ORCHESTRATING SOLUTION DEVELOPMENT IN INDUSTRIAL NETWORK

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Abstract

Solutions are typically developed in networks, which combine resources from multiple actors. Extant literature has shown that solution development is dependent on the relationships between the network actors. However, the processes and activities which are needed for orchestrating solution development network have remained unclear because solution development has been analyzed mostly from a single actor's perspective. Relying on literature on solutions and innovation networks, the present study develops a theoretical framework for orchestrating solution development network. Furthermore, the framework is empirically adjusted by conducting a single case study of a solution development network which consists of a supplier, a customer, a university and a financier. Data is acquired through seven in-depth interviews with all the network actors except the financier who was not actively involved in the solution development. The developed framework consists of six orchestration processes and altogether 28 orchestration activities. The results reveal that in orchestrating solution development network, also the on-going development process needs to be orchestrated. In addition, in solution development network the commitment of the members of the network is an important orchestration activity.

Keywords: Solution, Co-development, Network orchestration, Inter-organizational relationships

Paper type: 1) Competitive paper

INTRODUCTION

Integrating product and service elements into solutions that address and solve customers' problems has become the key focus of many firms' offering development (Tuli, Kohli and Bharadwaj, 2007; Fang, Palmatier and Steenkamp, 2008; Ulaga and Reinartz, 2011). Solution development appears to differ from traditional product and service development in terms of the degree of customization, and the number of involved actors in the development process. In fact, solutions are typically developed within networks which combine resources from suppliers, customers and third parties (Cantù, Corsaro and Snehota, 2012).

Extant literature has analyzed solution development from single actor's point of view and only recent studies have focused on solution development networks. These studies are focusing on the actor's roles in solution development (Cantu et al., 2012), capabilities needed for solution development (Gebauer, Paiola, and Saccani, 2013) and value co-creation in solution network (Jaakkola and Hakanen, 2013). However, the activities needed for building and maintaining solution development networks have been largely neglected in the academic research. As the transformation toward solution business implies increased organizational networkedness (Storbacka, Windahl, Nenonen, Salonen, 2013), it is important to take a network perspective into solution development. Moreover, the solution development remains an unexplored research area and further research is called for the topic (Brax and Jonsson, 2009; Evanschitzky, Wangenheim and Woisetschläger, 2011).

To address the aforementioned gaps in developing solutions in networks, the purpose of this paper is to analyze the orchestration of solution development network. More precisely, the research aims to answer the following research question: How should an established solution development network be orchestrated? The study focuses on the orchestration of an already established solution development network, as we acknowledge that the building of the network requires special activities which are affected by the type of the solution to be developed (Gebauer et al., 2013).

We build both on the literature on solution development (e.g. Windahl and Lakemond, 2004; Brax and Jonsson, 2009) and strategic networks (e.g. Jarillo, 1988; Dhanaraj and Parkhe, 2006) to analyze the hub firm's activities in orchestrating solution development network. Network orchestration refers to the actions that the hub firm takes in order to create value in the network (Dhanaraj and Parkhe, 2006). By hub firm we refer to an actor that sets up and proactively takes care of the network (Jarillo, 1988). Typically, in solution development, the supplier takes actions in developing the solutions, and thus the supplier is here regarded as the hub firm whose actions are analyzed.

At the present paper we firstly develop a theoretical framework based on extant understanding on orchestrating innovation networks and the identified characteristics of solution development. Secondly, the developed theoretical framework is empirically adjusted by conducting a single case study of a solution development network which consists of an industrial supplier, its customer, a university and a financier. The study relies on seven interviews conducted with members representing three different actors in the solution development network. The findings reveal six different orchestration processes which are further divided in 28 activities for orchestrating solution development network.

The paper is organized as follows. First, the characteristics of developing solutions in networks are presented. Second, the variety of network approaches as well as a theoretical

framework of the processes and activities in orchestrating solution development network is introduced. The third section explains the used methodology and fourth, the studied case is described. Fifth, the findings as well as the empirically adjusted framework for orchestrating solution development network are presented. Finally, the paper ends with conclusions including brief introduction to some future research avenues.

SOLUTION DEVELOPMENT IN NETWORKS

Co-creating solutions is today a broadly utilized way of doing business in industrial markets. Solutions can be defined as "individualized offers for complex customer problems that are interactively designed and whose components offer an integrative added value by combining products and/or services so that the value is more than the sum of the components" (Evanschitzky et al., 2011, pp. 657). However, solutions can also be regarded as a relational process between the supplier and the customer (Tuli et al., 2007), which emphasizes the customer's role in the solution development.

Solution development has proven to be extremely challenging for the companies, and yet it is unclear how solutions should be developed (Brax and Jonsson, 2009; Evanschitzky et al., 2011). The challenges of solution development lay in the solution characteristics. Solution development differs from the traditional product development because solutions are complex and multi-functional, they demand many knowledge inputs and include many tailored components (Hobday, 1998). As customers are often involved in the solution development (Cova and Salle, 2008; Tuli et al., 2007), the management of the development process is extremely important to ensure the future of customer relationships.

However, solution development is rarely a dyadic process between the supplier and customer. Operating in solution business requires collaboration across organizational boundaries and increases companies' networkedness (Storbacka et al., 2013). Thus, solution development often involves also actors such as users and governmental agencies (Hobday, 2000). Thus, according to the extant literature, the development of solutions typically includes a wide network of actors having varying resources (Cantù et al., 2012). These solution networks can be defined as "the set of actors, i.e. multiple suppliers and the customer, that are connected to each other for the purpose of integrating their resources to co-create value through solutions" (Jaakkola and Hakanen, 2013, pp. 48).

