Strategic value at the front end of a radical innovation program

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Abstract

Firms implement radical innovation programs to create strategic value, and ensuring their success may require involving the business network. This paper pursues increased knowledge on strategic value in a radical innovation program and the means to promote readiness for value creation in the business network. A case study was implemented at the front end of a radical innovation program introducing intelligent technologies. The multi-level nature of strategic value is revealed, thereby offering a novel perspective on value-related research. Business, technical, solution, customer, and change readiness are introduced as requirements for implementing strategic value in the business network.

Keywords: program management, radical innovation, strategic value, open innovation, front end

Introduction

Companies engage in radical innovations to achieve growth and a competitive advantage in their dynamic environments. Radical innovations mean novel solutions and technologies for novel or changed markets (McDermott & O'Connor, 2001), and while promising attractive business opportunities, they are typically very risky (Leifer et al., 2000). Some of the radical innovations require more than simply a new product or technology concept — they may involve process innovations (Reichstein and Salter, 2006), value innovations (Kim & Mauborgne, 1997) and business model innovations (e.g. Chesbrough, 2010), implying renewal in many aspects concerning processes, markets, earning logics, social systems, and supply chains. The nature of the innovation problem is a central issue in defining how the innovation should be managed (Gemünden, Salomo, & Hölzle, 2007). Radical innovations can be complex and may need to be carried out as a multi-project program, for instance. Companies pursue strategic value from such programs (Martinsuo & Hoverfält, 2018) covering various aspects of financial, social, ecological, and learning effects (Martinsuo & Killen, 2014), but the pursuit may be highly uncertain and risky. This paper concerns radical innovation programs and the expectations of their strategic value.

Value deals with the ratio of benefits and costs (Laursen & Svejvig, 2016), and it can be considered at any level of the project-based business (projects, programs, portfolios, firm, or business network). Strategic value draws attention to the parent organization's and stakeholders' strategic interests, particularly to such aspects of value that cannot necessarily be measured in financial terms but represent other relevant and beneficial outcomes (Martinsuo

& Killen, 2014). Project value is a multi-dimensional concept and extends far beyond "reaching project goals" (Ahola, Laitinen, Kujala, & Wikström, 2008; Laursen & Svejvig, 2016). The strategic dimensions of value are attracting particular interest (Martinsuo & Killen, 2014), possibly because their creation is not limited to project execution but spans the project lifecycle (Eskerod & Ang, 2017). Martinsuo and Hoverfält (2018) point out that previous program management research has overlooked the pursuit of program value, either as a result of cross-sectional research designs or because of the uncertainties pertaining to value in the fuzzily defined organization change programs without a tangible "product." They call for further research on value creation and delivery in different programs.

For a firm to succeed in its radical innovations, it needs supportive capabilities that do not always reside within the firm itself but can be found within its broader business network. The firm needs to involve its network partners in value creation and take changes in the organizations and networks thoroughly into account (Gemünden et al., 2007). Various linkage roles, such as relationship promotors, may be needed for the innovation program to succeed (Walter & Gemünden, 2000). Different stakeholders may make sense of the expected program value (or impacts) in different ways, causing uncertainty in how the innovation program is defined (Laine, Korhonen, & Martinsuo, 2016). The contextual connections of programs (Pellegrinelli, 2002; Pellegrinelli, Partington, Hemingway, Mohdzain, & Shah, 2007) and the multi-stakeholder view to project value generally and strategic value specifically are already well acknowledged (Eskerod & Ang, 2017; Laursen & Svejvig, 2016), but a network view to defining strategic value at the front end of a radical innovation program has thus far been insufficiently covered.

This paper is motivated by the need to understand the emergence and anticipation of strategic value in radical innovation programs. It explores stakeholders' expectations of strategic value at the front end of radical innovation programs that potentially influence the business network and thereby require external stakeholders' involvement. The goal is to increase knowledge of the nature of strategic value in the radical innovation program and of the means to promote readiness for such value creation in the business network. The study seeks answers to two research questions:

1. How do stakeholders in the business network perceive strategic value at the front end of the radical innovation program?

2. What kinds of requirements does the business network have toward the implementation of strategic value in the program?

This study focuses on the front end of programs, which has been identified as a key opportunity to influence strategic value (Thiry, 2002, 2004). The scope is delimited to radical innovation programs in terms of those innovations that may drastically change the business logic of the firm, besides generating new offerings, and other types of programs are purposely excluded. However, as a lot of program management research has taken place in organization change programs and strategic value is covered in major projects, such previous literature is utilized as the basis for this research. Furthermore, the study concerns the involvement of business networks more broadly than just the focal firm and extant customers. It is evident that at the front end of the program it is not yet known whether and how the actors in the business network will commit to the program.

The study responds to the call for further research on project-type-specific understanding of high-risk strategic value (Martinsuo et al., 2019). The study contributes through offering empirical evidence about the dimensions of strategic value in a specific type of project –

namely radical innovation program. This will supplement the previous value studies concerning delivery projects (Eskerod & Ang, 2017; Ahola et al., 2008; Kivilä et al., 2017), and provide a nuanced picture of the network-related requirements at the front end of such innovations and, thereby, illustrate the possibilities with external integration that is not covered in intra-organizational programs (Lehtonen & Martinsuo 2009). Furthermore, the study takes a multi-stakeholder view to the radical innovation program and reveals how value and readiness for its delivery appear on multiple layers of the business network. The findings of the inductive analysis yield analytical frameworks which could be useful in structuring and guiding forthcoming research and practice on developing readiness for strategic value.

The paper continues by introducing the previous research that builds a foundation for understanding strategic value, the front end of radical innovation programs, and the involvement of business networks in specifying strategic value. Then, the case study approach and its methods of data collection and analysis are introduced, and background information is offered on the front end of a radical innovation program focusing on intelligent materials in construction and engineering industries, possibly enabling radically new business models for the focal firm and its business networks. The results reveal expectations of strategic value not only at the firm level, but at the relationship and business network levels as well. Five dimensions of readiness are ultimately revealed as requirements for implementing strategic value in the radical innovation program. Finally, the findings are discussed in light of previous research, the contributions are highlighted, and further research avenues are proposed.

Literature review

Radical innovations deal with the development or application of novel technologies or ideas and entry to new markets or significantly changed existing markets, and they are often differentiated from incremental innovations that are used to modify existing technologies, products and markets through small steps (McDermott & O'Connor, 2002). In radical innovations, the possibilities with the business opportunity are considered as significant, but also the risks and uncertainties are high (Leifer et al., 2000). Although radical innovations frequently concern technologies, products and services only, they may also concern processes and logics of doing business (Reichstein and Salter, 2006). Current understanding is that the definition of radicalness depends on the perspective taken: it may imply novelty to a certain firm, a certain market, a certain industry, or the entire world (Reichstein and Salter, 2006). In any of these cases, established firms need to adapt and reconfigure their routines, in light of the radical innovations they engage in (Bessant et al., 2014).

