
Digital Platform Ecosystems – from information transactions to collaboration impact

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Abstract: The fourth industrial revolution triggered by internet development provides opportunities for development of a digitalized industry, “Industry 4.0”, which make the manufacturing industry, call for development of intelligent manufacturing. B2B innovation ecosystems of digital platforms have emerged to meet the demands of firms to enhance their innovation capacity through networking in the global knowledge economy. The purpose of this paper is to explore collaboration challenges and mechanisms for reaching value creation in the context of key actors’ development of a B2B digital platform ecosystem for fostering open innovation in the manufacturing industry. The paper addresses collaboration challenges key partners face in the development of B2B digital platform ecosystems in early phases. What is the core mechanisms’ fostering value creation and what is serving as barriers in the development of a sustainable digital platform collaboration model?

Keywords: Industry 4.0; B2B platform; digital platform; ecosystem; collaboration; open innovation; co-creation; value creation; challenges; mechanisms.

1 Introduction

A fusion of the physical and virtual world; the fourth industrial revolution triggered by interned development provides opportunities for development of a digitalized industry, “Industry 4.0”. However, the disruptive technology not only provide opportunities for manufacturing firms ta actively take part and benefit from the integration of the digitalization, it may also be a prerequisite to remain in business (Brettel et al., 2014). The Schumpeter’s theory on ‘creative destruction’ (Schumpeter, 1934) is well alive in the manufacturing industry; faced by a constant birth and death of firms. Nevertheless, it is not only about the survivor of individual firms but also about nations and continents to remain competitive.

The manufacturing industry is faced by global competitive pressure in the development of intelligent manufacturing calling for aspiration on new competitive advantages. Communication between machines, people and product based on Cyber-Physical-Systems and cloud based data storage enables turning of new ideas into marketable products and services (Brettel et al., 2014). Political and economic leaders, consultants, industry representatives and researchers all agree that technologies such as the Industrial Internet of Things (IIoT) will cause disruptive changes in the manufacturing industry worldwide. The opportunities provided by new technology enable the development of Manufacturing 4.0 also answering to the increased demand of e.g. customized products, rapid product development, flexible production, shorter product life cycles and complex environments. Development of Manufacturing 4.0 put the traditional way of work in a new light calling for development of new business models and work processes and thus also new organizational structures.

The manufacturing industry is as such faced by global competitive pressure calling for development of intelligent manufacturing. B2B innovation ecosystems of digital platforms have emerged to meet the demands of firms to enhance their innovation capacity through networking in the global knowledge economy. Innovative ecosystems as dynamic and agile self-organized institutions, aimed for market introduction of innovation through collaboration, have attracted attention as a facilitator in this global competitive game. Recent studies on innovation, consider ecosystems a means for co-creation and market introduction, highlighting the importance of digital platforms tailored for collaboration. Ecosystems are as such viewed as value networks encapsulating sustainable linkages between individuals and organizations. They emerge from a shared vision of desired transformations providing an economic context to catalyse innovation and growth. In line with this reasoning, collaboration models have become acknowledged as vital for the development of efficient and successful organizations (Nieto & Santamaría, 2007).

Inter-organizational collaborations in open innovation contexts are expected to lead to exchange of information and knowledge and have become a common practice in traditional industries (e.g. wood, manufacturing, furniture, construction) (Spithoven et al., 2011). Today, Supply Chain Management (SCM) is increasingly adapting collaboration as one of the strategies to gain competitive advantages and to meet various challenges e.g. to reduce production costs, adapt to environmental regulations and respond better to the complexity of market requirements (Daudi et al., 2016).

Studies consider different types of collaboration partners and the impact of collaborations on service and product innovation (Belderbos et al. 2004; Miotti & Sachwald, 2003; Ritter & Gemunden, 2003) also contributing with important

understanding of links between collaboration models, value creation and performance (Miotti & Sachwald, 2003; Lööf & Heshmati, 2002). Collaboration between multiple groups of stakeholders provides multifaceted values in the collaboration model where the different partners also take different roles and serves different purposes. Suppliers may enable identification of new solutions or development of new methods, identification of technical or design problems contributing to novelty, quality and time efficiency in products assuring for new product success (Jean et al., 2014). Collaboration with clients may contribute with knowledge in market trends, new ideas and solutions, improvement in design and identification of market opportunities (von Hippel et al., 1999; Langerak, et al., 2004).

Despite the recent attention to ecosystem collaborations from a number of disparate fields; there is a lack of a unified conceptualization of collaboration models (Blomqvist, & Levy, 2006). We know some about identified benefits, but still do not know much about mechanisms for accelerating the development of collaboration platforms operating in several countries across industries (Fuentelsaz et al., 2015). There are only a few studies on supply chain collaborations describing collaboration drivers and resistors (Fawcett et al., 2008) and an even more limited numbers of studies that explicitly explore the collaboration models, their fundamental cornerstones and orchestration of them, particularly in the context of digital platform ecosystems. Neither do we know much about challenges in the adoption of digital platforms in supply chain collaboration.

