Zahra & George, 2002).

Senior team heterogeneity can be defined as "the degree to which there are differences in demographic, functional, and background dimensions in team composition" and it influences the capability of a senior team to process information (Alexiev, Jansen, Van den Bosch, & Volberda, 2010; Simons, Pelled, & Smith, 1999). A senior team's capabilities regarding decision-making, judgement and problem solving are positively influenced by heterogeneity via healthy task-related conflicts and team reflexivity (Van Knippenberg & Schippers, 2007). Alexiev et al. (2010) have argued that senior team heterogeneity amplifies the level of external advice used in generating innovation due to the senior team's enhanced ability to connect to various external advisors (Hambrick, 1994), and their increased capability to combine this advice into new strategies (Hansen, 1999).

When heterogeneous senior teams combine their ideas, they create more original and valuable ideas than homogeneous senior teams (Van den Bosch, Volberda, & De Boer, 1999). Moreover, Pelled et al. (1999) argue that the effects of heterogeneity are most visible and strongest in complex cognitive tasks, which business model innovation most certainly is. Team heterogeneity is also associated by scholars with high levels of creativity and innovation (Murray, 1989). The presumed benefit of a heterogeneous senior team, having different points of view and being willing to challenge each other on these, stimulates the creation of novel and comprehensive ideas and leads to high-quality decisions (Wiersema & Bantel, 1992). Team diversity decreases groupthink (Williams & O'Reilly, 1998), which is linked to greater use of information (Dahlin, Weingart, & Hinds, 2005). The

decrease in groupthink supports the senior team to take all aspects of the decision into account (Simons, Pelled, & Smith, 1999), which in turn improves the quality of decision making (Eisenhardt & Zbaracki, 1992).

Having sufficient levels of knowledge overlap as precondition to ensure effective communication, a heterogeneous team in which each member has a different knowledge base will amplify the senior team's absorptive capacity and their ability to make new linkages and associations beyond what each member can do individually (Cohen & Levinthal, 1990). Although top-down knowledge inflows are likely to be narrow and will increase the depth of recipient's knowledge (Winter & Szulanski, 2001), they will most likely be close to the senior team's current knowledge base. A senior team's potential absorptive capacity, defined as its "capacity to acquire and assimilate external knowledge" (Zahra & George, 2002), will therefore not play a big role in top-down knowledge inflows. The senior team's realised absorptive capacity, defined as its "capacity to transform and exploit external knowledge" (Zahra & George, 2002), does play a role with regard to top-down knowledge inflows. As a heterogeneous senior team has a diverse knowledge base and a higher level of absorptive capacity, they are able to combine the narrow nature of top-down knowledge inflows with a broad base of existing knowledge. In turn, they are able to transform and exploit this external knowledge together with their own knowledge and make novel linkages and associations required to tackle the complexity of business model innovation and experiment on the unit's key value delivering activities. It will be more difficult for a homogenous senior team with a narrow but deep knowledge base to make these novel linkages and associations out of top-down knowledge inflows, because they lack the diverse knowledge to combine the external knowledge with and their narrow base of existing knowledge forces them to respond in familiar ways (Galunic & Rodan, 1998). In short, heterogeneous senior teams can use top-down knowledge inflows in favour of innovation of the unit's business model and therefore turn the negative effect of top-down knowledge inflows on business model innovation into a positive one, while homogeneous senior teams cannot.

The same applies to bottom-up and horizontal knowledge inflows, in relation to the moderating effect of heterogeneity via the senior team's realised absorptive capacity. As argued before, both knowledge inflows are expected to be broad in scope (Winter & Szulanski, 2001). A heterogeneous team can combine this broad scope of incoming knowledge with their broad base of existing knowledge, and transform and exploit this external knowledge to make novel linkages and associations required to experiment on the unit's key value delivering activities and tackle the complexity associated with business model innovation. This will be more difficult for homogeneous teams, as they have a narrower existing knowledge base to combine the external knowledge with.

Moreover, the relation between bottom-up and horizontal knowledge inflows and business model innovation will also be moderated by senior team heterogeneity via their potential absorptive capacity. This is based on the idea that "learning performance is greatest when the object of learning is related to what is already known" (Cohen & Levinthal, 1990). The variety and differentiation of the categories in which prior knowledge is captured and the links between these categories allow individuals to understand and acquire new knowledge (Bower & Hilgard, 1981). A heterogeneous senior team's diverse knowledge base will thus provide a solid base for learning because it increases the chance that knowledge flowing in correlates to parts of the senior team's existing knowledge. Consecutively, they are able to identify, acquire and assimilate externally generated knowledge which can be of use for the unit's operation and, via their realised absorptive capacity, use this knowledge to tackle the complexity of business model innovation. This is different for a homogeneous senior team. The chance that incoming external knowledge will not relate to what is already known is high when the knowledge base of the senior team is rather narrow. It will therefore be more likely that a homogeneous senior team will not recognise the value of knowledge coming in via bottom-up or horizontal inflows, and will subsequently not be able to use this knowledge to the unit's benefit. In short, a heterogeneous senior team's broad base of existing knowledge will give them the capability to identify the value of bottom-up and horizontal knowledge inflows in favour of innovation of the unit's business model, which will be more difficult for a homogeneous because of their narrower existing knowledge base. Senior team heterogeneity will therefore reinforce the positive effect of bottom-up and horizontal knowledge inflows on business model innovation.

However, researchers have also pointed out that diversity within a senior team has its costs. Senior team members with a different background and experience have more difficulties in communicating than members with the same background and experience, which enhances power struggles and conflict (Wiersema & Bantel, 1992). Communication becomes more strained and conflict laden when heterogeneity is high, which could lead to the senior team being unable to make decisions or take action (Wiersema & Bantel, 1992). This indicates that the benefits of senior team heterogeneity weaken as the level of heterogeneity increases and heterogeneity might even, at very high levels, have a negative impact on the organisation (Wiersema & Bantel, 1992). This is in line with Cohen and Levinthal's (1990) argument on the trade-off between efficient internal communications and the capability to assimilate and exploit externally generated knowledge. Both elements need to be balanced carefully in order to achieve effective organisational learning. As they argue, "if all actors in the organisation share the same specialised language, they will be effective in communicating to one another, but they may not be able to tap into diverse external knowledge sources" (Cohen & Levinthal, 1990). Thus, I expect that increases in senior team heterogeneity will have the strongest

effect on business model innovation at moderate levels of senior team heterogeneity. This leads to the following hypothesis:

> *Hypothesis 4: Senior team heterogeneity moderates the relationship between knowledge inflows and business model innovation in such a way that more senior team heterogeneity a) weakens the negative effect of top-down knowledge inflows on business model innovation, and strengthens the positive effect of b) bottom-up knowledge inflows and c) horizontal knowledge inflows on business model innovation, but the effects will decrease when senior team heterogeneity increases.*

Senior team social integration can be defined as "the attraction to the group, satisfaction with other members of the group, and social interaction among the group members" (O'Reilly, Caldwell, & Barnett, 1989), in which the senior team represents the term 'group' used in this definition. A senior team's collaborative problem solving is supported by social integration via the social interaction and trust among its members (Dailey, 1978). In addition, social integration provides a sound basis for the senior team to engage in contradicting views and discuss conflicting agendas (Jehn, Chadwick, & Thatcher, 1997), which helps them to search for solutions for conflicting goals associated with exploration related activities (Jansen, George, Van den Bosch, & Volberda, 2008). In this way and in accordance with senior team heterogeneity, senior team social integration also leads to high-quality decisions (Wiersema & Bantel, 1992).

