REQUIREMENTS FROM INDUSTRIAL INTERNET FOR INNOVATIONS IN ADVANCED INDUSTRIAL SERVICES

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ABSTRACT

Manufacturing firms are experimenting with the possibilities of the Industrial Internet, while at the same time adding services and service-related business models to their offerings. Previous research is not, yet, clear on how these simultaneous transformations are handled, particularly when firms being to offer more advanced industrial services. The objective in this study is to identify the key expectations and requirements that an industrial system manufacturer faces, when adopting Industrial Internet and innovating advanced industrial services for its business customers. A single case study was carried out in a manufacturing firm offering complex industrial systems and related services to business customers. Seventeen interviews and three workshops were carried out, to collect data. The results show that the manufacturing firms need novel segmentation criteria, to map their customer base and its prospects for advanced services. Four systemic requirements are identified, for the manufacturing firm to benefit from the Industrial Internet in advanced industrial services. As Industrial Internet can enable advanced services that are highly systemic in nature, service innovations require that the business ecosystem is engaged in the development work together with the manufacturing firm.

Keywords: Advanced services, Industrial Internet, Industrial service innovations

INTRODUCTION

Modern information and communication technologies have recently enabled connecting products, technical systems and people with each other in novel ways. This connectedness is currently understood under the term Internet of Things (Lee & Lee, 2015; Saarikko et al. 2017), which in the industrial business-to-business context is referred to as Industrial Internet. Industrial Internet is creating enablers for manufacturing firms and service providers to monitor and control industrial customers' processes remotely and to develop value-adding services based on the remote data (Porter & Heppelman 2014). At the same time, manufacturing firms have begun to consider servitization, i.e., the business logic change associated with service-centricity (Kowalkowski et al. 2017b) that calls for innovations in advanced services and can, thereby, benefit from Industrial Internet. This research is concerned with the requirements that Industrial Internet causes toward innovations in advanced industrial services.

Servitization does not only mean the addition of new services to the business portfolios of manufacturing firms, but the adoption of service-based business models (Kowalkowski et al. 2017b). With the business model transformation, manufacturing firms will in effect complement the basic services – e.g. spare parts and maintenance - with digitally enhanced, advanced services – e.g. availability and performance-based contracts. This change requires significant new capabilities from the manufacturers and changing the ways of doing business (Coreynen et al. 2017, Story et al. 2017). It is not only the manufacturing firms' own business that needs to change, but customers' role and processes are affected as well.

Innovations of advanced industrial services are different from innovations in basic services (Jaakkola et al. 2017) because they effectively transform the value creation logic between the supplier and the customer. Earlier research has identified the specific nature of value innovations (Berghman et al. 2012, Kim & Mauborgne 1997, Matthyssens et al. 2006), business model or logic innovations (Tongur & Engwall 2014, Visnjic et al. 2014), and radical service innovations (Perks et al. 2012). Previous studies have not, yet, revealed the types of systemic requirements that such innovations cause toward the manufacturing firm.

The purpose in this study is to explore the manufacturing firm's perspective to adopting Industrial Internet and, thereby, creating new innovations in advanced industrial services. The objective is to identify the key expectations and requirements that an industrial system manufacturer faces, when adopting Industrial Internet and innovating advanced industrial services for its business customers. The study focuses on one core research question:

1. How does the manufacturing firm perceive its customer base, when creating advanced services in the Industrial Internet?
2. How (through what kinds of actions) can the manufacturing firm benefit from the advanced service innovations in the Industrial Internet?

The focus is on business-to-business services concerning manufacturing firms and their customers, and consumer services are excluded. In this study, we take the manufacturing firm's perspective and other firms are not studied; in future studies, the customer view and partner firms' roles should be covered also. The focus is on advanced services, and even if manufacturing firms also offer various basic services, they are not included in this study. In advanced services, the assumption is that they are somehow built upon the technologies of the Industrial Internet, using e.g. remote solutions to gather information from customers' processes. This may mean the involvement of other firms, i.e., third parties, which is acknowledged.

The paper is structured as follows. We first review previous research concerning manufacturing firms' advanced services and related innovations, and the possible effects of Industrial Internet on service transformation. We then introduce the interview and workshop data collection and analysis for the qualitative single case study. As results, we present key dimensions for segmenting the customer base for advanced services in the Industrial Internet, and map the actions that the manufacturing firm could use to benefit from advanced service innovations. Finally, we discuss the key findings in light of previous research, and point out the key contributions and avenues for further research.

LITERATURE REVIEW

Innovations in advanced industrial services

Manufacturing firms operating on the business-to-business market are increasingly offering not just technology-based systems, but also services to their customers. They do not satisfy with basic services, but seek more value-adding solutions by deepening the customer relationship and engaging more in the customer's processes (Oliva and Kallenberg, 2003). The expansion of offerings toward services – i.e. service infusion - is sometimes (but not always) supported with a complete business logic change from a goods-centric to a service-centric logic, often referred to as servitization (Kowalkowski et al., 2017b). In both types of transformations, offerings are added or transformed.