Radical innovations do not need to concern products, processes, services or technologies only, but they may tackle renewal of business performance more broadly. Previous research has discussed, for example, business model innovations (Chesbrough, 2010), value innovations (Berghman et al., 2012; Kim & Mauborgne, 1997; Matthyssens et al., 2006), strategic innovations (Markides, 1998), disruptive innovations (Abernathy and Clark, 1985; Christensen, 1997; Danneels, 2004; Markides 2006), and breakthrough innovations (O'Connor & Rice, 2013), each with their particular perspective toward innovations. These additional perspectives emphasize the necessity for market creation, successful commercialization and customer acceptance for the radical innovations, as well as the prospects of novel performance logics from the innovations.

This study is concerned with radical innovations that in the empirical study involve innovation in products, services, processes of value creation and business models. They may also become strategic or disruptive, when implemented. As the performance implications of an

ongoing innovation are not, yet, known, the general, overarching concept of radical innovation is purposely used in this paper.

Strategic value of programs and innovations

Projects and programs are no longer seen only as mechanisms for reaching goals or producing tangible deliverables, they are seen as processes for value creation (Winter & Szczepanek, 2008). Programs, in particular, can be considered value-oriented, integrated, multi-project endeavors that create change in their context (Martinsuo & Hoverfält, 2018). In multi-project programs, various strategic, environmental, knowledge-centric, and stakeholder-oriented values are clearly beginning to complement the financial and customer values typically used in project evaluations (Martinsuo & Killen, 2014). Organizations are increasingly interested in the long-term benefits and impacts that they can achieve through their programs (Laine et al., 2016), but it is possible that the created value might not be observed until long after the project or program has been completed (Eskerod & Ang, 2017). Moreover, value creation may be hampered by various uncertainties and tensions (Laine et al., 2016; Rijke et al., 2014).

Organizations invest in radical innovation programs to extract benefits and value that they would not otherwise achieve through incremental innovations and their day-to-day operations. Innovation success is often measured in terms of meeting objectives, the success of the new product in the industry, or market/financial success (Griffin, 1997; Shenhar, Dvir, Levy, & Maltz, 2001). To complement this view, studies of project value (or strategic value) have advocated taking a multi-dimensional view of value (Ahola et al., 2008; Eskerod & Ang, 2017; Martinsuo & Killen, 2014; Shenhar et al., 2001) that accounts for not only the short-term costs and benefits but for the renewal and business achieved over time, once the project deliverables are in use (Ahola et al., 2008; Shenhar et al., 2001). Various frameworks have been presented to include environmental, economic, social, technical, aesthetic, and symbolic dimensions in the strategic value of projects and programs (Eskerod & Ang, 2017; Flyvbjerg, 2017; Kivilä, Martinsuo, & Vuorinen, 2017; Martinsuo & Killen, 2014). However, in the context of radical innovation programs, strategic value has not been clearly specified.

In this study, the term ‘strategic value’ is used, to draw attention to such costs and benefits that accrue to the program owner (often the parent organization) and potentially also to other stakeholders (for example customers, supply partners) through implementing the program and using its deliverables over its lifecycle. It, thereby, complements the efficiency-centric measures of meeting scope, cost and schedule objectives, and connects the program with the parent organization’s and stakeholders’ strategies. Strategic value, i.e., *any relevant and beneficial outcome achieved over the program lifecycle*, is certainly of interest in radical innovation programs. Such outcomes have exceptional features that may even challenge the organization’s current strategy and business (Artto, Martinsuo, Dietrich, & Kujala, 2008). Where ordinary product innovations tend to offer new functionalities and pursue new market and business value, radical innovations can be used to change the technology and knowledge base of the firm and, thereby, build capabilities for novel strategies and forthcoming product and service generations (McDermott & O’Connor, 2002; O’Connor & DeMartino, 2006), i.e., longer term value. Some of the radical innovations may transform the business logic or “industry recipe” by offering an entirely new way to create value (Berghman, Matthyssens, & Vandenbempt, 2012; Matthyssens, Vandenbempt, & Berghman, 2006) and by potentially renewing the business model of the firm (Chesbrough, 2010).

Due to the intent for strategic renewal, radical innovation programs are susceptible to all kinds of uncertainties, both from the business environment and from within the program and

parent organization. Radical innovation programs may actually face business model dilemmas, tensions, and barriers when the novel technologies force the reconsideration of the firm's business logic (Chesbrough, 2010), as was shown in a radical innovation program in the automotive industry (Tongur & Engwall, 2014). In order to overcome such barriers, there is a need to understand the expectations and requirements of strategic value and value-related innovations already at the front end of the program.

Expectations of strategic value at the front end of radical innovation programs

Significant decisions regarding the program scope are made at the program's front end (Edkins, Geraldi, Morris, & Smith, 2013; Thiry, 2002, 2004), that is, before the program officially starts. The idea for the program's scope is determined and the expected strategic value are defined early in the program in order to commit resources and guide planning. Thiry (2002) emphasized the strategic nature of the program's front end and suggested that value management can solve some of the insufficiencies in traditional project management and assist in bringing program management to a more strategic level. In his view, the front end of the program deals with sensemaking, ideation, and evaluation in a learning loop that characterizes the iterative and cyclical character of strategic programs. This nature of the program front end has been witnessed in some empirical studies concerning both successful and failed change programs (Lehtonen & Martinsuo, 2008, 2009; Martinsuo & Lehtonen, 2007) and more generally in project management (Samset & Volden, 2016), with indications of the systemic nature of the front end (Williams & Samset, 2010).

The front end of innovation, specifically, very often focuses on identifying the right product idea, assessing it, and defining its concept to guide actual product development work before the decision is made to develop the product (Eling, Griffin, & Langerak, 2014; Van Oorschot, Eling, & Langerak, 2017). It has been the focus of intense research over the past three decades but remains partly "fuzzy" (Eling & Herstatt, 2017). Opportunity identification and vision creation can be considered related to the expectation of strategic value, and according to Eling and Herstatt's (2017) overview, they are among the eight core domains of front end-related research. The vision creation often focuses on finding the market and matching market and technology opportunities (e.g., O'Connor & Veryzer, 2001; Reid & De Brentani, 2010; Reid, Roberts, & Moore, 2015), instead of considering strategic value more broadly. The front end of radical innovations has also been studied in terms of the prerequisites (Herrmann, Gassmann, & Eisert, 2007), innovator and broker roles (Gemünden et al., 2007; Reid & De Brentani, 2004), and formality vs. intuitiveness of decision making (Eling et al., 2014; Eling, Griffin, & Langerak, 2016), but not specifically from the perspective of the strategic value pursued through the innovation program.