Where I argue that senior team heterogeneity influences the senior team's capability to tackle the complexity related to business model innovation and to experiment on the unit's key value delivering activities because of their broad base of existing knowledge, it is the social interaction and trust among the senior team members that will enable them to acquire and assimilate the external knowledge and transform and exploit it to the unit's advantage. Again, the senior team does so via their potential and realised absorptive capacity (Zahra & George, 2002). With regard to potential absorptive capacity, it is the stimulus of critical debate (Jansen, George, Van den Bosch, & Volberda, 2008), and the increased confidence to engage in critical debate (Jehn, Chadwick, & Thatcher, 1997) that will increase the senior team's capability to fully assimilate the newly acquired knowledge. With regard to top-down knowledge inflows, this might be quite easy as this knowledge generally has a close relation to the organisational hierarchy of units which operate in distinct functional, geographical, technical, or product-market areas (Gupta & Govindarajan, 1991) and is therefore close to what a senior team already is familiar with. With regard to bottom-up and horizontal knowledge inflows, this might prove more difficult. The content of bottom-up knowledge

inflows and horizontal knowledge inflows may differ. As argued before, where bottom-up knowledge inflows mostly contain information regarding customers and markets (Brady & Davies, 2004) and mainly transport new knowledge (Schulz, 2001), do horizontal inflows contain knowledge which is ambiguous, tacit, and complex (Daft & Lengel, 1986) and facilitate transport of incremental knowledge (Schulz, 2001). Regardless of content, both knowledge inflows are expected to be broad in scope (Winter & Szulanski, 2001), which means it will require more cognitive effort to fully assimilate this external knowledge. It is their social interaction and trust among each other that stimulates the senior team members and gives them confidence to engage in critical debate, in order to completely understand the incoming knowledge. A socially less integrated senior team lacks this trust and social interaction and will therefore have more difficulty in really understanding the incoming knowledge. In short, a socially integrated senior team will poses the levels social interaction and trust necessary to grasp the full extent of externally acquired knowledge, regardless of the origin of that knowledge.

Acquiring and assimilating external knowledge is one, but the senior team will subsequently have to transform and exploit it in order to tackle the complexity of business model innovation. Senior teams do so via their realised absorptive capacity (Zahra & George, 2002). When facing problems occurring in innovating the business model, their increased collaborative problem solving (Dailey, 1978) will help them use the external knowledge in order find the right solution. With regard to top-down knowledge inflows, it is tempting for the senior team to respond to problems in familiar ways, as this knowledge inflow compels them to do so (Galunic & Rodan, 1998). A high level of social integration will help the senior team to withstand this initial reaction, as it provides them with a sound basis to engage in contradiction views and discuss conflicting agendas (Jehn, Chadwick, & Thatcher, 1997), even with persons at higher hierarchical levels. With respect to bottom-up and horizontal knowledge inflows, when senior teams first got to really understand the broad scope of external knowledge, they now need to decide on how to use this broad scope of knowledge to their unit's advantage. Experimenting means the senior team likely has a multitude of options on innovating their unit's key value delivering activities, especially when they have fully assimilated all bottom-up and horizontal knowledge inflows. As external shocks or crisis situations are the main drivers of business model innovation (Spieth & Schneider, 2016), the time available to experiment is most likely limited. Units should therefore not engage in haphazard experimentation, but should carefully select which experiment to engage and in which not. Once again, it is their social integration and trust among each other that stimulates the senior team members and gives them confidence to engage in critical debate, which is necessary to use the knowledge acquired externally and select the right way to experiment on the unit's key value delivering activities. A socially less integrated

senior team lacks this trust and social interaction and will therefore have more difficulty in deciding on which experiment to engage in and which not, with the risk of doing the wrong experiments, doing too little experiments or doing far too many experiments. This all lead to the following hypothesis:

> *Hypothesis 5: Senior team social integration moderates the relationship between knowledge inflows and business model innovation in such a way that more senior team social integration a) weakens the negative effect of top-down knowledge inflows on business model innovation, and strengthens the positive effect of b) bottom-up knowledge inflows and c) horizontal knowledge inflows on business model innovation.*

All hypotheses can be visualised in a research framework, figure 1.

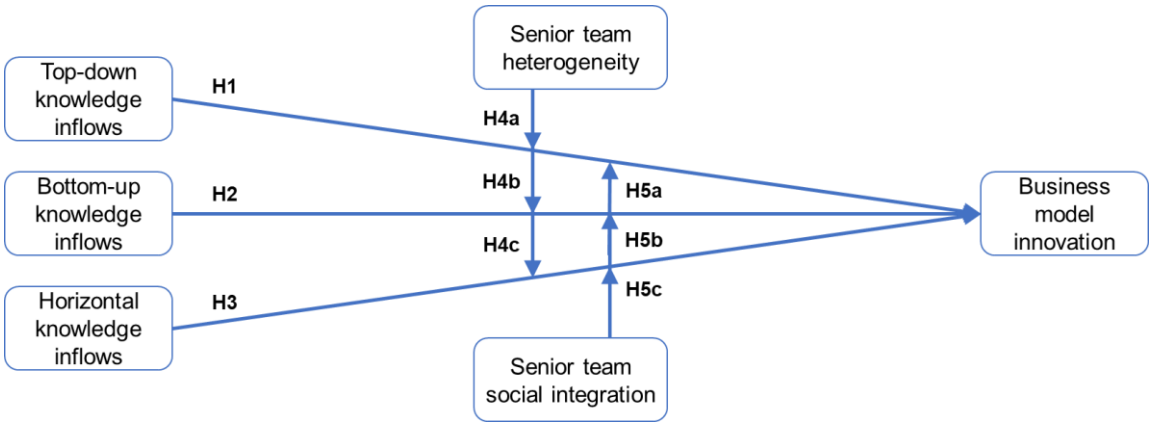

Figure 1: Research framework

3 Methodology

3.1 Data collection and sample

Previous studies on business model innovation are typically case studies of individual companies and have a conceptual focus, which makes hypothesis-testing in its early stages in this field of research (Markides, 2013). Wirtz et al. (2015) have argued a large scale survey as a highly ranked research methodology for future business model research. The approach of this research is therefore a quantitative one. The data is collected in a large, European, multi-unit construction company, which has a revenue of over €7 billion and ranks within the top 10 biggest construction companies in Europe. It employs construction activities on residential, non-residential, and infrastructural projects, and delivers project development, design and engineering services, and facility management in five home markets, as well as internationally. Each unit has a geographically distinct client base and operates on a secluded business model, with its own profit and loss account. A sample of 134 senior team members in 60 different organisational units is asked to rate their senior team and their units on knowledge inflows, business model innovation, and the senior team attributes. Their responses are aggregated to create unit-level measures, which is an appropriate approach, as senior team members have the best understanding of their unit and the activities they employ (Gibson & Birkinshaw, 2004). The senior team member's name and unit are threated confidentially. A total of 104 questionnaires of 55 units are returned, corresponding with a response rate of 77.6% and 1.89 responses per unit. The respondents have an average company tenure of 12.9 years (s.d. = 8.22). The units have an average size of 295.5 full-time employees (s.d. = 510.85), exist on average 73.2 years (s.d. = 280.50), and have an average senior team size of 7.2 members (s.d. = 5.90). Refer to table 3 for an overview of the sample characteristics.

