



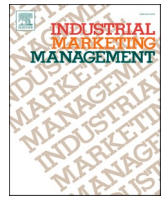
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Explaining business model innovation processes: A problem formulation and problem solving perspective

Joakim Björkdahl^{a,*}, Sara Fallahi^b, Magnus Holmén^c

^a Department of Technology Management and Economics, Chalmers University of Technology, 412 96 Göteborg, Sweden

^b RISE Research Institutes of Sweden, Division Digital Systems, 417 56 Göteborg, Sweden

^c School of Business, Innovation and Sustainability, Halmstad University, 301 18 Halmstad, Sweden

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ABSTRACT

This study explains the business model innovation processes in industrial firms. Drawing on three case studies of leading business-to-business firms shifting from product-based to service-based business models, it introduces problems as a theoretical concept to explain business model innovation processes. We show how formulating and solving problems guide the search for a viable business model and why some problem formulation and solving activities lead firms to shift between backward-looking and forward-looking searches. The decision to shift to a forward-looking search is triggered by the perception of failure to continue with an established way of working, while the shift to a backward-looking search is based on the perception of high alternative costs. We contribute to the business model innovation and servitization literature by theorizing the process of business model innovation and providing implications for managers.

1. Introduction

This study explores and explains the processes of business model innovation in industrial firms in a business-to-business context. A business model can be defined as the way firms create and capture value, and business model innovation is considered a business model that is new to the product market space (McDonald & Eisenhardt, 2020; Paiola & Gebauer, 2020; Snihur, Zott, & Amit, 2021; Teece, 2010). Sometimes, firms need to innovate their business model to maintain their competitiveness or unlock value from new technologies (Björkdahl, 2009; Snihur et al., 2021; Teece, 2018). However, business model innovations are costly, uncertain, difficult, and prone to failure (Afuah, 2014; Christensen, Bartman, & Van Bever, 2016; Visnjic Kastalli, Van Looy, & Neely, 2013).

A stream of research analyzing the processes of business model innovation highlights different stages of the business model innovation process (Frankenberger, Weiblen, Csik, & Gassmann, 2013; Pynnönen, Hallikas, & Ritala, 2012), proposes practitioner-oriented frameworks to design new business models (Evans & Johnson, 2013; Osterwalder & Pigneur, 2010; Sjödin, Parida, Jovanovic, & Visnjic, 2020), emphasizes how changes in managerial cognition are directly related to business model changes (Aspara, Lamberg, Laukia, & Tikkanen, 2013), and

explains business model innovation as trial-and-error, change, and learning processes (Berends, Smits, Reymen, & Podoyntsyna, 2016; Foss & Saebi, 2017; Sosna, Treviño-Rodríguez, & Velamuri, 2010).

Prior studies are underpinned by a search perspective wherein firms engage in innovation activities to find a viable business model. Some scholars recognize this explicitly by referring to cognitive search (e.g., Berends et al., 2016; Cavalcante, 2014; Martins, Rindova, & Greenbaum, 2015; Shepherd, Seyb, & George, 2021), exploitative search, and explorative search (Chesbrough, 2010; Sosna et al., 2010). For other scholars, search is dealt with when they address business model design (e.g., Eurich, Weiblen, & Breitenmoser, 2014; Frankenberger et al., 2013). Nevertheless, our understanding of how industrial firms innovate their business models is poor and requires more research (Cozzolino, Verona, & Rothaermel, 2018; Sjödin et al., 2020). For example, Sosna et al. (2010: 385) state that business model innovation “lacks theoretical grounding in the established literature which would allow us to understand its underlying mechanisms better and move the still shaky conceptual frameworks of business model development and innovation to more solid theoretical grounds.” Several scholars argue that research on the process(es) of business model innovation makes conflicting assumptions and provides different findings, and that a thorough understanding and explanation of how business model innovation evolves

* Corresponding author.

E-mail addresses: joakim.bjorkdahl@chalmers.se (J. Björkdahl), sara.fallahi@ri.se (S. Fallahi), magnus.holmen@hh.se (M. Holmén).

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from initiation and design to implementation is still lacking (Berends et al., 2016).

A specific type of business model innovation is when industrial firms substitute their product-based business models with service-based business models. Researchers have shown that there are multiple changes in firms' business models for this particular type of servitization journey, such as the value proposition, revenue model, customer segmentation, and customer relationships (see e.g., Baines, Bigdeli, Sousa, & Schroeder, 2020; Ferreira, Proença, Spencer, & Cova, 2013; Kowalkowski, Gebauer, Kamp, & Parry, 2017). While this type of business model innovation is dealt with in the servitization literature, scholars argue that there is a lack of in-depth insights about how the transition from product-based to service-based business models unfolds in firms (Baines et al., 2017, 2020; Kowalkowski et al., 2017; Martinez, Neely, Velu, Leinster-Evans, & Bisessar, 2017; Sjödin et al., 2020). Indeed, the business model as a concept is used in the servitization literature, but often to contextualize how firms move into advanced services rather than to study the business model innovation processes per se (see e.g., Foss & Saebi, 2017).

This study explores and explains how industrial firms search to innovate a business model. Previous literature clearly indicates that the search for a business model innovation may be performed in different ways but does not explain how or why. To address this, our research question is how industrial firms search for business model innovation when shifting from product-based to service-based business models. We investigate the processes in three world-leading industrial firms that aim to increase profits from their existing businesses by transitioning from product-based to service-based business models. Based on the results, the article shows that the search consists of backward-looking and forward-looking searches guided by sequences of problems.

2. Literature background

This section provides an overview of how business model innovation processes are characterized in the extant literature and discusses the mechanisms for business model innovation.

2.1. Business model innovation and its process characterization

Business models provide a lens to understand how firms do business by describing and explaining how they create value for customers and appropriate a part of the value created (Björkdahl, 2009; Chesbrough & Rosenbloom, 2002; Ritter & Pedersen, 2020; Teece, 2018; Zott, Amit, & Massa, 2011). Indeed, there are many suggested frameworks for business models involving different components of a business model (Teece, 2018). A business model is commonly characterized as a set of components, linkages, and interactions among those components (Afuah & Tucci, 2001; Foss & Saebi, 2015). However, disagreements about the content of a business model signal that firms are complex systems that are difficult to understand (Cavalcante, 2014; Denyer, Tranfield, & Van Aken, 2008). Some central components common to many frameworks have emerged in the literature to depict a business model. The firm's value proposition, revenue model, use of resources and capabilities, customer relationships, and customer segmentation have emerged repeatedly (e.g., Björkdahl, 2009; Chesbrough & Rosenbloom, 2002; Foss & Saebi, 2015; Osterwalder & Pigneur, 2010; Ritter & Pedersen, 2020; Saebi, Lien, & Foss, 2017; Teece, 2010).

Firms need to innovate their business models by changing the logic between how value is created and captured (Snihur et al., 2021; Teece, 2010). During the last two decades, repertoires for doing business and external collaboration have increased (Björkdahl & Holmén, 2013; Snihur et al., 2021). Industrial firms have increasingly moved downstream to provide services (Baines, Lightfoot, Benedettini, & Kay, 2009; Oliva & Kallenberg, 2003; Wise & Baumgartner, 1999), often because of new digital technologies (Baines et al., 2020; Björkdahl, 2020; Porter & Heppelmann, 2014; Ritter & Pedersen, 2020; Sjödin et al., 2020;

Vendrell-Herrero, Bustinza, Parry, & Georgantzis, 2017). Although the addition of services does not necessarily cause business model innovation, servitization, as a transformation in logic for value creation and capture, can give rise to business model innovations. The most obvious business model innovation in connection with services is the substitution of products with services, where firms' revenues are generated from selling a function instead of a product (Porter & Heppelmann, 2014). There have been many calls to understand the processes of business model innovation, both from the aspect of servitization as well as management scholars more broadly (see e.g., Baines et al., 2017, 2020; Berends et al., 2016; Martinez et al., 2017; Sjödin et al., 2020; Sosna et al., 2010).

How does prior research characterize the business model innovation processes? One strand of the literature emphasizes the primacy of cognitive search to conceptualize and select alternative business models according to their expected consequences before the selected one is put into action (see Table 1 for an overview). In the existing literature on the cognitive dimension of the business model innovation process, some studies propose tools and process frameworks to conceive new business models that often assume that the process occurs in a series of stages or steps like initiation, design, development, and implementation (e.g., Baines et al., 2020; Eurich et al., 2014; Frankenberger et al., 2013; Sheehan & Stabell, 2007; Sjödin et al., 2020). These process frameworks aim to reduce complexity by abstraction and guide managers to the key decision points along the process rather than describe the processes empirically (Bucherer, Eisert, & Gassmann, 2012; Frankenberger et al., 2013). Drawing on design science research, these frameworks emphasize cognitive search as a mechanism for learning before doing by suggesting that business models need to be conceived prior to being implemented, and downplay the role of previous experience. Others use cognitive search as a theoretical perspective to explain business model innovation (see e.g., Shepherd et al., 2021). For example, Martins et al. (2015) theorize business model innovation as a cognitive search process by explaining how business models can be innovated through processes of generative cognition, directed by mechanisms of analogical reasoning and conceptual combining.