Previous research concerning the front end of organization change programs emphasizes the connectedness of the change program with the parent organization in specifying the program content and scope (Lehtonen & Martinsuo, 2008, 2009; Martinsuo & Lehtonen, 2007), and this connectedness has also been found as central in implementing radical innovation programs (Kelley, 2009). In particular, Vuorinen and Martinsuo (2018) point out that the autonomy achieved during the program front end will guide how the program's later internal and external integration should take place. Although Lehtonen and Martinsuo (2009) explicate the possibility for a program's external integration (i.e., connections to external stakeholders), the focus of previous research has been on intra-organizational programs. As innovation programs are oriented toward offerings and solutions that are intended for external stakeholders, i.e., the market, they may therefore require external involvement from as early as at the point of scoping out the pursuit of strategic value.

The business network's view of strategic value in radical innovation programs

Programs are not merely connected to their host — the parent organization — but also to any external stakeholders that may impact or be impacted by them (Martinsuo & Hoverfält, 2018). Major projects and programs often involve multiple stakeholders, each of which may have their own idea of what is of strategic value and what impacts are desired (Eskerod & Ang, 2017; Laine et al., 2016). Consequently, there is a need to involve stakeholders in various activities that promote value creation in project-based business (Edkins et al., 2013; Kolltveit & Grønhaug, 2004; Matinheikki, Artto, Peltokorpi, & Rajala, 2016).

In radical innovation programs where the business model is completely new or potentially even cannibalizes existing business, companies can very well utilize inputs from external stakeholders from the earliest stages of the innovation (Chesbrough, 2003), and their tentative business network could participate in defining, creating, delivering, and using the innovation. This business network may include a focal firm's prospective customers, distributors, various actors offering complementary innovations (hardware, software, services), materials and components suppliers, research institutes, designers, consultants, and so on. Previous research has touched on the idea of open innovation, where a variety of partners could be involved in various phases of the innovation process, including the front end (Chesbrough, 2003; Huizingh, 2011; West & Bogers, 2013). The idea of open innovation ecosystems in particular has been promoted, characterized by the voluntary involvement and dynamic nature of stakeholders' capabilities and interests in value creation (Rohrbeck, Hölzle, & Gemünden, 2009).

Often, openness — particularly at the front end of innovation — is treated in terms of a focal firm's view to source, search externally, filter, and acquire innovations from external sources (West & Bogers, 2013) instead of the business network's equal and proactive engagement in defining what is of strategic value. Many authors express the need for certain capabilities specific to radical innovations, such as networking capability (Eggers et al., 2014; Reid et al., 2015), access to information from supply chain partners (Berghman et al., 2012), and inter-organizational collaboration (Gemünden et al., 2007), predominantly from a focal firm's perspective. When new territories are explored and conquered, firms need the ability to go beyond their established assumptions and knowledge, think in a divergent manner (Reid et al., 2015), transform their competences and "orientation" (Herrmann et al., 2007; also Talke, 2007), and perceive their environment and frame their market and technology search in new ways (Bessant, Öberg, & Trifilova, 2014). Various enablers and constraints have been identified in a focal firm's personnel attitudes and behaviors, affecting whether and how breakthrough innovations can be achieved (O'Connor & Rice, 2013).

This summary reveals that radical innovations are portrayed as open, networked endeavors requiring stakeholder involvement and inputs, but thus far they are primarily analyzed and discussed from the perspective of a focal firm. However, radical innovations that transform the business logic may require and imply that new business networks and supply chains are created, or the logics of existing networks and supply chains are transformed (Tongur & Engwall, 2014). Some previous research has indeed suggested that how the firm interprets its environment already affects whom it involves in the innovation and how it carries it out (Bessant et al., 2014). In this paper, an underlying assumption is that the business network should be considered and possibly also engaged in defining strategic value from the front end of radical innovation programs.

Method

Research design and case selection

Taking an exploratory research approach and asking "how" and "what kind"-type questions, this study adopted a qualitative single case design (Yin, 2003). The case study was conducted with a materials and systems manufacturer pursuing the radical innovation of increased intelligence in its offerings. The case can be considered as extreme and exemplary (Yin, 2003): the innovation would represent a radical shift in the logic of doing business in the industry, the focal firm is among the first to consider such a groundbreaking innovation, and even its proactiveness in engaging the network very early in the innovation process is exceptional. The focal firm (here called MaterialCo) is a company in the metals industry that delivers raw materials, components, systems, and solutions to various customers, particularly in the construction and engineering industries. The firm's business networks dealt with two separate business areas and markets (engineering and construction) that could potentially use the solutions commercially. The case was chosen due to the researchers' unique access to the front end of the radical innovation program, based on the company's own interest in studying the emergence of the innovation. Due to the similar stage of the radical innovation in the two business areas, the case is treated holistically. Table 1 summarizes some background information on the case firm and the two studied business areas.

Table 1. Background information on the case company and the two business areas included in the study.

Case details	MaterialCo	Business area 1	Business area 2
Industry	Metals, components, and related solutions	Engineering	Construction
Intelligent technology embedded in:	Raw materials	Components and products created from the raw materials, used in assembled systems (equipment, processes) with different degrees of complexity	Components, structures, and entire constructions created from the raw materials with different degrees of complexity
Focal firm sales (MEUR)	> 10 000		
Focal firm employees	> 15 000		

The focal radical innovation deals with the creation of an intelligent material that would carry material, product, and process knowledge over the solution lifecycle. From the very beginning, it was clear that a multi-project program was needed since the early phase development and experimentation was set up as multiple separate projects and the complexity was expected to increase over time. The front-end phase of the program resembles a vanguard project (Brady & Davies, 2004; Frederiksen & Davies, 2008; Midler & Beaume, 2010) and an exploratory project (Lenfle, 2008), and it already included multiple separate and partly interlinked projects, dealing with market development, customer search, technology research and development and also customer-specific pilot projects. Figure 1 illustrates the anticipated lifecycle of the program, where this study focuses on the front end only. At the time of the data

collection, the company was developing the technical solutions for the intelligent materials and exploring the business networks needed to make the business viable. It has consequently proceeded with the program implementation in various arenas and through multiple projects, but this study merely focuses on the front end of the program. The program is ongoing, it is expected to feature multiple sub-portfolios of projects over the decade(s) long lifecycle, and the innovation is now being designed and tested, but its market success is not yet known.