Solution development networks have been vastly neglected in the academic studies. Most of the extant literature has taken a single actor's perspective on solution development (Gebauer et al., 2013) and therefore, the activities and processes which are needed for orchestrating solution development network have remained unclear. However, these processes to orchestrate a solution development network require coordination of the various actors (Ritala, Hurmelinna-Laukkanen and Nätti, 2012) and balancing between the actors' diverging goals, perceptions, power constellations, and cultures (Corsaro et al., 2012). Furthermore, solution development networks do not emerge but they must be intentionally built by the focal actor (Gebauer et al., 2013).

Network orchestration in solution development is crucial. Many of the challenges in the solution development are connected to the relationships and interactions between the network actors (Windahl and Lakemond, 2006). Solutions emerge in interaction in which the actors' resources are combined (Cantù et al., 2012). This interaction relies on the inter- and intra-

firm relationships within the network (Windahl and Lakemond, 2006). Extant literature suggests that for example the creation of actor bonds is important as they can improve the use of resources within the network (Jaakkola and Hakanen, 2013). Also the actors' position and related power in the network must be coordinated because dominating actors can threaten the development (Corsaro et al., 2012). Therefore, the orchestration of solution development network requires multiple different kinds of activities which the extant literature has not fully depicted.

The challenges in solution development are also related to the long-term orientation related to solutions. Solutions are not just single transactions but they are long-term oriented systems, which integrate the supplier as part of the customer's process (Brax and Jonsson, 2009). Solution development is also often an iterative process during which the developed solution is constantly further developed on the basis of the customer's feedback. Therefore, solution provider must continually satisfy the customer as the customer need may develop over time (Evanschitzky et al., 2011). This sets challenges for the solution development network because in order to be able to answer the changing customer needs, the network must evolve over time.

Another challenge in solution development is their highly customer oriented nature. Solutions are developed for the customer's needs and therefore also the solution's impact on customer's internal activities and core processes should be taken into account in the development process (Windahl and Lakemond, 2006). However, as the customer needs are also dependent on the customer's network, the solution development network should take a larger perspective on a solution development. Epp and Price (2011) argue that also the customer network actors' goals should be taken into account in solution development while these goals affect the customer satisfaction. Therefore, besides the fact that solution development in network requires coordination of various actors, it also requires coordination outside the life-time of the developed solution and outside the solution development network.

As shown above, approaching solution development with a network perspective includes various levels of networks. Yet, from the theoretical perspective, there is extensive variety of theoretical traditions discussing these networks. These theoretical approaches are partly overlapping, but still in order to commit a consistent research the selection and utilization of these network related concept should be made visible. Thus, at the following chapter the selection of the followed network approach is made.

ORCHESTRATING SOLUTION DEVELOPMENT NETWORK

NETWORK APPROACH TO UNDERSTAND SOLUTION DEVELOPMENT

Research interest on the holistic systems beyond single actors and relationships between them has generated extensive amount of studies on networks. This interest has appeared in various disciplines, such as sociology, computer science, and business studies. Thus, it is not striking that several theoretical approaches and discourses to understand networks have emerged. Although the focus of the present paper is only on the business studies, the gamut of the alternative approaches is extensive (see e.g. Iacobucci, 1996; Borgatti and Foster, 2003). There are slightly differing network approaches such as strategic groups (Porter, 1985; McNamara, Deephouse, and Luce, 2003; Osborne, Stubbart, and Ramaprasad, 2001), actor network theory (Latour, 1987; Egels-Zandén and Wahlqvist, 2007; Geiger and Finch, 2010),

ecosystems (Moore, 1993; Iansiti and Levien, 2004; Basole and Karla, 2011), and channel management literature (Guiltinan, 1974; Stern and Reve, 1980; Achrol, Reve, and Stern, 1983).

A commonly known approach to understand business networks is the industrial marketing and purchasing group's work on business relationships and interaction within them. The approach is termed as the industrial network approach (Ford, 1980; Ford, Håkansson, and Johanson, 1986; Håkansson and Johanson, 1992). The approach is based on the ontological perspective that markets are interconnected webs of dependent exchange relationships that are built on actors' bonds, activity links, and resource ties (Håkansson and Johanson, 1992; Anderson, Håkansson, and Johanson, 1994; Easton and Håkansson, 1996). In compliance to the theory, network is not owned by any particular company. Also, although many companies might believe that they are at the "center" of the network, no company is the hub of the network as there is no center (Ford, Gadde, Håkansson, and Snehota, 2003). Accordance with the theory, it is not central to understand the management of the network, but the management in the network. In that sense, as the purpose of the present study is to increase understanding on focal actor's activities when developing solutions with partners, the theory has its limitations.

A theoretical tradition on strategic networks has as well an established position among the researchers on business studies and especially on strategic management (Jarillo, 1988, Gulati, Nohria, and Zaheer, 2000). Strategic networks are based on inter-organizational ties, with strategic significance for the including companies and those ties are relatively stable by their nature (Gulati et al., 2000). These strategic networks include strategic alliances, long-term buyer-supplier partnerships, and joint ventures (Gulati, 1999; Gulati et al., 2000; Gerwin, 2004). In the strategic alliances companies' cooperation is based on formalized and collaborative agreements, and thus those are deliberately formed structures to meet the goals of the alliance (Das, Sen, and Sengupta, 1998; Gulati et al., 2000).

