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An Integrated Product Service Engineering Methodology for Small Businesses in the Manufacturing Industry

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Abstract

Manufacturing processes constantly improve with automation solutions, in order to enhance production efficiency, effectiveness, and improved ergonomic solutions. The aim of this paper is to explore the transition of small automation suppliers or integrators into offering product service systems (PSS) through guidance by the Integrated Product Service Engineering (IPSE) methodology. It reports results from a longitudinal investigation of small companies providing solutions for industrial automation and digitalization, in an industrial cluster, where the IPSE methodology was applied.

As the era of digitalization and smart industry emphasizes automation and robotisation of the manufacturing industry, the importance of such automation suppliers or integrators increases. There is for example a risk that small manufacturers are left behind due to the high investments needed; the studied small automation suppliers or integrators then can tailor "right automation". Their customers are both large and small manufacturers. They are known to develop cost efficient and innovative solutions, in close dialogue with customers. These solutions, developed and tested in the small firms' workshop facilities with build-and-test laboratories, are rooted in their deep knowledge of manufacturing processes, mechatronics, robotics, control systems, and interface programming. By articulating value-added business offerings as PSS, the small automation suppliers or integrators could develop agreements ensuring increased win-win opportunities for both customers and automation providers, i.e. also their partners and suppliers.

The paper presents how the IPSE methodology can facilitate the transition from traditional product or service selling to PSS offerings for the small automation suppliers or integrators studied. The common denominating challenge for the firms in this niche was based on classical business limitations due to smallness. Being a small supplier towards larger customers, negotiation for price and payment dates are difficult; towards small manufacturing firms, the challenge instead being to be able to address the customer company's lack of investment possibilities. State of practice for the focal firms at the setting out of the study was an unclear business position, with unclear value proposition and fluctuating financial results.

The applied IPSE method includes integrated business and technology development and, in the adapted version presented in this paper, addresses especially the liability of smallness that the automation suppliers were suffering from, such as contractual issues, and the articulation of value for the larger market towards their customers, which may be both small and larger manufacturers. The result was a transition from being regarded as stand-alone automation supplier companies towards becoming automation service providers (ASPs).

Keywords: Small business, flexible automation, business cluster, PSS-product-service system, Integrated Product Service Engineering

1 Introduction

Automation is identified as one key for the future production by several large companies in Sweden (Wiktorsson et al, 2016) in order to keep and increase competitiveness. The linkage between increased automation and improvements in robotisation and performance in small and medium sized enterprises (SMEs), especially for early adopters of new technology (Garsombke and Garsombke, 1989), increase their output and profitability. This indicates a market niche for companies that have competence to develop automation and digital solutions for implementation in production systems. Depending on the manufacturing company's needs, automation solutions suppliers and integrators combine different technologies and engineering solutions, based on machinery and tools, spanning from control units and electronics to complete production system equipment for robot cells, consisting of e.g. robots, vision systems, grippers, control systems including all sorts of connected services such as development, training, installation, upgrading and maintenance. Their offering hence includes hardware, software and services, which combined, can be labelled as product service systems (PSS) (Tukker and Tischner 2006) or Integrated Product Service Offerings (IPSO) (Sakao et al 2014).

For this research, several automation suppliers and integrators were identified to reside in the a specific region. This region has a long tradition of state-of-the-art manufacturing suppliers and product manufacturers in business areas such as metal works for automotive, wooden furniture, and composites contract manufacturing. To address future challenges, about twenty small automation companies established a business cluster to share resources and join forces on important prerequisites for their survival, such as attracting competent employees, access to, and participate in advancing, technology development, legal and financial issues, and influence policy-makers for the automation industry as a whole. (Johansen and Öhrwall Rönnbäck, 2014)

The establishment of the regional cluster evolved from the experience identified at a visionary company in the region that had started its transition towards PSS by offering different solutions, but saw the difficulty to recruit competence. The intention was to facilitate future growth, inspire to innovation in relation to emerging technologies and form new business models. Therefore, the cluster was established with the intention to support several automation suppliers or integrators to collaboratively learn and develop offerings in line with PSS. (Johansen and Öhrwall Rönnbäck, 2014)

The aim of this paper is to explore the transition of small automation suppliers and integrators into offering product service systems (PSS) through guidance by the Integrated Product Service Engineering (IPSE) methodology.

2 Theoretical framework

2.1 Automation

Manufacturing processes, such as assembly and managing the shaping of material, could be done manually or by developing automated solutions for the different tasks. Groover (2008) argued for that automation e.g. can be used in order to reduce labor cost, increase efficiency as well as for improving product quality and increase safety for operators. Developing automated solutions demands knowledge about the product and its requirements, in order to be able to contribute to a production solution. Short production cycles and highly flexible design challenge the production systems, and rapid change in manufacturing requirements, as Tan et al (2009) argues, indicates that conventional automation technology has come to a bottleneck. Trends in automation is to develop fenceless robotic cells design for human-robot collaboration, HRC (Gopinath et al, 2018; Olsen and Johansen, 2013; Tan et al., 2009). Tan et al (2009) describe six main design factors that are important while designing HRC prototype production cells; Human Collaborative Design, Collaboration Planning by Task Modelling, Collaboration Safety, Mental Workload in Collaboration, Man-Machine Interface; and System Performance Improvement. Current industrial robots are optimized to "economy of scale", as Pichler and Wögerer (2011) state it, but customization, individualization, and service-orientation drive towards new business models. A need for diversity in robot models, performance and flexibility are identified as a key for increased automation as well as a need for following the trends in the development of robots and different emerging technologies that supports new applications (Brogårdh, 2007). This can be challenging for individual manufacturing SMEs (SMMEs), and indicates a need for collaboration with automation suppliers or integrators.