Another way to characterize the business model innovation process is as an experimental or trial and error process wherein the emphasis is more on learning from previous experience and action than cognitive search (Andries, Debackere, & Van Loo, 2013). The rationale is that the implementation of a new viable business model can be uncertain for established firms. It is often associated with lengthy trial-and-error learning for a firm (Chesbrough, 2010; McGrath, 2010; Sosna et al., 2010). For example, Sosna et al. (2010) investigated the processes through which business models change over time, based on a single case study. The authors argue that firms begin with a business model, and in response to external triggers, plan, design, test, and re-test alternative business model variants to identify the most viable.

Sosna et al. highlighted that business model innovation processes require specific learning mechanisms and second-order learning during the exploration phase. However, the underlying mechanisms remain unclear. Berends et al. (2016) advanced our theoretical understanding of the business model innovation process by investigating cognitive search and experiential learning. They show that the processes of business model innovation are not based on a single way of searching, as previous research suggest.

2.2. Mechanisms for business model innovation

Is there a more general way to explain business model innovation processes? A starting point is that firms need to search for new viable business models because searching is vital for their innovation activities (e.g., Laursen, 2012). Search is necessary because individuals can neither envision all available alternatives nor completely specify the causal linkages among alternative actions and outcomes because they are limited by many potentially relevant variables and their

Table 1

Selected research on the process of business model innovation.

Study	Focus	Method	Argumentation
Voelpel, Leibold, and Tekie (2004)	Business model reinvention	Conceptual	Discusses business model reinvention and introduces a model consisting of four dimensions: Customer sensing, technology sensing, business infrastructure sensing, and economic/ profitability sensing.
Sheehan and Stabell (2007)	New business models for Knowledge intensive organizations	Conceptual	Introduces a three-stage process of business model innovation: 1. Identifying four positioning characteristics including value creating activity, fee structure, reputational capital and governance. 2. Using the four positioning characteristics to map the firm and its competitors. 3. Evaluating how best to improve the firm's competitive position by altering one or more of the positioning characteristics.
Sosna et al. (2010)	Antecedents and process	Longitudinal study of a successful business model innovation	Applies learning perspective to business model innovation and maps a two-part development process consisting of exploration and exploitation.
McGrath (2010)	Firm's approach to business model innovation	Conceptual	Suggests a discovery-driven approach, involving experimentation, and learning to discover and exploit new business models.
Bucherer et al. (2012)	Matching business model innovation and product innovation	Multiple case study of 11 cases of business model innovation	Argues distinction between two origins of business model innovation; opportunity and threat. Draws on innovation management literature to build a process for business model innovation consisting of analysis, design, implementation, and control
Frankenberger et al. (2013)	Structure and challenges	Multiple case study of 14 business model innovations within six companies.	Develops a framework consisting of four process phases in business model innovation process namely as: initiation, ideation, integration, and implementation. The framework is derived from innovation management literature and adapted to business model innovation processes from the cases.
Khanagha, Volberda, and Oshri (2014)	Process of business model innovation	Longitudinal case study	Identifying five major phases in the process of business model innovation in relation to organizational structure: 1. Screening and speculation, 2. Initiating experimentation through an embedded temporary organization, 3. Continuation of experimentation through an independent structure, 4. Shrinkage of the separated structure and delegation of tasks, 5. Dissolution of the temporary organization and full integration of exploratory activities.
Cavalcante (2014)	Process of business model change	Conceptual	Introducing a process-based artefact for the design of business model change, consisting of three main phases: 1. Identification of the central components of the business model and their core processes, 2. Brief description of the change initiative and how the core processes will be affected, 3. Analysis of main challenges and solutions to overcome them.
Velu (2016)	Effect of level of dominance on business model innovation	Longitudinal, single case study	Shows that in network markets the less dominant firms tend to engage in cooptation to innovate their business model in an evolutionary manner before the dominant firms, as a defensive strategy to protect their existing business model. In contrast, the dominant firms tend to engage in cooptation to innovate their business model in a revolutionary manner after the less dominant firms, as an offensive strategy to alter radically their existing business model.
Laudien and Daxböck (2017)	Process of business model innovation	Multiple case study of ten average market players	Explains implementation of a new business model based on success or failure in completing a four-phase framework: 1. Monitoring the business model fit beyond the industry-level, 2. Business model development, 3. Opening up the business model, and 4. Deliberate business model innovation.
Berends et al. (2016)	Process of business model innovation	Multiple case study	Applies organizational learning as an analytical lens and introduces two patterns of business model innovation. Drifting starts with experiential learning and shifts later to cognitive search. Leaping, in contrast, starts with cognitive search and shifts later to experiential learning. The occurrence of the two processes depends on whether a new business model takes off from an existing one and when it goes into operation.
Snihur et al. (2021)	Value appropriation in business model innovation	Conceptual supported by case illustrations	Draws on institutional and resource-based theories to develop propositions for how business model innovators can mitigate value appropriation dilemma can create value for all stakeholders through strategic business model design.
Sjödin et al. (2020)	A process model for business model innovation	Multiple case study of outcome-based business models	Compares two successful and four unsuccessful cases of business model innovation when shifting from product-based to outcome-based business models. The study shows that effectiveness in business model innovation depends on three process phases that unfold in collaboration with customers: value proposition definition, value provision design, and value-in-use delivery. Success is determined by the alignment of value creation and capture activities in each phase.
Shepherd et al. (2021)	Business model change	Conceptual	Discusses how business models as schemas can drive boundary-object-based interactions that reveal the extent of business model coherence and affect the decision to change a business model. Attends to the inter-relationship between business models as schemas and business models as formal representations and draws on cognition theories to offer a grounded-cognition framework of business model change.

interrelationships (Gavetti, 2005). Rather than trying to envision all the alternatives and their relationships, actors can search based on their experience, that is, a backward-looking search or think ahead i.e. forward-looking search (Gavetti & Levinthal, 2000).

Backward-looking and forward-looking searches are based on different choice logics (Gavetti & Levinthal, 2000). Backward-looking or experiential search is history-dependent and founded on experiential wisdom, so the search for novelty is rooted in the firm's routines and organizational capabilities. Firms typically progress along a particular technological trajectory in an incremental and cumulative manner by solving specific sets of problems (Nelson & Winter, 1982). Prior choices that led to positive outcomes were reinforced, whereas choices that led to negative outcomes were dismissed. In other words, the firm's experiential wisdom accumulates over time as a consequence of the positive and negative reinforcement of past choices (Patel & Pavitt, 1997), such as from customer interactions (Christensen, 1997; Ruokolahti & Aarikka-Stenroos, 2016).

Forward-looking, or cognitive search, is based on the cognitive perception of the linkage between the actions chosen and their impact (Gavetti & Levinthal, 2000). A forward-looking search results in numerous alternatives that need to be analyzed and evaluated. However, in contrast to a backward-looking search, the evaluation of alternatives does not require direct feedback from trials such as market activities (Gavetti & Levinthal, 2000), and rejections of alternatives are unlikely to be costly, as they will not risk the current business.

In the context of firms' business model innovation, prior research provides some conflicting characterizations of how the business model innovation process unfolds over time. To explain business model innovation processes, we need to explain the requisite circumstances for firms to start searching, what triggers the change in their search mode, and when to stop searching. In particular, from a methodological perspective, a subjectively based explanation of the realities of actors is warranted. Fortunately, the literature on search provides us with *problem* as a mechanism. This is in line with the strategy literature, which stresses that a manager's task is to formulate and solve problems (Lyles, 1981; Mintzberg, Raisinghani, & Theoret, 1976). In the general case, a mechanism is part of a process in a system capable of bringing about change or preventing change within the system or some of its subsystems (Bunge, 1997; Czakon & Czernek, 2016). Here, the problem is a mechanism capable of bringing about a change in a firm's business model. Problem formulation and problem solving are the most important managerial activities as they largely determine a firm's course of action (Hsieh, Nickerson, & Zenger, 2007). Problems are important as the creation of useful knowledge can create value and be a source of profit for the firm, but the search for new knowledge is inherently uncertain. To investigate the process of creating useful knowledge, it is important to focus on how the firm formulates and solves problems (Hsieh et al., 2007; Nickerson & Zenger, 2004). Problems can be understood as deviations from a set of desired conditions that produce a symptom or a web of symptoms (Newell & Simon, 1972; Watson, 1976). Problem formulation depends on the individual's or firm's aspiration level and the actors' perceptions of the objective reality (Landry, 1995). Important managerial mechanisms feeding on how managers or firms formulate problems include deviations of profit or turnover from the budget, returns on sales, returns on investment, and differences in quality or performance based on customer feedback (Pounds, 1969).