Value creation is according to research and practice devoted to social challenges and potential in adoption of supply chain collaboration making collaborations a difficult proposition to many companies (Akkermans et al., 2004). There are social mechanisms that impact on the development of collaboration models and it is necessary to generate a deeper understanding of the interdependencies within platform ecosystem. Firms and organizations operating under interdependencies are dependent on key partners in the collaborative ecosystems for accomplishing value creation and reaching innovation impact (Cenamor, 2015). Examples of other barriers are: non-supportive organization, inadequate supply chain and partnering arrangements, weak management, technology orientation, inadequate knowledge management, unacceptable costs. The need for coordination of collaborations motivates establishment of rules guiding behaviour by key actors in the ecosystem, known as ecosystem governance. Thus, given the novelty of phenomena, the volume of interactions and the heterogeneity of the users, ecosystem governance represent an underexplored, rapidly expanding body of regulation with important implications for the whole ecosystem (Wareham et al., 2014).

Despite the significant hype around new collaboration and business models in order to design the future industry moving towards Industry 4.0 there is a lack in understanding on how to reach these goals. Much focus is on the technology development while knowledge on social and economic mechanisms lag behind. The knowledge based paradigm provides strong theoretical basis for exploring collaboration challenges in the development of B2B digital platforms. In this article, we propose that the competences are a key source of resources contributes to future productive benefits for manufacturing industries (cf Blair and Wallman, 2001). As such, the understanding of the competence base and competence acquisitions in retaining the knowledge-base can provide industrial actors such as manufacturing firms with a strategic weapon in retaining critical resources in the firm.

The purpose of this paper is to explore collaboration challenges and mechanisms for reaching value creation in the context of key actors' development of a B2B digital platform ecosystem for fostering open innovation in the manufacturing industry. We also discuss the progression of value creation through inter-organizational collaboration via B2B digital platforms. Inherent in this progression is also platform transformation from information transactions to a collaborative exchange.

More specifically, the paper addresses what collaboration challenges key partners face in the development of B2B digital platform ecosystems in an open innovation context in early phases? What are the core mechanisms' fostering value creation and what is serving as barriers in the development of a sustainable digital platform collaboration model?

We can conclude that the general tenor of the scientific and business literature is positive to collaborative value creation while we need to recognize and be open to problems and challenges as barriers to reach true impact from the collaborative ecosystems (Patel et al., 2012). We need to be clear about the wide range of social mechanisms and human factors for managing such barriers.

2 A collaboration framework of B2B-platform eco-system

A collaborative network, designed as a B2B platform eco-system, is created with the intention of creating value through collaboration, since value is seen to be co-created in interaction between customers, sellers and other actors (Marcos-Cuevas et al., 2016). Collaboration can be defined as a process consisting of more or less independent and interdependent partners interacting by using formal and informal negotiation. Together they create rules and structures that govern the relationships between the partners, as well as rules and structures for how to act and how to achieve collaborations. Hence, a collaboration process includes shared norms and mutually beneficial interactions (Thomson, Perry & Miller, 2009).

Co-creation is an activity that takes place between economic and social actors within networks that interact and exchange across and through the network (Vargo & Lusch, 2008; Pera, Occhiocupo & Clarke 2016), and co-creation happens when firms and/or organisations and users share, combine and renew each other's resources and capabilities, and together create value through new forms of interactions, services, and learning (Arnold, 2017). The prevailing view is that value is co-created through the interaction of a range of stakeholders, rather than in interaction processes between two parts (Vargo & Lusch, 2008). It is precisely the interaction between stakeholders, which hold different and sometimes conflicting identities and that have come together within the same ecosystem, which triggers the mechanism of value co-creation (Pera et al., 2016). Important to notice is that value co-creation includes the co-production of the offering (Marcos-Cuevas et al., 2016).

Value co-creation is also seen to extend beyond the present interaction to include also past and future experiences and expectations (Marcos-Cuevas et al., 2016). However, Arnold (2017) claims that co-creation concepts seldom address how companies should operate co-creation throughout their organization, how they should institutionalize the processes within the company, or which department should be responsible for an on-going co-creation. Marcos-Cuevas et al. (2016) agree and argue that there only is a limited body of work illustrating its implementation in practice,

which makes value co-creation a somewhat abstract concept without much empirical development.

Currently there are substantial investments in research and development (R&D) projects focussing on inter-organisational collaborations (Emden et al., 2006). These R&D-projects face high expectations on rapid and front edge technology development and business exploitation (Goerzen, 2007), and the involved organizations mainly expect three achievements; technology transfer (for development of new technologies and services); knowledge transfer (for acquisition of new competencies); and competitive advantages (for the individual organization) (Knudsen, 2007).

However, studies show that the expected advantages are not easily achieved; collaborative R&D projects often show a high degree of failure in innovative organizations' business models (Chesbrough & Rosenbloom, 2002). The reasons for this can be explained by challenges and obstacles in technology development, but equally important are the social relations in the collaboration. For example, Knudsen (2007) has found negative effects on innovation outcome in inter-organizational R&D-collaborations if partners' abilities or willingness to exchange information on own high-technological offerings is limited. In other studies, Emden et al. (2006) report of leakage of core competitive knowledge to collaborative partners, something which has negative effects of social relations in inter-organizational collaborations.