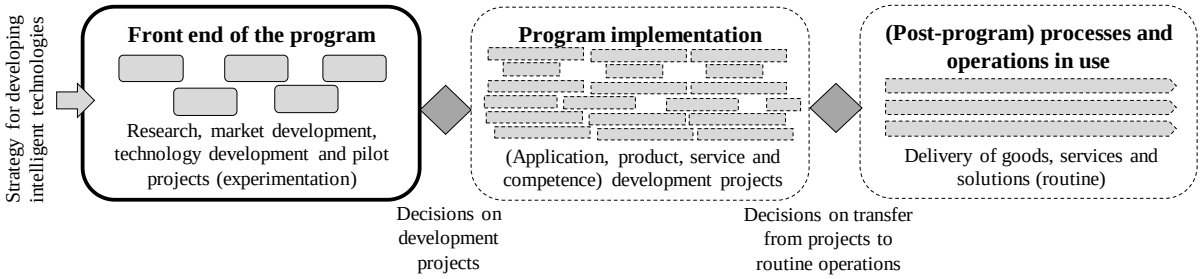

Figure 1. Overview to the intended lifecycle of the radical innovation program. This study focuses on the front end.

Material-related information has previously been delivered either through documentation or through electronic means (information systems) in the focal firm's business network, separately from the material and with little business potential as such. The radical innovation implies that the material itself would include intelligence, it could communicate with other systems and materials, the same information would be available for all firms throughout the supply network, and the information would enable creation of new business and service solutions. Intelligence could be added to MaterialCo's component material by either RFID (radio frequency identification), sensors, or other kinds of tags and consequently used for products, systems, and solutions in various products, equipment, and processes (engineering sector) and in structural components and buildings (construction sector). It would also require modern, advanced information systems to read, store, and utilize this information. Consequently, the product or solution would include all material-feature, functionality, and handling data that can be read, replicated, used, updated, and followed by customers and other partners in the business network. Implementing the intelligence into commercial solutions would, thereby, require intensive inter-organizational collaboration to become useful solutions for the customer industries. The delivery of customer and end-user value would also require the involvement of various external stakeholders. This intelligence would consequently enable a variety of novel solutions and services, based on the possibility to follow in real time and even anticipate the use, consumption, location and state of any products using the materials. Such solutions could range from condition-based maintenance, real-time tracking and warehouse management, to the optimization of temperature, energy consumption and other facility parameters, and they could also enable using value-based pricing in the business logics, instead of material and consumption-based.

Data collection

The focal firm was investigating whether and how it could use intelligent technology to improve the traceability of its materials and components in the delivery chain and became curious about customers' interests and needs, and therefore its commercialization potential. Data were collected at the front end of the radical innovation internally in the focal firm as well

as externally in two business areas through interviews and workshops before the official program launch.

To collect data, 21 interviews were held involving a total of 27 persons in the focal firm, its selected current customers in both the construction and engineering industries, some prospective partners and customers for novel intelligent solutions, and an external research partner supporting the research and development (R&D) of the technological solutions. Four of the interviews were held in pairs, one was a group interview with three participants, and the other interviews were held individually. Table 2 summarizes the collected interview data. Additionally, field notes were taken in several meetings with the focal firm's contact person and in four workshops (two with research partners and two with prospective customers, communicating the interview results and discussing them further), and these additional data are used as secondary data and for triangulation purposes.

Table 2. Data collection episodes and information on interviewees.

Interview episode	**Companies**	**Nr of interviewees (exceptions)**	**Interviewees' job positions**	**Average duration (min)**
1. Focal firm	Metal industry firm interested in smart materials	4 (1 pair interview)	Development manager, specialist, technology manager, expert (in a certain area of the process)	72
2. Customers and development partners in engineering	One research institute and two engineering firms involved in the development and use of intelligent materials	4	Customer director, research team leader, vice president of R&D, system manager	60
3. Customers and potential supply partners in construction	Ten different firms (systems, solutions, and service providers and contractors in construction), interested in the development and use of intelligent materials	11 (1 pair interview)	CEO, sales manager, production manager, service manager, regional director, business area manager	37
4. Customers in engineering	Three engineering industry firms using or intending to use intelligent materials in their production	8 (1 individual, 2 pair, 1 group interview with 3 persons)	Sourcing manager, innovation manager, R&D expert, product manager, materials manager, materials engineer, system expert	43

Slightly different interview outlines were developed for the different target groups, but they included similar thematic domains. The common themes included: current level of knowledge and use of intelligence in the business; experienced and expected benefits from intelligence; experienced and expected challenges; requirements and possibilities concerning business models and the business network; and requirements and possibilities concerning end-users. Some additional and more detailed questions were also covered that were not central to this paper. An open-ended approach was used in the interviewing, starting with asking very broad questions to enable the respondents to tell their stories from their own perspectives. More detailed questions were only asked if the responses did not offer useful information. Because

the interviewees' firms were in very different stages of understanding and adopting intelligence into their businesses, the question list was adjusted as needed in order to gain an in-depth picture of the current state and future orientation of each firm.

Additionally, four different workshops were held with the intent to verify the key findings, thereby developing the radical innovation idea further and identifying actions for the next phases of the process. They involved 5–12 participants each and lasted 2–4 hours. One workshop included the customers and partners in the engineering industry, another included the customers and potential partners in the construction industry, and two included research and development partners. The workshops always began with a short introductory presentation of some of the key results obtained from the interviews, led to a discussion of the findings to confirm, complement, or debate them in the form of small group work, and finished with drawing conclusions on developing the radical innovation idea further. The workshop results were documented in handwritten notes, and in the industry workshops, minutes were also taken and distributed to participants for confirmation. The workshop experiences are used as secondary data for triangulation and validation purposes.

Data analysis

The analysis of the interview data proceeded in four main phases. The first phase included reading and assessing the usefulness of the different sections of the interview data for the purposes of this study. At this point, it became apparent that while some interviews were rich and broad in the information they provided, a few short interviews contained less relevant information for this study. Tentative ideas for potential codes were identified and consequently used in the second phase, where a full coding structure was developed for the two primary themes included in this paper: 1) strategic benefits and value of the radical innovation (17 codes); and 2) requirements from the business network for implementing strategic value (24 codes). Additional themes were coded to understand the overall situation at the program front end, to map the barriers to achieving strategic value, and to characterize the radical innovation.