The value of a formulated problem depends on the range of possible solutions and the costs involved in identifying a particularly valuable solution (Hsieh et al., 2007; Nickerson & Zenger, 2004). A valuable problem consists of a forward or backward-looking conjecture about a non-mundane problem-solution pair. There are three aspects required

for the formulation of a valuable problem: a) an actor that discovers, identifies, or defines the problem; b) a perceived possible solution or a viable way of solving it; and c) a perceived beneficiary of a potential solution. From a business model innovation perspective, we posit that the value of a problem relates to conjectures about the value its solution will create for potential customers or users, and the degree to which this value can be captured by the actor providing the solution. A valuable problem-solution pairing becomes an identified opportunity if the actor's aspiration level is sufficiently high to allow the decision to act on the valuable problem-solution pair. The decision to act implies a selection of potential alternatives.

3. Method

Our research design was guided by our concern about how an unfolding process yields a particular outcome (in our case, business model innovation). Therefore, we draw on process research concerned with understanding how and why things evolve (e.g. van de Ven & Huber, 1990), and provide explanations in terms of sequences of events leading to an outcome (Langley, 1999).

Our research design is oriented toward qualitative research to generate theory about the processes leading to the phenomenon of business model innovation (Beverland & Lindgreen, 2010). We draw on studies of these processes in three leading multinational firms (Alfa Laval, Essity, and Titanium¹) with regard to how they innovated their business models. All firm cases investigated business model innovation because their established business models were transformed into a completely different way of doing business over time. They changed from providing products to providing services, the way they segmented and interacted with their customers, how they distributed their offerings, and the revenue model they employed.

3.1. Selection of cases

We used replication logic to understand the events and occurrences leading to a particular outcome (Eisenhardt & Graebner, 2007). We chose firms that shared the same focal phenomenon and seemed to share common processes. The drawback of one firm is its limited generalizability. In contrast, finding firms that showed similar process patterns and outcomes in purposefully different settings would likely improve our theory building (Eisenhardt, 2021). Our choice to go for three firms in different settings (sectors) would help us understand the scope of the likely applicability of the theory and mitigate alternative explanations. More specifically, we not only selected case firms based on outcomes and processes, but also carefully selected firms that had: 1) perceived that over time they had created superior knowledge of some customer needs that they had not exploited, 2) had been world leaders in their markets for several decades based on manufacturing and downstream assets such as sales channels, 3) had patterns of innovation based on improving product performance but experienced unsatisfactory performance, and 4) had innovated the business model of one of their core businesses by moving from product-based business models to service-based business models. These four aspects improve theoretical generalizability across settings.

3.2. Data collection

We drew on multiple sources of data, including interviews, archival data, and participant observations (Table 2).

¹ The name of the corporation has been disguised for reasons of confidentiality.

Table 2
Overview of data sources.

	Primary data	Secondary data
Alfa Laval	<p>Formal retrospective interviews with the CEO, vice president and innovation manager (3 interviews).</p> <p>22 interviews with the line organization around technological and business problems.</p> <p>3 site visits.</p> <p>Internal workshops to find a new business model.</p> <p>Participation during CEO presentation of the new business model.</p>	<p>Articles from trade press.</p> <p>Technical reports.</p> <p>Annual reports.</p> <p>Business plan for the new business</p> <p>Internal documentation on the business model innovation and reports conducted by a management consultant firm analyzing the market opportunity of the business.</p>
Essity	<p>Formal retrospective interviews with managers and staff at different functions (35 interviews).</p> <p>7 site visits for repeated manager conversations with the innovation manager and responsible managers for the business.</p> <p>Workshops to analyze a new business model. These workshops consisted of one 1-day workshop and four 2-day workshops. Four of the workshops were run simultaneously consisting of 3–4 independent workshop groups addressing different markets in Europe. Each workshop consisted of 4–8 participants from the and run by a moderator. The groups were setup to reflect different roles and skills; e.g. consisting of region presidents, marketing directors, salesmen, key account managers, engineers and HR.</p>	<p>Articles from trade press.</p> <p>Annual reports.</p> <p>Internal documentation.</p> <p>Five presentations of the history of the business model innovation by innovation and service managers (2009–2014).</p>
Titanium	<p>Internal workshops to find a new business model.</p> <p>Formal retrospective interviews with the business development managers, directors and sales people (4 interviews).</p> <p>1 site visit.</p>	<p>Articles from trade press</p> <p>Annual reports</p> <p>Business plan</p> <p>Internal documentation</p>

3.2.1. Interviews

We conducted interviews with informants involved in searching for a new business model or implementing it, which could inform us about technological development and events leading to business model innovations. Interviewees were from different hierarchical levels and functional positions, including chief technical officers, chief operating officers, vice presidents, innovation managers, senior engineers, business directors, and sales personnel.

The interviews were semi-structured, and included open-ended questions and an interview protocol. The questions were designed to obtain information on the history of the business model innovation being studied and the interviewees role in the process. If interviewees provided situation-specific details, we asked follow-up questions to achieve a deeper understanding of how the process unfolded. The interviews involved one or two interviewers and one interviewee. They lasted between 45 and 180 min and were recorded and transcribed.

3.2.2. Archival data

We collected secondary data on historical events and actions related to our cases, particularly those related to the process of identifying a new business model. Business plans provided information on intended activities, motives for business model innovation, highlighted challenges, and information on competitors, technical specifications, and future plans. We also gathered internal documentation of the cases, articles from the trade press, and annual reports.

3.2.3. Participant observations

We participated in workshops in all three firms, where we played the role of observers along with our colleagues. In all three cases, these workshops focused on examining business model innovations to overcome challenges related to the existing business model. These workshops were held before the implementation of a new business model in Alfa Laval and Titanium, while in the case of Essity, the workshops were held following early attempts in pilot markets. The firms had made technological product and process breakthroughs to improve customer processes, but their established business models were unable to capture

value from this newly created customer value. The conversations during the workshops provided a large amount of data on the history of the respective business model development.

3.3. Data analysis

The first step in our data analysis was to develop case histories. To create case histories, we compared information from participant observations and interviews with archival data. We compared this with the formal presentations of the cases made by the CEO or senior manager responsible for the business model. This allowed data triangulation (Jick, 1979) to construct reliable historical timelines for events and activities related to finding a viable business model. We constructed an overview of the sequence of significant events (van de Ven & Poole, 2005; Yin, 2003) to discover and identify theoretically important trends, and retained the interview respondents' verbatim formulations (Gioia, Corley, & Hamilton, 2013). We conducted follow-up interviews with the relevant informants in the event of identified gaps. Our informants were given copies of the case descriptions to ensure that we had not missed or misunderstood the events and activities.

In line with the strategy for analyzing process data, we focused on patterns among our cases to determine what was most needed for accomplishing the business model innovation. A pattern refers to an arrangement of non-random describable entities or objects (Bouncken, Qiu, Sinkovics, & Kürsten, 2021; Trochim, 1989). The case histories derived from the data revealed substantial and unexpected ways in which firms searched for new business models during different periods. They highlighted patterns consisting of an extensive representation of business-model-related problem formulation and solving. This led us to review research on problem formulation and problem solving. Therefore, after the case histories were developed, our data analysis entered a second step based on cycles of inductive and deductive reasoning (Hoffman & Ocasio, 2004; Walsh & Bartunek, 2011). We used the procedures recommended by Strauss and Corbin (1998) and Gioia et al. (2013) to create a list of first-order codes from evidence in our case histories (examples are provided under illustrative quotations in

Table 3). We next applied deductive reasoning using researcher-centric concepts and searched the existing literature for frameworks that might help explain what emerged from the initial data coding. We grouped our first-order codes related to specific problems into mechanisms according to the type of problem; whether they were related to problem formulation or problem-solving activities (Hsieh et al., 2007; Nickerson, Silberman, & Zenger, 2007; Nickerson & Zenger, 2004), and whether they triggered changes in current ways of doing business. This resulted in nine second-order categories (mechanisms). We split the mechanisms based on whether they relate to a technological or business problem in the search for a viable business model because two of the cases started with the formulation and solving of a technological problem that later became a business problem for the firm (see Table 3). We organized the theoretical categories into aggregate third-order dimensions related to the search mode for the problem solutions. Here, we drew on the search literature (Augier & March, 2003; Cyert & March, 1963; Simon, 1955), the mode of search (backward-looking or forward-looking), and what triggered shifts in search modes (Gavetti & Levinthal, 2000).

The third step in our analysis was to use the set of mechanisms in the case histories to identify distinct episodes based on the type of search mode used and whether there was a trigger for the shift in search mode (see Table 5). Finally, we mapped the changes in the business model components during each episode (see Table 4). To map the changes in the business models, we used the component value proposition, customer segment, customer relationships, resources used, and the revenue model based on changes we found in our data, in line with the business model components in the frameworks of Björkdahl (2009), Chesbrough and Rosenbloom (2002), Osterwalder and Pigneur (2010), and Teece (2010).