Respondents		**Units**					
104		55					
Tenure (years)		**Size (FTE)**		**Age (years)**		**Senior team size (members)**	
Mean	*S.d.*	*Mean*	*S.d.*	*Mean*	*S.d.*	*Mean*	*S.d.*
12.93	8.22	295.50	510.85	73.20	280.50	7.20	5.90

Table 3: Sample characteristics

A t-test is executed to examine the differences between respondents and non-respondents and thereby test for non-response bias. The test showed no significant differences ($p < .05$) between the two groups based on their tenure, the unit's size, the unit's senior team size and the unit's age, refer to table 4. Non-response bias is therefore not an issue in this research. In addition, because

	Response	*N*	*Mean*	*S.d.*	*t*	*df*
Respondents						
Tenure (years)	Yes	104	12.93	8.22	-.06	132
	No	30	13.043	9.36		
Units						
Size (FTE)	Yes	55	295.50	510.85	.87	58
	No	5	95.00	42.17		
Age (years)	Yes	55	73.20	280.50	.41	58
	No	5	21.60	21.66		
Senior team size (members)	Yes	55	7.20	5.90	1.36	58
	No	5	3.60	1.95		

†p < .10; * p < .05; ** p < .01; *** p < .0001

Table 4: T-test for non-response bias

each variable in my model represent unit characteristics and I utilise individuals as assessor of those characteristics, it is necessary to statistically demonstrate within-unit agreement (Klein & Kozlowski, 2000). I therefore determined the interrater agreement score (r_{wg}) for each variable (James, Demaree, & Wolf, 1993), which has a range from 0 to 1 (no agreement to complete agreement). The median and mean interrater agreements for business model innovation (.95; .92), top-down knowledge inflows (.75; .68), bottom-up knowledge inflows (.72; .64), horizontal knowledge inflows (.75; .63), senior team heterogeneity (.89; .85), and senior team social integration (.94; .86) are all above the .60 cut-off point for acceptable interrater agreement suggested by Glick (1985). This indicates satisfactory agreement amongst respondents and individual responses can be safely aggregated to unit-level measures. Refer to table 5 for an overview of r_{wg} scores.

Business model innovation		**Top-down knowledge inflows**		**Bottom-up knowledge inflows**		**Horizontal knowledge inflows**		**Senior team heterogeneity**		**Senior team social integration**	
Median	*Mean*	*Median*	*Mean*	*Median*	*Mean*	*Median*	*Mean*	*Median*	*Mean*	*Median*	*Mean*
.95	.92	.75	.68	.72	.64	.75	.63	.89	.85	.94	.86

Table 5: Interrater agreement scores (r_{wg})

Finally, I also evaluated the potential for common method bias, which can occur due to the mono-methodological approach of this research and can therefore threaten its validity. Thus, a Harman's one-factor test is executed to assess for common method bias (Harman, 1976). All measurement items are divided into fourteen factors with eigenvalues higher than 1.0, which explain 70.8% of the total variance. The first factor explains only 14.0% of the variance, which is less than the benchmark value of 50.0% (Harman, 1976). This suggests that this research is unlikely to be affected by common method bias.

3.2 Measures

Dependent variable. As indicated by Clauβ (2017), the few existing quantitative empirical studies into business model innovation use different measurement instruments with variance in scope. Zott and Amit (2008) use an instrument which differentiates a business model into a focus on efficiency or a focus on innovation. Patzelt et al. (2008) designed their measures to be sourced from company websites. Bock et al. (2012) capture the level of business model innovation as a percentage of the company's total innovation efforts. Brea-Solís et al. (2015) determine the level of business model innovation by measuring technical changes and operating efficiencies. To tackle this issue, Clauβ (2017) designed and validated a measurement scale to measure business model innovation and its subconstructs value creation innovation, value proposition innovation, and value capture innovation, which is used in this study in an adapted form. Originally, the scale to measure business model innovation consisted of thirty-three items in total. A small test survey on business model innovation proved this to be too extensive, as respondents indicated they were having difficulties in completing all the questions within the time they could make available. To reduce the risk of dropout, I reduced the number of items to twenty by selecting the ones with the highest factor loadings, maintaining a minimum of four items per subconstruct. Following Clauβ (2017), respondents are asked to provide ratings on five-point Likert scales to measure business model innovation. Appendix 2 presents the items on business model innovation used in this study. Value creation innovation is assessed using eight items. Eight other items measure value proposition innovation. Finally, four items measure value capture innovation. The scale for business model innovation is reliable (α = .83). The scales for the subconstructs value creation innovation and value proposition innovation are reliable (α = .76; α = .73). The scale for the subconstruct value capture innovation proves unreliable (α = .29), removing one or two items does not improve reliability to above the desired minimum.

Independent and moderating variables. Top-down knowledge inflows, bottom-up knowledge inflows, and horizontal knowledge inflows are measured using the items defined by Mom et al. (2007). Following Gupta and Govindarajan (2000), Schulz (2001), and Mom et al. (2007), respondents are informed that knowledge inflows relate to tacit knowledge on technologies, processes, products, systems, strategies, customers, and markets, and that they do not relate to operational or financial data. Next to this, following Mom et al. (2007), the respondents are briefed to think of different ways knowledge can be transferred, such as formal or informal meetings, e-mail, phone, and internal company communications. Following Schulz (2001; 2003) respondents are asked to provide ratings on five-point Likert scales to measure knowledge inflows. Refer to appendix 2 for the items on knowledge inflows used in this study. Three items are used to measure top-down knowledge inflows. Two items are used to measure bottom-up knowledge inflows. Finally, three

items are used to measure horizontal knowledge inflows. All three scales are reliable (top-down knowledge inflows, α = .77; bottom-up knowledge inflows, α = .78; horizontal knowledge inflows, α = .80).

Senior team heterogeneity is measured using the items used by Alexiev et al. (2010) and adopted from Campion et al. (1993), and assesses the degree of heterogeneity on expertise, background and experience, and complementary skills (Alexiev, Jansen, Van den Bosch, & Volberda, 2010). Following Campion et al (1993), respondents are asked to provide ratings on five-point Likert scales to measure senior team heterogeneity. The three items used on senior team heterogeneity are presented in appendix 2. The scale for senior team heterogeneity proved not sufficiently reliable at first (α = .68). I therefore removed one item, which improved reliability to above the desired minimum level (α = .80).

Senior team social integration is measured using the items as defined by O'Reilly et al. (1989) and Smith et al. (1994). These items have successfully been used in previous research (Jansen, George, Van den Bosch, & Volberda, 2008). Jansen et al (2008) use a seven-point scale to measure senior team social integration, while O'Reilly et al. (1989) use a four-point scale. In order to align with the other measures and following Smith et al. (1994), respondents are asked to provide ratings on five-point Likert scales to measure senior team social integration. Refer to appendix 2 for the seven items used in this study. The scale for senior team social integration is reliable (α = .79).

3.3 Control variables

Following Jansen et al. (2005), while larger units may have more resources but are also more resistant to implement the necessary changes in order to successfully innovate their business model, I controlled for unit size using the natural logarithm of the number of full-time employees. Since knowledge acquisition and exploitation capabilities are influenced by a unit's age (Autio, Sapienca, & Almeida, 2000), I included the natural logarithm of the unit's age as control variable, measured by the number of years from founding. Research has shown that senior team size influences the social integration within the team (O'Reilly, Caldwell, & Barnett, 1989) and could affect the heterogeneity of senior teams (Jansen, George, Van den Bosch, & Volberda, 2008). I controlled for senior team size using the natural logarithm of the number of senior executives responsible for the formulation and implementation of the unit's strategy (Siegel & Hambrick, 2005). A unit needs to match its internal rate of change with the dynamics of their environment (Floyd & Lane, 2000), since this influences the unit's necessity, willingness, and availability of resources to innovate its business model (Laursen, 2012). Therefore, I controlled for environmental dynamism

using the scale developed by Jansen et al. (2006). Five items are used to measure environmental dynamism. Finally, I controlled for the degree to which a unit is decentralised using the scale used by Van Wijk et al. (2012), as it permits a unit to make decisions autonomously and it influences a company's capacity to accumulate and apply knowledge (Cohen & Levinthal, 1990). Five items are used to measure decentralisation. Both scales for environmental dynamism and decentralisation proved reliable ($\alpha = .77$; $\alpha = .73$), refer to appendix 2 for the items used.