To succeed with co-creation, Marcos-Cuevas et al. (2016) argue that 'compelling events' are of great importance for the co-creation capability development process, where compelling events should be understood as important occurrences that either generate new or reinforce existing value co-creation activities. They continue that this requires the ability to sense and seize opportunities for value co-creation and also to develop and use the capabilities that are needed to build strong relationships, in order to enable sustainable co-creation. Necessary conditions to co-create value in B2B systems are high levels of interaction, strong connections, collegiality and trust, but these are not sufficient – co-creation requires high level of engagement among network partners (Marcos-Cuevas et al., 2016). Also, focus should be on internal production processes, development of management and accountability but also management of external relationships (Grönroos, 1990). Marcos-Cuevas et al. (2016) have identified six strategic 'interaction capabilities' that makes it possible for organizations to co-create value by facilitating the mutual integration of resources, namely the capabilities of:

- Individuated interaction, concerns the identification of actors' expressed and underlying needs, processes and what value they are looking for.
- Relational interaction, addresses the need to cultivate social and emotional ties between the parties and empathic interaction with the actors. Fair and non-opportunistic processes and trust is important and should be established for joint value realization.
- Ethical interaction, ensure that actors are able to influence the nature and content of the processes.
- Empowered interaction, to stimulate optimal value the process should also contribute to knowledge expansion, competence building and learning necessary for resource integration among actors.

- Developmental interaction, resource integration for knowledge expansion, competence building and learning to engender the optimal value.
- Concerted interaction, finally, is the capability to co-ordinate and to involve actors in value-creating activities.

Collaboration factors

The literature for all the factors and sub-factors relevant to collaboration is massive, and research into collaboration is found in a large number of disciplines and professional fields. According to Patel et al. (2012) the top level factor groups are: context, support, tasks, interaction processes, teams, individuals (this is consistent with team performance models and other frameworks of collaboration (e.g. Harvey & Koubek, 2000; Salas et al., 2007)). In Table 1, the top level factors are found in the table heading, and their respective sub-factors below.

Table 1 Collaboration model framework

Main factors:	Context	Support	Tasks	Interaction processes	Teams	Individuals	Overarching factors
Sub factors:	Culture Environment Business climate Organizational structure	Tools Networks Resources Training Team building Knowledge management Error management	Type Structure Demands	Learning Coordination Communication Decision-making	Roles Relationships Shared awareness/knowledge Common ground Group processes Composition	Skills Psychological factors Wellbeing	Trust Conflicts Experience Goals Incentives Constraints Management Performance ³

Source: Patel et al. (2012).

The table shows that there are many contingency variables (context, support, task, interaction processes, teams, individuals and overarching factors) involved for sustainable collaboration to happen. The collaboration model framework implies that in order to design a model for collaboration, it is needed to understand the complexity of collaboration, and reflect upon, manage and address these contingency variables. The sub-factors related to the contingency factors also need to be elaborated for a more detailed design of the collaboration model.

For example, concerning the *context* of the collaboration model, the sub-factors culture, environment, business or collaborative climate and organisational structure are vital, since they define the context of the collaboration model. Step one can be to discuss and define these.

The collaboration model can be *supported* through development of tools, networks, resources, training, team-building, knowledge management and error management. These sub-factors are central for the management control of the collaboration model.

Moreover, for further identification of the nature of the collaboration model it is needed to identify and characterise central *tasks*. Here it is vital to sort out what are the types, structures and demands on the tasks that are included in the collaboration model?

The fourth step is to identify the nature of the *interaction processes*, and this is done through the sub-factors of learning, coordination, communication and decision making.

Teams of partners are of course fundamental for the collaboration model, and it is important to create awareness of the team members different roles, their part of various relationships, how to share awareness/knowledge, how to work towards a common ground. This can be rather tricky, since there are group processes constantly going on between partners. The design of the collaboration model must also identify the compositions of partners in a team, and carefully address this. Even if collaboration models includes organisations, it must be remembered that organisations are fundamentally built up of individuals with their personal skills and psychological factors affecting the them, hence also factors such as wellbeing among the individual team members must be considered.

Lastly, there are a number of *overarching contingency factors* that are of importance when designing collaboration models. Trust between current and potential partners must be built up, as well as the identification of current and potential conflicts that might need to be dealt with. Finally, experiences, goals, incentives, constraints, management and performance, are included in what should be addressed, in order to succeed in the collaboration processes. Altogether, it is all about creating and designing for sustainable collaborations that bring values to all involved in the collaboration model.