The extant literature on networks includes an interesting debate about the management of networks. These network approaches embodies concepts such as network orchestration (Dhanaraj and Parkhe, 2006, Nambisan and Sawhney, 2011), network governance (Provan and Kenis, 2007), whereas the scholars leaning on the industrial network approach argues that the network cannot be centrally managed, although all companies try to manage within it (Ford, Gadde, Håkansson, and Snehota, 2003). Based on the literature on the loose coupling and complex systems (Simon, 1962; Orton and Weick, 1990), the researchers among the strategic network discourse have developed the concept of network orchestration to understand the management activities of a hub firm in a network (Dhanaraj and Parkhe, 2006; Ritala, Armila, and Blomqvist, 2009; Nambisan and Sawhney, 2011). Since, having suitable tools to understand a single actor's orchestration processes of a solution development network, the strategic network discourse with the network orchestration process is selected as the theoretical ground for the present study. In addition, describing the solution development components as well as network dimensions is consistent with the ARA model (Håkansson and Snehota, 1995), which disaggregates networks into Actors, Resources and Activities. Actors capture the horizontal and vertical dimensions of the solution development networks; they can be positioned vertically, i.e. downstream and upstream in the value chain of the hub firm, as well as horizontally (e.g. auxiliary service providers). Activities reflect the components of the solution development process and the later in-depth study illustrates the resources part of the ARA model in that case solution development network.

Orchestration in networks has aroused an emerging research interest. Network orchestration can be defined as "the set of deliberate, purposeful actions undertaken by the hub firm as it seeks to create value (expand the pie) and extract value (gain a larger slice of the pie) from the network" (Dhanaraj and Parkhe, 2006, pp. 659). The central actors in a network are known with various concepts, such as hub actors (Jarillo, 1988; Dhanaraj and Parkhe, 2006), brokers (Lingo and O'Mahony, 2010), key actors (Knoke, 1994), triggering entities (Doz, Olk, and Ring, 2000), strategic centers (Lorenzoni and Baden-Fuller, 1995), and flagship firms (Rugman and D'Cruz, 2000). At the present study we lean on the concept of the hub firm, since it possesses clear focus on matching actors, having central position on the network, and tend to lead the network. These hub firms are understood as actors setting up the network and taking a pro-active attitude (Jarillo, 1988). Dhanaraj and Parkhe (2006, p. 659) define a hub firm "as one that possesses prominence and power gained through individual attributes and a central position in the network structure, and that uses its prominence and power to perform a leadership role in pulling together the dispersed resources and capabilities of network members".

Network orchestration is argued to include three processes, which are ensuring knowledge mobility, managing innovation appropriability and fostering network stability (Dhanaraj and Parkhe, pp. 2006). Each of these tasks is further divided in the activities, which the hub firm takes in orchestrating the network. Ensuring knowledge mobility includes not only the knowledge sharing but also its deployment whereas managing innovation appropriability refers to capturing the value that the network creates, and fostering network stability aims to create stability, which allows actors to join and leave the network (Dhanaraj and Parkhe, 2006).

Nambisan and Baron (2011) have identified two more innovation network orchestration processes, namely managing innovation leverage and managing innovation coherence. Managing innovation leverage refers to the activities in which the hub firms aims to improve the sharing of network's resources while managing innovation coherence relates to alignment of processes and outputs within the network and against the external environment (Nambisan and Baron, 2011). These studies provide altogether five different orchestration processes for managing innovation network. However, since the innovation networks are differing on their nature compared to solution development network, the extant frameworks need to be complemented and adjusted with the solution development perspective. The following Figure 1 assembles the five orchestration processes and activities needed for managing solution development network and the activities are discussed next in more detail.
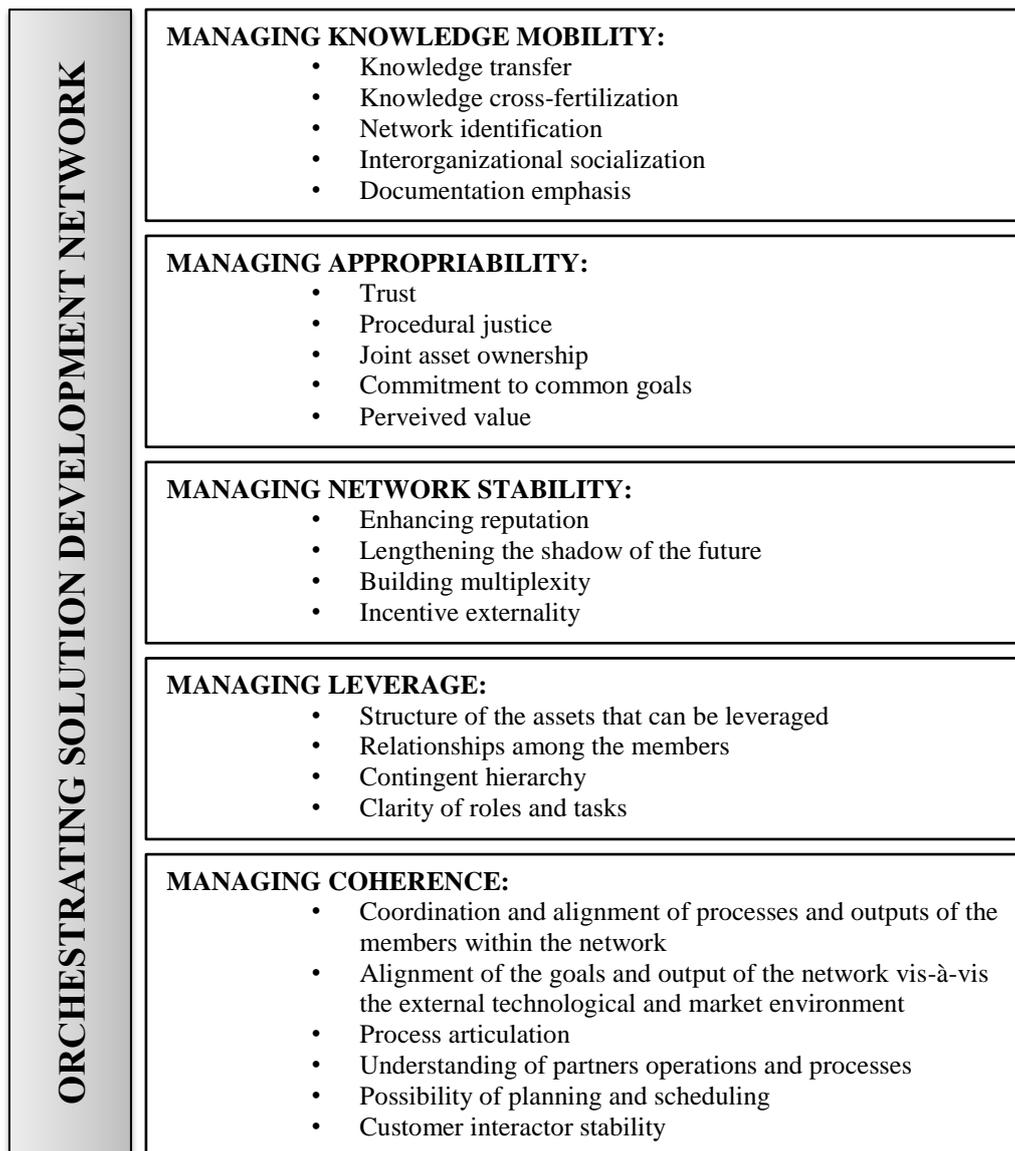
Figure 1. Theoretical framework for orchestrating solution development network.