4 Analysis and results

4.1 Initial analyses and results

Table 6 displays the descriptive statistics and correlations for the study variables. Table 7 displays the results of the hierarchical regression analyses for business model innovation. Before creating the interaction terms in models 4 and 5, I mean centred the independent variables to reduce multicollinearity (Aiken & West, 1991). In addition, to examine if multicollinearity is still an issue, I calculated the variance inflation factors (VIF) for each of the regressions. The maximum VIF within the models is 2.34, which is below the cut-off point of 10 (Neter, Wasserman, & Kutner, 1990). Model 1 contains the control variables. Models 2 and 3 introduce the independent variables on knowledge inflows, senior team heterogeneity and senior team social integration. Models 4 and 5 examine the moderating effects of senior team heterogeneity and senior team social integration respectively.

Regarding the effects of knowledge inflows on business model innovation, model 2 shows that the effect of top-down knowledge inflow is negative but not significant (β = -.03, ns). Although the effect is as expected, hypothesis 1 is not supported. The results show that the hypothesised positive relationship between bottom-up knowledge inflows and business model innovation is as expected but not significant (β = .05, ns). Hypothesis 2 is therefore not supported. The effect of horizontal knowledge inflows on business model innovation is also positive but not significant (β = .08, ns). As with hypothesis 1 and 2, the effect is as expected but hypothesis 3 is not supported. These findings indicate that knowledge inflows have no direct effect on the level of business model innovation within a unit. In addition to these direct effects, I also hypothesised that these effects would be moderated by both senior team heterogeneity and senior team social integration. Model 4 shows the interaction effects for senior team heterogeneity and model 5 for senior team social integration. Senior team heterogeneity has a positive interaction effect on top-down knowledge inflows and a negative interaction effect on bottom-up and horizontal knowledge inflows, although all three are not significant (top-down knowledge inflows, β = .12, ns; bottom-up knowledge inflows, β = -.01, ns; horizontal knowledge inflows, β = -.19, ns). As these effects are not significant, no further analysis is executed to see whether the effects will decrease when senior team heterogeneity increases. Hypotheses 4a, 4b, and 4c are not supported. Senior team social integration has a negative interaction effect on top-down and horizontal knowledge inflows, but both are not significant (top-down knowledge inflows, β = -.14, ns; horizontal knowledge inflows, β = -.03, ns). Hypotheses 5a and 5c are therefore not supported. Senior team social integration has a positive and marginally significant effect on bottom-up knowledge inflows (β = .33, p < .10), while the main effects of both

Table 6: Descriptive statistics and correlations

	Mean	*S.d.*	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*	*(15)*	*(16)*	*(17)*	*(18)*
1. Business model innovation	3.45	.37																		
2. Value creation innovation	3.68	.42	.79**																	
3. Value proposition innovation	3.20	.48	.88**	.48**																
4. Top-down knowledge inflows	3.06	.81	.09	.20	-.02															
5. Bottom-up knowledge inflows	3.66	.73	.15	.36**	-.01	.39**														
6. Horizontal knowledge inflows	3.13	.72	.18	.42**	-.02	.37**	.36**													
7. Senior team heterogeneity	3.88	.47	.16	.42**	-.07	.27*	.33*	.30*												
8. Senior team social integration	3.96	.61	.31*	.21	.26†	.04	.10	-.07	.30*											
Interactions																				
9. Top-down knowledge inflows[a] x senior team heterogeneity[a]	.10	.41	-.05	-.10	-.03	.26†	.13	.16	-.15	-.01										
10. Bottom-up knowledge inflows[a] x senior team heterogeneity[a]	.11	.39	.22	.09	.20	.15	-.13	.06	.18	.16	.40**									
11. Horizontal knowledge inflows[a] x senior team heterogeneity[a]	.01	.36	-.02	-.06	.01	.16	.05	.02	-.12	.05	.65**	.41**								
12. Top-down knowledge inflows[a] x senior team social integration[a]	.02	.54	.07	.02	.08	.29*	.11	.04	-.01	.14	.46**	.31*	.32*							
13. Bottom-up knowledge inflows[a] x senior team social integration[a]	.04	.44	-.05	.08	-.12	.12	.40**	.20	.16	-.06	.30*	.00	-.07	.33*						
14. Horizontal knowledge inflows[a] x senior team social integration[a]	-.03	.42	-.10	-.04	-.13	.04	.21	-.08	.06	.11	.41**	-.03	.40**	.56**	.33*					
Controls																				
15. Environmental dynamism	3.52	.60	.30*	.19	.25†	.33*	.11	.16	.13	.16	-.01	-.06	-.11	.23†	-.14	.11				
16. Decentralisation	3.49	.62	.05	.14	-.04	-.02	.21	.03	.15	-.13	-.29*	-.10	-.13	-.32*	-.00	-.12	-.09			
17. Unit size[b]	4.85	1.44	-.08	.13	-.28*	.28*	.18	.23†	.23†	-.02	.01	-.07	-.15	.09	.25†	.07	.16	.20		
18. Unit age[b]	2.84	1.39	-.06	.04	-.17	.09	-.02	.17	.09	-.05	-.06	.04	-.24†	-.00	.26†	-.13	-.18	-.15	.33*	
19. Senior team size[b]	1.80	.56	-.04	.09	-.10	.05	.16	.12	-.10	.04	-.05	-.19	-.18	-.06	.19	-.02	.05	-.08	.51**	.16

N = 55 [a] Mean centred variable before creating interaction [b] Natural logarithm † p < .10; * p < .05; ** p < .01; *** p < .0001

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Top-down knowledge inflows		-.03	-.02	-.05	-.04
Bottom-up knowledge inflows		.05	.03	.05	.08
Horizontal knowledge inflows		.08	.10	.08	.10
Senior team heterogeneity			.18*	.17†	.15†
Senior team social integration			-.01	.02	-.07
Interactions					
Top-down knowledge inflows[a] x senior team heterogeneity[a]				.12	
Bottom-up knowledge inflows[a] x senior team heterogeneity[a]				-.01	
Horizontal knowledge inflows[a] x senior team heterogeneity[a]				-.19	
Top-down knowledge inflows[a] x senior team social integration[a]					-.14
Bottom-up knowledge inflows[a] x senior team social integration[a]					.33†
Horizontal knowledge inflows[a] x senior team social integration[a]					-.03
Controls					
Environmental dynamism	.22*	.21*	.18†	.18†	.19†
Decentralisation	.08	.07	.09	.10	.06
Unit size[b]	.04	.02	.01	.02	.02
Unit age[b]	-.06	-.06	-.06	-.06	-.05
Senior team size[b]	.03	.02	.02	.02	.01
R^2	.12	.16	.24	.27	.30
ΔR^2		.03	.08	.03	.06
F	1.39	1.06	1.36	1.14	1.34
Sum of squares	.92	1.15	1.74	1.96	2.20

N = 55
[a] Mean centred variable before creating interaction
[b] Natural logarithm
†p < .10; * p < .05; ** p < .01; *** p < .0001

Table 7: Results of hierarchical regression analyses for business model innovation

bottom-up knowledge inflows and senior team social integration on business model innovation are not significant. This indicates a cross-over interaction, where the moderating effect of senior team social integration on business model innovation is opposite, depending on the level of bottom-up knowledge inflows. To visualise this interaction, both bottom-up knowledge inflows and senior team social integration are plotted one standard deviation below (i.e. low level) and above (i.e. high level) the mean, refer to figure 2. In line with hypothesis 5b, this figure shows a positive relationship between bottom-up knowledge inflows and business model innovation when senior team social

