The wicked problems of supplier-driven innovation

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Published in: Journal of Business and Industrial Marketing

DOI: 10.1108/JBIM-06-2015-0110

Publication date: 2017

Document version Peer reviewed version

Document license Other

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Abstract

Purpose: Suppliers stand in the wake of a new diversified strategic momentum in the global production network, where innovation is growing in importance. We coin the term “supplier-driven innovation” in contrast to the current hype on user-driven innovation and aim to discuss the wicked problems for suppliers to actively engage in customers’ innovations.

Design/methodology/approach: A qualitative case study of eight Danish suppliers.

Findings: The wicked problem of supplier-driven innovation is generated by two intertwined constraints: the ability to engage customers in the co-creation of attractive offers and the ability to include technological knowledge and capabilities residing in the upstream network of suppliers.

Research Limitations/implications: This research combines an industrial network approach with perspectives generated through design management literature aiming to develop a platform for co-creation across diverse organizational, technological, and managerial domains in the global production system.

Practical implications: To participate in supplier-driven innovation, partners need to co-create an innovative space for joint development.

Originality/value: Co-creation enriches our understanding of the diversity of forms of interaction, ranging from information and knowledge exchange and mutual adaptation processes to experimentation with processes co-creation. Through a complementary view on how suppliers co-create innovative spaces of action in the upstream spaces of technical knowledge as well as the downstream spaces of preferential needs, the research contributes insights about the characteristics of the wicked problems that suppliers need to handle in bridging and expanding these spaces for innovative actions.
Keywords: supplier-driven innovation, wicked problems, innovation spaces, co-creation, self- and collective interests

Paper type: Research paper
1. Introduction

This study focuses on suppliers who strive to develop their own innovation capacity for taking on a new dynamic role in contributing to customers’ innovation activities. These suppliers build their business by facilitating the combination of new knowledge from the technical fields embedded in their network of sub-suppliers with new knowledge embedded with their customers, including lead users or user communities. We term it ‘supplier-driven innovation’.

Our exploratory study aims to contribute with insights of how supplier-driven innovation initiatives enable firms to influence customers’ innovation to a growing extent by taking a more proactive role in contributing to the development of their key customers. We study the co-creation activities spanning across the supplier-firm’s network of sub-suppliers and customers for jointly specifying and expanding the potential innovative solution spaces. While current research and many recent studies have taken user-driven innovation as a main focus (Lettl et al., 2006; von Hippel, 2005) and a growing number of studies take interest in suppliers’ contribution to customers’ innovation (Johnsen, 2009; Rosell & Lakemond, 2012). However, no studies have so far combined the two perspectives into a whole as far as our search reveals. Thus, the present study aims to combine the two strands by studying firms who build their business by not only exchanging knowledge but create new knowledge jointly with customers through co-creating activities in order to build and expand their innovative action space through joint efforts (in line with the work of, e.g., Håkansson & Waluszewski, 2007). Only few studies have considered the role of wider supply networks on innovation (Johnsen, 2009:196 - exceptions include, e.g., Rosell & Lakemond, 2012; Teichert & Bouncken, 2011; Wagner, 2009). This limits our knowledge on new aspects of suppliers’ role in innovation, since a narrow focus on developing products excludes insights on suppliers’ engagement in developing other parts of a customer’s business.

As suppliers engage in supplier-driven innovation, they engage in a transformation from production suppliers with ad hoc supplies of knowledge to knowledge brokers qualifying as a different type of innovation partner, primarily by engaging in the customers’ innovation process in early stages of the customers’ innovation funnel (Johnsen, 2009). Accordingly, this study expands the traditionally perspective of suppliers seen as contributors to the efficiency and innovation of their customers through cost reductions and flexible, custom-tailored deliveries (Wagner, 2010). The transition to a more proactive role is complex, as intricacies in technologies for developing product and service offerings need to be connected across customers and several tiers of sub-suppliers, where innovative solutions cannot be founded on experiences from the past. The transition becomes even more complicated since the solution space is not known at the outset. The multiple facets of the problem cannot be known but must be jointly explored by the collaborating parties.
Experimentation and co-creation are necessary to unveil potential solutions. Moreover, the effort is not only to be handled in single relationships but also in relation to the wider network setting. The many intervening aspects resemble wicked problems as defined by Churchman (1967): “[W]icked problem(s) refer to that class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing” (p. 141). In this study, we set out to explore the complexity of supplier-driven innovation through the following research question: What characterizes the wicked elements of supplier-driven innovation?

The following sections outline the theoretical foundation for discussing supplier-driven innovation. Then, we will discuss requirements for co-creative development needed in supplier-driven innovation, as introduced in the design management literature. Methodological considerations will precede the presentation of eight cases of suppliers aiming to engage in supplier-driven innovation. The findings of our study reveal two essential strands. On one hand, the wickedness of supplier-driven innovation is related to technological and market aspects explored in collaboration with customers. On the other hand, the wickedness relates to the social and managerial complexity of collaboration in the global production network. Together, these elements affect suppliers’ efforts to develop their own capacity for co-creating a inter-organizational space for taking a proactive part in customers’ innovation processes.

2. The evolving ground for supplier-driven innovation

In the wake of the continuous transformation of global production networks, it is becoming more difficult for large contractors to match their internal knowledge base to the speed and complexity in knowledge production needed to generate innovations at a competitive pace (Chesbrough, 2003; Hamel, 2011). This gap opens new tasks for suppliers who are challenged to build new competencies to drive innovation with their customers and to adapt to the changing and emerging competitive and collaborative conditions (Gadde, 2013; Gereffi et al., 2005; Johnson, 2009).