Literature on solutions identifies multiple factors that affect the solution development. For example Tuli et al., (2007) argue that solution development is a relational process, which is affected both by the supplier and the customer variables. This study focuses on the supplier's network orchestration activities and therefore the customer variables which are understood as activities which the customer takes during the solution development are left outside the analysis. Furthermore the focus is on the factors that are related to the solution development process and not on the factors that are related to the outcome of the process. The factors related to supplier are contingent hierarchy, documentation emphasis, incentive externality, customer interactor stability and process articulation (Tuli et al., 2007). Furthermore, Hakanen and Jaakkola (2012) identify six more factors affecting solution development: 1) commitment to common goals, 2) clarity of roles and tasks, 3) possibility for planning and scheduling the process, 4) understanding on partners' operation and processes, 5) trust and rapport, and 6) perceived value in co-operation (Hakanen and Jaakkola, 2012). In this study these factors are seen as activities that the hub firm should take in orchestrating the network.

The orchestration process managing knowledge mobility includes activities of knowledge absorption, network identification and interorganizational socialization (Dhanaraj and Parkhe, 2006). In this study knowledge absorption is further divided in knowledge transfer and knowledge cross-fertilization, because knowledge cross-fertilization is emphasized in solution development (Liu and Hart, 2011). Knowledge cross-fertilization refers to "the process of companies bringing back knowledge from different network alliances which they work on to develop advanced or new knowledge" (Liu and Hart, 2011, pp. 693). Network identification refers to increasing the common identity among network members while interorganizational socialization is understood as the activities during which the hub tries to create linkages between the network actors (Dhanaraj and Parkhe, 2006). Furthermore, we see documentation emphasis as part of managing knowledge mobility. Documentation emphasis in solution development refers to the extensity of which the process is documented (Tuli et al., 2007).

Managing appropriability consists of trust, procedural justice and joint asset ownership (Dhanaraj and Parkhe, 2006). As commitment to common goals and perceived value are seen as important in solution development (Hakanen and Jaakkola, 2012), in the developed framework they are regarded as activities belonging to the managing appropriability. Trust and rapport among network actors is seen as a condition for solution development as well as commitment to common goals which makes the collaboration smooth (Hakanen and Jaakkola, 2012). Procedural justice refers to activities which encourage collaboration despite the uncertainty of the final output e.g. consistency in decision making, while joint asset ownership motivates actors to participate in collaboration (Dhanaraj and Parkhe, 2006). Perceived value refers to the value, which the actors taken part in the development perceive from the co-operation (Hakanen and Jaakkola, 2012).

Managing network stability is an orchestration process that includes enhancing reputation, lengthening the shadow of the future and promoting multiplexity (Dhanaraj and Parkhe, 2006). Enhancing reputation refers to the hub firm's own reputation and it encourages network actors to join and stay in the network (Dhanaraj and Parkhe, 2006). Shadow of the future relates to the expected reciprocity in making favors and it encourages actors to collaborate in the hope of future benefits while promoting multiplexity encourages actors to join additional projects with network members (Dhanaraj and Parkhe, 2006). Incentive externality is regarded as part of managing network stability because it refers to the extent in which the incentives complement to each other and thus support developing solutions (Tuli et al., 2007). In this study incentives are not seen only as financial but they are seen to include all incentives which encourage members to collaborate and stay in the network.

Managing leverage includes taking care of the structure of the assets and relationships between members so that resources can be leveraged (Nambisan and Baron, 2011). In solution development network leveraging requires also supplier-related activities of contingent hierarchy and clarity of roles and tasks (Tuli et al., 2007; Hakanen and Jaakkola, 2012). Contingent hierarchy refers to the multiple and flexible hierarchical arrangements, for example changes in the relationships, that are needed in solution development to answer the customer needs (Tuli et al., 2007).