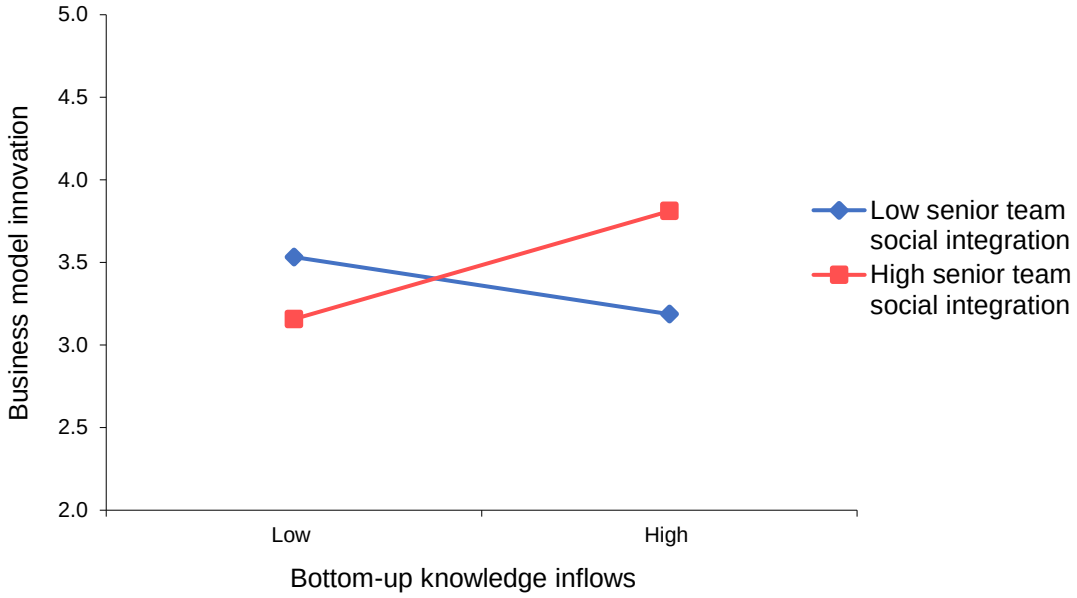

Figure 2: Interaction of bottom-up knowledge inflows and senior team social integration on business model innovation

integration is high. However, the relationship between bottom-up knowledge inflows and business model innovation is negative when senior team social integration is low. More bottom-up knowledge inflows will therefore only have a positive effect when the senior team is highly socially integrated. Thus, there is no overall effect of either bottom-up knowledge inflows or senior team social integration on business model innovation but there is a cross-over interaction. Overall, these findings indicate that the relationship between knowledge inflows and business model innovation is not moderated by senior team heterogeneity, and only moderated by senior team social integration for bottom-up knowledge inflows.

While not hypothesised, model 3 shows a direct, significant and positive effect of senior team heterogeneity on business model innovation ($\beta = .18$, $p < .05$). This indicates that the more heterogeneous the senior team is, the higher the level of business model innovation within their unit is. In addition, model 1 shows a significant and positive effect of environmental dynamism on business model innovation ($\beta = .22$, $p < .05$). In other words, the more dynamic a unit's environment is, the more they innovate their business model. The other control variables show no significant effect on business model innovation.

4.2 Additional analyses and results

In the previous statistical analyses, the direct effects of knowledge inflows and the interaction effects of senior team heterogeneity and senior team social integration on the construct of business model

innovation has been examined. However, business model innovation consists of the three subconstructs value creation innovation, value proposition innovation, and value capture innovation. Therefore, I performed additional analyses using the subconstructs value creation innovation and value proposition innovation as a separate dependent variable, examining the same direct and interaction effects as before. Value capture innovation is not used as separate dependent variable, as the scale used to measure this proves unreliable, with no option to improve reliability. Table 8 displays the results of the hierarchical regression analyses for value creation innovation and table 9 for value proposition innovation.

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Top-down knowledge inflows		-.04	-.04	-.05	-.03
Bottom-up knowledge inflows		.14	.09	.12	.12
Horizontal knowledge inflows		.19*	.18*	.18†	.19*
Senior team heterogeneity			.10	.09	.09
Senior team social integration			.20	.21	.14
Interactions					
Top-down knowledge inflows[a] x senior team heterogeneity[a]				.07	
Bottom-up knowledge inflows[a] x senior team heterogeneity[a]				-.06	
Horizontal knowledge inflows[a] x senior team heterogeneity[a]				-.10	
Top-down knowledge inflows[a] x senior team social integration[a]					-.21
Bottom-up knowledge inflows[a] x senior team social integration[a]					.18
Horizontal knowledge inflows[a] x senior team social integration[a]					.03
Controls					
Environmental dynamism	.15	.10	.08	.07	.08
Decentralisation	.11	.06	.07	.07	.03
Unit size[b]	-.02	-.06	-.01	-.01	-.03
Unit age[b]	.02	.01	-.01	-.01	.00
Senior team size[b]	.03	.02	.01	.01	.00
R^2	.07	.25	.33	.34	.35
ΔR^2		.18	.08	.01	.02
F	.78	1.95	2.16*	1.61	1.72†
Sum of squares	.69	2.38	3.09	3.18	3.32

N = 55
[a] Mean centred variable before creating interaction
[b] Natural logarithm
†p < .10; * p < .05; ** p < .01; *** p < .0001

Table 8: Results of hierarchical regression analyses for value creation innovation

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Top-down knowledge inflows		-.02	-.01	-.05	-.03
Bottom-up knowledge inflows		.00	-.00	.02	.06
Horizontal knowledge inflows		.01	.04	.02	.04
Senior team heterogeneity			.20†	.19	.17
Senior team social integration			-.14	-.11	-.21
Interactions					
Top-down knowledge inflows[a] x senior team heterogeneity[a]				.27	
Bottom-up knowledge inflows[a] x senior team heterogeneity[a]				.82	
Horizontal knowledge inflows[a] x senior team heterogeneity[a]				.13	
Top-down knowledge inflows[a] x senior team social integration[a]					-.11
Bottom-up knowledge inflows[a] x senior team social integration[a]					.41†
Horizontal knowledge inflows[a] x senior team social integration[a]					-.11
Controls					
Environmental dynamism	.26*	.26*	.23†	.23†	.24†
Decentralisation	.06	.05	.09	.10	.06
Unit size[b]	.08	.07	.03	.04	.03
Unit age[b]	-.13*	-.13*	-.11†	-.11†	-.10
Senior team size[b]	.01	.01	.01	-.00	-.00
R^2	.18	.18	.23	.28	.29
ΔR^2		.00	.06	.05	.06
F	2.08†	1.23	1.33	1.22	1.26
Sum of squares	2.17	2.18	2.86	3.45	3.53

N = 55
[a] Mean centred variable before creating interaction
[b] Natural logarithm
†p < .10; * p < .05; ** p < .01; *** p < .0001

Table 9: Results of hierarchical regression analyses for value proposition innovation

As with the previous analysis, I mean centred the independent variables before creating the interaction terms in models 4 and 5 (table 8 and 9) to reduce multicollinearity (Aiken & West, 1991). I again calculated the variance inflation factors (VIF) for each of the regressions to examine if multicollinearity is still an issue. The maximum VIF within the models is 2.34, which is once again below the cut-off point of 10 (Neter, Wasserman, & Kutner, 1990). In the additional regressions, the control variables are included in model 1. Models 2 and 3 introduce the independent variables on knowledge inflows, senior team heterogeneity and senior team social integration. Finally, models 4

and 5 examine the moderating effects of senior team heterogeneity and senior team social integration respectively.