We balanced detachment and involvement (Pettigrew, 1990) by combining multiple interpretations of the data to improve the robustness of our findings. For each case, the analysis was performed by one member of the research team responsible for collecting the data, followed by iterations with all the authors.

4. Findings: Three industrial firms and their processes for a business model innovation

Starting with the research question of how industrial firms search for business model innovation when shifting from product-based to service-based business models, this section narrates the cases of business model innovation in three industrial firms. Table 4 highlights the changes in the three business models over time to provide an overview of the three cases. Thereafter, we delve into each case, portraying the main events prior to and during the business model innovation process. Finally, Table 5 provides the timelines for the business model innovation processes of the three cases.

4.1. Alfa Laval

Alfa Laval implemented a new business model based on optimizing sludge dewatering in wastewater plants. Alfa Laval manufactures decanter centrifuges designed to dewater sludge, which is the costliest wastewater plant process. For several decades, it has been the world leader in sludge-treatment technology. However, each time the firm launched a new decanter, it was imitated by competitors, resulting in low profit margins until a new decanter was released.

Over the years, Alfa Laval has accumulated good knowledge of its customers' processes, but has not exploited this knowledge (see Table 5). Some of this knowledge was considered difficult to imitate if it

was coded into a decanter software. The firm saw an opportunity to capture value by incorporating ICT components and subsystems in its decanters to optimize the sludge dewatering process and provide huge savings for its targeted customer segment. This triggered a change in how to search from backward-looking to forward-looking to formulate and solve technological problems.

After some time spent searching and evaluating new product alternatives sequentially, the firm encountered technological problems because the sensors available in the market failed to continuously measure the sludge. Alfa Laval's in-house resources and capabilities were not sufficient to produce the necessary sensors, resulting in new technology representing an inferior value proposition. After almost ten years, the quality of the sensors available in the market improved, and the product development was restarted, where it could draw on its prior experience using a backward-looking search.

This renewed development required ICT related resources and capabilities that were not available within Alfa Laval. They include software development skills to code their knowledge of customer processes into software algorithms. The firm contracted a partner firm, which after some time encountered difficulties and filed for bankruptcy, bringing development to a halt, thus inducing Alfa Laval to build the required competencies, which was accomplished in part by employing staff made redundant by its former partner. These competencies allowed Alfa Laval to develop a decanter consisting of ICTs.

From a business perspective, Alfa Laval saw an opportunity to profit by lowering customers' operating costs and demonstrating its ability to provide a superior value proposition compared to competitors. The economic value to the customer in the form of annual cost savings was substantially higher than the cost of a decanter during its life cycle, and no competitor could match this potential offer. However, the decanters were sold via public tenders with a one-time upfront payment, and the tender was awarded to the firm offering the lowest price for a decanter that met certain criteria. Alfa Laval's marketing department that was responsible for selling decanters, wanted to continue selling according to the old business model. However, the top management considered it impossible to make a profit based on a one-time upfront payment for its ICT-based decanters. This triggered a change to a forward-looking search and evaluation of solutions to the business problem to realize the potential value of the offering.

Given the resistance in the organization to change the existing business conduct, Alfa Laval's management team created a separate business unit to protect it from the line organization and formed a team around the project with the autonomy to search and develop a business model innovation. To capture value from the value created for customers, Alfa Laval decided to launch its new technology with a new business model by adopting a license fee based on customers' cost savings, despite the dramatic shift compared to existing business conduct. The new business model also involved a change in customer relations and closer interactions related to the distribution and sale of decanters.

After the new business model was implemented and the completion of the evaluation, problems related to the value proposition were encountered. Although the firm had a superior offer, the vast majority of customers were unconvinced that they would save money in the long term. The value proposition needed to be substantiated beyond claims of its superiority. The firm searched for new ways to support claimed customer savings in a backward-looking manner. To solve this problem, Alfa Laval set up test installations and created algorithms to demonstrate the potential savings to customers.

As a result of the technological and business problems encountered, it took several years to search, develop, evaluate, and implement

Table 3

Overview of data structure.

Illustrative quotations	1st order codes (statements related to)	2nd order categories (mechanisms)	Aggregate dimensions
“Our margins looks like a tooth-saw function. Every time we launch a better product, the business margin increases, but then the competitors start to copy it and the margins decline until we launch yet another better product”. “Our target group does not understand the benefits of our service offer.” “Our sales force struggles with sales as they can just negotiate two dimensions: price and quantity”.	Discovering or formulating shortcomings of the business model based upon previous experiences gathered while the business model was in operation.	I) Path dependent technological problem formulation II) Path dependent business problem formulation	Backward-looking
“The quality of the sensors had improved which gave the project a restart”.	Improving business model components based upon previous experiences gathered while the business model was in operation.	III) Path dependent technological problem solving IV) Path dependent business problem solving	
“We really had to work hard to prove to early adopters that our solution worked and that it worked extremely well”.			
“It did not work. We found it impossible to make the solution robust since we had difficulties to measure the characteristics in the sludge”.	Decision to change practice into novel terrains based on evaluation of the experience from current approach, which is expected to fail to satisfy aspiration levels.	Trigger that changes how to search	Shift in the search mode
“The income from the new control system was really disappointing. We create a lot of value to our customers, but we hardly earn any money ourselves”.			
“We had a lot of knowledge about compressors that we could use to optimize the energy use”.	Formulating potential shortcoming of a business model based on new technologies, competition or regulations.	I) Technological problem formulation II) Business problem formulation	Forward-looking
“Every time we raised the issue that we needed to consider other ways to earn money on our decanters, there was a huge			

Table 3 (continued)

Illustrative quotations	1st order codes (statements related to)	2nd order categories (mechanisms)	Aggregate dimensions
resistance among the sales staff. They wanted us to sell decanters in the way we always had done”.			
“We needed to find out if a sensor based product would work. This is a real concern, will it be comfortable for the wearer and is it acceptable ethically to collect so much information?” “People understand the logic of licenses internally and the requirements to introduce that. But it is a change in the way we normally do things. We need to think differently than what we are used to”.	Conceptualizing new business model components never tried before and identifying the required changes.	III) Technological problem solving IV) Business problem solving	

business model innovation from the initial formulation to the first commercial sales. Although the initial idea did not involve the formulation of a new business model, the search mechanisms and problems encountered based on evaluations necessitated business model innovation.

4.2. Essity

Essity (formerly SCA) was a world leader in hygiene products for nursing homes. Despite incremental product innovations from improvements to materials and manufacturing processes and internationalization of sales, their margins were low because of increasingly commoditized products. The firm recognized that its capabilities and resources were underutilized.

A manager supported by top management decided that it was necessary to find alternative ways to do business. Rather than a backward-looking search, a small group was set up that searched in a forward-looking manner using a broad set of alternative actions, including workshops to identify alternative ways of doing business, combined with open-ended interviews and discussions with customers about their day-to-day problems. The team organized a series of workshops that involved mixed teams of managers, nurses, and salesmen to assess how the firm could use its existing customer knowledge to provide education or customized services integrated with existing product offers to enable customer differentiation. The team rejected an educational focus as it would fail to exploit synergies with Essity's current business. However, an evaluation of Essity's business model showed that low staff motivation and high staff turnover among customers were problematic and led to low service quality in nursing homes. Additionally, poor handling of hygiene products resulted in various patient complications, diseases, and hygiene costs per patient, which far exceed the price of the firm's products. This was recognized as an opportunity to transition from selling products to selling services. To solve forward-looking business problems, the internal team organized new internal workshops, customer visits, and pilot studies to understand customer needs and formulate new value propositions. This led to the formulation of

Table 4
Changes in the business models over time.

Business model components	Established business model	Episode	New business model
Alfa Laval			
Value proposition	Dewatering of sludge	3, 5, 11	Optimization of dewatering of sludge and peace of mind
Customer segments	All users having a wastewater plant	8	Installed base of large customers
Customer relationships	Sales through public tenders	5, 8, 11	Direct sales and tighter relationships with customers
Resources	Relied completely on own development and sales.	3, 8, 11	Partnerships with ICT companies and hiring of employees with digital competence
Revenue model	Price per unit	8	License fee
Essity			
Value proposition	Manufacturing and selling hygiene products	3, 7, 12	Selling customized services and hygiene solutions
Customer segments	Nursing homes	6	Nursing homes
Customer relationships	sales based on close customer relationships by individual sellers who interacted with nursing homes	4, 10	Direct customer relationships through professional nurses as new sales staff. New service-oriented sales capabilities.
Resources	Relied completely on own development and sales.	4, 6, 9, 10, 12	New service-supporting resources and tools
Revenue model	Price per unit	12	One-time fee for monitoring activities and suggesting customized solutions + price per unit for products
Titanium			
Value proposition	Compressed air	3, 7, 9	Optimization of compressed air and monitoring of installed compressors. Higher up-time and peace of mind.
Customer segments	Manufacturing companies; New sales	3	Manufacturing companies; Sales to the installed base and through new sales
Customer relationships	Sales through the line organization	9	Through the line organization but with dedicated sellers
Resources	In-house development drawing on own resources	3	Sourcing of ICT components and sub-systems; Hiring of employees with digital competencies
Revenue model	Price per unit	7	License fee

new business problems and changed the value proposition from selling products to selling services in the form of new hygiene routines in nursing homes, and a new service-marketing customer relationship was proposed.