Final orchestration process, managing coherence, includes activities of managing the inner and external alignment of processes and outputs (Nambisan and Baron, 2011). Furthermore, customer interactor stability, process articulation and understanding of partner's operations and processes are seen as supplier-related factors affecting the solution development (Tuli et al., 2007; Hakanen and Jaakkola, 2012). Customer interactor stability refers to the time,

which the interactor is assigned to customer as longer time enhances a capability to customize the solution (Tuli et al., 2007). Process articulation is understood as activity in which the supplier clarifies the processes of solution development (Tuli et al., 2007). Understanding of partner's processes is seen to improve solution development while it makes the knowledge transfer more effective (Liu and Hart, 2011; Hakanen and Jaakkola, 2012; Corsaro et al., 2012). In solution development also possibility of planning and scheduling is emphasized (Hakanen and Jaakkola, 2012) and here it is regarded as part of managing coherence. After introducing the tentative framework for orchestrating solution development the sequential step is adjusting the framework empirically. Thus, the next chapter of the paper introduces our methodological approach to do the adjustment.

METHODOLOGY

The study aims to generate profound understanding about the processes and activities involved in orchestrating solution development networks. As extant studies have mostly taken a single actor or dyadic perspective on solution development (Gebauer et al., 2012), we extend the perspective of the studied phenomenon to the viewpoint of multiple actors in the solution development network. Thus, the unit of analysis is the solution development network including various actors, and by studying the solution development network we attempt to understand the hub firm's orchestration activities in that network.

The present research is abductively developing theory on orchestrating solution development network instead of testing one. Thus we build a theoretical framework based on the extant literature and subsequently develop it with empirical data. We approach the complex social phenomenon qualitatively by conducting an exploratory single case study. According to extant literature, the case study approach is found to be particularly suitable when there is only a little knowledge on the phenomenon, the phenomenon is broad and complex, current theories seem inadequate, the phenomenon cannot be studied outside its natural context, and when studying complex and unique social systems (Bonoma, 1985; Eisenhardt, 1989; Easton, 1995; Miles and Huberman, 1994; Yin, 2008). Even though case studies are criticized due to a lack of statistical representativeness, they offer a depth and comprehensiveness for understanding the studied phenomenon (Easton, 1995). Since the studied phenomenon at the present study is complex and broad, it is based on social interaction between actors, and there is relatively little known of orchestrating solution development network, the case study seems to be suitable approach to utilize at the present study. An in-depth single case study design was selected to gain a deep and profound understanding of the processes and activities within the solution development network (Halinen and Törnroos, 2005).

In case study research the selection of the studied case(s) is a critical event (Yin, 2008; Eisenhardt, 1989). Eisenhardt and Graebner (2007) argue that the selection of the case should be made by the means of the theoretical sampling. According to Yin (2008), in single case studies, the selected case should be unusually revelatory, have extreme exemplars, or opportunities for unusual research access. However, since having a specific research context, the case selection criteria were supplemented with a fourth criterion. Firstly, the studied solution development network should have the long-term traditions of co-developing solutions, which ensures that the orchestration processes have already developed. Secondly, the solution development network should be operating in industry with traditions to co-develop solutions. Thirdly, the heterogeneity of actors in the studied solution development

network should be relatively extensive. The heterogeneity ensures that the diversity of orchestrating network is observable. Finally, the studied network should have clear boundaries to ensure the clear focus on the relevant actors.

Based on these criteria, an extreme exemplar solution development network including an industrial supplier (global provider of mining technology and services), its customer (unit of global mining company), a university, and financier (funding agency) was selected for the study. The particular network has long history of co-developing industrial solutions ensuring that the orchestration processes and activities are developed. In addition, the solution development network is operating in the mining industry, which has in the recent years emphasized the solution business. Furthermore, the selected network has clearly identifiable boundaries and still the heterogeneity of actors is adequate for the purposes of our study.

Interviews were used as data collection method, since they are suitable in research requiring in-depth understanding or discussing on delicate issues. In addition, interviews provide opportunity for clarification (Eriksson and Kovalainen, 2008). The study draws on seven in-depth interviews with two managers working for the supplier, three customer representatives, and two university researchers (see Table 1 for interviewees). The persons of the financier were not interviewed, since they did not have a notable role in the studied case. The interviewees (n=7) were selected by employing the snowball method (Biernacki and Waldorf, 1981) after first contacting the supplier's automation director who was known to be active in this solution development network. Subsequently, each interviewee pointed persons who have played a central role in the development network.

Table 1. Interview sample.

Actor	Title	Duration
Supplier	Automation Director	59 min
	Development Manager	1 h 46 min
Customer	Manager of Processing	1 h 41 min
	Safety, Health and Environmental Manager	1 h 6 min
	Mill Superintendent	37 min
University	Post-doctoral Researcher 1	1 h 22 min
	Post-doctoral Researcher 2	1 h 10 min
	Total:	*8 h 41 min*
	Average:	*1 h 14 min*

Each of the interviewees was asked open ended questions related to the solution development network. The questions covered themes such as the development process, interaction during the process, actors' resources, activities and collaboration. All the interviews were recorded and transcribed.

The analysis phase of the research process included the coding of the data with the specific coding framework. This deductive content analysis (Miles and Huberman, 1994) was made with the help of NVivo software. The interviews were coded according to the theoretical framework developed from the extant literature and introduced above. The utilized coding nodes were the network orchestration activities. Thus, the emerging of the each orchestration activity from the data was made possible. The approach also enabled to point out the activities that may not emerge from the data but were found from the extant literature. In

addition, new coding nodes were created if needed, and thus the activities that did not emerge from the extant literature but emerged from the data could be identified. Finally the activities were compared to the orchestration processes at the pre-formed framework and necessary adjustments to the framework were made. At the following chapter the studied case is depicted more thoroughly.