Regarding ways for companies to face such challenges, the literature on open innovation (Chesbrough, 2003), for example, has offered insights by discussing the purposive exchange of knowledge across organizational borders. As such, organizations intend to combine internal and external knowledge in ways that overflow the innovative capacity of the single organization. While the open innovation field has a distinct focus on the upstream supply of technological knowledge, another downstream perspective—user-driven innovation—has flourished (Buur & Matthews, 2008; von Hippel, 1986). User-driven innovation aims to tap knowledge from users’ experiences, needs, and emotions. Several strands of user-driven innovation are evolving, ranging from studying and interacting with lead users (von Hippel, 1986), engaging with user
communities (Hienerth, Lettl, & Keinz, 2013), and seeing users as innovators (Bogers, Afuah, & Bastian, 2010).

The Industrial Network Approach (associated with the Industrial Marketing and Purchasing Group, www.impgroup.org) has long advanced the idea that dyadic studies of user–producer and buyer–supplier relationships must be seen as part of a larger, complex industrial network (Anderson et al., 1994; Håkansson & Snehota, 1995; Håkansson & Waluszewski, 2007). This study has used the Industrial Network Approach to combine the separated perspectives on user-driven and supplier-driven innovation presented in the introduction. We call it supplier-driven innovation for the simple reason that a new generation of suppliers is emerging who combine these perspectives.

Scholars have argued that an innovation has to “live” in different settings (Håkansson & Waluszewski, 2007). It is not enough for an innovation to bring something new; the new also needs to fit into the existing physical and organizational investments without any negative side effects (Wagrell & Waluszewski, 2009). These arguments have questioned the ease of implementing innovations due to differences in organizational settings hindering the embedding of potential innovations (Wagrell & Waluszewski, 2009) or due to the different settings (e.g., supplier and user) in which the innovations unfold (Ingemansson & Waluszewski, 2009).

Other scholars explain this issue of implementation as the clash of technological complexity and innovation routines embedded inside firms (Pavitt, 2000). As collaboration patterns develop between partners, relational routines and constraints also evolve (Andersen, 2003). This evolution relates to changes in the layers in the dominant design established through socio-technical linkages forming in the task partitioning taking place (Utterback & Abernathy, 1975). As noticed by Håkansson and Waluszewski (2002), innovations tend to fine-tune and cement interactions around the dominant design, thus favoring path dependency. In order to pursue their innovative contributions, suppliers therefore may need to break up institutionalized collaborative routines and perceived interests embedded with their customers.

According to Henderson and Clark (1990), the dynamics of dominant design systems take place on two levels: the architectural and component levels. The involved layers of innovation underscore the distinctly different types of knowledge and competencies included and thus also the variety of knowledge communities to engage and manage.

3. The wicked problem of supplier-driven innovation

The wicked problem phenomenon was described by Rittel in the 1960s. Developing the phenomenon, Rittel and Webber (1973) distinguished between tame and wicked problems. A wicked problem may not only be an open, technically complex problem, but to grasping the problem may require information that challenges preconceived ideas of how to solve it, due to the ideas, experiences, and
knowledge infused by other stakeholders. Hence, new aspects defining the essence of the problem surface along the path stakeholders take to co-create their preferred solution. The full spectrum of the problem, therefore, is not revealed before solution processes are set in motion (Churchman, 1967; Rittel & Webber, 1973).

The wicked problem of supplier-driven innovation has two fundamental sources. First, because innovation is dealing with what is to come to shape (Simon, 1969; Buchanan, 1992), the wicked problem is linked to an iterative and nonlinear path for implementation of future products, services, and systems. The second aspect of the wicked problem of supplier-driven innovation is found in the dynamics of social interactions surrounding the innovation process. As no company is an island (Håkansson & Snehota, 1989), no innovation is born on an island; users, suppliers and a number of other stakeholders surround the innovation process and influence the prospects of successful implementation and growth in the market.

The characteristics of wicked problems relevant for the present purpose are as follows:

- Wicked problems always have more than one path to solution space.
- Wicked problems have no stable, best solution but are time dependent, situated, and consensus based.
- The character of a wicked problem is represented differently by different stakeholders, dependent on the worldview and perspective of the stakeholder (Buchanan, 1992:16).

These characteristics emerge in supplier-driven innovation as different perspectives on what might be technically possible and have attraction among customers and users as well as how the innovation resides in the wider network. If collaborative processes come into step, a number of constraints associated with asymmetric possession of knowledge (O’hern & Rindfleisch, 2010) and contextual insights need to be overcome to empower joint innovation.

A wicked problem of supplier-driven innovation is, in essence, a question of how to engage in joint experiments with alternative future options, including knowledge contributions, ideas, emotions, and constraints delivered by the participants joining. New ideas and demands, no doubt, surface in such collaborative processes. The supplier needs to establish an understanding of requirements early in the development process so the sub-supplier still has the opportunity to question, influence, and develop the initial conditions for innovation. Essentially, coordination is needed to bridge the knowledge and competencies of sub-suppliers, the firm, and the customer (Gadde, 2013). Project-specific changes in the interfaces in the upstream supplier–customer relationship will have a spillover effect on the wider downstream network of actors (Gadde & Håkansson, 2001; Hines, 1994). This is illustrated in Figure 1.
Figure 1. Supplier combining sub-supplier and user settings for engaging in supplier-driven innovation.

Figure 1 illustrates the iterative exchange and expansion of the frames forming the innovative space of the actors engaged in the collective aim to find attractive and feasible solutions. Solutions may often turn out to be so wicked that post-launch engagement innovation is needed in order to address still unforeseen constraints spotted by users and suppliers (Heiskanen et al., 2014). This is especially important in cases of radical innovations disrupting dominant design systems. This new role requires suppliers to take on a more integrative and problem-solving role vis-à-vis their customers as well as own sub-suppliers. In order to develop sustainable solutions in such settings, partners need to join forces in co-creating processes (Bucciarelli, 2005).