The general trajectory of increased addition of value implies a move toward more advanced services. Advanced industrial services are often considered as long-term oriented service contracts where manufacturing firms deliver the resource, capacity, availability or performance that the customer uses as part of its core processes (Baines & Lightfoot, 2013). As an advanced industrial service, the manufacturing firm could, for instance, offer condition-based maintenance; operate the customer's processes; offer manufacturing capacity in terms of hours or tonnage; and share the risks and revenues with the customer (Baines et al., 2013; Story et al., 2017). Many of the modern advanced industrial services rely upon the idea of digitization, i.e., use of sensors, remote monitoring of the equipment, and connectivity and analytics using information and communication technologies (Baines & Lightfoot, 2013). Advanced services also may use a value-oriented pricing logic, instead of a cost-based (Töytäri et al., 2015).

Advanced industrial services are of significant interest because they may transform the value creation logic between the manufacturer and the customers, they require customers' involvement in various ways, and they (or at least the circumstances in which they are delivered) are often unique and not repeatable across customers. Some studies have already covered the specific capability and transformation requirements created by advanced services in the manufacturing firms and in their networks (Sousa & Da Silveira, 2017; Story et al., 2017). Advanced services cause requirements toward the technologies and operative practices (Baines & Lightfoot, 2013), and organization, skills and behaviors of employees (Baines et al., 2013). Research indicates that advanced services require a specific approach to service innovations also, differentiated from basic services (Jaakkola et al., 2017; Story et al., 2017), and the business model innovations become more beneficial if tightly connected with product innovations (Visnjic et al., 2016).

One of the core features in advanced service innovations is that it does not only deal with changes concerning the offering, but also other aspects of value creation and business logic. While there are some previous studies focusing on value innovations (Berghman et al. 2012, Kim & Mauborgne 1997, Matthyssens et al. 2006), business logic innovations (Tongur & Engwall 2014), business model innovations (Chesbrough 2010, Visnjic et al. 2014), strategic innovations (Markides 1997), and radical service innovations (Perks et al. 2012), there is very little research on the innovations in advanced services specifically. As the value creation and operating logic between the manufacturing firm and the customers change as part of advanced service innovations, there is a need to investigate it with more detail, particularly in connection with transformations dealing with Industrial Internet.

Industrial Internet creating requirements to service innovations

Industrial Internet implies harnessing the Internet of things for the purposes of industry and industrial business (Jeschke et al., 2017). Manufacturing firms delivering complex product systems for their customers can benefit from making their products connected with each other and with people (Porter and Heppelmann, 2014; Saarikko et al., 2017), and this connectedness of equipment and people through information and communication technology is an enabler for service innovations. Although some studies distinguish between the network of devices (Internet of things), the access to computing resources (e.g. cloud computing) and predictive analytics (Ardolino et al., 2017), we take a broad perspective to Industrial Internet in this study, covering both the device network, computing resources, and analytics solutions and other service enablers built upon them. Digitization may take many different pathways in a manufacturing firms' service transformation (Coreynen et al., 2017), here coined under the term Industrial Internet.

Industrial Internet can enable various benefits for manufacturing firms that want to keep updated on the status and use of their systems. Firms can, for example, follow up and optimize the material flows and logistics costs (Lee & Lee, 2015), gain knowledge of how their customers use their products (Rymaszewska et al., 2017), enhance longer-term business relationships with the customers (Saarikko et al., 2017), and create new services and new kinds of business models for their solutions (Kiel et al., 2017). Specifically, the big data produced through ICT during servitization can enable various new opportunities for business development (Opresnik & Taisch, 2015). Closer technical integration between the manufacturer and the customer can enable broader and more advanced offerings (Kowalkowski and Brehmer, 2008). This also implies new kind of variety in the process interfaces of the supplier and the customers.

The successful adoption of the Industrial Internet requires understanding on how customer value can be enhanced through its connectedness and communication capacities. According to Lee & Lee (2015) the main application areas relate to: monitoring and control, big data and business analytics, and information sharing and collaboration. However, also major challenges exist, concerning data management and mining, privacy and security, and lack of standards (Lee & Lee, 2015). Some studies have already identified various requirements from Industrial Internet toward advanced services and service innovations, and examples are summarized in Table 1.

The table shows that various case studies and exploratory or quantitative studies have been carried out, when considering servitization or service business changes while adopting operating models associated with the Industrial Internet. The previous studies clearly draw attention to the manufacturers' capabilities and resources (Coreynen et al., 2017; Kiel et al., 2017), the closeness, trust and commitment in the manufacturer's and customer's relationship (Falkenreck and Wagner, 2017; Kiel et al., 2017; Rymaszewska et al., 2017), and the role of data in value creation (Rymaszewska et al., 2017). Industrial Internet is clearly portrayed as a demanding systemic change driving and enabling business model changes (Kiel et al., 2017; Rymaszewska et al., 2017). However, previous research concerning the Industrial Internet has not tied the findings specifically to the manufacturing firms' advanced service innovations and related practices, and there is a need to understand this connection better.