The results in table 8 show that the relationship between horizontal knowledge inflows and value creation innovation is positive and significant ($\beta = .19$, $p < .05$). In other words, an increase in horizontal knowledge inflows leads to an increase in value creation innovation. The direct effects of top-down and bottom-up knowledge inflows and interaction effects of senior team heterogeneity and senior team social interaction are not significant. Regarding value proposition innovation, table 9, the results show a positive and marginally significant direct effect of senior team heterogeneity in model 3 ($\beta = .20$, $p < .10$). Higher levels of senior team heterogeneity therefore lead to more value proposition innovation. Senior team social integration has a positive and marginally significant effect on bottom-up knowledge inflows ($\beta = .41$, $p < .10$), while the main effects of both bottom-up knowledge inflows and senior team social integration on value proposition innovation are not significant. This indicates a cross-over interaction, where the moderating effect of senior team social integration on value proposition innovation is opposite, depending on the level of bottom-up knowledge inflows. To visualise this interaction, both bottom-up knowledge inflows and senior team social integration are plotted one standard deviation below (i.e. low level) and above (i.e. high level) the mean, refer to figure 3. This figure shows a positive relationship between bottom-up knowledge inflows and value proposition innovation when senior team social integration is high. However, the

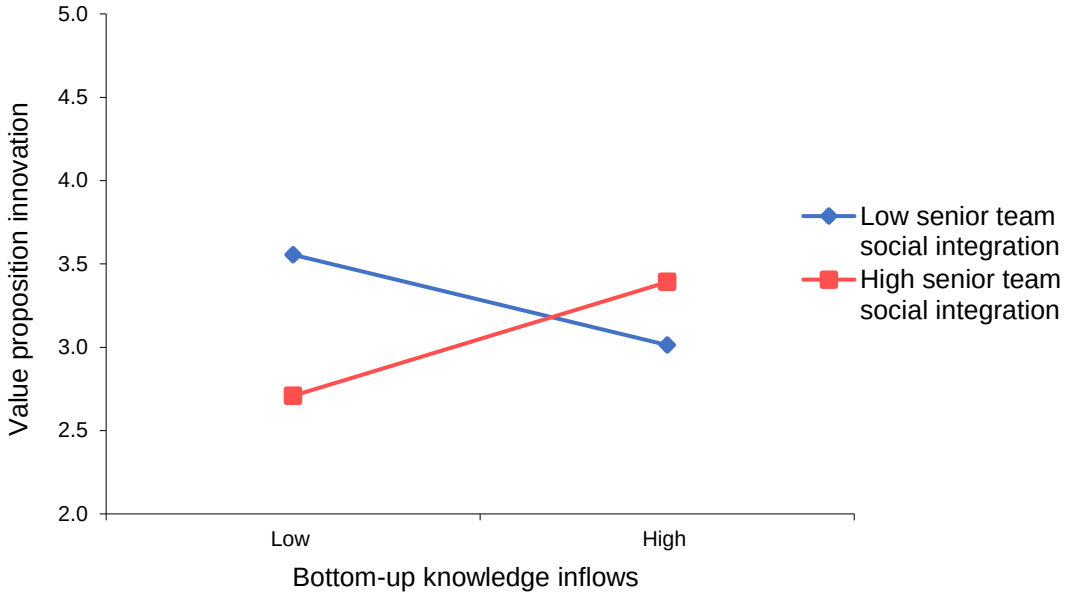

Figure 3: Interaction of bottom-up knowledge inflows and senior team social integration on value proposition innovation

relationship between bottom-up knowledge inflows and value proposition innovation is negative when senior team social integration is low. More bottom-up knowledge inflows will therefore only lead to more value proposition innovation when the unit's senior team has a high level of social integration, otherwise it will have a negative effect. Thus, there is no overall effect of either bottom-up knowledge inflows or senior team social integration on value proposition innovation but there is a cross-over interaction.

In addition, the results show a positive and significant effect of environmental dynamism ($\beta = .26$, $p < .05$), and a negative and significant effect of the unit's age ($\beta = -.13$, $p < .05$). In other words, the more dynamic the unit's environment is, the higher the level of value proposition innovation, and the older the unit, the lower the level of value proposition innovation. The direct effects of the different knowledge inflows and the interaction effects of senior team heterogeneity on all knowledge inflows and senior team social integration on top-down and horizontal knowledge inflows are not significant.

5 Discussion and conclusion

While there is a reasonable understanding of the drivers, prerequisites and barriers of business model innovation, we know little of the enablers of business model innovation (Foss & Saebi, 2017). This study applies knowledge inflows as an enabler of business model innovation, as most innovations in organisations result from borrowing knowledge rather than inventing new knowledge (Hippel, 1988). I progress current scientific knowledge regarding top-down, bottom-up and horizontal knowledge inflows as sources of business model innovation. Moreover, I add new insights on the moderating role of senior team heterogeneity and senior team social integration to the existing literature on senior team attributes.

5.1 Implications and future research

While the scope of top-down knowledge inflows is narrow and it increases the depth of the senior team's existing knowledge base (Winter & Szulanski, 2001), my findings indicate that there is no significant negative relationship between top-down knowledge inflows and business model innovation and its subconstructs. In other words, knowledge transfers from a multi-unit company's senior team to a unit's senior team does not lead to less business model innovation, nor to less values creation innovation or value proposition innovation. However, I have not found a significant positive relationship either. This has an important managerial implication for senior teams of multi-unit companies in which units have the autonomy to innovate their business model. When a company's senior team wants a unit to innovate its business model, there is no point for the company's senior team in putting effort into directly transferring their knowledge to the unit's senior team. Instead, they may spark exploration activities indirectly by increasing the unit senior team's participation in decision making or by decreasing the unit senior team's task formalisation (McGrath, 2001), or by instating cross-functional relationships between units (Egelhoff, 1991). This research however provides no evidence for the latter, with regard to business model innovation. In addition, they might better focus on creating the right organisational context for business model innovation to thrive. Birkinshaw and Gibson (2004) have highlighted the performance context, with high levels of both performance management and social support, as an enabler of ambidexterity and subsequently superior performance. While organisational ambidexterity and business model innovation are different concepts, face ambidexterity and business model innovation similar challenges (Markides, 2013). To my knowledge, there are no investigations into which organisational context is best suited for business model innovation. Future research might therefore focus on this organisational context and the work of O'Reilly and Tushman (2011) might prove a good starting point, as it emphasises the influence of vision, strategic intent, values, incentives and leadership on realising ambidexterity.

Although bottom-up knowledge inflows increase the senior team's understanding of the evolution of customer needs and requests and market developments (Brady & Davies, 2004), and this understanding can urge the senior team to reconsider strategic decisions (Floyd & Lane, 2000; Ghoshal & Bartlett, 1994), my findings indicate that bottom-up knowledge inflows have no influence on business model innovation, nor on the subconstructs value creation innovation or value proposition innovation. Especially this last finding is of interest, as value proposition encompasses all the solutions offered to customers, including the way they are offered (Morris, Schindehutte, & Allen, 2005; Johnson, Christensen, & Kagermann, 2008). If an increased understanding of the evolution of customer's needs and requests and market developments does not make a senior team decide to innovate their unit's value proposition, but it does urge them to reconsider strategic decisions as posed by Floyd and Lane (2000) and Ghoshal and Bartlett (1994), it might lead them to decide to change on which customers to work for. Based on the theory of risk aversion (Kahneman & Tversky, 1984), this makes sense as the decision to retain the unit's current value proposition and to find suiting customers introduces a lot less insecurity than innovating the unit's value proposition and retaining the unit's current customers. Whether this is the most fruitful decision on the long run depends on the market and the customer base. Future research might investigate into how to benefit from the knowledge of people working close to the customers and markets via other means than direct knowledge inflows, as these people poses knowledge which can be of importance for innovating a unit's or company's value proposition in particular.