4. The prospect for co-creation in supplier-driven innovation

To understand the evolving wickedness of supplier-driven innovation, we have drawn from design literature on participatory innovation (Buur & Matthews, 2008; Ramaswamy and Gouillart, 2010) building insights relevant for co-creating innovation. The ill-defined problem that constitutes the wickedness is widespread in the network of actors. Only by bringing the actors together to sketch, expose, experiment, reflect on, and bridge their perspectives, interests, and competencies can the partners involved bring elements together that constitute feasible solutions to the wicked problem at hand (Liedtka & Ogilvie, 2011). In this process, the innovative space of action is co-created. This is a mean-driven rather than goal-driven process since unexpected yet feasible solutions emerge out of new combinations of knowledge and insights embedded with actors.

The aim of co-creation is fundamentally to reduce wickedness in the socio-technical realm constituted in the meeting of the upstream network of suppliers and users. Two levels are at stake: the architectural level of knowledge and the component level of knowledge which includes fundamental
matters of relationship-building. Since customers seldom can handle the diversity of component knowledge needed in complex product innovation and often are also troubled in spanning fields of architectural knowledge, key suppliers of components and subsystems play a vital role in the development. Co-creation therefore has a double-edged agenda of promoting collaborative action as well as breaking with past dealings and meanings.

The concept of co-creation was launched at the turn of the century by Prahalad and Ramaswamy (1999). Later, Sanders and Stappers (2008) stressed the role of design as a common platform for co-creation, highlighting a number of basic concepts and tools to drive the process of co-creation. These included methods used to reveal technical constraints, contextual and situational factors influencing use, tacit emotions, interests, and perspectives, as well as to facilitate conversations in an iterative process of working with wicked problems. The concept of co-creation is a turning away from a sole-product and technique focus to a focus on people’s needs and the creation of collective meaning. Design thus offers concrete methods to enhance the process of co-creation—for example, concepts for creative flows across organizational borders, or, for example, technological systems of the involved participants, the airing and sharing of ideas, the exploration of ideas in a collective process of pre-sensing the future, and breaking with perspectives from the past (Scharmer, 2008). These elements offer a common design platform of interaction, facilitating the process of co-creation.

Strong relationships between the involved actors are important in building this common platform of interaction, as also emphasized in design literature. Relationships must be built on the basis of meetings and workshops where several techniques and approaches offer the participants an opportunity to physically experiment, sketch, prototype or in other ways visualise knowledge and ideas as part of the process. Examples are design probes (Mattelmäki, 2006), exploratory design games (Brandt, 2011) or generative tools (Sanders, 2000) and common for these techniques and approaches are that they encourage to dialogue among the participants through tangible means. Within the field, it is commonly accepted that these tangible ways of having a dialogue contribute to establishing and/or refining a common platform for knowledge generation between participants coming from different backgrounds (i.e. Bang & Christensen, 2013; Binder & Hellström, 2005).

Most research in co-creation has a prime downstream focus on how to include the voices of users. Our focus is how to bridge processes of co-creation in the upstream network of suppliers with the downstream processes of co-creation with customers and users. This is in line with the underlying assumptions in the Industrial Network Approach (e.g., Ford & Håkansson, 2005; Håkansson & Waluszewski, 2002), since execution of innovative activities always involves a number of interactive actors in the network. Therefore, the question posed here is not whether co-creation should take place but rather what
the wicked elements associated with co-creation are. Diversified actors pointing to needs and problems are often out of sight of those who are pointing to possible solutions. Varied actors carrying pieces to the puzzle and forming competing solutions are also located apart in time and space.

5. Methodological considerations

The empirical basis of this study consists of eight explorative cases of suppliers who to an increasing degree have acted as customer developers. The suppliers have started to develop their role and engagement in customers’ innovation activities using co-creation in various forms to perform supplier-driven innovation. Choosing a qualitative case study approach allows for meaningful exploration in a real-life setting of possibilities and obstacles for suppliers to handle wicked problems (Yin, 2003). Further, using a case method follows the arguments of Dubois and Gadde (2002) who claimed that “the interaction between a phenomenon and its context is best understood through in-depth case studies” (p. 554). Whereas some scholars suggest using only one very rich case (Dubois & Gadde, 2002), others recommend 4–10 cases to reach theoretical saturation (Eisenhardt, 1989). Here we followed the argument of Easton (1998) and Harrison and Easton (2004) and let the phenomenon and its context guide the number of cases chosen.

The eight cases of suppliers acting as customer developers are characterized as critical (Flyvbjerg, 2011) in the sense that they maximize the utility of information obtainable concerning the specific roles as customer developer. The cases were carefully chosen in order to provide detailed knowledge of the possibilities and obstacles related to acting as customer developer. They were selected within one of four industries: food, textile/design, plastic, and stainless steel. Since the overall research project was based in a Danish context, these industries were chosen due to their general national importance (in terms of exports, high national competencies gathered, e.g., in clusters and/or labor intensity). In each case, the supplier chosen has been deliberately allocating resources to act as a customer developer not only by contributing to specific product development projects with customers. The supplier, for example, has also engaged actively in customers’ innovation activities, bridging technological knowledge sources and knowledge of the end-market originating from different sources in the business network. Some of these suppliers have used design as an explicit co-creation method while others have not. Suppliers have been identified through the snowballing technique. The names of the companies will be kept anonymous. Table 1 provides basic background information on the eight cases.