Table 1. Examples of recent research that has identified requirements from Industrial Internet toward advanced service innovations.

Source	**Method and context**	**Key findings and identified requirements**
Coreynen et al., 2017	Multiple-case study with four manufacturing SMEs	Alternative servitization pathways: industrial servitization, commercial servitization, value servitization. Overcoming the path-specific barriers, e.g. • *Industrial*: sales competences, tangibilization of benefits, customer's process change • *Commercial*: customer interface skills, streamlining front-end customization processes • *Value*: in addition to the above, uncertain investments into totally new value chains, destruction of customer competence
Falkenreck & Wagner, 2017	Mixed methods: qualitative study in a medium-sized mechanical engineering firm, and quantitative survey-based study with customers in machine building industry	Antecedents of manufacturer's credibility in Internet of things, trust in the relationship, and perceived usefulness of Internet of things. Focus is on the manufacturer-customer relationship: • Importance of a trustful relationship • General attitude toward the manufacturer • Duration of the relationship • Activities to strengthen the relationship
Kiel et al., 2017	Exploratory interview-based study, n=76	Identification of business model component changes experienced by manufacturing firms due to the adoption of Internet of things. Also evident interdependencies between the business model components: when one aspect changes, so do the others. Top-most changes (in terms of how frequently mentioned): • Value proposition • Core competences • Relationships • Value configuration
Rymaszewska et al., 2017	Multiple-case study with three medium to large manufacturing firms in different sectors	Conceptual framework for value creation through data over the solution lifecycle. Developing the Internet of Things solution to create value, e.g. • Identifying the opportunities to create value for customers • Supplementing products with services building upon the manufacturers' unique capabilities • Redesigning the value chains • Using the technologies to getting closer to the end customers • Affordable access to relevant data

RESEARCH METHOD

Research design

A single case study was carried out in a manufacturing firm offering complex industrial systems and related services to business customers. It is a successful, large technology-based firm operating globally, with a sales revenue of over 3 BEUR and with over 10000 employees. This study is focused on one of its business units that offers technology, processes and related services for a certain process industry globally. In this paper, the business unit is referred to as SysCo. Industrial Internet enables the use of remote monitoring and control for the company's systems, benefiting both the manufacturer and the customers. SysCo has an active orientation toward servitization and innovations in advanced services.

Data were collected in three workshops, through interviews with employees and managers, and supportive meetings with the key contact person. The interviews took place in two separate phases between the three workshops so that their findings could be discussed and validated in the workshops, and this approach is illustrated in Table 2.

Table 2. Research process and data collection.

Data collection type	Content focus	Nr of persons	Profiles of participants
Workshop 1	Vision for advanced service innovations and what they can enable and require in the firm and among the customers	8	experts and middle managers from sales, technology development and product development
Interviews 1	Customer value and customer segments	8	middle managers + one expert and one director, sales, technology development and product development
Workshop 2	Customer value and approaches to segmentation in advanced services	6	experts and middle managers from sales, technology development and product development
Interviews 2	Challenges and requirements for innovating advanced services	9	Three middle managers + two experts and four directors, sales, technology development and product development
Workshop 3	Possible business models / earning logics for advanced services	6	experts and middle managers from sales, technology development and product development

Data collection

As shown in Table 2, the interviewees represented different job positions including directors, middle managers and experts, primarily in the functions of sales and marketing, and technology and product development, and they were chosen through the contact person as key informants relevant to the possible new advanced services. Altogether 17 interviews were carried out (average duration 43 min) in two separate episodes.

The first interviews dealt with customer value and segmentation, and they inquired the interviewees' experiences on: the current advanced service offerings in the firm; current customer relationships; ways for the firm to create value for the customers; required capabilities to implement advanced services; and challenges and risks. The second interviews focused more on the challenges and required capabilities for innovating advanced services, inquiring the interviewees' experiences on: the current advanced service offerings and the intended advanced service innovations; the challenges and risks in advanced service innovations (both for the manufacturer and customers); competitors' actions in the domain of advanced services; requirements for new capabilities to implement the advanced services (both for the manufacturer and customers); and requirements more broadly to the business ecosystem. Also some update questions concerning customer segmentation identified through the first interview round were made with some of the new interviewees. The interviews were recorded and transcribed.

Workshops were targeted at the managers and employees who would likely have a role in designing, delivering and selling the advanced industrial services. Most of the participants were the same people who were also interviewed, but also some additional persons were included. The three workshops (2-3 hours each, with 6-8 participants) were designed to inform the participants about the strategic importance of advanced industrial services, collect further information to develop the business logic of such services, and also develop participants' commitment for the innovations. The workshops were designed so that after a brief opening presentation, two or three discussion questions were presented, the participants were divided into two or three subgroups to discuss them, and the subgroups' discussions were summarized at the end. The interview data were used in the two latter workshops to prepare for the opening presentation and to identify relevant topics for the group discussions. Two researchers and the company's contact person acted as facilitators and took notes in the discussions. These handwritten notes were afterwards typed and compiled and are used as data that complement and validate the interview data. The workshop results were also circulated among the participants, to spark further ideas or and potentially reveal misunderstandings.