In the third phase, the coded data was inspected to identify recurring patterns and broader categories that could be used to interpret the data. Due to the nature of the radical innovation, it became evident that strategic value varied depending on the level at which it was expected in the industry system, i.e., whether the value dealt with a single company (usually that of the interviewee), a certain dyadic relationship (the interviewee's firm and customer, or MaterialCo and customer), or the business network (delivery chain broadly and the intelligent system throughout its lifecycle). While these levels were identified inductively by exploring the data, this categorization brings together learnings from separate previous studies on strategic value, covering firm-specific (Laine et al., 2016), dyadic (Ahola et al., 2008) and multi-stakeholder views (Eskerod & Ang, 2017). As a result, a decision was made to categorize the data according to the level at which the value appeared (a single firm, relationship, or business network), four dimensions of strategic value (economic, technical, product, and service value), and five dimensions of requirements for implementing value (business readiness, technology readiness, customer readiness, solution readiness, readiness for change). These dimensions are explained in the findings section. Minor adjustments to the coding took place at this point to ensure consistency in the analysis. In the fourth phase, the results of the analysis were cross-tabulated and illustrative quotes were selected from the data, resulting in the writing of the findings.

The validity of the results was mainly ensured in the following ways. The key findings of the interviews were presented to the respective target groups in their specific workshops and elaborated on through the workshop discussions. These discussions were used for triangulation

purposes to verify certain findings. During the actual analysis, the initial coding framework was iterated with a fellow researcher and viewed in light of previous research findings to improve the content validity of the analysis.

Results

Overview of the front end of the radical innovation program

The front end of the case program can be considered quite fuzzy. The early phase of the program at MaterialCo included stating and explicating a rough vision and intent and making some investments into technology development and experimentation. The front end of the program did not have an official structure or process, but it included some development projects and roughly planned business development activities and proceeded in an evolutionary manner. MaterialCo involved selected network partners in various development and experimentation activities, depending on the partner's interest in developing and piloting partial solutions within the scope of'intelligent materials.

It became very evident in the interviews that all stakeholders had their own opinions of and expectations for the use of intelligent materials, and they had a range of previous experience with intelligent technologies. Even if the program remained unstructured during the interviews, the overall hope concerning intelligent materials was commonly agreed upon. The interviewees described wanting the "paper trail" of the materials to be replaced with RFID tags, sensors, and other information sources embedded into the materials or components, complemented by either manually operated or automated reader devices and links to information systems and the cloud, with complete information concerning the material/components provided over the different phases of its lifecycle. These opportunities could enable developing an open platform upon which the network of actors could build modern, advanced information-based solutions to promote new business opportunities and efficiency throughout the business network in completely novel ways.

While the interviewees perceived that, in its more advanced form, intelligent materials would manifest in automated "self-awareness", self-corrected faults, dynamic functionalities, and various other advanced options, they were quite aware that even the commercialization of information-rich applications from the materials were still in their infancy and would take a long time to implement. Although the technical requirements and properties of the applications for the engineering and construction sectors are quite different, all of them would transform the role, network position, value chains, and earning logics of MaterialCo as well as many of its partners. This would imply a quite novel proposition of value, both for MaterialCo and its customers and partners.

Perceptions of strategic value at the program front end

The interviews revealed various perceptions of the radical innovation's strategic value at the program's front end. The networked nature of the radical innovation was very apparent in the interviews. Typically, value is only considered for a particular firm, but in this study, we mapped the perceptions of strategic value for the firm, for the dyadic relationship, and for the business network separately. A summary of the value perceptions on different levels is reported in Table 3.

Table 3. Summary of perceived strategic value at the front end of the radical innovation program.

Strategic value	Firm level	Relationship level	Business network level
Business value	**Economic performance** • Shorter than expected payback time for the investment in intelligence • Lifecycle cost savings • Saving resources in information search and offer targeting	**Payback and foresight** • Mutual investment – mutual payback • Forecasting needs and demand	**Optimization of resource use in the supply chain** • Long-term cost savings from energy/resource awareness throughout the network • Optimized resource usage across the supply network
Technical value	**Improved process performance** • Improved process efficiency, e.g., through automatized process and information flows • Right solutions for the right purpose • Risk reduction (both economic and personnel safety)	**Continuous monitoring and access to information** • Up-to-date status information for supplier and customer • Quality through managing actual deviations compared to performance targets (not averages) • Customers' ability to respond to deviations • Alarm systems and anticipation of failures	**Improved visibility in the supply chain** • Improved system understanding • Improved traceability (or responsibility allocation) • Improved information flow and access
Product value	**Improved usefulness of products and services for a firm** • Increased access to information • Ease of use (e.g. due to electronic guidelines linked with the material or product) • Increased safety through automated processes	**Improved usefulness of solutions benefiting both actors** • Automating formerly manual tasks • Performance levels according to demand (e.g., temperature) • Convenience in use and maintenance operations	**Improved system-level performance** • Increased maintenance efficiency • Improved system efficiency and service availability
Service value	**Improved service availability** • Proactive maintenance and improved availability • Ability to offer additional services	**Response speed** • Solving problems such as machine failures fast, so that they do not cause interruptions in customers' operations • Responding to customer requests and fault signals quickly or even anticipating them • Avoiding the cascading of problems through the anticipation and quick responses	**Improved system-level adaptability** • Improved adaptability – adapting the system and environment for the special needs/events • Proactiveness and speed in problem-solving

At the level of **the single firm**, interviewees characterized ordinary issues concerning economic performance, process performance, product and service usefulness, and service availability as dimensions of value. According to the interviewees, the intelligence developed in the radical innovation program is useful for their firm, and some interviewees introduced practical examples of how the value appears in their specific solutions. For example, the

economic value was discussed in terms of cost savings, resource efficiency, and shorter than expected investment payback time, with the latter exemplified in this quote concerning a firm supplying intelligent systems and services for constructions: "*We have calculated that it is about two to four years in principle that this system pays itself [the investment] back through the [end users'] reduced consumption of energy and water*" (P9 Construction). Process performance as a technical value dealt with the value achieved through efficiency, doing the right things, and avoiding or reducing risks through the built-in intelligence of the system. Product usefulness was experienced in terms of increased access to information through intelligence, throughout the supply chain: "*It can be extremely valuable for our production to know if the products coming into our site… are they still on the way or are they lost*" (P18 Engineering). This access to information was also reflected in the idea of service availability. With information, services can be offered more proactively and new kinds of services (such as condition-based maintenance, wear parts optimization, on-line tracking of material flow) can be developed.