Knowledge based view

The knowledge based paradigm, based on tenets of the resource based view provides a strong theoretical basis for exploring the development of digital platforms for inter-organizational collaborations through R&D-projects (Grant, 1996; Barney, 1991) and hence enables exploration of development of sustainable competitive advantages. Having a knowledge based view provides us with insights into the need of specific organizational knowledge, which enables exploration of the role of knowledge in

collaborative digital platform development projects. In projects, participating organizations' competences are critical for the project performance (cf Barney, 1991)

It is well known that effective learning and competence development is central for reaching performance (Nonaka & Takeuchi, 1995) since knowledge management enables development of critical organizational-specific knowledge that is hard to imitate and is a key source of positive organizational outcomes (Hatch & Dyer, 2004). In order to gain competitive advantages, to respond to the uncertain and dynamic nature of both organizations' internal processes and external environment, organizations' need the ability to produce value despite of changes taking place in the surrounding environment (market, the technology or in other critical triggers) (Sanchez & Heene, 2004). This also requires having an ability to deal with other organisations, and hence coping with competences for development of sustainable competitive advantages.

3 Research design

A case study approach is taken for exploring the early phase in the development of a collaboration model for an open innovation digital platform ecosystem (Yin, 2013) by studying collaborations by 17 key actor organizations from seven countries. The collaboration aimed to develop an open source supply chain digital platform for supporting innovation processes, particularly in SMEs. Triangulation of methods was used for crystallizing and validating data. Data was collected during the first 6 months through unstructured interviews (around 16 hours) with key actors in the digital platform ecosystem and through participant observations and workshops at each use case site (around 60 hours) where key actors presented and discussed key issues such as their work, incentives, ideas, needs, plans when designing and developing the digital platform and the collaborative ecosystem (early requirements). The purpose of the workshops was also to initiate a sense-making process between the technical and business partners. In addition a workshop was conducted in relation to a project meeting in month 6, during which each use case discussed what strengths, weaknesses, opportunities and threats they experienced so far, in relation to the development of the B2B-platform. Written documentation was also used. Interviews were recorded and field notes taken by all four researchers. Content analyses were carried out by all researchers individually and compared for matching.

The rationale for the use case workshops is that they are the ones who will use the B2B platform, and as such they play a critical role. They should have a voice and be involved in the design of the platform, since it will be part of their future situation (Simonsen & Robertson 2012). Thus, user involvement is a critical factor in order to : 1) understand those who actually will buy and/or use the product/system/solution, 2) create insight in that people have varying objectives, goals, needs and ways of thinking, 3) ensure good foundations for decisions, 4) increase the probability of taking right design decisions, 5) speed up the decision process for identification of initial requirements, and 6) prepare for better acceptance of the platform with its collaboration and business models. In short, user involvement both increases the potential of success while it simultaneously decreases the risk of failure.

4 Contextual embeddedness of the B2B-platform development

The overall project is funded by the European Commission's H2020 technology research programme for Factories of the Future, and organised as such. The goal of the project is to develop a collaborative, multi-sided and cloud services-based business ecosystem that supports B2B collaboration in the manufacturing industry with a focus on business and logistics. The platform aims to attract different stakeholders as supply-chain actors, e.g. providers, vendors, and buyers. Important characteristic is that the platform is user-friendly, scalable in business offerings, and trustworthy.

Aim of the B2B-platform

The development of the B2B-platform aims to be a collaboration platform for the manufacturing industry in Europe, and will be based on a cloud-based infrastructure. The goal is to be an Industry 4.0, Internet-of-things-enabled B2B platform on which European manufacturing firms can register, publish machine-readable catalogues for products and services, search for suitable supply chain partners, negotiate contracts and supply logistics. As such it will provide B2B and M2M information exchange channels to optimise business work flows. The objectives of the platform should be:

- to build an easier communication channel (thanks to the standardization adoption, that allows the fast integration of new actors in the market, already using the format adopted by the platform),
- to be able to trace all the production and to provide, easily and quickly, those data to the customers, so they will have a real time granular monitoring of production flow, as well as real time sharp forecasts of machinery and product availability,
- to be able to monitor the workflow with “plug and play” sensors,
- to be able to produce the origin certificate declaration (preferential and not preferential) automatically.

The partners

The organization of the project consisting of 17 partners with different key roles in the project. The partners are organized into three core groups of key actors based on their different roles. The three core groups are as follows:

1. ***The use case group***: each use case consists of the problem owner, one research partner as mentor, one software company as service provider, and one or more supply chain partners. The four use case groups are; White Goods, Eco Construction, Textile Manufacturing, and Wood Furniture.
2. ***The core platform developer group*** consists of different IT-system partners and institutes.
3. ***The platform adoption group*** with partners is in charge of standardisation, and regional industrial sector representatives acting as multipliers for adoption. The partners all have different expertise and competences: Architectural Development, Data Management, Expertise in Optimization Methods and Algorithms in operational Supply Chains, Trust, Privacy, Security, Business Models and Business Processes Valorisation of Research Results and Outreach, Project Management, and User involvement

The partners together form the project team, the ground of the project collaboration. In this many of the partners new one another since before but there were also new project

partners. Both old and new relations were to be developed. This also implies that some partners had a relatively shared understanding and common ground of the aim with the project while others where new and not had the same frame of reference or the same ground. Taken together, this outlines a project with high complexity where the orchestration of the project and the linked knowledge management of current and potential key partners are critical for the progress of the development of the platform; both within the frame of the project but also for development of a sustainable platform in the long run. (*See Table 1 Team*)

Summary of Use cases

The four contextually embedded use-cases are now briefly outlined for further understanding of the development of the business platform.