Data analysis

The analysis covers dimensions of customer value; alternative dimensions for clustering / segmenting the customer base, based on the prospects for value creation through the innovations in advanced services; and the requirements for benefiting from value innovation in advanced services. Basic thematic content analysis was carried out to code the interview data, firstly through exploring the data, then identifying key categories within the themes, and then coding all interviews contents into those categories. Workshop data were used to validate the interview findings. We will use thematic summary tables and quotes from the interview data, to illustrate some key findings.

Various measures were taken to improve the validity of the results. The data collection approach was designed jointly with the company contact person, to ensure thematic appropriateness and transferability of results. The confirmability and credibility of the results was validated by bringing the interview findings to the workshop participants' discussion, and by circulating the workshop results among participants for possible further comments. Also a written report from the entire study was shared with the participants, and the contact person reviewed it carefully and offered his comments, to improve the validity of the findings.

FINDINGS

Within the study, we sought understanding about the types of service innovations that Industrial Internet can enable. The employees of SysCo perceived that Industrial Internet can transform the logic of value creation between the firm and the customers. The interview and workshop findings revealed that in the advanced services, value innovations are sought through performance enhancement, quality improvement, adaptability and risk management, and sustainability in the customers' processes. These values complement the basic services where value is created primarily through the availability and usability of the equipment. Many interviewees emphasized that Industrial Internet is not a value in itself, but its service innovations need to provide genuine benefits and solutions for the customers' real needs.

The interviewees saw that the design of holistic service solutions for e.g. the customers to save energy and optimize quality would be more interesting than merely offering dashboards and cloud services. The holistic service solutions can naturally include dashboards for process monitoring and various cloud service components, but these features and functionalities should not be the core of service offering development and marketing, as they are not connected with the customers' value as such. One of the interviewees characterized this as a marketing issue as follows:

> *"You cannot sell it as IoT (Internet of Things), but you need to frame it into a more specific context. With the customer, you could say that, 'hey, let's talk about your energy issue – with this capability and this additional service we can guarantee this [level of energy consumption] or solve the issue in this way'. Then, all of the customers can be interested. But if I say that I have IoT or cloud or something, they will think it is just too unpractical and unreal."*

Customers differ in how much they know about Industrial Internet and whether they are willing to be forerunners with the novel technologies. Finding and emphasizing the practical benefits was perceived as particularly important with customers that were not, yet, aware of the possibilities of the Industrial Internet. Showing evidence and examples may be needed, to convince them of the attractiveness of the new services, compared to traditional ways of working. The interviewees also told that there are some highly innovative customers who require new solutions and innovations, in order to keep up with the trends and to be the forerunners in the field. However, also they may question the usefulness of the new solutions unless the benefits are demonstrated. Communicating the benefits was considered as important, not just in terms of practical value, but also in terms of money and payback times.

The interviewees emphasized that communicating the sources of value depends very much on the customer's preferences and value expectations. There is a need to differentiate the value offerings, depending on the customer. Because of the differences across customers, a modular service offering may be needed instead of just one single solution, so that each customer can be offered the right services.

Dimensions for mapping the customer base for advanced industrial services

Due to the strategic nature of advanced services, we anticipated that SysCo would need to see their customer base in a new light, when offering new advanced industrial services. Particularly the first two workshops and the first interviews included questions regarding the customer base and its segmentation for advanced service innovations. The interviews and workshops revealed that indeed the traditional segmentation criteria of basic services (such as purchase volumes, patterns and locations) do not apply for the advanced services. With advanced services, there is a need to understand and take into account the customers' histories, installed base of equipment, and strategic choices, to offer the right service solutions.

From the interviews and workshops, relevant dimensions of the customer base were identified, to segment them for advanced industrial services, including: their installed base of equipment (origin, age), digital infrastructure availability, readiness for procuring advanced services and for Industrial Internet. These dimensions are summarized in Table 3.

Table 3. Key dimensions for customer segmentation for advanced services in the Industrial Internet.

Dimension	Explanation
The customer's readiness for service procurement and Industrial Internet	Some customers are more willing to make service purchases and outsource activities through services. Also their attitudes toward Industrial Internet varies from negligent or neutral to very positive.
Digital infrastructure availability (and geographical and cultural background)	There are differences across countries in the availability of telecommunications networks and related infrastructure, which differentiates countries in terms of the usefulness of Industrial Internet. In developed countries, the digital infrastructures may be more readily available. In western countries, industrial customers may be more willing to use services than eastern, due to procurement being a common practice.
Origin of the customer's installed base of equipment	Customers may have equipment of SysCo, or equipment sold by competitors. SysCo would have better possibilities for data collection, monitoring and use with its own equipment (than that of competitors).
Age of the customer's installed base of equipment	The age of the equipment affects the easiness to collect data and the availability of historical data.