Despite the broadening effect of horizontal knowledge inflows on a senior team's knowledge base (Mom, Van den Bosch, & Volberda, 2007), my findings indicate that there is no significant relationship between horizontal knowledge inflows and business model innovation or its subconstruct value proposition innovation. Thus, although horizontal flows facilitate importing of knowledge from different parts of the organisation to generate new knowledge from it (Schulz, 2001), it does not lead to higher levels of business model innovation. Interestingly, more horizontal knowledge inflows do lead to higher levels of value creation innovation. This indicates that knowledge coming from persons or units at the same hierarchical levels as the senior team is a source to innovate the way a unit creates value for its customers. Senior teams should therefore seek for knowledge of peers within the organisation if they want to innovate on value creation, instead of knowledge originating from higher or lower levels in the organisation. A possible explanation for this might be that peers face challenges of similar nature and complexity with regard to value creation innovation as the unit's senior team. In this research, I've defined horizontal knowledge inflows as intra-organisational knowledge inflows. Future research might investigate into

interorganisational horizontal knowledge flows as a possible source of business model innovation, as the senior team can also borrow the knowledge from outside the organisation.

You could argue that horizontal knowledge inflows play a role in the implementation of a business model innovation as well, via the networks they create between the different units. This might be the case in organisations which operate on one business model and in which different units each fulfil their specific part in executing this business model. There is a need for the units in these kind of organisations to coordinate and align their activities in order to successfully implement the business model innovation, as business model innovation affects the full logics of a company's business model (Casadesus-Masanell & Zhu, 2013). The networks created by horizontal knowledge inflows can indeed be beneficial for the implementation of an innovation regarding a company's business model. However, in multi-unit organisations in which each unit operates on a secluded business model and is permitted to make decisions regarding business model innovation fairly autonomous, this is not the case. Units in these kind of organisations do not need to coordinate and align their activities, as there are no interdependencies between their activities or their business models. The networks created by horizontal knowledge inflows can nevertheless initiate reciprocal knowledge exchange between the units, as they now know each other and know what kind of knowledge the other unit might poses. Horizontal knowledge inflows can therefore have a self-reinforcing effect.

While senior team heterogeneity shows no moderating effect on the relationship between knowledge inflows and business model innovation, it does show a significant direct effect on business model innovation. This indicates that a more heterogeneous senior team will directly lead to more business model innovation, which is in line with the findings of other researchers. Alexiev et al. (2010), for example, state that "heterogeneity leads to the creation of more original and valuable ideas", and Murray (1989) states that "heterogeneity is associated with high levels of creativity and innovation". Management of multi-unit companies should therefore put effort into composing a diverse senior team for the unit in which they want business model innovation to take place and should take demographic, functional, and background dimensions into account when selecting new team members. Future research might investigate into whether diversity within a senior team has its costs with regard to business model innovation. More specific, they should look for an inverted u-shaped relationship between senior team heterogeneity and business model innovation. While the results show no limit to the positive effect of senior team heterogeneity on business model innovation, previous research gives rise to believe there is a limit to this positive effect, as argued by Wiersema and Bantel (1992) for example.

Interestingly, senior team social integration has a marginally significant, moderating effect on the relationship between bottom-up knowledge inflows and business model innovation and its subconstruct value proposition innovation, while there is no direct effect of bottom-up knowledge inflows and senior team social integration on both business model innovation and value proposition innovation. The results show that this is due to a cross-over interaction, which means that more bottom-up knowledge inflows will only lead to higher levels of business model innovation or value proposition innovation when the unit's senior team is highly socially integrated. When the unit's senior team's social integration is low, will more bottom-up knowledge inflows actually have a negative effect on business model innovation or value proposition innovation. A possible explanation for this would be that bottom-up knowledge inflows are of such complexity and diversity that, without the increased collaborative problem solving (Dailey, 1978), stimulus of critical debate (Jansen, George, Van den Bosch, & Volberda, 2008), and increased confidence to engage in critical debate, all enhanced by social integration, the senior team is overwhelmed and dismayed, and as a primary response decides to retreat to exploitation related activities. The senior team depends upon social integration as a means to make sense of the knowledge received and apply it to innovate their unit's business model.

In contrast, senior team social integration has no moderating effect on the relationship between top-down and horizontal knowledge inflows and business model innovation and its subconstructs, nor on the relationship between bottom-up knowledge inflows and value creation innovation, while the levels of social integration among senior teams in the study sample are fairly high (mean = 3.96, s.d. = .61). It therefore seems that social integration and the corresponding increase in collaborative problem solving, stimulus of critical debate, and confidence to engage in critical debate only play a minor role in business model innovation. This is contrary to what you would expect, as business model innovation requires experimentation on the companies key value delivering activities (McGrath, 2010), which makes it complex and risky, and its outcomes are unpredictable (Chesbrough, 2010). A possible explanation would be that senior team use a different set of attributes to tackle this complexity, such as a shared vision or group contingency rewards. Both attributes have been shown to positively influence organisational ambidexterity (Jansen, George, Van den Bosch, & Volberda, 2008) and might play a similar role in business model innovation, as ambidexterity and business model innovation face corresponding challenges (Markides, 2013). Future research might therefore investigate into these and other senior team attributes, because we know little on how senior teams tackle the complexity of business model innovation.

Regarding knowledge inflows in general, there are four possible explanations for them not leading to higher levels of business model innovation in this study sample. First, it might be that either the knowledge transferred is very narrow of scope, or the senior team's current knowledge base is very limited. I have measured a considerable amount of knowledge flows in the study sample (top-down knowledge inflows, mean = 3.06, s.d. = .81; bottom-up knowledge inflows, mean = 3.66, s.d. = .73; horizontal knowledge inflows, mean = 3.13, s.d. = .72), which makes it unlikely that all transferred knowledge is narrow of scope. The senior teams in the study sample are rated as quite heterogeneous (mean = 3.88, s.d. = .47), which would indicate that the senior team's knowledge base is divers. This makes it unlikely that the incoming knowledge is not related to what is already known within the senior team and the senior team subsequently does not recognise the value of the incoming knowledge.

Second, another cause for not finding any significant relationships between knowledge inflows and business model innovation might be that there are barriers present in the study sample which hinder the units to innovate their business model. As the level of business model innovation measured in the study sample is considerable (mean = 3.45, s.d. = .37), this is unlikely. Thus, the units in the study sample do seem to innovate their business model and they are not hindered by either structural or organisational barriers or cognitive barriers, as defined by Chesbrough (2010).

Third, the unit's senior teams might rely on own experience gathered while the business model was in operation to innovate it and do not use the knowledge received from higher, equivalent or lower hierarchical levels in the organisation. The unit's in the study sample might therefore apply the drifting trajectory as defined by Berends et al. (2016). This trajectory starts with experiential learning and uses the experience from the current performance of the unit's structure, sales and partnerships before turning to cognitive search for the conceptualisation and creation of changes on the elements of the business model. Because this is induced by knowledge gained from experience, it is likely the senior teams don't use knowledge gained from inflows in this trajectory. In contrast, the leaping trajectory, as defined by Berends et al. (2016), starts with cognitive search to first develop concepts and ideas for changes on the elements of the business model without actually changing any of the elements, before shifting to experiential learning for adaptation of and experimentation with these elements. It is likely the senior team in this trajectory uses the knowledge gained from inflows as well, as they are not constrained to knowledge gained solely from experience by starting with experiential learning. Future researchers are encouraged to distinguish between the two trajectories when looking at business model innovation as these can pose differences in the sources of business model innovation.

Fourth, the final cause for not finding any significant relationships between knowledge inflows and business model innovation is likely due to the sample size used in this study. The same applies to not finding any significant interactions on these relationships, other than the two marginally significant ones. This brings us to the limitations of this study.