Based on experience, Essity's top managers were afraid to charge for its services because of presumed buyer resistance in a number of markets; therefore, they left the product-based revenue model unchanged. The services offered would provide customer value and are bundled with its products at a premium price. Customers would reap benefits in terms of money saved in the long term from lower total lifetime hygiene costs, and Essity would benefit from closer customer relationships, which would enable them to sell products with higher margins. By means of branding, the plan was to sell bundles of services and products to its existing customer segment (nursing homes) because of the firm's close relations with nursing home customers and its knowledge of the processes in nursing homes.

However, formulating and organizing a service-based value proposition for its customers proved unsuccessful, as neither customers nor the sales force understood the logic of hygiene services despite the efforts of a dedicated service development team. To solve this problem, Essity segmented its market in a new way to differentiate between lead users willing to engage in services and mainstream customers. To do this, Essity had to conduct a forward-looking search to create service-supporting tools such as standard procedures and documents that differed from their product-based offers. The new services were evaluated in selected geographical markets like Italy and Sweden, where the staff were supported with new tools like sales sheets, and protocols, such as an *Assessment Report Generator* that required problematization and

analysis of the customer context. Several efforts failed because most sellers lacked experience in this "consultancy-oriented approach."

Following this, Essity created a new service-oriented business model aimed at nursing homes, but its business model innovation encountered problems shortly after its launch. Many customers were interested in the services offered, especially when explained by nurses, who were better able to understand customer problems than other sales personnel. However, the sales force invested large amounts of time to educate customers without achieving extra sales, and alternative costs and sales force costs were high, resulting in reduced profits and sales force incentives. Essity found it difficult to profit from its new business model since its revenue model was based on product sales with no obligation on the part of the nursing homes to buy Essity's products. The new personnel-intensive business model provided free services, resulting in increased costs, but not increased revenue. This problem was not identified by a forward-looking search, thereby triggering a change in how Essity searched (see Table 5).

To solve this problem, Essity decided to conduct a more focused customer segmentation through the inclusion of a screening phase that would allow the identification and selection of customers interested in a long-term relationship and a willingness to pay a product price premium. However, most potential customers did not understand or believe in the new service-based value proposition for decreased hygiene costs. The problem was that most of the sales personnel engaged in customer interactions lacked expert knowledge in nursing home management and were unable or unwilling to convince customers. A backward-looking search was not feasible because institutions, revenue streams, and business models varied greatly across different markets. For example, service

Table 5

Timelines.

Alfa Laval		Essity		Titanium	
Episode 1–Pre-1990: Backward-looking search based on <i>technological</i> and <i>business</i> problem formulation and solving.	“Our margins looks like a tooth-saw function. Every time we launch a better product, the business margin increases, but then the competitors start to copy it and the margins decline until we launch yet another better product”.	Episode 1–Pre-2004: Backward-looking search. <i>Technological</i> problem formulation and solving related to improvements of materials and processes. <i>Business</i> problem formulation and solving related to cutting the costs of operation, focusing on internationalization of sales and manufacturing.	“We continue to improve the material, to keep fluids away from the skin without leaking, and improving our production machines”. “Our sales force struggles with sales as they can just negotiate two dimensions: price and quantity”.	Episode 1–Pre 1997: Backward-looking search based on <i>technological</i> problem formulation. The firm’s product innovations did not increase revenue substantially	“We had a solid business, but our product innovations did not render new income streams or new businesses”.
Episode 2–1991: Trigger that changed how to search. Opportunity to optimize the dewatering process in wastewater plants.	“We had a lot of knowledge about our customers processes that we did not use”.	Episode 2–2004: Trigger that changed how to search. Decision to find alternative ways of doing business. Threat of losing competitiveness if focusing only on product features.	“We didn’t think we could differentiate our products to low cost competitors”	Episode 2–1997: Trigger that changed how to search. Opportunity to lower customers’ energy cost.	“If we could solve the customer problem on wasted energy we could find a way to earn money on that”.
Episode 3–1991: Forward-looking search. <i>Technological</i> problem formulation and solving by integrating ICT into decanters to optimize the dewatering process.	“We had to try new things we had not done before. We had no idea if it would work”.	Episode 3–2004: Forward-looking search. <i>Business</i> problem formulation and solving through a number of workshop, customer visits and pilot studies. The value proposition changed from selling products to selling services in the form of new hygiene routines in nursing homes, and a new service marketing customer relationship was proposed. No changes were applied to the revenue model.	“Tender criteria do not reflect the need for our services” “It is hard for the purchaser to capitalize on our total offer”. “We need to find out what customers really need and want in terms of services”.	Episode 3–1999: Forward-looking search. <i>Technological</i> problem formulation and solving by making products intelligent through the incorporation of a centralized control system which allowed monitoring of the compressors.	“We had a lot of knowledge about compressors that we could use to optimize the energy use”. “We did not give any thoughts what so ever about new ways of doing business... It was obvious that we should use our old way of doing business”.
Episode 4–1992: Validation of the forward-looking <i>business</i> solution. Failure to deliver on the expected value proposition due to lack of proper technologies on the market.	“It did not work. We found it impossible to make the solution robust since we had difficulties to measure the characteristics in the sludge”.	Episode 4–2004-2005: Creation of a service approach. Backward-looking search to improve customer relationships through adjustments of sales technique focusing on branding.	“We created one tool that were to help the sales force interact on the strategic level. But our sales force is not used to work on that level”. “Monitoring of performance and behavior was lacking”.	Episode 4–2002: Validation of the <i>technological</i> solution. Launch of a centralized control system using the established business model.	“It worked in terms of the technology... The problem was that many competitors claimed to do the same thing, but this was not true”.
Episode 5–1999: Restart. Backward-looking search. <i>Technological</i> problem solving by developing a system that could optimize customer’s dewatering processes.	“The quality of the sensors had improved which gave the project a restart”.	Episode 5–2005: Validation of the new service-oriented business model. The effort to improve branding and the service-focus increased costs, slowed business, and did not result in additional income. Failure to capture value from the service-focus triggered a change in how to search.	“If we don’t charge for the services, it is just an extra cost.” “We had a consultant working with us. There was a lot of focus on branding and product positioning that went on for a couple of years.” “We have thick carpets in our organization where we put the dust from our failed ideas. We never speak of them again.”	Episode 5–2003: Failure to capture value from the new <i>technological</i> solution. The business model did not work to appropriate value. Trigger that changed how to search.	“The income from the new control system was really disappointing. We create a lot of value to our customers, but we hardly earn any money ourselves”.
Episode 6–2002: Validation of the solution. Failure to capture value based on the established business model. Misfit between the established value capture logic and the new value proposition. Trigger that changed how to search.	“Since we sold decanters through public tenders we initially could not see how we could earn money on this”.	Episode 6–2005-2006: Forward-looking search based on <i>business</i> problem formulation by identifying buyer resistance. <i>Business</i> problem solving via customer segmentation supported by new resources (service-supporting tools such as sales sheets, and protocols such as an assessment report generator.)	“Bomb carpet of half-baked solutions for service support. But some of them are actually really good and popular with the sales teams”. “Most purchasers operate in a political organization and often look for short term cost savings rather than long term operational efficiency improvements”.	Episode 6–2003: Forward-looking search. <i>Business</i> problem formulation to identify a new way to do business and appropriate value.	“I think now it is all about life cycle cost on new purchases on a compressor room... so if you offer the best life cycle cost through reduced energy consumption you have a competitive advantage”.