CASE DESCRIPTION

The actors in the studied case network have collaborated on multiple projects. These projects have aimed at developing solutions such as remote control or education systems for the mining processes. The developed solutions consist of technology such as analyzers and supporting services such as education, remote control and software.

The actors have collaborated in this form about ten years while the collaboration team at personal level has been the same about seven years. Due to the long history that the actors have together, collaboration is based on close personal relationships and high mutual trust. The solution development team has been almost the same during the years and all persons know each other well. The team includes about ten persons depending on the type of solution to be developed. Three members are from the customer's organization, two are researchers from the university and the rest two to four persons are managers from the supplier's organization.

A key characteristic in the studied solution development network is the complementarity in the actors' resources. Therefore, each actor is needed for successful development. The supplier has resources to develop prototypes and commercialize new solutions while the university has resources to create new ideas and test them. The customer is motivated to test new solutions and provides a real mining process in which the developed prototypes can be tested. The financier wants to advance the development of new solutions and provides funding for risky development processes that focus on creating new solutions.

The supplier can be seen as the hub firm in the network because it is the one who sets the direction for the development process and commercializes the developed solution. However, the university often coordinates the actual development phase because it has more resources to document the process and organize meetings. The supplier and the university are the most active actors in the solution development process. The customer's role is mainly to comment on suggested ideas and provide testing facility for the prototypes. The financier is not taking part in the actual development, though it has set some limitations for the collaboration. For example, the financier insists that the solutions are not too customized for the customer's need so that also other customers can implement the solutions. At the next chapter, the findings from the data are discussed as well as the final version of the framework for orchestrating solution development network is suggested.

FINDINGS

All the five orchestration processes: managing knowledge mobility, managing appropriability, managing network stability, managing leverage and managing coherence,

that were identified from the literature emerged also in the studied solution development network. However, some of the activities that were part of the theoretical framework did not appear in the studied case while few additional activities emerged from the data. Furthermore, a sixth additional orchestration process emerged from the studied solution development network and is named as managing on-going development process. The empirically adjusted framework is depicted in Figure 2 and next the orchestration processes are discussed in detail with illustrating quotes from the interviewees.
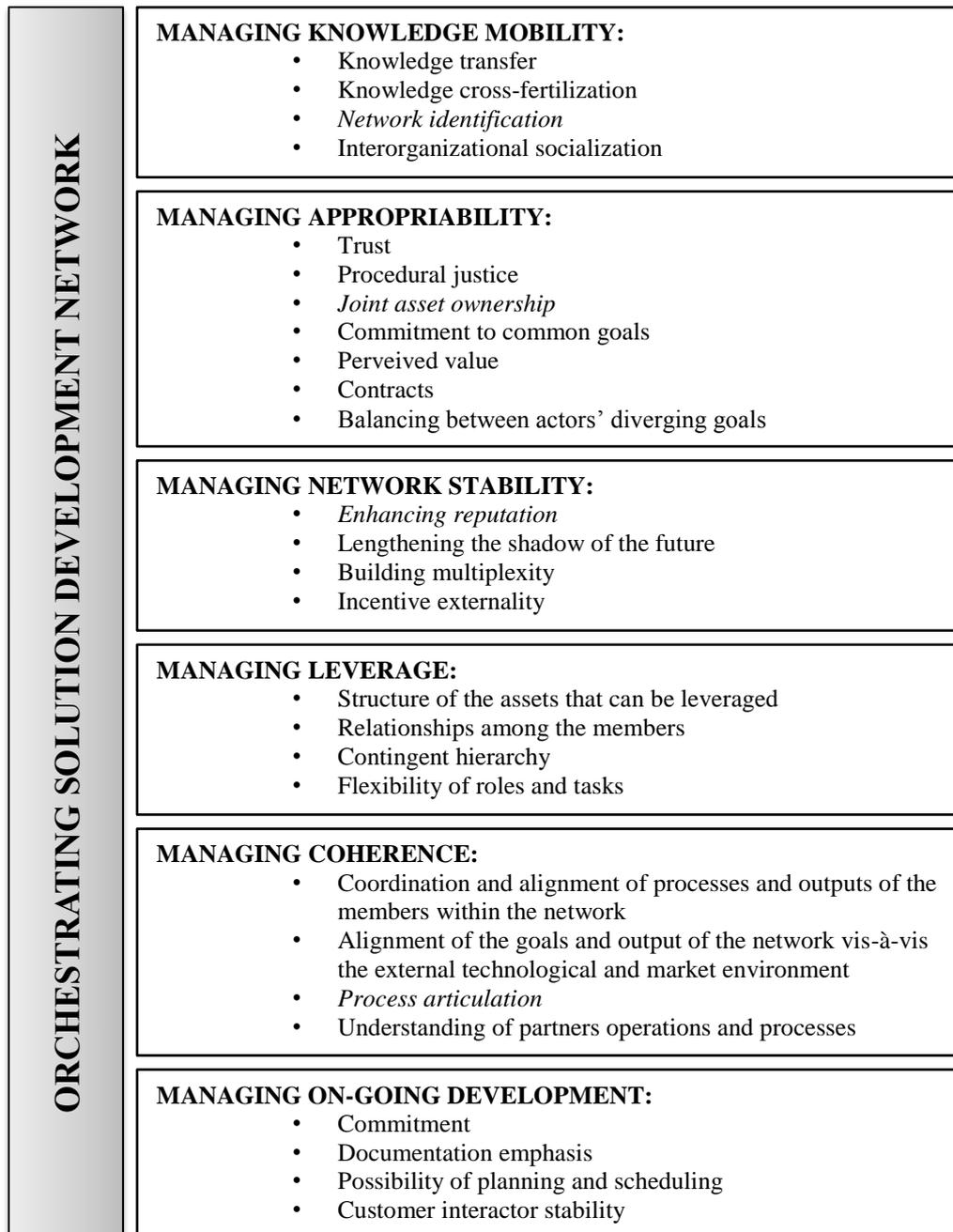
ORCHESTRATING SOLUTION DEVELOPMENT NETWORK