Strategic value was also perceived in the **dyadic relationship** between the interviewee's firm and its customers (sometimes alternatively suppliers) in various ways. The interviews revealed that experiences of strategic value were not merely the interviewee's own firm's concern, but that it has a relational character in the dyadic setting. Economic value was not discussed directly in terms of money, but in terms of foresight and mutual payback from the investment — both for the firm and its customers. Concerning technical value, continuous monitoring and information flow was seen as a means for both partners in the dyad to stay up to date, respond quickly, anticipate problems, and manage deviations. One interviewee contrasted intelligence with the old way of working: "*Traditionally, if there are bigger problems [in the delivered material], we need to dig up the material data document from somewhere and compare whether it is the kind of stuff we requested*" (P13 Engineering). The usability of solutions through automation, standard performance levels, and convenience characterized product value. One interviewee shared an example of the convenience in dealing with a pilot solution including intelligence:

> *We did this system [for a customer] with these RFID tags in the equipment. We can use this handheld device to monitor from several meters' distance where this piece of equipment is, what is its maintenance history, what are the tolerances and so on, and when it next needs maintenance.* (P8 Construction)

A key issue in the dyadic setting was service value in terms of the response speed, anticipation and prevention of problems such as machine failures or wrong use of materials, and capacity to avoid the path-dependency and cascading of problems.

For the interviewees, the **business network** level implies both the engagement of multiple partners in the network and a lifecycle view of the solution. In the interviews, the system-level view to value was emphasized — interviewees saw that the intelligent material required the involvement of supply chain partners broadly and an awareness of the long lifecycle of the material (could be decades). Many of the value dimensions dealt with optimization over the broader system: resource optimization, cost savings, and energy consumption across the value chain were characterized as aspects of economic value, and supply chain visibility dealt with information transparency and access for all network partners as a technical issue. As one interviewee explained, achieving system-level value also meant considering investments:

> *Of course, there needs to be some benefit for the end user. If the material costs more, someone in the supply chain must pay for it. It could be the manufacturer, or it could be the customer. It could be the nuclear power station or something. If they need to*

monitor the material properties or something over the lifecycle of [the product], they need benefits over this product's lifecycle. (P17 Engineering)

Furthermore, the adaptability of the system was discussed: when changes occur in some part of the supply chain, the system may need to be adjusted throughout the chain. The rapid evolution of information technology caused particular concern because of its different pace of change when compared to the long lifecycles of construction and engineering materials. With intelligent materials, the radical innovation program needs to take into account these different rhythms of evolution.

Requirements for implementing strategic value in business networks

The interviews covered the requirements for implementing the strategic value in various ways. Because of the complexity of intelligent technology and its pervasiveness throughout the business network, the requirements were not limited to a certain firm only, but spanned across the firms and also looked to the future when the materials are expected to be used in various systems and constructions. Again, such requirements were mapped onto the three different levels (single firm, dyadic relationship, and business network). The inductive coding of the data revealed that the organizations involved and the broader adoption of the intelligent technologies in a business network will require readiness to convert the program into strategic value. This readiness is required in terms of business, technology, customers, solutions, and change in order for the firms to implement the strategic value of the intelligent materials successfully. A description of these readiness dimensions at the different levels is summarized in Table 4.

Table 4. Summary of requirements for implementing strategic value in the radical innovation program.

Requirement	Firm level	Relationship level	Business network level
Business readiness	**Defining the winning business model** • Discovering the domain of specialization and strategy of differentiation from competitors • Unique offerings • Superior knowledge of customer needs • Sustainable earning logic for the solution • Access to development funding	**Marketing, selling and delivering solutions in cooperation** • Lead users; customer interest; negotiations • Promoting awareness • Investments, customers' explicit expressions of need, purchases • Consultation and marketing to activate new business	**Network core firm leadership** • Core firm communicating the vision • Finding the right partners and involving them, sharing information • Establishing common goals • Coordinating the network • Understanding the complete value chain • Offering the interface for smaller firms to join
Technology readiness	**Reaching/fulfilling certain technical requirements** • Equipment: their environment and settings • Sensors • Technical routines • Interfaces • Guidelines	**Aligning systems to specific needs** • Level of complexity according to customer need • Right kinds of guidelines for certain customers/user groups	**Complying with legal requirements and norms** • Includes international norms • Standards for components and technologies • Interface standards for systems • Auditing for compliance

Requirement	Firm level	Relationship level	Business network level
Customer readiness	**Helping customers become interested** • Pilot projects to show benefits • Agreeing on data ownership and openness • Activeness in information updates	**Involving and cooperating with customers** • Customers educating personnel to use systems • Customers taking action to modify the system, solve problems, active cooperation • Consultation and "sparring" to promote customer readiness for new solutions	**Contractual arrangements in the network** • Defining and agreeing on key issues in contracts • Handling data-related issues in contracts • Specific contracts for products and services • Inclusion of joint development in contracts
Solution readiness	**Fit-for-purpose solutions** • System simplicity, usability • Suitability for different conditions • Capabilities for sales, operations, services • Supervision and follow up	**Fit-for-use solutions** • Customers' circumstances taken into account in solutions • Information security issues solved • Demos and proofs of concept to show functionality and benefits • Education and training	**Solution integration at the network level** • Managing the interfaces • Network coordination • Agreeing on roles, tasks, duties, deliverables at the network level • Joint practices and ways of working
Readiness for changes	**Flexibility** • Startup spirit, experimentation, prototyping • Learning through trials • Readiness to respond to needs throughout the system lifecycle	**System adaptability** • Two-way communication with customers • Optimizing the system use in cooperation; adaptability • Anticipation of usage patterns • Mutual readiness for change in thinking and habits	**Network-level risk management** • Using remote monitoring as part of risk management • Mapping and anticipation of risks • Specific risks from information security and cloud computing • Risk management procedures within the network

The dimensions of readiness concerning **a single firm** appeared in the interviews as very ordinary requirements that firms face at the front end of any innovation project. The respondents explicated the interest in finding a concept that differentiates the firms, attracts sufficient funding, has a feasible technology concept and related processes, sufficient support, and agreement from at least some customers, has a sufficiently well-developed solution that can be piloted quickly with customers, and flexibility and a startup spirit in the innovation team to be ready to learn and adapt operations based on change needs. According to one interviewee:

> *Even if we do not have a winning idea, we should immediately have some way of differentiating. If you start and challenge those bigger firms, you really need to have some niche specialty where you are really strong and see, over the course of time, if you could challenge the competitors. The bigger ones [manufacturers] tend to have quite an advantage from [the perspective of] cost efficiency*. (P17 Engineering)

Various examples were given of firm-specific ways to achieve a winning concept, such as the following:

> *Ease of use is really important. All competitors will eventually do the same thing and almost in the same way, but ease of use can make you different. This is probably the most important thing, speaking the language of the users and making things easier [for them]*. (P7 Construction)

The nature of the radical innovation as a networked endeavor was reflected in the variety of interview responses concerning the **relational aspects** including either MaterialCo and its business customers or the business customers and end-users (or intermediary firms in the downstream supply chain). Some interviewees made it clear that marketing and vision promotion was immediately needed at the front end — there was a need to attract potential customers to the idea early on because many intelligent applications required customers' investments. According to one interviewee,