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Table 5 (continued)

Alfa Laval		Essity		Titanium	
Episode 7–2002: Forward-looking search based on <i>business</i> problem formulation.	“Every time we raised the issue that we needed to consider other ways to earn money on our decanters, there was a huge resistance among the sales staff. They wanted us to sell decanters in the way we always had done”.	Episode 7–2005–2006: Backward-looking search and validations of new services in a few markets including Denmark, Italy, and Sweden. The bundling of services with products improved the value proposition but most customers were not interested in paying for services. Failure to implement services in specific markets (e.g. Germany) because sales force consisting of nurses were substituted by sales personnel with limited professional hygiene training.	“Management and staff pay lip service to the services” “We don’t know how to raise prices, haven’t done that in a long time. But we know how to lower product prices; that’s the business we’re in”.	Episode 7–2003: Relaunch. Forward-looking search. <i>Business</i> problem solving by introducing a license based on payment of a fee depending on how much the customer saved, in order to appropriate more value.	“If the customer can be convinced that this is fantastic, the solution will give them a big benefit”. “We did this because we wanted more revenue streams... licenses are more profitable, so it makes sense to have that”. “People understand the logic of licenses internally and the requirements to introduce that. But it is a change in the way we normally do things. We need to think differently than what we are used to”.
Episode 8–2002: Forward-looking search based on <i>business</i> problem solving by formation of a corporate venture and search for a new business model.	“We had to create a separate organization for this business... It would be impossible to have a license fee in the line organization... they wanted to give the solution away”. “We cannot sell licenses with the decanters because we do not sell directly to the end user... First we wanted to sell the licenses with the new decanters, but it was impossible because the contract is based on public tenders... We had to change focus to our installed base”.	Episode 8–2006: Trigger that changed how to search. The slow uptake and poor performance perceived as caused by lack of staff and managerial interest in most markets led to a decision to change how the services were implemented.	“Our sales force believes we will lose customers in the short term by implementing the proposed [service] solution.” “We don’t know why it [the service bases approach] does not work”. “The service thinking was just based on Michael Porter’s work”.	Episode 8–2004: Validation of the new business model. Only a few customers were interested in the license fee model because the firm had not demonstrated how much money or energy could be saved.	“Customers do not understand the value because they have very hard times to visualize it”.
Episode 9–2003: Implementation and validation of the new business model.	“Let me tell you, the uncertainty was in the commercial side... how to sell this and if the customers would accept the license concept”. “It seems that it is more difficult for competitors to copy us now when we have licenses... We thought we had three years, but still it has not happened”.	Episode 9–2007–2009: Forward-looking search based on <i>business</i> problem formulation and solving. Market managers and the service development team decided to advance the development of service-oriented business model by professionalizing service support. In a series of workshops held across Europe, problems and weaknesses in key activities and resources were identified. New context (market)-specific ways of solving them were discussed.	“Need to teach our staff about services. Why not bring in [Christian] Grönroos?” “[We need to know] what our biggest problem is when implementing our new service-based business model”. “For our two or three most important and solvable problems, we must formulate how we are to solve them”. “We are going to create an action agenda directly, and put in responsible people directly”	Episode 9–2005: Backward-looking search based on further <i>technological</i> and <i>business</i> problem formulation and solving. The search resulted in new technologies to demonstrate customer savings using simulators. The firm changed its relations with customers in order to better demonstrate value which required dedicated sales personnel.	“We need to prove where the savings are”. “We needed a simulation tool in order to convince the customer about the savings”.
Episode 10–2004: Backward-looking search based on <i>business</i> problem formulation. Misfit between the new value proposition and revenue model.	“Few customers believed in what we achieved”.	Episode 10–2009–2011: Backward-looking search. Continued <i>business</i> problem formulation and solving by improving resources through staff training, creation of sales tools and KPIs, and involving nurses to improve customer relationships.	“Our target group does not understand the benefits of our service offer” “The vast majority of customers do not know the cost of incontinence... that is, how big a chunk of the elderly care budget goes to providing incontinence care”	Episode 10–2006: Validation and implementation of the new changes to the business model.	“We have finally found a business that both create and appropriate value”.

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Table 5 (continued)

Alfa Laval		Essity		Titanium	
<p>Episode 11–2004: Backward-looking search based on <i>business</i> problem solving by adapting the new business model. The promised savings which were part of the value proposition, were backed by algorithms that showed customer savings and involved lengthy demonstrations. A different type of customer relationships were required.</p>	<p>“We really had to work hard to prove to early adopters that our solution worked and that it worked extremely well”. “It is necessary to quantify the value of the offering by testing the system at the customer... It takes between 3 and 6 months”. “Many customers do not still believe in the sensors... the sensors are something we have to convince each customers about”.</p>	<p>Episode 11–2012: Validation of the new business model. Many customers did not believe in or understand the suggested product or service offerings. Trigger that changed how to search.</p>	<p>“Our customers do not understand our new services because we communicate poorly to our customers what the value is” “In six weeks we show the customers how much they can save from improving their operations, with the consequence we sell fewer products than before. Our self-evaluation that the customer uses approach is too good.”</p>		
<p>Episode 12–2007: Validation and incorporation of the business model into the business unit selling decanters.</p>	<p>“It has been a real shock to me how long it has taken to sell the solution.... I have never had any doubts that it was a matter of ‘when’ rather than ‘if’ the customers buy it... but ‘when’ has turned out to be a lot further down the road than I thought”.</p>	<p>Episode 12–2012: Forward-looking search based on <i>technological</i> problem solving led to sensor-based hygiene products that allowed monitoring.</p>	<p>“We needed to find out if a sensor based product would work. This is a real concern, will it be comfortable for the wearer and is it acceptable ethically to collect so much information?” “Now we dare to charge for services and not just give it away. I mean we should have done that a long time ago”</p>		
<p>The business proved to work, activities involved in running the business model became routinized, and the search became path dependent.</p>		<p>Forward-looking search based on <i>business</i> problem solving. Changes were made to product portfolio and the revenue model since sales were license-based. The new value proposition supported by IT-based monitoring system justified the change to the revenue model and charging for services.</p>			
		<p>Episode 13–2012: Validation and implementation of the service-based business model. The new business model proved to work and incremental changes based on technology and business problem solving have followed.</p>	<p>“With the new sensors, we can charge for both the product and services. But I don’t think we have found use for its full potential”.</p>		

orientation did not work in some markets like Germany, as a new lower-cost sales force was employed instead of retaining nurses. Additionally, the services were launched before vital resources like testing tools were secured to guide the sales force’s activities and convince customers of the financial viability of the new hygiene-oriented processes. This constituted a new problem not considered when the new business model was launched. Top managers realized that a more systematic approach to orchestrating business model transformation was required, which triggered a change in the search for means to implement services.

Essity held a series of workshops across Europe aimed at improving the utilization and diffusion of the new business model to formulate and manage the combined problems of poor capabilities, lack of resources, and lack of incentives for local managers and staff. During these forward-looking workshops, it became clear that understanding the new

service logic compared to the dominant product logic was a problem for both the sales force and managers because the firm’s dominant logic was product- but not service-oriented. Essity also suffered from organizational inertia; the sales force wanted short-term targets and rewards for sales and was not interested in setting up costly and time-consuming service projects.

Following the workshops, several initiatives were implemented to solve these problems using a backward-looking search. These included specific training for staff, creation of a set of resources to support staff interactions with nursing homes, and involvement of nurses in the project teams to facilitate communication between the firm and nursing homes. Although Essity changed its business model to try to overcome the problems related to business model innovation, it was difficult for it to make its services attractive. According to Essity managers, this was

because top management was unwilling to change the revenue model. However, parallel to the work on service development, a new product development team was experimenting to make their products more “intelligent.” This necessitated the inclusion of new skills and resources, as key aspects included low-cost sensor technologies and software. After some time, Essity introduced sensors that could be connected to high-end diapers. Staff could use the new sensor-based product to analyze the behavior and needs of the wearer. For Essity, embedding data into its products allowed sellers to sell services in addition to product sales. Once the new technologies were implemented, the new business model could be fully implemented.

4.3. Titanium

Titanium introduced a business model innovation based on a centralized control system for compressed air installations. Compressed air is used in many industries as a power source in a wide range of applications. A large part of the industrial energy consumption comes from compressors; energy is often wasted because the need for compressed air often cannot be known prior to operation.

This triggered a forward-looking search process to formulate and solve problems related to its technologies to optimize the use of compressed air. The firm realized that it could lower its customers' energy costs by integrating ICT hardware and software into its existing products. Titanium identified an opportunity to generate more revenue based on the value proposition to optimize customers' energy costs for compressor installations and began to develop technologies based on new and unique algorithms (see Table 5).

The technologies were commercialized through its established business model at the time of launch. For customers, the value created in terms of lower energy bills during the product lifecycle was higher than the price of the equipment. However, because the firm had decided to sell at a per-unit price, it captured a low value compared to the savings made by customers. Soon after launching its new technologies, Titanium realized the need to search for a completely new business model to profit from the new technologies.

It conducted a forward-looking search to formulate and solve business-related problems. It changed the revenue model from selling a product to selling a service contract based on what customers would save. Unfortunately, when the change was evaluated on the market, few customers were interested because the value proposition did not show how much they would save, and there were competing systems on the market; they were not convinced that Titanium's system was better. Hence, based on market evaluation, Titanium formulated new technological and business-related problems that needed to be solved. Top management established a dedicated team to search for a business model that would create value for customers and allow the firm to achieve an appropriate value. To design the business model, the team primarily drew on experience from market evaluations using a backward-looking search. The search resulted in new technologies to demonstrate customer savings by using simulators. The firm also changed its relationship with customers to better demonstrate the value that required dedicated sales personnel. Titanium believed that it had found a viable business model that created value for customers and allowed the firm to profit from the technologies.