<table>
<thead>
<tr>
<th>Case</th>
<th>Industry</th>
<th>No. of employees</th>
<th>Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Textile</td>
<td>31</td>
<td>Production of knitted fabrics in close cooperation with customers and suppliers; creating an open environment between the parties in order to develop new business opportunities together</td>
</tr>
</tbody>
</table>
Table 1: Basic Information on the Eight Exploratory Cases Included in the Study

<table>
<thead>
<tr>
<th>Case</th>
<th>Industry</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Textile</td>
<td>67</td>
<td>Develops high performance textiles in a close network of suppliers and customers; is the catalyst for the development processes throughout the value network</td>
</tr>
<tr>
<td>C</td>
<td>Food</td>
<td>130</td>
<td>Producing innovative quality bakery items for the convenience category; creating transparency in order to promote cooperation, contribution, and knowledge sharing with customers as well as suppliers</td>
</tr>
<tr>
<td>D</td>
<td>Food</td>
<td>110</td>
<td>Supplier of spice mixtures and functional ingredients; is included early in the customer’s development process and contributes with knowledge that defines needs, leads to an inquiry or inspiration</td>
</tr>
<tr>
<td>E</td>
<td>Metal</td>
<td>50</td>
<td>Develops and produces tray cleaners and utensil washers for the food industry; assists distributors and customers in co-creating design and requirement specifications. They have an ongoing dialogue clarifying critical processes in specific development projects.</td>
</tr>
<tr>
<td>F</td>
<td>Metal</td>
<td>170</td>
<td>Assists customers in product optimization and automation solutions, usually by industrial robotic systems; plays a leading role in the design process vis-à-vis customers</td>
</tr>
<tr>
<td>G</td>
<td>Plastics</td>
<td>480</td>
<td>Develops complex and advanced plastic packaging solutions for food products; gets involved as early in customers’ product development as possible in order to combine the needs of the customers with the company’s technical competencies</td>
</tr>
<tr>
<td>H</td>
<td>Plastics</td>
<td>120</td>
<td>Production of window frames in plastic; assists customers in developing sustainable products using the newest production technology and adapted to needs of end-market</td>
</tr>
</tbody>
</table>

5.1 Data collection

The data collected for each case consists of in-depth, semi-structured interviews as well as company and industry reports. Additionally, to allow for triangulation, semi-structured, industry-expert interviews and expert workshops have been included as data in developing the cases. Experts have been included from trade and industry organizations, as well as business consultants. Data from experts form an essential empirical input for identifying and verifying trends and developments for doing innovation in each of the industries in the study as well as the specific role played by the supplier in each case.

The in-depth, semi-structured interviews were conducted with one or two informants from each supplier. We followed the recommendations of Wilke and Ritter (2006), choosing dyads as the structural level of analysis and the organization and expert network levels as actor level of analysis. This implies collecting data from individuals in organization and as well as expert with knowledge and insights from the network level. We chose interviewees among middle and project management directly involved in customers’ development activities. In most cases, we interviewed the main customer as well regarding the supplier’s role. Every interview was completed at the company and was recorded and transcribed.
In general terms, the interview guide included issues related to clarifying each case firm’s network and collaborative partners, identifying challenges and opportunities for handling suppliers’ early involvement in customers’ development processes, and examining design methods used (explicitly or implicitly) for increasing innovative collaborations. Further, interviewees have expressed their perception of the suppliers’ performance as customer developer and the business value this role brings to the relationship as well as the challenges experienced as the role has developed.

5.2 Data analysis

We the authors of this paper have jointly cross-case analyzed the empirical data. The analyzing process followed recommendations by Miles and Huberman (1994). First, a data display following the theoretical framework outlined provided an organized overview of information for each case. This data display was developed at a joint author meeting. Second, we have discussed the cases, providing the basis for cross-case matrix analysis. Discussions of each case followed the same systematic format: characteristics of customer relationships, interaction with significant partners, and perceived network effects. Further, the data matrices provided the basis for outlining possibilities and challenges related to solving wicked problems and to interviewees’ perceptions of the value created from the suppliers acting as customer developers. By dividing the data in this manner, we had the opportunity to explore elements of wicked problems facing suppliers. This allowed us to detect similarities and differences across cases and also identify cross-case patterns. These comparisons are the bases for writing case presentations and cross-case discussions. The third and last step in the analyzing process was to outline conclusions.

6. Cases: Eight suppliers engaged in supplier-driven innovation

When engaging in supplier-driven innovation, firms approach the task in different ways depending on their goals, partners, and wider network. Accordingly, they face different wicked elements. This section introduces eight cases of firms engaging in supplier-driven innovation in different ways. Table 2 highlights the wicked elements experienced in each case.