Case White Goods

Case White Goods main objective is to improve the flow of information from their customer service and field service back to the internal organisations. Access to aggregated data and hence analysis of it will improve the design knowledge about the product and enhance field technicians' diagnostic and prognostic capabilities. The use case focuses on third-party SMEs, and as such exemplifies the complex relationship between larger and smaller companies collaborating on a multi-sided platform. A B2B platform would improve the flow of knowledge in both directions of the value chain, and hence lead to faster innovation.

The vision of the use case is to achieve a collaborative environment where it is possible to share, in a correlated way, product quality data coming from different sources. This would allow actors involved in the Product Lifecycle to improve their capability to make decisions that have impact on product quality. They have a wish that all information will be accessible from one single user interface, e.g. that the user will access the system inserting the serial number of the product and thereby retrieve, in real time, all the information associated to it.

Case Eco Construction

Case Eco Construction wants to establish new logistics chains, and improve monitoring of transport and on-site construction, in order to ensure that reliable quality information of supplier's products from the construction sites are transferred back to the organization. A major benefit will be the simplification of data handling. Currently this is dominantly happening through manual tasks. The supply chain of the use case would be improved by seamless connection between stakeholders, and through exchange of data for manufacturing buildings. All stakeholders and possible business partners should be able to publish ordering information (e.g. invoices) and specification documents for direct B2B exchange. This use case also wishes for sensor data that cover the processes / stages of production, construction and after sales. The data should be enriched by an "Analysis Supplier" with expertise in eco houses to transform plain data into knowledge (e.g. usage conditions based on RH and temp, or leakage to a distinct alarm in a specific area).

Case Textile Manufacturing

Use Case Textile Manufacturing wants to build close relationships between fabric designers and clothing stylists, since they are aiming for more customized production of their exclusive fabrics. The adoption of virtual prototyping tools would make possible this tight collaboration. It would lead towards a fully virtual clothing design, which would greatly increase the speed of both design and production processes. In sum, design proposal quality, flexibility in production and delivery, and also service and quick responses to customers' needs are critical to build added-value and overcome pressure of prices. The platform should be a platform for a fast and reliable data exchange service, based on IoT, M2M and B2B data transfer. They wish that the platform itself should act as a place where textile industries can monitor and exchange data of several types. They reason that the main value of the platform is found in its standardization, which would allow companies to interact with new customers/suppliers (mainly B2B), without having to set up a new channel (and format) of communication or use their legacy systems. They would find all the data needed through the platform.

Case Wood Furniture

Use Case Wood Furniture is focused on the definition and configuration of an optimal value chain from a rich and reliable business ecosystem which would make matchmaking possible regarding suppliers. This value chain covers both production needs and logistics. The ecosystem includes information about certifications of their members, as well as the option to access the normative and regulation awareness system. The use case vision is to facilitate collaborative supplying partnership and increase innovation capabilities by finding providers of required materials and operations which the use case cannot cover with its own resources, or aims at improving at different levels (i.e. operational costs, ultimate quality).

The platform would retrieve a list of companies that matches the introduced parameters. Then, the company would be able to filter the results and compare different providers. Also, manufacturer and selected provider should be able to negotiate the order conditions through the platform, which would also allow the exchange of needed documentation via file sharing and by providing a messaging system or platform inbox to discuss further details.

The contextual descriptions of the participating actors and the use-cases outline the broad market potential for the platform services to be produced. The organization of the project enables development of a platform that may be used in an environmental setting of different countries, different industries, and also involving firms and actors from different cultures, different size and different organizational structure. (Table 1 Context). The contextual embeddedness of the project outlines broad and deep competence in many areas and also different wants and needs by participating actors. Taken together, this outlines a project with high complexity where the orchestration of the project and the linked knowledge management of current and potential key partners are critical for the progress of the development of the platform; both within the frame of the project but also for development of a sustainable platform in the long run.

Initial work processes

To further enrich the organization of the project we will now outline the initial work process of the project since this is the phase studied. Different research groups are formed with dedicated work packages, consisting of different professionals and competences aimed to nurture one another. The use cases are organized into one work package each. The initial idea is also that each use case owner should be supported by an academic partner, and when needed, also a technology partner. These supportive activities are part of the knowledge management aiming to support the use-cases to better understand their needs and wants in terms of what is possible to accomplish within the frame of the project. The supportive actors may also provide tools and resources and help out with training. Together the actors get together and learn to know the roles of one another. (*Table 1 Support*)

Early in the project start-up phase, the use case representatives were asked to describe their specific situation and establish an initial set of requirements covering their use case, in order to identify the initial, common requirements and specifications for the B2B platform. The use case representatives were asked to follow a template and the use case stories also contained a formal description of the case. The template consisted of three sections to be filled in by all use cases, namely;

1. Application: the use case description and workflows with AS-IS work flow (what are the current processes in the use case?), and TO-BE workflow (how/where does the platform support the use case activities?)
2. System requirements: IT-perspective on the use case
3. Challenges and Risks: expected problems and barriers

This outlines the task where the type of work, the structure and the demands are further outlined in the project. (*Table 1 Task*)

The initial work with identification and outlining of the tasks of defining the structure and identification of the requirements appeared to be more complex and challenging than expected by the participant. Each group of participant found it relatively easy to know what to do and how until people with other roles and competences were involved. People with different competences, roles and functions had their focuses and none had the overall picture. They realised that they understood things differently and also saw different ways of doing things. Therefore, the partners realized a need of an interaction process; i.e. a workshop for getting together and enable development of a mutual understanding. The workshop aimed for organizing transformation of knowledge between key partners with different roles, developing the communication, coordinating future actions and also for decision-making.