MANAGING KNOWLEDGE MOBILITY:
- Knowledge transfer
- Knowledge cross-fertilization
- *Network identification*
- Interorganizational socialization

MANAGING APPROPRIABILITY:
- Trust
- Procedural justice
- *Joint asset ownership*
- Commitment to common goals
- Perveived value
- Contracts
- Balancing between actors' diverging goals

MANAGING NETWORK STABILITY:
- *Enhancing reputation*
- Lengthening the shadow of the future
- Building multiplexity
- Incentive externality

MANAGING LEVERAGE:
- Structure of the assets that can be leveraged
- Relationships among the members
- Contingent hierarchy
- Flexibility of roles and tasks

MANAGING COHERENCE:
- Coordination and alignment of processes and outputs of the members within the network
- Alignment of the goals and output of the network vis-à-vis the external technological and market environment
- *Process articulation*
- Understanding of partners operations and processes

MANAGING ON-GOING DEVELOPMENT:
- Commitment
- Documentation emphasis
- Possibility of planning and scheduling
- Customer interactor stability

Figure 2. Framework for orchestrating solution development network. (The activities that did not appear in the case example are presented with italics font)

In managing knowledge mobility the activities interorganizational socialization, knowledge transfer and knowledge cross-fertilization were identified in the studied case. However, network identification did not appear in the interviews and based on the empirical example, documentation emphasis was regarded as part of managing on-going development process. The change of the activity to another orchestration process was made, since due to on-going nature of solution development, the role of documentation was found to be emphasized. With efficient documentation the network may lean on the existing knowledge when renewing or restarting the solution development.

Interorganizational socialization was emphasized in the studied network as all the members of the development network knew each other well. This led to the situation where the knowledge transfer was fluent and it happened also in informal occasions. Knowledge transfer during the development phase took place in formal meetings but informal knowledge transfer was seen important especially in the ideation phase. This suggests that different kinds of orchestration activities are needed in different phases of the process. As interviewees put it:

> "Ideas come often in informal environment but the collaboration is quite formal"(Supplier's Automation Director)

> "it [communication] was quite direct and spontaneous." (Customer's Safety Health and Environmental Manager)

Knowledge cross-fertilization happened in meetings in which the actors collaborated in and in on-site tests when the developed solutions were integrated as part of the customer's process.

MANAGING APPROPRIABILITY

In the studied solution development network managing appropriability included the following activities: trust, procedural justice, commitment to common goals and perceived value. Joint asset ownership did not appear in the studied case, though two additional activities in the process of managing appropriability emerged in the data and they are named as contracts and balancing between actors' diverging goals.

All the network actors agreed that the collaboration is based on high mutual trust and personal relationships. Mutual trust also supports managing knowledge mobility because mutual trust enables openness and sharing of knowledge. As the interviewees state:

> "X [Customer] is extremely good partner, they do not have any confidentiality issues…they have given access to all databases and they help us when needed." (Post-doctoral Researcher 2)

> "For example X [one of the supplier's managers] I have known for 25 years so I know that tasks are taken care of. Also the others, they are all good guys. It is based on mutual trust."(Manager of Processing)

> "We don't have any secrets." (Mill Superintendent)

Besides mutual trust, also the importance procedural justice was brought up in the interviews and interviewees stated that the collaboration took place in formal meetings. Similar to

procedural justice, also contracts were identified to ease the collaboration. However, the contracts were not seen as important for each actor. They were most important for the supplier because contracts were a tool for sharing the intellectual property rights. Furthermore, the importance of contracts was emphasized especially in the early phase of the development process, but after they had been signed their importance decreases.

Commitment to common goals was identified important, but it emerged from the data that the actors should understand the diverging goals that the actors have. For example, the university has to publish its research findings, which diminishes time from the development. Therefore, the actor acting as a hub firm must balance also between the actors' diverging goals.

Perceived value for each actor is slightly different. The supplier gets value from commercializing the developed solution, the customer gets competitive advantage while the developed solution makes its process more effective, and the university gains reputation and money from the published research results. From the point of view of the collaboration, it appears that is good that the actors are aiming different kinds of value, because it helps sharing the value.

<div align="center">MANAGING NETWORK STABILITY</div>

In the process of managing network stability, building multiplexity, lengthening the shadow of the future and incentive externality appeared in the data but enhancing reputation was not identified to be important. As the actors have collaborated for a long time, they have already built multiplexity over the multiple projects that they have shared. Still it was seen as important in managing network stability and new projects were set up also for continuing the collaboration in times when project was ending and new project was not seen to start right after that. Almost all the interviewees state that the good results in earlier projects encourage continuing the collaboration which can be seen as a form of lengthening the shadow of the future:

> *"We got also some good results and that may also be one reason why X [Customer] is willing to continue" (Post-doctoral Researcher 1)*

> *"There has been multiple projects and in all of them we have gone little bit forward" (Customer's Safety Health and Environmental Manager)*

Incentive externality encouraged the actors to continue the collaboration in solution development. However, all the actors in the studied network were so motivated to collaborate, that incentives were not widely used. The customer was offered discounts on the developed solution if it decided to acquire the commercial version. In addition, person taken part in the collaboration were entitled to have compensation if they developed a solution that could be patented.