> *Maybe it is about marketing to the customer some system... that this system is better than some other part of their process and this adds more value or does something better [than the old system]. If the customer understands the benefits and allows for including the system in the plans and contracts, then it has a chance of becoming part of the deal, maybe*. (P3 Construction)

Technology-, customer-, and solution-readiness dimensions considered the simplicity of design, customers' cooperation to learn the system in advance, and such solutions that really match with customers' needs and capabilities. One interviewee's example illustrates technical and customer readiness as follows:

> *If you go to [a customer site in a remote location], look around you and notice that, damn it, you are in the middle of nowhere. There is no infrastructure [e.g., telecommunications networks, IT systems], everything has to be built from scratch and these [customers] want a system that functions like a train toilet [faultlessly]. They have this attitude that it [the system] should not be too fine or fancy because they are afraid that it would not work in this environment, with this minimal infrastructure. And if there is a minor problem, no-one can do anything about it. This brings you back to the ground level — customers really do not want anything too fancy*. (P16 Construction)

Readiness for change was discussed predominantly in terms of the system's adaptability and optimization to various needs and mutual anticipation of changes and consequent changes in thinking and habits.

At the level of the **business network**, its network, and lifecycle, various requirements were expressed, linking the network actors together and to the industrial environment. For many interviewees, it was clear that succeeding in the business would require one (or some) of the network actors to adopt a leadership role, coordinating and engaging the broader network toward the new business. "*There needs to be this kind of firm that wants to, or a partial chain [of firms] that wants to achieve a competitive edge compared to others, they should just take the lead and drive these things forward from a new perspective*" (P8 Construction). While interviewees saw that technologies can be created and integrated by certain firms and partners and that this solution integration implies integration between organizations as well, they emphasized that the network's technology readiness depends strongly on the norms and laws binding all network actors in the industry. Certain norms and standards are needed to drive — or at least would help in driving — the intelligent technologies forward. Some interviewees stated that current norms need to be taken into account when developing the intelligent solutions, too:

> *In welding, of course, there are these international norms that specify how welding*

must be done and what values must be reached and what procedures must be followed. We need to use the remote-monitored data and compare it to norms and report the deviations [also in the new systems]. (P11 Engineering)

Here, customer readiness concerned contractual arrangements: what new types of contracts were needed, potentially also linking third party actors to the contracts? Readiness for change was discussed in terms of risks and risk management, particularly regarding how the network would face and solve information security issues and risks stemming from the development stage of information technologies.

Discussion

Strategic value in radical innovation programs

This study began with the premise that programs are means for creating strategic value and that expectations for such value are already specified at the front end of the program. Radical innovation programs were chosen as the focus to complement the delivery-project centric previous research on strategic value (Eskerod & Ang, 2017; Kivilä et al., 2017), and as some of them are purposely intended for value or business model innovations (Berghman et al., 2012; Chesbrough, 2010; Matthyssens et al., 2006) that may transform a firm's business logics and market presence. The first research question asked: How do stakeholders in the business network perceive strategic value at the front end of the radical innovation program? The results offer three main possibilities for consideration, dealing with the dimensions of strategic value, levels of strategic value, and the nature of the program front end in defining strategic value.

The identified dimensions of strategic value offer information about how strategic value may be specified, particularly in radical innovation programs (compared to other types of programs and projects). Strategic value was considered in the interviewees' experiences in terms of business value, technical value, product value, and service value, which likely reflects solution innovation as the content of the program, and thereby it offers a clear contrast to other types of projects and programs. It also complements the previous interpretations about success criteria in terms of reaching goals, product performance, and market and financial success (Griffin, 1997; Shenhar et al., 2001). As a point of comparison, previous research has focused on delivery and construction projects and emphasized environmental, social, aesthetic, and symbolic dimensions of value, for example, alongside economical and technical dimensions (Eskerod & Ang, 2017; Flyvbjerg, 2017; Kivilä et al., 2017). While Martinsuo & Killen (2014) have explicated synergies, knowledge sharing, and learning as one dimension of value in multi-project settings, it is likely that the front-end phase of the case program has limited interviewees' attention to only those dimensions of value that deal directly with the innovation deliverables and not yet their post-program consequences.

The findings show strategic value at the front end of a radical innovation program on three levels: firm, relationship, and business network. Where previous research acknowledges different stakeholders' subjectivity and diversity in value perceptions and impact expectations (Eskerod & Ang, 2017; Laine et al., 2016; Laursen & Svejvig, 2016), and usually covers either within firm (Laine et al., 2016), dyadic (Ahola et al., 2008) or multi-stakeholder situations (Eskerod & Ang, 2017) separately, this study suggests that the stakeholders' value domains may differ depending on whether the value can be pursued by the firm alone, in a dyadic relationship, or the business network more broadly. Although a single case cannot be used for generalization purposes, this finding may be helpful in defining, understanding, and possibly explaining the challenges concerning the value propositions and value creation in radical

innovations (Tongur & Engwall, 2014), and also in developing novel analytical frameworks for future research, covering the multiple levels of value.

This study explored perceptions of strategic value at the front end of a radical innovation where the entire program was still unstructured and fuzzy, proceeded in an evolutionary manner, and included stakeholders based on their voluntary involvement in experimentation. Each of the stakeholders offered their own unique perspective on strategic value, thereby revealing a range of experiences. A key result shows the front end of the radical innovation programs to not merely be a phase where immediate market and technology opportunities are envisioned, but also a sensemaking effort where stakeholders in the business network begin to consider and negotiate alternatives that might be mutually beneficial. At least in this study, the radical innovation program was not bound by the focal firm's visions alone; rather, it could evolve through the stakeholders' input, thereby supporting the ecosystem idea of radical innovations (Chesbrough, 2003; Rohrbeck et al., 2017). The framework developed for mapping strategic value in this radical innovation program, both in terms of content and level, may offer a tool to support such sensemaking in other contexts.

Readiness for implementing strategic value in the radical innovation program

While previous research has often only taken a focal firm's perspective on strategic value into account, this paper assumed that the business network should be involved in defining strategic value in the innovation program, and early on, if possible. The second research question asked: What kinds of requirements does the business network have toward the implementation of strategic value in the program? The interviews portrayed the front end of the innovation as a phase where the readiness for strategic value is built and promoted. As key results, a framework of readiness dimensions at the different levels of strategic value was developed, the front end of radical innovations is suggested as a phase for promoting such readiness, and also some challenges are pointed out concerning the possibilities for open innovation.