5. Explaining business model innovation processes from a problem perspective

How can we explain how a search leads to business model innovation? The findings show that business-to-business industrial firms search for new business models by addressing *sequences of problems*. The sequence of the problem is not given; rather, problems are subjective mental models based on actors' perceived historical and contextual realities. In other words, a problem sequence is a mechanism that determines whether a search should be backward-looking or forward-looking, and explains why there is a shift in how firms search. In this section, we explain business model innovation processes based on our cases and formulate propositions regarding how business model innovation depends on problems and shifts between forward-looking and backward-looking searches.

5.1. Problems as mechanisms of search

Problems are critical for search because the creation of useful knowledge is a source of profit for the firm; however, the search for new knowledge is inherently uncertain. Problems can be understood as deviations from a set of desired conditions (Newell & Simon, 1972), or artifacts that produce unwanted symptoms or webs of undesirable symptoms (Hsieh et al., 2007; Newell & Simon, 1972; Pounds, 1969; Watson, 1976).

The findings show that problems guide search because over time, one or several explicitly formulated problems, or ones that are taken for granted warrant a solution, which in turn could lead to a new problem (see Table 5). Consequently, problems can occur in linear, parallel, or iterative sequences of problem formulation and solving (see also Ganco, Kapoor, & Lee, 2020). Humans are not automata, and therefore, problems are not specified or predetermined. Instead, they need to be identified, framed, formulated, or constructed. Thus, the process of business model innovation involves problem formulation and not just problem-solving and evaluation of perceived or created solutions (Hsieh et al., 2007; Nickerson & Zenger, 2004). Problem solving and problem formulation are interdependent in the sense that solving a problem can cause the emergence of a new perceived problem, while formulating a problem calls for decisions and problem-solving activities. Combinations of problem formulation and problem solving can occur in parallel and/or consecutively. Problems may be formulated independently from problem solving, but they can be better understood or reformulated based on the relative success in finding solutions to the problems. This is in line with the view that problem formulation and problem solving are the most important managerial activities because they largely determine a firm's course of action (Hsieh et al., 2007; Nickerson & Argyres, 2018; Rumelt, 2011). Therefore,

P1. *Problems, understood as (sequences of) problem formulation and problem solving activities, guide the business model innovation process.*

5.2. Shifts between backward-looking and forward-looking searches

The findings show that search in the case of business model innovation consists of four main aspects: backward-looking search, forward-looking search, shifts from backward- to forward-looking search, and shifts from forward- to backward-looking search, all of which are determined by the identified and formulated problems. Our explanation of business model innovation processes is based on these four main

aspects, where a backward-looking search solves routine-based problems, while combinations of forward-looking and backward-looking searches lead to more radical business model innovations (in our case, the shift from product-based business models to service-based business models). Only when the firms completed all four steps in the entire “loop” did it result in a business model innovation.

Backward-looking search for novelty was the dominant type of search in terms of time spent. A backward-looking search is rooted in a firm's routines and organizational capabilities. Search is backward-looking if experiential problem solving is perceived as solving formulated problems. During such a search, several mundane problems are discovered, formulated, and evaluated, which triggers new problem-solving activities. It could be said that problem solving dominates problem formulation in that problem formulation is a routine activity that receives relatively limited amounts of cognitive attention (c.f. Von Hippel & Von Krogh, 2016).

The shift to a forward-looking search occurs when managers perceive or hypothesize that a formulated problem cannot be solved using existing problem-solving approaches and there is a need to find a new approach. Table 4 illustrates this in episodes 2 and 6 for Alfa Laval; episodes 2, 5, and 8 for Essity; and episodes 2 and 5 for Titanium. All firms identified that backward-looking search would be insufficient because of their (expected) failure to reap satisfying profits from their established business models and because further incremental adjustments to their technological or business problems were not sufficient to solve the situation. More precisely, firms formulated *introspective* future-oriented problems as a *hypothesized cause* of failure to profit.

While this explains the limitations of backward-looking search, introspective problem formulation does not in the general case suffice to explain why firms decided to shift how they searched. Each firm framed a problem around the idea that services would be the solution to capture value from technological innovations. The problem-framing concerning the advantages of shifting to forward-looking search consisted more of presumed correlations than explicit hypotheses.

Theoretically, identifying the potential advantages to be gained from shifting to forward-looking search is triggered by the formulation of a new valuable problem that Nickerson and Zenger (2004) characterize as a problem that, once solved, will create (substantial) value. Here, a valuable problem consists of a forward conjecture about a non-mundane problem-solution pair. The value of a formulated problem depends on the range of possible solutions and the costs involved in identifying a particularly valuable solution (Hsieh et al., 2007; Nickerson & Zenger, 2004). According to Nickerson and Zenger (2004), the formulation of a problem requires the problem to be formulated by someone, managers who are motivated and willing to solve the problem, and involves the expectation that the problem can be solved or that there is at least a willingness to experiment with new alternative approaches. We posit,

P2. *Firms' decision to shift to forward-looking search are based on the formulation of a new valuable problem which they expect to be unsolvable if continued with normal procedures.*

Thus, we argue that from a business model innovation perspective, the value of a problem relates to conjectures about the value its solution will create for potential customers or users and the degree to which this value can be captured by the actor providing the solution. In our cases, the firms' decisions to shift to a forward-looking search were based on experience, as they hypothesize about the shortcomings of continuing with the normal procedure and the formulation of a new valuable problem. These shortcomings were related to the disadvantages of continuing along the existing path, regardless of the existence of a crisis. The firm formulates a causal explanation for why the alternative of a

backward-looking search to improve the solution would fail to achieve a satisfying outcome. Valuable problems consisted of a perceived valuable problem-solution pair related to creating an innovation, where a change to the search mode might identify a solution. Sometimes, one of these reasons is sufficient to trigger the shift to a forward-looking search, but as the findings show, both reasons are needed for it to occur.

The formulation of a valuable problem leading to a forward-looking search for a new business model consists of the formulation of a *business* problem, not a technological or other type of problem. However, in two of the cases (Alfa Laval and Titanium), the formulation of a valuable problem was initiated by evaluating the potential of a new technology to produce a profit using the firms' existing business models. In the third case (Essity), the formulation of a forward-looking technological problem followed the formulation of a business problem and creation of a new business model.

Once the shift from backward-looking to forward-looking search has been made, the search consists of attempts to solve the formulated problem and other emerging problems. The search is based on the cognitive perception of the linkage between the actions chosen and their impact, which results in several alternative possible solutions (Gavetti & Levinthal, 2000). However, forward-looking search differs from backward-looking search not only in terms of the cognitive sources of the search but also in terms of how to organize for search. A forward-looking search is likely to be performed outside normal operating procedures. All firms created dedicated task forces to organize for search because their experience indicated that their standard operating procedures would fail to lead to new solutions despite the intention to innovate. The organization was based on framing a problem, suggesting that a dedicated team would be likely to come up with a design or logic for a working business model. However, while the search for new solutions is forward-looking, not all search activities are forward-looking (Lopez-Vega, Tell, & Vanhaverbeke, 2016). Typically, the creation of new content is forward-looking, while many of the means of content creation, such as bringing in consultants and external experts and running workshops to create and test ideas, are standard practices.

After a period of time, firms abandon forward-looking searches. One reason for shifting to a backward-looking search is the perception that forward-looking activities are deemed to have been successful so that the firm's experience will succeed in launching and implementing a new business model. In other words, a continued forward-looking search comes with a high alternative cost compared to implementing the new business model. This shift is intentionally triggered because a backward-looking search is deemed preferable. Another reason is that continued forward-looking search is viewed as too costly to continue, as it fails to formulate viable solutions or that the project is running out of funding. A backward-looking search can also be triggered by the identification of a successful solution that routinizes the activities involved in a forward-looking search. Thus, we propose:

P3. *The shift to backward-looking search is based on the firm's expectation that continued search comes with disproportionately high alternative costs.*

The explanation of how firms search for a viable business by formulating and solving problems is shown in a process model (see Fig. 1). Our cases showed that formulating a problem that triggered a change in the search was only part of the process. That is, our explanation of the business model innovation process includes several shifts between backward-looking and forward-looking searches caused by newly formulated problems. More precisely, firms formulate and solve different problems during distinct episodes (see Table 4). Some problems emerged only as firms dealt with their earlier problems and led to new changes in business model components. Formulating and solving