<div align="center">MANAGING LEVERAGE</div>

All the activities that in the literature were identified as part of managing leverage appeared also in the studied solution development network. The structure of the assets had been managed already when the collaboration was started as each actor had complementary resources to be provided to the network. All the actors had also good relationships and as the collaboration had continued about a decade, there was not need to build new ties between the actors.

Flexible hierarchical arrangements, also known as contingent hierarchy was identified in the studied solution development network when the coordination of the development phase shifted to the university. Flexibility occurred also in the actors' roles. Even though each actor had their basic tasks, the tasks changed according to the development process' requirements. As one interviewee states:

> "I guess in these projects the roles are not that clearly defined. If we see that some person is useful, we take use of them" (Customer's Mill Superintendent)

The development team also had some short-term personnel, such as master thesis workers or research assistants who could be used as extra resources in the development process. Therefore, in the developed framework, the clarity of roles and tasks is updated as flexibility of roles and tasks.

MANAGING COHERENCE

In the orchestration process of managing coherence, the activities alignment in the network and in the external environment as well as understanding of partners operation and processes emerged in the data. Also customer interactor stability emerged in the data but in the studied network it was seen as part of the process on managing on-going development. Process articulation did not emerge in the data, probably because the network had operated for such a long time that the process is familiar for all the members.

As the partners had many years of history in collaboration, their understanding of each other's processes was found to be extensive which was seen to improve the collaboration. The coordination and alignment of processes and outputs of the members was done effectively, because in the time when the development was intensive, the university took care of the bureaucratic coordination tasks.

Alignment of the external environment's goals was emphasized in the studied solution development network. As solutions are always customized, collaboration with one customer can lead to a situation where the developed solution does not answer the external market environment's needs. It was the supplier's tasks to ensure that the developed solution is also suitable for other customers. As interviewees point out:

> "If we co-develop a lot with one customer, there is a risk that the developed products are too customized to that particular customer" (Supplier's Automation Director)

> It should be seen as a larger entity. We should not solve only the X's [Customer's problem] but we should solve a general problem and them make some effort in solving the X's [Customer's] case. (Supplier's Development Manager)

MANAGING ON-GOING DEVELOPMENT

The network orchestration process of managing on-going development emerged from the studied solution development network. In the studied network, the solution development was typically continuous when the developed version of the solution was further developed and

improved in the following development projects. This set the hub firm a challenge of managing the on-going development process. One of the key activities in the management of the on-going development was identified to be commitment which is understood as committing the project team members into the on-going solution development. Multiple interviewees pointed out that there is a huge risk if the key people leave the team:

> *"The biggest risk is that if one person is responsible of some critical part of the project and he/she decides to leave" (Researcher 1)*

> *"These Researcher 1 and Researcher 2 have been all the time involved and they are the critical people…If they leave, then it is going to be tricky." (Customer's Manager of Processing)*

Documentation emphasis and possibility of planning and scheduling was regarded important. For example it was pointed out that careful documentation of all the ideas that come up is important, because even though they might not be used in the current development project, they might offer collaboration possibilities in the future.

In the examined case example it was identified that customer interactor stability is important in managing the relationships to the customer. If the person changes, the change should happen in a longer period of time show that the relationship is not affected.

CONCLUSIONS

The purpose of the research was to increase understanding on solution development and especially the orchestration of solution development network. The study developed a theoretical framework of the processes and activities needed in orchestrating solution development network. The developed framework for orchestrating solution development networks builds on the orchestration of innovation processes (Dhanaraj and Parkhe, 2006; Nambisan and Parkhe, 2011) and the literature on solutions (Tuli et al., 2007; Liu and Hart, 2011; Hakanen and Jaakkola, 20122). The framework was empirically adjusted through a single case study of a solution development network.

The research contributes to the literature on solution development networks (Cantù et al., 2012; Jaakkola and Hakanen, 2013) by suggesting processes and activities that the hub firm takes in orchestrating solution development network. The developed framework includes six orchestration processes: managing knowledge mobility, managing appropriability, managing network stability, managing leverage, managing coherence, and managing on-going development process. In our study, the management of on-going development process emerged as a new important orchestration process. The finding is supported also by the extant literature, since for example Evanschitzky et al. (2011) have argued that the once developed solutions must answer the changing customer needs in continuous manner. For the hub firm this means that it should commit the members into an on-going development.

In the developed framework the orchestration processes are further divided in altogether 28 activities. Our case example suggests that different kinds of orchestration activities might be more effective in different phases of the development process. For example the study revealed that in the ideation phase, interorganizational socialization is important while in the development phase the actors relied more on procedural justice.

An obvious limitation for the study is the single case study method, which limits the generalizability of the results. The studied solution development network had been operating for many years and thus, the orchestration processes and activities needed in building the network were not studied. Furthermore, in order to simplify the research setting, the studied solution development network was limited in size and thus in future studies on more complex solution development networks could emerge new orchestration processes and activities.

For future research the study offers some fruitful research avenues. We urge researchers to study orchestration processes and activities in different phases of the solution development as our study suggests that different activities might be useful in different phases of the process. Furthermore, future studies could take a look at the orchestration processes and activities which are needed in building the solution development network. Solution development networks are still an understudied research area and we believe that our study encourages more research on this important topic of orchestrating solution development networks.

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