5 Collaboration challenges

In this section, we reflect upon the project's collaborative development process of the B2B platform during the project's initial phase and also the challenging work with orchestration of such a project. By identifying challenges and mechanisms, but also

potential effects, consequences and lessons learned this might render, lessons learned for how the work with development of a B2B platform and how such work may be organized in order to facilitate future collaboration for value creation.

Starting a large project aiming to develop a B2B platform for collaboration, involving a large number of partners, contributing with different competences and expertise, is challenging. A first key activity is thereby to start with 'setting the scene' and involving the project's key actors, since developers are dependent on key partners in the collaborative ecosystem for accomplishing value creation and reaching innovation impact (Cenamor, 2015). In this project the use case key actors were involved early in the platform development process, since one aim was to identify initial requirements. However, the process was unclear and it was not obvious for all four use cases, neither how to fill in the template, nor what content was really asked for. The three use cases, who also engaged their IT competent colleagues, were those who could best describe their situation, and also come up with initial requirements. This shows the importance of involving people with different knowledge and competence in collaborations.

In the project, effort was spent on creating well-elaborated information and communication strategy from the beginning, i.e. creation of mail-sending lists, in order to make possible that dedicated information can be sent out to different groups. However, with 17 partners there is a risk for information overload, making it hard for different actors to know what, of all information, actually concerns them. In this project, an information and communication structure was built around each work package, encouraging its own information management. The project management is an overarching factor to be considered and in this case the project management has long experiences and is highly skilled in organizing this kind of projects and this is also a central part of the project. The management emphasise the importance of openness in information in the project and is such contributing to developing a culture based on openness. All key partners involved are part of the information and communication processes, something that is appreciated by the team members in the project.

Openness in information and communication is a mechanism aimed to be part of the culture and used in the B2B platform for collaboration as well. A need for well thought through information and communication channels is as such critical on the agenda for key activities. Based on a workshop arranged in the project we learn from one of the use cases that it is important to offer various information and communication channels, so that each collaboration taking place in the project, is able to design their own way of communicating. A need of flexibility in information and communication processes are as such identified to fit to the particular exchange in need to take place in particular situations between specific key actors.

Thus, the trick when it comes to B2B platforms, is to use standardized solutions while simultaneously make possible business unique solutions. A culture of openness may well stimulate such an approach.

When collaboration aims at co-creation, new forms of interactions are needed for the actors involved to reach new services/products, and learning (Arnold, 2017; Pera et al., 2016). Not only are the actors about to co-create value, they are also collaborating in the production of the offering (Marcos-Cuevas et al., 2016). Therefore, the actors may need to elaborate on and discuss their different and sometimes conflicting needs and wants, for making the collaboration happen. This is also, as Pera et al. (2016) argue, what triggers the mechanism of value co-creation. Our findings from the project

indicate that initial face-to-face meetings are crucial, asked for and valued, while most correspondence in the project happens through distance technology, something that will be default when the B2B platform is up and running. The face to face interactions enable people to get to know one another and to develop trust between one another. Relationships are as such a key trust creating mechanism. Inclusion or exclusion of face-to-face interactions in the platform need to be further considered in regard to trust creation of the platform.

Considering that sense-making and co-creation happens when actors actually meet (Arnold, 2017), it is central that the B2B platform provides a genuine toolbox for meetings, which can replace the initial face-to-face meeting. This is most important when initiating new collaborations, with new actors. Another example showing the importance of adequate meeting tools is that workshops and discussions during the first period of the collaboration are crucial to create sense-making over; the business requirements (the needs); what will be managed initially and; what needs and requirements will be continuously developed later on. The project process further shows that collaborations must overcome some barriers early on and this can be solved by having a supportive organization, adequate supply chain and partnering arrangements in place. This indicates that the B2B platform also should provide management tools, and not be too technically oriented (Wareham et al., 2014).

When selecting use cases to a B2B platform development project, it is not only important to discuss different roles, it is equally important to discuss appropriate competences among key actors involved in the use cases. To mix actors knowledgeable in IT technology with actors from the business side facilitates the transformation of business needs to more technical requirements, because if not, there might be a gap between the technical side of the project and the business side. It is essential in the development of a B2B platform that the key actors can understand possibilities and articulate the needs from a business perspective. Digitalization of a business might require a new type of competence in an organization since new IT-solutions are always available. We identify in this project a need for developing formal plans for the co-creation in an early phase. In line with this we also identify a need to plan for how business potentials that not may be further elaborated in the particular project may be captured for future collaboration potentials. One such example is micro-services that are not part of the initial packages of services to be developed but still involves high potentials for reaching out to new markets and customers in the future. How can such services be packaged, valued and planned for?