The results revealed five readiness dimensions (business, technology, customer, solution, and change readiness) on the three levels of strategic value (firm, relationship, and business network), which jointly form a novel framework on innovation readiness in a business network. These findings exemplify how the adoption of a radical innovation begins not only in a certain organization, but within a business network. The mapping of the interviewees' experiences shows the implementation of strategic value in a radical innovation program as an innovation adoption task in a business network. The concept of readiness was previously acknowledged in innovation adoption literature (Parasuraman, 2000; Parasuraman & Colby, 2015) and in literature concerning organizational change (Armenakis & Harris, 2002; Armenakis, Harris, & Mossholder, 1993; Weiner, Amick, & Lee, 2008), but most typically on the individual level. The inductive analysis expanded existing understanding of the multi-dimensional aspect of readiness, particularly concerning the business network involved in a radical innovation program. This may open up new avenues for research through combining views of radical innovation programs as innovation diffusion and adoption tasks with a change management task.

The results portrayed the front end of radical innovations as a phase for promoting the network's readiness for the innovation. Previous research has often been limited to the focal firm's perspective and called for its networking capabilities, information access, and inter-organizational collaboration (Berghman et al., 2012; Eggers, Kraus, & Covin, 2014; Gemünden et al., 2007; Reid et al., 2015). As a contrast, the findings in this study suggest that the business network may and should likely be involved at the front end of the radical innovation so that the

stakeholders' readiness for the innovation can be promoted well before the solution enters the market. The idea of open innovation (Chesbrough, 2003) in this study is complemented by the business network's perspective, besides that of the focal firm. Therefore, the front end of radical innovation is not merely for concept development, but for creating and preparing the network for implementing the radical innovation. Consequently, the findings also contribute to research on value innovations (Berghman et al., 2012; Matthyssens et al., 2006) and its particular challenges (Tongur & Engwall, 2014).

The case study dealt with the front end of a radical innovation program that, thus far, appears to be proceeding toward success, since it is now in the implementation phase. It was fuzzy and reflected the emergent (unplanned) and sensemaking nature of program front ends, as previously pointed out by Thiry (2002, 2004), for example. When the business network is involved, it is possible that the complexity of the program can increase uncontrollably through the different value expectations of the stakeholders involved. In order to manage the complexity and solve the dilemmas in the business logic transformation (Tongur & Engwall, 2014), this study suggests that, in addition to technology and market visioning, the programs need to assess the network readiness systematically. Understanding the network's readiness for and to embrace the radical innovation could be helpful in reducing complexity and justifying decisions.

Conclusions

Contributions

This study offers four main contributions to the existing research. First, the findings contribute to the ongoing discussion on program front-end management by explicating how strategic value is defined and anticipated, particularly at the front end of a radical innovation program. In contrast to the lifecycle-oriented view of strategic value that is typically identified in delivery projects, strategic value in the beginning of a radical innovation program appeared to be very solution centric (in terms of business, technology, product, and service value). When compared to previous research particularly concerning delivery projects, the findings suggest that the dimensions of strategic value need to be considered specifically to each project type. Second, this study contributes to research on project and program value by revealing the three-tiered nature of strategic value (firm, relationship, and business network) and, thereby, connecting and aggregating ideas from previous studies that have covered a specific level only. Although previous research has acknowledged the stakeholders' subjective views on value, the findings suggest that strategic value manifests differently, depending on the level at which it is viewed in the business network.

Third, a contribution is made to radical innovation research, particularly concerning the inter-organizational collaboration required for its success. The front end of the radical innovation was introduced as a phase for identifying and enhancing the network's readiness for the innovation in terms of business, technology, customer, solution, and change readiness. The findings thereby connect the program front end with theories on innovation adoption and organization change, and encourage researchers and practitioners to consider ways in which the innovation readiness can be promoted from early on in the program. Finally, the study contributes to program management research generally by offering potential analysis frameworks for structuring strategic value and readiness for innovation in the front ends of programs — radical innovation programs, in particular.

Limitations and suggestions for further research

This study's research validity is limited by the case study research design, the choice of the case, the choice of the informants, some choices in the data collection procedure, and the analytical approach taken. Single cases cannot be used to generalize the findings to a broader population, but they can be useful for developing knowledge of the studied phenomenon. Here, an exploratory case study was motivated by the intent of gaining in-depth knowledge about strategic value at the front end of a radical innovation program. The case itself was chosen both because of its topicality and extreme nature and because it offered good access to data through a broader research program. The case context and background were introduced thoroughly to enable readers to assess it in comparison to other potential radical innovation programs.

Informant selection and some procedural issues in the data collection were limited through the access offered by MaterialCo contact person, the fuzziness of the program's front end, and the research project context. For example, to carry out the interviews, the target firms were handpicked by MaterialCo's contact person, possibly causing some pro-innovation bias. Consequently, the informants were selected by the target firms' contact persons on the basis of their familiarity with ongoing developments in intelligent technologies. Moreover, the all interviewees were not directly connected to the radical innovation program, thereby possibly limiting some informants' knowledge and awareness of the specific radical innovation. Somewhat different interview outlines were used in the four interview episodes, due to MaterialCo's expectations evolving over the progress of the research, partly limiting the possibilities for exact comparisons to be made or more detailed analysis. The validity of the research was enhanced purposely through the testing of partial results in workshops and repeated communication about the results with the contact person. Furthermore, the paper topic and the inductive approach to the analysis was decided after the data was already collected. While this hampers the possibility of going back to the front end of innovation or collecting further data on it later (since the program has progressed to the implementation phase already), it also enabled focusing on such issues that organically emerged in the program front end.

Radical innovation programs represent one type of program that potentially comprises multiple projects. The front end of a radical innovation program represents an extreme context characterized by uncertainty and fuzziness. This research offers one avenue for making the front end less fuzzy: understanding it in terms of building readiness for innovation implementation. While the findings offer tentative and novel thematic frameworks concerning the different levels of strategic value and the dimensions of readiness for implementing strategic value at the front end of a radical innovation program, it is obvious that the frameworks will require further development and elaboration in different kinds of program contexts. For the case program in particular, it would be interesting to study what actually happens during the program implementation in terms of value creation, particularly in the collaboration of the focal firm and its different business networks.

Further research is also encouraged on radical complex innovation programs with an active research component (and therefore a high degree of uncertainty). Particularly, if the actual definition of and decision on strategic value requires research, it would be of interest to take a micro-level view of the emergence of value dimensions during a long innovation front end. As this study introduced the front end of a radical innovation program as a phase of building network-wide readiness for the innovation, the results pave the way for further studies on network readiness for radical innovations. Some of the findings in this study indicate that the entire study could be viewed from the perspective of knowledge stickiness in a business network, or (radical) innovation adoption in a business network. These both are very interesting

potential theoretical pathways, but as they were not originally chosen for this study, they are proposed as avenues for further research.

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