<table>
<thead>
<tr>
<th>Company</th>
<th>Wickedness related to the emerging technological and market regime</th>
<th>Wickedness related to the dominating design system and the network structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textile A</td>
<td>Uses different methods (trends, samples, etc.) to co-create specifications. Cross-functional teams align marked needs and technological possibilities.</td>
<td>Bridges differences in value demanded by customers and end users. Collaborates closely with own suppliers to develop yarn functionality.</td>
</tr>
<tr>
<td>Textile B</td>
<td>Uses, e.g., swatches and samples for co-creating specifications with customers.</td>
<td>Collaborations with own suppliers often lead to new customer relationships. Aligns and utilizes competencies from different suppliers (sewing, dying) with customers’ insights on new fashion trends.</td>
</tr>
<tr>
<td>Food C</td>
<td>Studies end users and uses knowledge to facilitate joint workshops with immediate customers as well as suppliers. Cross-functional teams established for innovation projects.</td>
<td>Some business partners are both supplier and customer in specific innovation projects. Aligns information on end users’ needs across immediate customers, wholesalers, and retailers.</td>
</tr>
<tr>
<td>Food D</td>
<td>Hosts development workshops for key customers to co-create specifications for innovations. Development teams service selected key customers.</td>
<td>Is an integrated part of customers’ innovation activities. Spill-over effects (technology and learning) from selected customers provide business opportunities among other customers. Connects knowledge on emerging trends, development on international markets with new technological developments among suppliers.</td>
</tr>
<tr>
<td>Metal E</td>
<td>Modularization is the basis for co-creating specifications and product design.</td>
<td>Utilizes distributors’ knowledge and market access for developing to smaller customers. Has reduced own supplier base to build tighter relationships to access selected technological competencies.</td>
</tr>
<tr>
<td>Metal F</td>
<td>Integrate product and process development at customers to strengthen benefits obtainable. Uses, e.g., workshops and visualization for co-creating specifications. Uses cross-functional teams for assisting customers’ process developments.</td>
<td>Is an integrated part of customers’ innovation activities.</td>
</tr>
<tr>
<td>Plastics G</td>
<td>Uses, e.g., design briefs and CAD drawings for co-creating specifications with customers.</td>
<td>Sets up abroad to be closer to important customers. Bridges diversified market needs with suppliers’ technological competencies.</td>
</tr>
<tr>
<td>Plastics H</td>
<td>CAD drawings and 3-D printing used for co-creating specifications with customers. Establish cross-functional teams for developing projects. Teams include employees from the customers.</td>
<td>Plays important role for utilizing new technology for window production to assist customers in meeting the continuous development in legislation concerning sustainability.</td>
</tr>
</tbody>
</table>

Table 2: Overview of wicked elements experienced in each case

6.1 Case 1: Textile A

Textile A has in recent years redefined its service through innovation in products and production. Variations on demands from different customers have led to an intensified collaboration with sub-suppliers of yarn to expand the functionality of the fabrics as well as the flexibility of the weaving technology in order to include diverse concerns articulated by key customers (laundries) and end users (hotels and hospitals). Accordingly, the main drivers in the firm’s innovation effort are technology as well as deep insight into the needs of customers and end users. To meet and balance the needs and interests of its many partners,
Textile A has established internal cross-disciplinary teams for co-creating specifications with external partners. Textile A uses methods such as trend development, fabric sampling and collection development, color combination, and storytelling.

6.2 Case 2: Textile B

Textile B designs circular knitted fabrics for the fashion industry. Developing unique, specialized fabrics with customers often requires industrial sewing partners to contribute technical knowledge and competencies on fabric tailoring. The tight collaboration with sewing partners and sub-suppliers has often resulted in access to new customers. Other important partners are dye factories which add technology and knowledge on obtaining the correct color as specified in intensive dialogue with customers in the fashion industry.

Offerings to customers are based on knowledge of trends, competencies for design, aesthetics, and knitting techniques, developed in combination with knowledge and competencies in upstream partners. For co-creating developments, in-house designers and knitters develop swatches, textile samples, and prototypes, constructing a platform for experimenting with customers on tacit emotions and attractive tactility. These methods link new fashion concepts co-created with targeted customers to new technical opportunities emerging in the industry.

6.3 Case 3: Food C

Food C collaborates with different retail and food-service customers to develop and produce convenience-food. It is of growing importance that Food C understands both the needs and interests of the immediate customer as well as their end users. This is not always a straightforward task since many customers also work with wholesalers and retailers in development. Thus, the firm has observed how important information on needs can be lost when “translated” across actors. Sometimes, customers approach Food C for developing a product based on some of their own ingredients, making Food C both the supplier and customer to these particular partners. Accordingly, Food C seeks to become engaged in customers’ innovation activities as early as possible in order to gain insight into customers’ interests, needs, and perceptions. To co-create joint understandings, Food C conducts observation studies of end users and facilitates joint idea-generation workshops with immediate customers. Food C also arranges “partnership days” with the purpose of bringing together customers and sub-suppliers to create mutual awareness of opportunities and constraints in the network. This way of working is reflected internally, where Food C works in interdisciplinary project teams.

6.4 Case 4: Food D

Food D develops and provides functional ingredients and spices for large food producers and retail chains. Food D’s declared strategic goal is to be a perceived part of selected customers’ innovation. Its
contributions are an integrated part of customers’ processing of food, which makes up a larger part of the value created in final products sold to consumers. The combination of knowledge of trends, opportunities in international markets for ingredients, technological options, and optimization of production constitute Food D’s main competitive advantage. The firm has built teams serving key customers, supplying all competencies needed to accommodate customers’ interests. However, because of frequent changes in trends in the food industry and because the market is ruled by large food producers and retailers in fierce competition, Food D has to be constantly alert to new consumer trends to form customers’ interests. Occasionally, changes in customer interests lead to alterations in internal processes and the team servicing this customer, which may also have a spillover effect on collaborations with other customers.

6.5 Case 5: Metal E

Metal E works in stainless steel development and produces tray cleaners and utensil washers for the food industry, servicing a wide range of customers in different food branches both nationally and internationally. Whereas Metal E has direct connections to large industrial customers, it relies on distributors to connect with its many small customers. The distribution partners are important for aligning market knowledge. To service the widespread needs and interests among customers, Metal E has invested in product and modularization technology to streamline productions. Metal E assists distributors and customers in co-creating design and requirement specifications, and they always have an ongoing dialogue clarifying critical processes in specific development projects. By combining several standard items from a single supplier and sharing knowledge and core competencies, the firm has reduced its number of sub-suppliers in order to build tight, trusting partnerships.