The findings from the interviews and workshops suggest that the customers' attitudes toward Industrial Internet and service procurement is a main defining factor, for segmenting customers. A major issue for the customers is, whether they are willing to outsource certain activities (such as condition-based maintenance or data analytics) through service procurement, or do they need outsourcing quite necessarily, due to the lack of their own capabilities or resources. The interviews revealed that customers also differ significantly in how they relate to Industrial Internet: some customers are very prejudiced, whereas others are very interested and already taking steps to adopt it, as the following quote suggests:

> *"There are major differences. Some customers are very interested in it [Industrial Internet] and practically pull us [SysCo] into collaborative activities concerning it. Some others are more negative, saying that this is not really good, and it is difficult to justify to them why we should move towards it [Industrial Internet]."*

Some interviewees described that the ownership of the customer firm (i.e. traditional limited equipment manufacturer or a firm owned by a capital investor), their innovativeness and future orientation have quite a strong effect on the general attitudes toward service procurement and Industrial Internet. Also, the customer's own capabilities and resources (or lack thereof) influence their willingness to procure services. According to some interviewees, the size of the company may affect service procurement intentions and orientation toward Industrial Internet in various ways; e.g., small and medium-sized firms may be procurement-oriented, if they do not have a certain resource themselves, whereas large firms vary broadly in terms of their strategic focus and scope of activities and, consequently, their interest toward outsourcing such work that could be delivered as service.

Digital infrastructure availability was also perceived as an important factor, and it was often discussed in terms of geographical and cultural differences. A clear overlap was noticed regarding service procurement attitudes in that customer firms in certain countries are more prone to use services than in some others. As developed countries have better access to digital infrastructures, they were seen as better potential contexts for solutions based on Industrial Internet.

The two other dimensions in Table 3 deal with the customer's installed base of equipment. Customers differ clearly in the scope of the installed base of equipment, but for example the number of the equipment is not particularly relevant concerning advanced services. The possibility for advanced services appears to depend on the suppliers of the customer's equipment, as well as their age. If the equipment are manufactured by SysCo, the firm naturally has an easier access to the kind of data needed for advanced services. With competitors' equipment, in turn, data-based services require extra effort. The following quote offers an example of this:

> *"Of course it makes it easier if all are ours [SysCo's equipment], but it is not really a constraint. We take connections to competitor's systems and can collect the competitor equipment data, too, so this is not a constraint. Of course it makes things somewhat more challenging."*

Concerning the equipment age, the older the equipment, the more difficult it may be to access such data that would be needed for advanced services. With old equipment, the sensors, monitoring systems and software are not available, and historical data may be manually collected and stored in a different format than the current systems. With medium-aged equipment, it is possible that the sensors, monitoring systems and software represent a different generation than the current systems. With new equipment, in turn, the sensors and software may be in place, but historical data does not exist. One interviewee explained the necessity to take all these into account as follows: "*We need to develop solutions for all ages of equipment, definitely all. If we only developed solutions for the new equipment, it would be peanuts. You cannot create business from that. This industry will fade away before that becomes significant business.*" The interviewees did not quite agree on which types of customers (in terms of equipment age) might be most suitable for advanced services but, rather, emphasized that any customers may have equipment of different ages in their use, and service solutions should somehow be suited to the customers' unique needs. In all cases, the diversity in the installed base of equipment in each customer's use implies that advanced services will require customization.

Requirements to benefiting from advanced service innovations

The second interviews and the third workshop included issues regarding ways in which SysCo could benefit from adopting Industrial Internet and developing advanced service innovations. Four primary requirements were identified for the manufacturing firm, to benefit from the value innovations of Industrial Internet (Table 4): developing an integrated approach within the organization to delivering services; customers' willingness to share data; coherence in the business ecosystem; and flexible, rapid responses to emerging new competition.

Table 4. Requirements in the manufacturing firm for creating service innovations in the Industrial Internet.

Requirement	Issues discussed in the interviews
Developing an integrated approach within the organization to delivering services	• Strategic corporate-level leadership of the change toward offering advanced services based on the Industrial Internet • Seamless cooperation between units and functions – making the transformation in a cross-unit change program • Clear and coherent implementation of Industrial Internet principles • Developing the new services together • Communication and knowledge sharing across units and functions
Customers' willingness to share data	• Managing data security and solving issues regarding data ownership and use • Contractual arrangements concerning data and services • Communicating the value and benefit of the services to the customers
Coherence in the business ecosystem	• Different stakeholders with different requirements and expectations regarding Industrial Internet • The positions and boundaries of different stakeholders in relation to each other • Diversity in customer's installed base of equipment • Development of technical standards (and current lack of standards)
Flexible, rapid responses to emerging new competition	• Recognizing and understanding the competitive threat from multiple different types of competitors (manufacturers, diversified technology firms, service-centric startups) • Keeping track of competitors' actions; responding to competition; being ahead of competition • Taking the ecosystem perspective (to reduce competitor threat)

The integrated approach to delivering services deals with the necessity for involving multiple different units and functions to the development and delivery of service solutions. Services or their delivery cannot be planned in one unit or by one function alone, because basically all areas of business are affected through the novel ways of working with the customers. Interviewees saw the change as such a strategic transformation that requires leadership from top management, engagement of different units and functions in planning and carrying out the changes, and planned activities for new service development. Some interviewees mentioned the need to have a shared roadmap for the development activities, dedicated people leading the change, and active communication so that all units are kept informed of ongoing changes.