Yet another challenge is the differences in digital competence by different actors on the B2B platform. The platform aims to target SMEs and all such organizations may not have both business and technical competence in-house. A need for enabling customers with different competences and experiences to reach the platform and to use the platform is as such needed.

Moreover, there is business potential identified in platform exploitation in where ideas on how to operate co-creation and how to institutionalize the processes within the SME may be taken care of as part of service offerings (Marcos-Cuevas et al., 2016).

We have also identified the importance of having a plan for how to closely involve the use cases, in order to advance value-creation and sustainability of the platform. Different actors have different incentives for taking part of the collaboration and for engaging in the development of a business platform and this appear to be a central part of the orchestration of the project, i.e. to balance different incentives to accomplish a

mutual platform. Business actors have for instance different incentives than the academic partners and the technological partners. These aspects also outline the social aspects of project management. There are challenges and obstacles in technology development in general, but equally important are the social relations in the collaboration. For example, Knudsen (2007) has found negative effects on innovation outcome in inter-organizational R&D-collaborations if partners' abilities or willingness to exchange information on own high-technological offerings is limited. Co-creation requires high level of engagement among network partners (Marcos-Cuevas et al., 2016); hence, a plan for how to engage the use cases is vital during the development process. The plan should define what to contribute with, to whom, and when. It is important that the use cases feel that they are central, that they have a voice and that they are listened to. Such a plan also outlines the development of a culture in the project. Relating this to the B2B platform shows a dilemma since co-creation of value in B2B platforms requires high levels of interaction, strong connections, collegiality and trust, and still, this is not sufficient. Marcos-Cuevas et al. (2016) suggest 'compelling events' to trigger the co-creation capability development process, to generate new or reinforce existing value co-creation activities. How to design these 'compelling events' in the project, as well as how to make them possible in the B2B platform, will be interesting to follow.

We base our further analyses on six strategic 'interaction capabilities' outlined by Marcos-Cuevas and colleagues (2016). The strategic 'interaction capabilities' makes it possible for organizations to co-create value by facilitating the mutual integration of resources. Some of these are in this project identified as particular critical in the early phases of platform development processes. The first critical interaction capability for this project is the 'Individuated interaction capability' which we translate as the importance for use case actors to express their underlying needs, processes and what value they are looking for. This can be achieved by having an interaction and collaboration plan initially in the project and f2f meetings (technical partners and the use cases actors) via workshops and other means. The importance of this is often underestimated.

The second critical interaction capability, 'Relational interaction', addresses the need to cultivate social and emotional ties between the parties and empathic interaction with the actors. Also this capability requires time and place for f2f meetings and the possibility discuss the needs in an open and positive environment early in the project. This will foster a culture of openness and trust. This capability is much integrated with a third 'Empowered interaction', to stimulate optimal value the process should also contribute to knowledge expansion, competence building and learning necessary for resource integration among actors.

In the project we have also identified the need of functions and roles that work with and make sure that there is a bridge between the different work packages and the actors, i.e. 'Concerted interaction capability', the capability to co-ordinate and to involve actors in value-creating activities.

Finally 'Ethical interaction', ensuring that actors are able to influence the nature and content of the processes and 'Developmental interaction' capabilities are also essential but not yet elaborated upon here. However, these capabilities are also important to consider for the B2B platform, and we suggest that time should be spent on how to design the platform so that future users can get guidance on how to develop these capabilities when using the B2B platform.

For example, concerning the context of the collaboration model, culture, environment, business or collaborative climate and organisational structure are vital. In the project, with 17 partners and several actors, it is a very heterogeneous mix of people from different countries with different domestic culture and business culture, and different types of industries. Since the platform will attract European SMEs, it must incorporate several languages, even though English is the first natural language to develop the platform for.

It is essential in a development project with many partners and actors to support the building of a collaboration model through for example different tools and team-building. These sub-factors are central for the management control of the collaboration model. In the development of the B2B-platform, each use case was allocated a technician as support. However, there was no actual team-building between the technical partners and the use case actors. But as the project progresses there is a responsiveness to create supportive tools for interaction. How to share documents, how to communicate, how to co-create. This can be developed in the project for collaboration between the different actors, but the lessons learned during the project time can also be applied in the B2B-platform during its lifetime after the project end. Therefore it is essential to have actors in the project with competence in how to act as collaboration facilitator, how to investigate mechanisms for social interaction etc.

Moreover, for further identification of the nature of the collaboration model it is needed to identify and characterise central tasks, i.e. to sort out what are the types, structures and demands on the tasks that are included in the collaboration model. Central tasks in the development of a B2B-platform and co-creation are both technical and social activities. In the start of a project, different compelling events for making use case actors engaged in discussions with developers are central, which can create opportunities for value (Patel et al., 2016). Hackatons can be one example of an event. It is also important to have tasks that are working on building a community of future users of the platform so that the functions of the B2B-platform are tested and evaluated during the project, e.g. with test-beds.