6.6 Case 6: Metal F

Working in steel and metal, Metal F develops and produces industrial robot systems. Whereas Metal F used to follow customers’ specifications, it now increasingly aims to tap into the knowledge of customers to make an optimal match between market needs and technological possibilities and constraints. Today, Metal F plays a leading role in the design process vis-à-vis customers, from defining the problem to optimizing solutions. Further, the firm guides customers to make changes to internal production setups to better fit with an industrial robot system. Taking on this broader responsibility for developing solutions for customers, Metal F operates with cross-functional teams encompassing every competence needed in specific projects. Metal F urges customers to participate in collective “startup projects” with shared financing, where the goal is to understand all critical processes in the design project and to create a collective foundation for success. To facilitate the joint development, Metal F uses different methods for coordination and joint sessions of co-creation, such as mock-ups that assist in obtaining joint evaluation of ideas, and video prototyping to visualize the solution.
6.7 Case 7: Plastics G

Plastics G develops complex and advanced plastic packaging solutions for food products. The firm offers customers a product that is a necessity but only contributes marginally to the final value offering. To illustrate their value, Plastics G must get involved as early in customers’ product development as possible in order to combine the needs of the customers with the company’s technical competencies within tool mastering and material technologies. Relationships to sub-suppliers are increasingly important to bridge diversified market demands with flexible technological possibilities. To accommodate the needs of strategic customers, Plastics G willingly invests additional resources, establishing production unit and a sales office abroad, for example.

Coordination with customers is obtained through meetings and design briefs, prototypes or hand samples, as well as computer-aided design (CAD) drawings since Plastics G reports that having physical objects and drawings as a foundation for co-creation aids in building collective interests with customers.

6.8 Case 8: Plastics H

Growing competition from low-cost regions has pushed Plastics H to increase collaboration with customers in developing systems for window production. CAD drawings are central for coordination and communication in development projects with customers. The drawings create the platform for discussions about customers’ needs and interests to be combined with Plastics H’s knowledge about environmental and technical constraints and possible production and technology solutions. During meetings, possible adjustments and suggestions for further developments are drawn by hand and later included in the CAD drawing. It is an iterative process in which the parties meet several times to discuss and adjust the project, with Plastics H being responsible for driving the process and suggesting additional new solutions. In some cases, the firm also uses rapid prototyping based on 3-D printed models. When the two parties agree on the specifications, Plastics H develops the window sections and the tools that must be applied. When developing new tools, the firm uses known and trusted suppliers in the existing network. To accommodate project development, Plastics H always establishes a cross-functional team that includes employees of the customer.

7. Discussion: Coining the wickedness of supplier-driven innovation

The cornerstone of wicked problems is that the complexity and ambiguity of the problem at hand rise with the number of different partners involved and their perspectives, interests, and underlying assumptions posed to define and solve the problem (Rittel & Webber, 1973). However, processes of co-creation have the potential to raise the innovative possibilities significantly as firms engaging in supplier-driven innovation take responsibility for specific domains of component knowledge and architectural knowledge. The cases in this paper demonstrate how firms need to “travel forth and back” as solutions
brokers between initial ideas developed with their customers and the feasible, emerging technological solutions provided in collaboration with the network of sub-suppliers. This process will twist and eventually expand the initial ideas developed with customers. However, the process entails more than product or process development, for example—rather, the organizing and design of interaction in customers’ network and business paradigm also require innovations.

Across the eight cases presented, variations have emerged in the wicked elements related to solutions being co-created. These variations emerged in the technological and market system as well as in the complexity of the dominating design and the layers of architectural knowledge, for example, in how to frame interactions in the production network and how to structure the network of competencies and technologies mutually supporting each other. Table 3 presents an overview of the findings and six wicked elements identified. These variations will be discussed in more detail in the following paragraphs.

<table>
<thead>
<tr>
<th>3 elements related to the wicked problem of bridging the emerging market and technological system</th>
<th>Detailed explanations of each element</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A break with established routines</td>
<td>When specifications are no longer given by the customer but are co-created by two or more partners in the network, the matter complicates. To co-create specifications, established routines within and across partners need to be broken if the innovative competitiveness is to be kept.</td>
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<tr>
<td>2. Bridging evolving boundaries between partners in the network</td>
<td>This element relates to the evolving boundaries between partners in the network and how the use of boundary-spanning objects creates innovation action spaces. All eight cases provide examples of co-creation practices utilized for bridging use and production settings and for creating space for the joint innovative effort.</td>
</tr>
<tr>
<td>3. Building an extended co-creation function</td>
<td>The third wicked element directs attention to internal developments as an extended key co-creation function is constructed to bridge technological options from sub-suppliers with customer needs. Some firms build an expanded key co-creation function by setting up cross-functional teams with different competencies for better servicing the needs of customers and other partners participating in various projects.</td>
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<th>3 elements related to the wicked problem of the dominating design system and the network structure</th>
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<tr>
<td>4. Actors in the network may take multiple roles</td>
<td>The fourth wicked element presents the multiple roles of actors in the network as the same partner may act in two roles, such as supplier and customer, at the same time.</td>
</tr>
<tr>
<td>5. The need to align self- and collective interests among partners</td>
<td>A fifth wicked element is to let a strong commitment to collective interests surface between the partners. During the course of changing routines, the mindset of the collaborative partners’ self- and collective interests are broken, gaining new dynamics.</td>
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6. The combination of partners’ competencies and the possibility of building cross competencies

Competencies understood as the collective learning within an organization are needed to coordinate production skills and integrate technologies.