One of the challenges potentially slowing down the progress with advanced services deals with customers' reluctance to share data. As the data-related procedures and systems are just developing, some customers are concerned with the risk that critical business information would end up in the competitors' hands. An evident requirement for the advanced industrial services to succeed is that customer data are treated securely, data ownership issues are handled appropriately, and the service contracts include clear operating principles regarding data. However, customers' willingness to share data is not just a contractual issue, but an issue of trust. Being able to communicate the benefits, the ways of operating, and mutual relational activities in the service were experienced as important activities to promote trust and, thereby enhance customers' willingness to share their data.

The interviewees discussed that offering advanced industrial services in the Industrial Internet may involve other stakeholders than just the manufacturer and the customer. When external service providers, competitors, software providers, data analysts and other stakeholders are involved, the ecosystem dealing with service provision is much broader than with basic services. Therefore, when moving toward the Industrial Internet, there is a need for some degree of coherence in the business ecosystem. At the moment, different stakeholders may have a different idea of what Industrial Internet implies. Also, stakeholders may have different ideas about their own position, boundaries and capabilities in the business ecosystem. For example, a manufacturing firm's role in the Industrial Internet ecosystem may vary from a pure manufacturer to a holistic service provider, and this may be affected by the other stakeholders' positions and actions in the field. Some interviewees discussed that the diversity of equipment in customers' use, the lack of technical standards, and the lack of shared control systems may slow down the ecosystem development. The coherence of the ecosystem may evolve, as the technical standards are being developed and companies engage their ecosystems to joint development work.

Some interviewees considered competition as one challenge to be solved, when moving toward the Industrial Internet. When involving in service delivery and analytics, the manufacturing firms are actually taking a position in a new industry where the competition may be different from what it was in the field of delivering technical systems. Besides the competition from similar kinds of manufacturing firms, interviewees identified the competitive threat from diversified technology firms and innovative small (e.g. service-centric) firms. Also the customers' strategic positioning may generate new competition, as they may expand their own business and, thereby, reduce the manufacturer's prospects for services. The interviewees told that it was important to understand each competitors' unique competitive factors and be able to respond to their actions fast. However, many interviewees also pointed out that it might be difficult for start-ups to enter the industrial service market, because of the very high knowledge requirements in the industry. It is possible that some of the competition-related concerns are removed, when a broader ecosystem engages in developing the standards and practices for the Industrial Internet and mutual gains are sought.

Some additional requirements were expressed in the interviews, but to a smaller extent. For example, there is a need to find employees with the right capability profiles, maintain active communication both within the firm and with the customers (despite the technical remote connections), and make customers such promises that can be kept. Interviewees generally expressed that the technologies regarding Industrial Internet are largely already available and that possible emerging challenges are just minor practical issues to be solved.

DISCUSSION

When manufacturers of complex systems adopt Industrial Internet and transform their value creation logic by engaging in increasingly advanced services, they need to view their customers in new ways. Compared to the delivery of unique complex systems or repetitive basic services, advanced services have potential for quite different value propositions such as enhanced performance, energy efficiency or adaptability, as pointed out in the findings and previous research (Baines & Lightfoot, 2013; Baines et al., 2013; Story et al., 2017). They also imply establishing a longer-term relationship between the manufacturer and the customer (Saarikko et al., 2017). It is quite important for the manufacturers to understand for which customers advanced services can be designed and offered, which is why this study first asked, how the manufacturing firm perceives its customer base, when creating advanced services in the Industrial Internet.

As the first result of the qualitative study, we identified four key dimensions for segmenting the customers for advanced services in the Industrial Internet: customers' readiness for procuring advanced services and for Industrial Internet, the availability of digital infrastructure depending on the cultural and geographical location of the customers, and the origin and age of the customers' installed base of equipment. We suggested that customers cannot be clustered through their service volumes, locations or service types, but instead more elaborate clustering is needed, to identify the right service innovation activities for each customer segment. This finding is relevant to research in three ways.

First, where previous research has suggested that manufacturers map their industrial services based on transactional vs. relational grounds and product vs. process centricity (Oliva & Kallenberg, 2003), our findings suggest that there is a need to make a more fine-grained analysis concerning each of the service types, to target them appropriately to customers. This study focused on advanced industrial services in particular, such as performance-based contracts and delivery of energy efficiency. Even within that category of services, there are a variety of potential customers that may have very different needs and preferences, affecting their intent to procure services. The manufacturing firm will need to customize their service innovations appropriately for each customer segment.