5.2 Limitations and associated future research

Although other studies have successfully used comparable sample sizes (e.g. Gibson and Birkinshaw (2004) with an aggregated sample size of 41 business units), the sample size used in this study might be too small to find any significant relationships. Future research should therefore increase the sample size to reinvestigate into the hypothesised relationships between knowledge inflows and business model innovation and the hypothesised interaction effects of senior team heterogeneity and senior team social integration.

In addition, this study points to the interaction of bottom-up knowledge inflows and senior team social integration on business model innovation and value proposition innovation as marginally significant. Due to the small sample size, I consider it appropriate to highlight these findings even though they do not comply with the established levels of significance of $p < .05$ or even $p < 0.01$. However, before we can fully support these interactions, additional quantitative research herein is necessary. Future researchers are therefore stimulated to provide this substantiation.

Next to this, this study limits its sample to a single industry. While the concept of business model innovation applies to many industries and the measured level of business model innovation is moderate (mean = 3.45, s.d. = .37), is the construction industry not known for its innovativeness. Expansion to other industries was not within the possibilities of this research but could provide more and better substantiation of my findings, as innovation levels differ per industry. Future researchers are therefore encouraged to expand this research into other industries and it would be particularly interesting to see if the effects vary between different industries.

Further, the scale designed by (Clauβ, 2017) to measure business model innovation is quite new and has not been used widely. While this is a validated instrument and reliability analyses in this study indicated that the scale was reliable, using this scale in other industries could help to better substantiate the validity and reliability of the scale. Having a substantially validated scale to measure business model innovation could greatly benefit future business model research, as the few existing quantitative studies into business model innovation use different measurement instruments with variance in scope (Clauβ, 2017).

Finally, the scale used to measure value capture innovation proved unreliable, with no option to improve reliability. While this proved no problem to measure business model innovation in general, future research should first investigate into whether the original six item scale designed by Clauβ (2017) increases reliability to above the desired threshold before using these items to measure value capture innovation separately. Subsequently, researchers might investigate into the effect of knowledge inflows on value capture innovation, as the unreliability of the scale used in this study did not allow for this investigation. It is especially interesting to see whether the same effects apply as to value creation innovation and value proposition innovation, and if not, why this is the case.

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Appendix 1: Business model canvas

<table>
<tr><td rowspan="2">Key partners</td><td>Key activities</td><td rowspan="2">Value propositions</td><td>Customer relationships</td><td rowspan="2">Customer segments</td></tr>
<tr><td>Key resources</td><td>Channels</td></tr>
<tr><td colspan="2">Cost structure</td><td colspan="3">Revenue streams</td></tr>
</table>

Business model canvas (Osterwalder, Pigneur, & Smith, 2010)

Appendix 2: Measurement items

Construct	*Sub-construct*	*Second level sub-construct*	*Items*	*Acronym*
Business model innovation	Value creation innovation	New capabilities	Our employees constantly receive training in order to develop new competences	CAP1
			We constantly reflect on which new competencies need to be established in order to adapt to changing market requirements.	CAP2
		New technology/ equipment	We keep the technical resources of our company up-to-date.	TEC1
			We regularly utilise new technical opportunities in order to extend our product and service portfolio.	TEC2
		New partnerships	We are constantly searching for new collaboration partners.	PAR1
			We regularly utilise opportunities that arise from integration of new partners into our processes.	PAR2
		New processes	We utilise innovative procedures and processes during the manufacturing of our products.	PRO1
			Existing processes are regularly assessed and significantly changed if needed.	PRO2
	Value proposition innovation	New offerings	Our products or services are very innovative in relation to our competitors.	OFF1
			Our products or services regularly solve customer needs, which were not solved by competitors.	OFF2
		New customers and markets	We regularly address new, unserved market segments.	MAR1
			We are constantly seeking new customer segments and markets for our products and services.	MAR2
		New channels	Constant changes of our channels have led to improved efficiency of our channel functions.	CHA1
			We consistently change our portfolio of distribution channels.	CHA2
		New customer relationships	We try to increase customer retention by new service offerings.	REL1
			We emphasise innovative/modern actions to increase customer retention (e.g. CRM).	REL2
	Value capture innovation	New revenue models	We recently developed new revenue opportunities (e.g. additional sales, cross-selling).	REV1
			We increasingly offer integrated services (e.g. maintenance contracts) in order to realise long-term financial returns.	REV2
		New cost structures	Our production costs are constantly examined and if necessary amended according to market prices.	COS1
			We regularly utilise opportunities which arise through price differentiation.	COS2

Measurement items on business model innovation and its subconstructs (Clauß, 2017)

Construct	*Items*	*Acronym*
Top-down knowledge inflows	To what extent did you and members of your senior team, last year, receive or gather knowledge from one hierarchical level above your senior team?	TKI1
	To what extent did you and members of your senior team, last year, receive or gather knowledge from two or more hierarchical levels above your senior team?	TKI2
Bottom-up knowledge inflows	To what extent did you and members of your senior team, last year, receive or gather knowledge from one hierarchical level below your senior team?	BKI1
	To what extent did you and members of your senior team, last year, receive or gather knowledge from two or more hierarchical levels below your senior team?	BKI2
Horizontal knowledge inflows	To what extent did you and members of your senior team, last year, receive or gather knowledge from other senior teams within your own division (Business Unit and/or Operational Company).	HKI1
	To what extent did you and members of your senior team, last year, receive or gather knowledge from other senior teams outside your own division (Business Unit and/or Operational Company).	HKI2

Measurement items on knowledge inflows (Mom, Van den Bosch, & Volberda, 2007)

Construct	*Items*	*Acronym*
Senior team social integration	The members of the senior team are quick to defend each other from criticism by outsiders.	SSI1
	Everyone's input is incorporated into most important business unit's decisions.	SSI2
	The members of the senior team get along together very well.	SSI3
	The members of the senior team are always ready to cooperate and help each other.	SSI4
	When final decisions are reached, it is common for at least one member to be unhappy with the decision. *(reversed)*	SSI5
	There is a great deal of competition between members of the senior team. *(reversed)*	SSI6
	The members of the senior team really stick together.	SSI7

Measurement items on senior team social integration (O'Reilly, Caldwell, & Barnett, 1989; Smith, et al., 1994)

Construct	*Item*	*Acronym*
Senior team heterogeneity	The members of the senior team vary widely in their areas of expertise.	STH1
	The members of the senior team have a variety of different backgrounds and experiences.	STH2
	The members of the senior team have skills and abilities that complement each other.	STH3

Measurement items on senior team heterogeneity (Alexiev, Jansen, Van den Bosch, & Volberda, 2010; Campion, Medsker, & Higgs, 1993)

Construct	*Items*	*Acronym*
Environmental dynamism	Environmental changes in our market are intense.	EDY1
	Our clients regularly ask for new products and services.	EDY2
	In our local market, changes are taking place continuously.	EDY3
	In our market, the volumes of products and/or services to be delivered change fast and often.	EDY4
	In a year, nothing has changed in our market. *(reversed)*	EDY5

Measurement items on environmental dynamism (Jansen, Van den Bosch, & Volberda, 2006)

Construct	*Items*	*Acronym*
Decentralisation	To what extend can you make decisions autonomously on stopping to offer a product or service	DEC1
	To what extend can you make decisions autonomously on investing in buildings, people and resources	DEC2
	To what extend can you make decisions autonomously on changing the selling prices of products and services	DEC3
	To what extend can you make decisions autonomously on buying products and services from third parties	DEC4
	To what extend can you make decisions autonomously on collaborating with sister units	DEC5

Measurement items on decentralisation (Van Wijk, Jansen, Van den Bosch, & Volberda, 2012)