Table 3: Overview of Findings—Six Wicked Elements in Supplier-Driven Innovation

7.1 Elements of wickedness in the emerging technological and market system

A first wicked element is the iterative and nonlinear path for developing future offerings in which suppliers and the network of sub-suppliers get involved. When specifications are no longer given by the customer but are co-created by two or more partners in the network, the matter complicates. To co-create specifications, established routines within and across partners need to be broken if the innovative competitiveness is to be kept (in line with Adler et al., 1996; Mathews, 2001). For example, Food C must be able to translate the information across diverse development partners. In the case of Food D, co-creation for specifications surface as the supplier continuously develops its integration in customers’ development activities, accommodating shifting consumer trends while raising demands for sub-suppliers to develop their extensive technological knowledge.

A second wicked element of supplier-driven innovation springs from breaking with existing routines to set up new co-creating practices for engaging in joint innovation processes. All eight cases provide examples of co-creation practices utilized for bridging use and production settings and creating space for the joint innovative effort (in line with Håkansson & Waluszewski, 2007). These methods resemble boundary-spanning objects (Gasson, 2006). In the cases of Food C, Food D, and Metal F, workshops with customers and other relevant participants provide such a space. Some of the companies examined (Plastics G, Metal F, and Textile A) use hand samples, mock-ups, or rapid prototyping for experimenting and co-creating with customers. And several (Plastics H, Plastics G, and Textile A) use CAD drawings, co-created design briefs, or storytelling as methods for tracking evolving specifications of the joint concept development.

The third wicked element resides internally. Some firms build an expanded key co-creation function by setting up teams, which breaks the established functional competencies and combines them in new innovative ways for better servicing the needs of customers and other partners participating in various projects. Where the traditional key account function focuses on interaction with key customers, the expanded key co-creation function focuses on creating innovation spaces for bringing together upstream knowledge and technology and downstream needs and interests (Food C, Metal F, and Plastics G). As such, the wickedness of supplier-driven innovation is not only related to products and technology but also to the ways of business interaction (Markides, 2008).
7.2 Elements of wickedness in the dominating design and structure of the network

Elements of wickedness in supplier-driven innovation are also found in the dynamics of design and structuring of the network surrounding joint and interactive innovation processes. A fourth element of wickedness flows from the structure of the network as the network evolves when firms develop and terminate or adopt multiple roles regarding specific partners (Ford & Håkansson, 2005). From the cases, we have learned how Food C engages in multiple roles vis-à-vis specific partners who are customers as well as providers of ingredients and technologies and thus also act as sub-suppliers to Food C when innovating. Roles are shifting and developing as joint projects evolve. Food D and Metal E face wickedness as their networks expand or develop with new relationships being developed or terminated.

A fifth wicked element is to let a strong commitment to collective interests surface between partners. The supplier’s self-interest in participating in supplier-driven innovation is to capture value and to pursue own right and share (Medlin, 2006). However, achieving self-interest comes through successful joint action (Medlin, 2006). Firms will engage in joint innovations with different strategies and goals, depending on their understanding of self- and collective interest in the collaboration (Munksgaard, 2015). During the course of changing routines, the mindset of the collaborative partners’ self- and collective interests are broken, gaining new dynamics. In the eight cases, we see variances in how self- and collective interests evolve. At Plastics G, the offering to customers constitutes only marginal value for end users. Accordingly, the supplier needs not only to understand the interests of its customers to coin their collective interest but also to interact accordingly. Metal E is in a different situation, doing business in a notably heterogeneous network involving a great number of partners and actors. This supplier thus needs to overview and build innovation on the collective interest of many partners. Textile A also needs to take the interests of diverse actors into consideration while bridging interests from end users to sub-suppliers of technological solutions. Most important, the supplier and customer alike must understand the collective interest in order to truly capture collaborative benefits (Munksgaard & Medlin, 2014).

The sixth and final wicked element is related to competencies. Prahalad and Hamel (1990) described competencies as the collective learning within an organization needed to coordinate production skills and integrate technologies. Based on the cases Metal F and Textile A, we have found the core competencies of suppliers engaging in supplier-driven innovation to be T-shaped, that is, having a deep understanding of the technical and commercial domain of the business on one side and, on the other side, a complementary understanding of how knowledge and competencies are distributed and embedded with actors in the business network (Maula, Keil, & Salmenkaita, 2006; McGee & Sammut-Bonnici, 2002). Engaging in supplier-driven innovation calls for developing such “cross” competencies.

7.3 The innovative action space
It is important to note that the wicked elements of supplier-driven innovation do not exist in a vacuum. On the contrary, they appear and develop at different paces to different actors. Wicked problems are closely entwined, creating a high level of complexity due to the numerous elements and relationships among them. This implies that the search for solutions must involve a broad participation of the actors directly and indirectly affected, and decisions must be based on a wider spectrum of information sources (Mason & Mitroff, 1981). On one hand, by gathering and coordinating the technical and material options nested in sub-suppliers’ competencies and combining these with the suppliers’ own core competencies, spaces for joint innovation are then created, and sustainable solutions are co-created with key customers. On the other hand, by expanding the innovative spaces in the wider network with actors representing the using and producing setting respectively. However, the real wicked problem of supplier-driven innovation is combining the two.

We propose that the innovative action space of the firm comprises the innovative opportunities generated through co-creation with customers, users, and suppliers. The innovative space is kept alive and expanded through participants’ elaboration of co-creating competencies and the co-creation of a creative atmosphere. It is thus a vulnerable space fueled by collaborative ambiguity. To better understand the representation we sketch here, envisage a firm standing between two fields of knowledge—or user and supplier setting—that need to be brought into interplay. The firm must expand its own innovative action space as well as expand the borders of the collective space for innovative interaction.