Second, the findings emphasize that customer's technology readiness as well as the digital infrastructures in the business context may either promote or hinder progress in advanced industrial services. Previous research treats the technology enablers as enablers of connectedness, often at the level of single equipment or customer site (Porter and Heppelmann, 2014), and as a means to get closer to the end customers (Rymaszewska et al., 2017). Our study highlights that the manufacturing firm is not necessarily in charge of such technology enablers, as the infrastructures in a certain geographical context may not be available, yet, and as the customers' cultural context may restrain the use of technologies. Here, the findings propose that moving toward advanced services using Industrial Internet are greatly an ecosystem issue that cannot be solved by one manufacturing firms' activities alone. This lends support to seeing Industrial internet as a systemic change (Kiel et al., 2017; Rymaszewska et al., 2017)

Third, the results show clear evidence regarding the connectedness of service innovations with products and systems, i.e., the installed base of equipment in customers' use. Advanced industrial services cannot be developed in isolation from the products and systems, but require in-depth technological and process knowledge and even integrated development.

To delve further into the systemic nature of advanced service innovations, we posed the second question: How (through what kinds of actions) can the manufacturing firm benefit from the advanced service innovations in the Industrial Internet? The results identified four themes for the manufacturing firm, to benefit from the value innovations of Industrial Internet: developing an integrated approach within the organization to delivering services; customers' willingness to share data; coherence in the business ecosystem; and flexible, rapid responses to emerging new competition. This finding offers additional and supportive evidence to previous research that has proposed requirements and changes due to Industrial Internet.

Previous research has emphasized the requirements from Industrial Internet toward the manufacturers' capabilities and resources (Coreynen et al., 2017; Kiel et al., 2017), the manufacturer's and customer's relationship (Falkenreck and Wagner, 2017; Kiel et al., 2017; Rymaszewska et al., 2017), and the role of data in value creation (Rymaszewska et al., 2017). Such previous research acknowledges Industrial Internet as a factor driving business model innovations and value innovations, which imply not only developing the value propositions but also developing the business logic and system for delivering value (Berghman et al., 2012, Matthyssens et al., 2006; Chesbrough, 2010; Visnjic et al., 2014). As a contribution, this study has highlighted the need for integration in the manufacturing firms' service delivery system as well as at the level of the business ecosystem, to create and deliver the value innovations concerning the advanced industrial services. Previous research has not covered this integration issue sufficiently, yet.

CONCLUSIONS

The objective in this paper was to identify the key expectations and requirements that an industrial system manufacturer faces, when adopting Industrial Internet and innovating advanced industrial services for its business customers. The findings suggest that advanced industrial services in the Industrial Internet require manufacturing firms to adopt a systemic orientation toward value innovations. Understanding of the systemic innovation requirements in customer segmentation, ecosystem design, and competitive logics will help manufacturing firms to develop their capabilities in a holistic way and, thereby, respond to customer needs in the Industrial Internet.

The qualitative research has validity limitations that need to be taken into account. It is evident that with a single case study, the generalizability of the findings is limited and the focus has been on increased understanding on the studied phenomena in their real-life context. We have offered information on the case context, and the same phenomena can well be found among other firms manufacturing equipment, processes and systems. The data collection procedure including interviews and workshops was designed in such a manner that data triangulation could be used to improve research validity. However, the choice of interviewees and workshop participants was limited and covered only selected functions in the case company. Also other parts of the organization are affected by advanced services and Industrial Internet, and the research could later be extended to other parts of the organization. Furthermore, we are aware that the open-ended interview technique and inductive coding procedure have its drawbacks. An open-ended and inductive approach was chosen, due to the lack and inconsistency of previous frameworks concerning requirements from Industrial Internet toward advanced industrial services. With this approach, we hoped to learn about the experiences of the informants, in their real business context. However, it is possible that all relevant issues were not identified with this practice.

Further research is encouraged concerning three primary issues. First, we have in this paper pointed out the systemic nature of advanced service innovations, dealing with both the value proposition and value delivery and capture in a broader ecosystem. We propose that this systemic aspect of advanced service innovations should be studied further, both in in-depth case studies and potentially also through cross-sectoral surveys. Second, it is evident that Industrial Internet as a context and factor affecting advanced industrial services is still evolving, and will require further research in many ways. Not only should the connections between technologies and services be explored, but also the behavioral and strategic changes induced by the Industrial Internet should be studied further. Third, this study has pointed out the centrality of the customer's technology base and readiness for service procurement regarding the manufacturing firms' prospects to sell and deliver advanced services. There is a need to understand these antecedents of advanced service use much better, to help manufacturers develop their processes and routines as service providers. For example, customer's outsourcing and procurement strategies as well as technological maturity could be studied further, in connection with the manufacturers' servitization.

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REFERENCES

Ardolino, M., Rapaccini, M., Saccani, N., Gaiardelli, P., Crespi, G. & Ruggeri, C. (2017). The role of digital technologies for the service transformation of industrial companies. International Journal of Production Research, DOI: 10.1080/00207543.2017.1324224

Baines, T. & Lightfoot, H. W. (2013). Servitization of the manufacturing firm: Exploring the operations practices and technologies that deliver advanced services. International Journal of Operations & Production Management, 34(1), 2-35.