But in order to develop a sustainable collaboration process in the project, the nature of the interaction process must be identified. There is a need of developing mechanisms for building a team spirit and finding “right” communication channels between the project actors. The process of ‘who-needs-to-share-what-and-when’ (information logistics) needs to be developed along the project time. A transparent process of decision-making is equally important so that project members feel that they can participate when important decisions are taken. In the project, different types of meetings are identified and members are allocated which of these meetings to participate in. There is a list showing different representatives from the partners. But a list is not sufficient, information of what is going to be discussed when is imperative. Also, all representatives must shoulder the responsibility to participate in the meetings. An information and communication plan is developed and updated during the project. Agenda of the meetings must be sent out in time. There are indications in the project that not all have been aware of what has been decided when, the character of the meeting. This indicates that there is an information gap and a lack of awareness of the effects of not participating in the meetings. The format of the information is important. There is a difference between an invitation to a meeting and request. This is much about project management, and it would be of great value if tools for managing the collaboration could be available in the B2B platform.

Teams of partners are of course fundamental for the collaboration model, and it is important to create awareness of the team members different roles, their part of various relationships, how to share awareness/knowledge, how to work towards a common ground. Therefore the allocation of roles of the different actors in the project was important, and includes giving descriptions of what responsibilities these roles imply in the co-creation process. It is vital in the beginning of the project to have mechanisms that sense the different expectations of the collaboration but also worries and doubts. The use case actors need to have a forum to turn to with initial questions and worries so that a good spirit can be spread in the project and trust be built so that the use case actors early build an engagement. Frustration and uncertainty in the beginning of the project must be limited. The wellbeing among the individual team members must be considered early.

6 Discussions

The purpose of this paper is to explore collaboration challenges and mechanisms for reaching value creation in the context of key actors' development of a B2B digital platform ecosystem for fostering open innovation in the manufacturing industry. More specifically, the paper addresses what collaboration challenges key partners face in the development of B2B digital platform ecosystems in an open innovation context in early phases? What is the core mechanisms' fostering value creation and what is serving as barriers in the development of a sustainable digital platform collaboration model?

The release of the report Industry 4.0, published in April 2013 is often referred in research and among industry professionals in the striving for further understanding of the consequences for manufacturing. The disruptive impact taking place need to be well known and dealt with for businesses to take advantage of opportunities. The competitive landscape is about to change and being a fast mover is a strategic competitive advantage. Manufacturing firms are about to adapt their value chain and production to mass production based on unique products aimed for and adjusted to specific customers' needs. Enabling of digitalization of the physical flow expect to bring forth potentials for such adjustments with tailor made products. The manufacturing process call for new competences and skills and the nature of the work taking place in manufacturing firms at the shop-floor as well as in other parts of companies' changes. This also calls for new challenges among firms and among professionals in need of adjustment to the digitalized workflow. There is a need for adjustment of the communication between suppliers and customers to the new need of competences and also new competence needs in the production processes. There is a need for changes to take place in the organisational structure and control systems, i.e. to be adjusted to the new demands, new opportunities based on digitalisations and new ways of collaborating worldwide. Taking advantage of new opportunities call for strategic and systematic efforts by organizations that goes beyond individuals sharing and repository of skills and experiences (Kiessling et al. 2009). We argue in line with Kiessling et al. that "Knowledge alone is not sufficient, but the actual application and knowledge management is required for firm performance outcomes."

Challenges

Core challenges outlined in the current project are now discussed. The use-case actors in the development of the B2B digital platform put forward needs for a multi-sided platform that will support different types of collaboration activates valued in their own business. These needs must be evaluated in relation to the overall aim of the platform to support standardized micro-services suitable for different types of companies within different industries and in various countries. Hence one challenge is customization of services versus standardization of services.

Another challenge of the development of the B2B-platform is to develop services that support collaboration and not just exchange of information. Therefore it is vital to discuss and identify what collaboration is about in the different use cases, and to plan for collaboration tools even though this type of tools was not planned for initially, they need to be further elaborated upon. Different visualization tool were discussed by the use cases, but they are not initially planned to be developed. What does communication channels mean? Different businesses have different use of channels.

A third collaboration challenge is to compromise the type of data that will be handled by the platform. There is a variation of data volumes that need to be handled, from single exchange of files to aggregated data analysis. Also, different format of data that will be exchanged must be designed for, (BOM; production data, QA protocols etc.).

A fourth challenge is to be able to ensure the governance and sustainability of the B2B-digital platform. It is important to have external use case actors part of the development of the platform, to have access to real users, in the same time work for how the platform will survive after the project ends. Therefore, developing and evaluating different business models must work in parallel with the platform development. This to ensure viability of the platform and support the case use actors' engagement in the project.

A fifth collaboration challenge is that the platform must be easy to use and to adopt by the target group of users. For example if the target group is SMEs, they must not be required to have specific systems for adoption of the B2B-digital platform. The benefit of the platform will be a facilitator of interaction with actors without having to set up new channels (and format) of communication.

But it is essential to address cost and timing for new tool adoption (critical for SMEs) and different adoption barriers. Therefore, continuous test of the functions are vital during the development, and hence to develop a plan for this.

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