It is a matter of not only fostering a joint technical space but also instituting a social space for collaboration and experimentation involving mutual social exchange and adaptation processes and a joint code of conduct for relationship management. The partners need to develop competencies for co-creation across their organizations. Clausen and Yoshinaka (2007) termed these processes the creation of “socio-technical spaces.” Altering their former engagement in production activities, suppliers turn to investments in new roles as network coordinators. This is in line with Gadde (2013), who argued that it is relevant to discuss how the evolving boundaries between partners affect the multiplicity of awareness and influence in the wider network, as well as with Andersen and Christensen (2005), who saw suppliers as nodes of translation between upstream suppliers and downstream users.

Engaging in supplier-driven innovation in the wake of the emerging transformation in the global production network entails handling the development of multiple interfaces, and effort is needed to build collective interests for releasing the innovation potential simply because the necessary supplier task is not easily specified and must be developed along the way. The supplier has to build understandings of the interest of the customer and their potential mutual and collective interest (in line with Munksgaard & Medlin, 2014). To build this understanding, the supplier requires knowledge extending beyond that of the
customer on material and technical possibilities to also introduce knowledge on how this understanding may be built in the wider network of their supplier-customer relationship.

8. Conclusion

In this study, we have examined supplier-driven innovation as opposed to the hyped term “user-driven innovation” for the simple reason that we find a growing number of suppliers taking on a renewed role as crucial innovative partners for their target customers. In doing so, they introduce knowledge and competencies co-created with their network of suppliers in order to combine upstream sources of knowledge with downstream knowledge and insights from the market served by their customers. The description of supplier-driven innovation provided in this study differs in viewpoint from the upstream view so often seen, which is the perspective of the contractor dominating research on suppliers’ innovative contributions. Our study has placed a more proactive role with the supplier, who tries to expand the innovative space with the customer and deliver access to knowledge and co-creations processes that generate new solutions the customer did not know in advance. An essential part of expanding the innovative space of the customers is to bridge and set in play the supplier’s own network of sub-suppliers. Further, this study has addressed a common phenomenon in the innovation literature of studies mainly focusing on companies who include only the existing suppliers/users in direct contact, excluding considerations of how to include the wider network of suppliers, users, and other partners. The aim of this contribution has been to investigate what characterizes the wicked elements of supplier-driven innovation.

The expansion of the innovation space of key customers forms the wicked problem of supplier-driven innovation generated by two intertwined constraints: the ability to engage customers in the co-creation of attractive offers and the ability to include technological knowledge and competencies residing in the upstream network of suppliers. From the present study of eight cases, six wicked elements of supplier-driven innovation are outlined. The first concerns a break with established routines for co-creating an offer. In collaborative ventures, it is hard to formulate a clear and stable problem that will lead to anticipated and intended solutions. Innovations that do not sustain dominant design and existing dominant networks are especially in need of co-creative experimentation leading to collective innovation spaces. The second element relates to the evolving boundaries between partners in the network and how the use of boundary-spanning objects creates innovation spaces. The third directs attention to internal developments of an extended key co-creation function, which is constructed to bridge technological options from sub-suppliers with customer needs. These first three elements relate to the wicked problem of bridging the emerging market and technological system.

The following three elements are related to the dominating design system and the network structure. The fourth wicked element presents the multiple roles of actors in the network as the same
partner may act in two roles, such as supplier and customer, at the same time. The fifth concerns the need to align self- and collective interests among partners for co-creating a collective mindset and valuable solution; and the sixth concerns the combination of partners’ competencies and the possibility of building cross competencies. The six elements are to be understood as interdependent and entwined as they will appear and develop in different phases to different actors.

The fundamental issue is how customers and suppliers jointly engage in supplier-driven innovation to frame a platform for co-creation and innovation. Several key issues involved are new to the research agenda’s framing of the network perspective on innovation in business systems.

First, we contribute to existing research illustrating the dynamics of innovation in business networks depending not solely on either an upstream or a downstream view of participatory innovation but instead on an exploratory view combining the two streams of research and practice. Second, we contribute with a distinction between a single firm’s innovation capacity and the collective notion of innovative action space. In our case studies, the expansion of the innovative action space depends on collective action falling in step, and thus its orchestration depends on the hidden competencies included in the innovative capacity of the individual firm.

Third, we have included design research in order to highlight how co-creation adds new perspectives in addition to those often held (knowledge sharing, outsourcing of NPD, etc.), namely that of experimenting, that is, being co-engaged in the generation of new ideas whose development may include sketching and the co-production of boundary spanning objects (e.g., iterations of prototypes, rapid prototyping, recipe development, etc.). Through co-creation activities, participants share not only knowledge but also emotions and perspectives and form mutual expectations leading to aligned creative processes. A new key co-creation function is even built in many firms striving to do supplier-driven innovation. This third contribution has important limitations to mention. The empirical foundation is still scant for in-depth studies of suppliers taking the lead as boundary-spanning actors forming innovative spaces with their customers. This explorative study did not include a close examination of the barriers embedded with perspectives forming supply-chain policies and routines of the contractors. The empirical foundation does provide thick insights about suppliers taking innovative lead positions. This limitation indicates multiple opportunities for further research. A few tracks are worth mentioning: (a) the need to study the formation of innovative action spaces in a managerial and organizational perspective; (b) the perspectives in studying the expected new role of supplier-driven innovation in forming flexible innovations systems, eventually leap-frogging established innovation networks and contractors controlling dominant design; and (c) the future role of 3-D scanning and printing, since they may work as boundary spanners in flexible innovation systems.
References