Baines, T.S., Lightfoot, H. & Smart, P. (2011). Servitization within manufacturing: exploring the provision of advanced services and their impact on vertical integration. Journal of Manufacturing Technology Management, 22(7), 947-954.

Baines, T., Lightfoot, H., Smart, P. & Fletcher, S. (2013). Servitization of manufacture: Exploring the deployment and skills of people critical to the delivery of advanced services. Journal of Manufacturing Technology Management, 24(4), 637-646.

Berghman, L., Matthyssens, P. & Vandenbempt, K. (2012). Value innovation, deliberate learning mechanisms and information from supply chain partners. Industrial Marketing Management, 41(1), 27-39.

Chesbrough, H. (2010). Business model innovation: Opportunities and barriers. Long Range Planning, 43(2-3), 354–363.

Coreynen, W., Matthyssens, P. & van Bockhaven, W. (2017). Boosting servitization through digitization: Pathways and dynamic resource configurations for manufacturers. Industrial Marketing Management, 60, 42-53.

Falkenreck, C. & Wagner, R. (2017). The Internet of Things – Chance and challenge in industrial business relationships. Industrial Marketing Management, 66, 181–195.

Jaakkola, E., Meiren, T., Witell, L., Edvardsson, B., Schäfer, A., Reynoso, J., Sebastiani, R. & Weitlaner, D. (2017). Does one size fit all? New service development across different types of services. Journal of Service Management, 28(2), 329-347.

Jeschke, S., Brecher, C., Meisen, T., Özdemir, D. & Eschert, T. (2017). Industrial Internet of Things and Cyber Manufacturing Systems. In Industrial Internet of Things (pp. 3-19). Springer International Publishing.

Kiel, D., Arnold, C. & Voigt, K-I. (2017). The influence of the Industrial Internet of Things on business models of established manufacturing companies – A business level perspective. Technovation, 68, 4–19.
Kim, C. W. & Mauborgne, R. (1997). Value innovation: The strategic logic of high growth. Harvard Business Review, 75(1), 102-112.
Kowalkowski, C. & Brehmer, P-O. (2008). Technology as a driver for changing customer-provider interfaces. Management Research News, 31(10), 746-757.
Kowalkowski, C., Gebauer, H. & Oliva, R. (2017a). Service growth in product firms: Past, present, and future. Industrial Marketing Management, 60, 82–88.
Kowalkowski, C., Gebauer, H., Kamp, B. &Parry, G. (2017b). Servitization and deservitization: Overview, concepts, and definitions. Industrial Marketing Management, 60, 4–10.
Lee, I. & Lee, K. (2015). The Internet of Things (IoT): Applications, investments, and challenges for enterprises. Business Horizons, 58(4), 431-440.
Markides, C. (1997). Strategic Innovation. Sloan Management Review, 38(3), 9–23.
Matthyssens, P., Vandenbempt, K. & Berghman, L. (2006). Value innovation in business markets: Breaking the industry recipe. Industrial Marketing Management, 35(6), 751-761.
Oliva, R. & Kallenberg, R. (2003). Managing the transition from products to services. International Journal of Service Industry Management, 14(2), 160–172.
Opresnik, D. & Taisch, M. (2015). The value of Big Data in servitization. International Journal of Production Economics, 165, 174–184.
Perks, H., Gruber, T. & Edvardsson, B. (2012). Co-creation in radical service innovation: A systematic analysis of microlevel processes. Journal of Product Innovation Management, 29 (6), 935–951.
Porter, M. E. & Heppelman, J. E. (2014). How smart, connected products are transforming competition. Harvard Business Review, 92(11), 64-88.
Rymaszewska, A., Helo, P. & Gunasekaran, A. (2017). IoT powered servitization of manufacturing – an exploratory case study. International Journal of Production Economics, 192, 92–105.
Saarikko, T., Westergren, U.H. & Blomquist, T. (2017). The Internet of Things: Are you ready for what's coming? Business Horizons, 60, 667—676.
Sousa, R. & da Silveira, G.J.C. (2017). Capability antecedents and performance outcomes of servitization. Differences between basic and advanced services. International Journal of Operations & Production Management, 37 (4), 444-467.
Story, V.M., Raddats, C., Burton, J., Zolkiewski, J. & Baines, T. (2017). Capabilities for advanced services: A multi-actor perspective. Industrial Marketing Management, 60, 54-68.
Tongur, S. & Engwall, M. (2014). The business model dilemma of technology shifts. Technovation, 34 (9), 525-535.
Töytäri, P., Rajala, R. & Brashear-Alejandro, T. (2015). Organizational and institutional barriers to value-based pricing in industrial relationships. Industrial Marketing Management, 47, 53–64.
Visnjic, I., Wiengarten, F. & Neely, A. (2014). Only the brave: product innovation, service business model innovation, and their impact on performance. Journal of Product Innovation Management, 33 (1), 36-52.