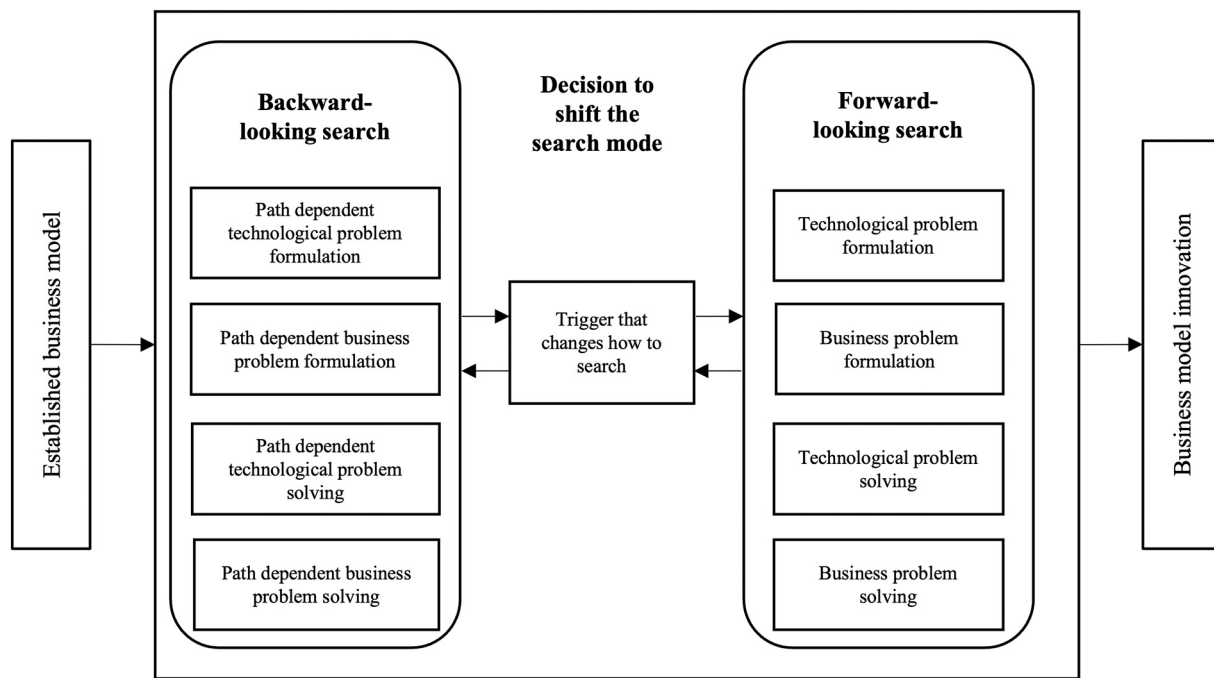


Fig. 1. A process model of business model innovation.

other problems requires simultaneous changes to several business model components because of the interdependencies among them. That is, one “round” of changes in search may not suffice because any decision to shift from a backward-looking to a forward-looking search is characterized by uncertainty, implying that erroneous decisions are common. Therefore we propose,

P4. *Business model innovation processes are characterized by shifts between forward-looking and backward-looking searches.*

6. Conclusion

This article begins from the premise that the extant literature provides a weak theoretical rationale for the business model innovation process (see e.g., Baines et al., 2020; Berends et al., 2016; Demil, Lecocq, Ricart, & Zott, 2015; Massa & Tucci, 2014; Sjödin et al., 2020; Sosna et al., 2010). Our aim is to explain the process by which industrial firms search to innovate a business model. The questions of how firms search and why a particular way of searching is triggered are explained in terms of a backward-looking search, a shift to forward-looking searches, followed by a forward-looking search, and a shift to backward-looking searches. Each of these four is explained by the processes of problem formulation and problem solving. Hence, we explain the business model innovation process from a search and problem solving perspective (Cyert & March, 1963; Gavetti & Levinthal, 2000; Hsieh et al., 2007; Nickerson & Zenger, 2004; Simon, 1962). Below, we present the contributions, implications, and limitations of this study.

6.1. Theoretical contribution

This study adds to our understanding of the business model innovation process in the following ways: First, we contribute to the literature on business model innovation and servitization by showing that

firms use both forward-looking and backward-looking searches. We show that the theoretical concept *problem* is useful for determining the search mode, and can explain the business model innovation process in industrial firms when moving from products to services. Our explanation based on problem formulation and problem solving is supported by the literature on search (Augier & March, 2003; Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Cyert & March, 1963; Gavetti & Levinthal, 2000; Nickerson & Zenger, 2004; Simon, 1955, 1991) because the search corresponds to managerial (the firm’s) representation of the problem space (Simon, 1991). Therefore, it seems surprising that previous literature on how business model innovation unfolds does not consider the role of problem formulation and problem solving in business model innovation. Our explanation contrasts with prior accounts based on first- and second-order learning (Sosna et al., 2010), or learning modes to explain the process (Berends et al., 2016). Specifically, prior explanations of backward-looking and forward-looking searches suggest predefined mechanisms for why changes in search modes occur. Instead, we propose that shifts between modes of search are based on managerial (firm) hypotheses around the inadequacy of continuation of backward-looking or forward-looking search, respectively. Our explanation stresses that managers select the problems they want to solve by identifying and prioritizing them in their business model innovation process (c.f. Loasby, 2007; Baer, Dirks, & Nickerson, 2013). This explanation is in line with the knowledge-based theory of the firm, which argues that a manager’s knowledge-based objective should be to create valuable new knowledge (Teece, Pisano, & Shuen, 1997; Wernerfelt, 1984).

Second, we show that search processes based on formulating and solving problems are characterized by several shifts between forward-looking and backward-looking searches, involving both business and technology-related problems. Many problems cannot be predicted, but are formulated as a result of finding a solution to another problem. For example, business-related problems can be formulated as a consequence

of solving technology-related problems. Moreover, solving problems related to one component of the business model may lead to problem formulation and problem solving related to other business model components. Thus, we demonstrate the interdependencies among the changes in business model components. Furthermore, formulating and solving business-related problems may result in new technology-related problems.

Third, our explanation contributes to the behavioral theory of the firm and the literature on search for innovation, as we show that the problem is a mechanism for changing search modes (Knight, 1967; Levinthal & March, 1981; Lopez-Vega et al., 2016). From a behavioral perspective, the search for an innovation depends on an actual or expected failure to achieve current business goals. Our propositions, which emphasized changes in search, were framed around searching for a solution to a problem and, in turn, to behavioral change to achieve the required performance (Augier & March, 2003; Cyert & March, 1963; Simon, 1955). Central to this argument is the idea of a problem, or more generally, a sequence of problems, as the search mechanism. The inclusion of backward-looking and forward-looking shifts based on problem formulation and problem solving explicitly introduces the idea of cognition and how problems are perceived in terms of gaps, correlations, or hypothesized causes. More specifically, our explanation can be viewed as a general explanation of the search for innovation. The findings show that our explanation of how firms search for business model innovation is also applicable to the search for technological innovation, suggesting that the same explanation may be transferable to other types of search for innovation. Our explanation sheds light on the interdependence of technological and business-related problems and shows how these problems together guide the search process for innovation. However, the literature on search for innovation does not consider the problem as a mechanism for explaining how and where to search, and has therefore reduced the explanatory power for why firms change their search mode. Therefore, our explanation contributes to the literature on the search for innovation by showing how problem formulation and problem solving both characterize how firms search, and why they change how they search.

6.2. Managerial implications

Several managerial lessons have been learned from this study. Firms need to be prepared to challenge the organization by searching in both a forward-looking and backward-looking manner if they want to escape path-dependent routines and develop new business models. Backward-looking search is likely to result only in incremental improvements and not in more radical innovation, such as substitute products with services. Prior research tends to rush into prescriptive writing to address how the shift from product-based business models to service-based business models can take the shape of different phases that need to be tackled. In reality, because business model innovation is a highly iterative process, it is difficult to plan for business model innovation because firms must search in unknown territories and knowledge to be integrated and tested. Moreover, the search and development of business innovation seem to be difficult, if not impossible, without a breakout structure. Hence, business model innovation may require firms to organize differently compared to what they are used to.

6.3. Limitations and direction for future research

Our study has some limitations. We analyzed cases of business model innovation processes that persisted over several years, which allowed us to analyze how problems determine the process. The three business-to-

business firms analyzed were world leaders in their market segment, made reasonable but unsatisfactory profits, and were not in crisis when shifting to service-based business models. As our explanation is characterized by a sequence of problems, it may be inadequate for other contexts, such as for firms in fast-moving industries, entrepreneurially oriented firms, firms dominated by visionary and charismatic leaders, and those pressured by owners. We would expect power, authority, and political maneuvering on the one hand, and competition and imitation on the other hand, to be important complementary perspectives. The purpose of this study was to develop a theory and not test it. Thus, our theoretical sampling and number of cases are in line with this purpose (Eisenhardt & Graebner, 2007). Although we have tried to increase generalizability by choosing cases that are not dependent on a specific industry or technology, we do not know if and to what extent our findings are applicable to other contexts. Further research is needed to determine whether and how our explanation is applicable to other contexts.

Additionally, our cases show that firms started to organize differently during a forward-looking search compared to a backward-looking search (e.g., dedicated teams with responsibility for formulating and solving business problems and creating a new organization to protect the business). More research is needed to understand the conditions under which firms choose to change search modes and how they organize forward-looking searches.

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