2.2 Manufacturing flexibility versus automation

Manufacturing companies need to balance their product portfolio versus the level of flexibility in the production system. Brown et al (1984) expressed a "taxonomy of flexibility types" in order to managing manufacturing responsiveness. These flexibility types where related to machine, process, product, routing, volume, expansion, operation and production (Brown et al, 1984). In order to complement Brown's taxonomy, Sethi and Sehti (1990) included that flexibility in a manufacturing system also need to include material, program and market. Related to the need of flexibility in order to manage customized products and components, there is a need for understanding the business, and how business is related to the manufacturing strategy (Beach, 2000). As Scholl (2012) argues, automation suppliers need to develop and provide intelligent automation solutions that efficiently can manage the rapid product or model changes from the customers. This corresponds to that many products are produced in mediumsized batches and variable volumes, requireing more flexible automation solution (Heilala and Voho, 2001). It is challenging to balance the efficiency against the need for variety in the manufacturing process, with several impacts to manage; high inventories, feeding complexities, excessive capital investment, and change in assembly sequence, and complexity in line balancing (as identified by Dean et al., 2009). However, Groover (2001) listed nine reasons that justify a transition towards increased automation:

1. To increase labor productivity
2. To reduce labor cost
3. To mitigate the effects of labor shortages
4. To reduce or eliminate routine manual and clerical tasks

5. To improve worker safety
6. To improve product quality
7. To reduce manufacturing lead time
8. To accomplish processes that cannot be done manually
9. To avoid the high cost of not automating

To summarize, automation developed in the right way, that easily can be reconfigurated related to product variety, supporting a manufacturing strategy for a company can contribute to a more efficient manufacturing process, including contributing to achievement that supports “the global goals”, such as the 9th goal focusing “Industry, innovation and infrastructure” (www.globalgoals.org).

2.3 Business related to automation

European companies are facing a global competition, and as Barton and Thomas (2009) argue, the competitiveness is articulated through value adding activities, such as services and customization, as in the case of PSS. This require either dedicated resource allocation or adaptiveness in the supply chain (Barton and Thomas, 2009) or higher responsiveness in manufacturing (Beach, 2000). New customer solutions for automation in production is continuously needed from automation suppliers or integrators (Scholl, 2012), which can be developed continuously as the technologies evolves (Brogårdh, 2007). This indicates a need for an automation solution that is possible to continuously maintain and upgrade in a cost efficient way in a long term relationship between the producing SME and the automation supplier or integrator. As Johansen (2005) argue, collaboration between engineers in such an extended company network during industrialization is built on trust and communication.

With a robust and highly responsive manufacturing systems at an SME, it is possible to achieve better financial and technology sustainability, which contributes to a more stable market position (Thomas et al., 2008). However, this includes a culture of continuous technology implementation (Thomas et al, 2008) and, if possible, to integrate and automate as many task as possible with a communication network to increase competitiveness, as argued by Selladurai (2004). However, this indicates a need for continuous training for the operators in the production line as well as continuous learning of new trends and technologies at the automation supplier or integrator. As an automation supplier or integrator it is possible to develop offerings to their customers’, SMMEs, that combines physical equipment with services. This could be developed according to the concept of product-service systems (PSS) (eg. Oliva and Kallenberg, 2003).

2.4 Integrated Product Service Engineering (IPSE)

Based on a literature review, Terziovski (2010) analysed that SMEs viewed their performance in relation to technological capability as an enabler, instead of a driver. Following this line of thought, the servitization trend can be seen as enabled by technology development. To enable servitization enabled by technology capabilities, Integrated Product Service Engineering (IPSE) was originally developed as an ecodesign method, to assist companies to move from selling products or technology, to providing solutions with sustainability focus (Sundin et al. 2007; Lindahl et al. 2006). This could be compared with Oliva and Kallenberg’s (2003) framework for Product Services Systems (PSS), which can facilitate evaluation possibilities to offer combined manufacturing system solutions. Furthermore, when it comes to understanding of customer needs, and how to address future demands such as integrate emerging technologies into automation solutions, it could be presented as values constellations (Normann and Ramirez, 1993) in order to add customer value. Market value, which in this case could be compared to customer value, could be analysed by using the framework that is called "profit pools" (Gadiesh and Gilbert, 1998). All these different tools, in combination into the business model canvas tool can visualize and guide PSS providing companies' value-based offering (Osterwalder and Pigneur, 2011). Integrated Product Service Engineering (IPSE) is therefore suggested as a method for a company to develop its offering from selling products (goods, hardware) or services (including software-as-a-service, training, maintenance services etc) towards combinations, in so-called Product Service System, PSS, solutions that provides a complete integrated function. In the manufacturing context, a PSS solution could be to "provide production", a part of the manufacturing function at the customer's facilities, instead of "selling parts and components to a production system". PSS has many labels as it has developed over the last 20 years, often referred to as a total offering, integrated solution or industrial service solution (Lindahl et al 2006). As described in the introduction the automation industry faces several challenges today at a company level.

3 Research Methodology

3.1 An action research approach with follow-up interviews

An action research approach (Stringer 2007; Gustavsen et al., 2008; Coghlan and Shani, 2017) was chosen as a means to better understand the studied companies and their industrial context, in their established cluster. The criteria for membership was (1) business activity mainly within the field of industrial automation, (2) geographical proximity to the studied region, and (3) a willingness to collaborate, with the aim of establishing a network for regional competitiveness through automation solutions (Johansen and Öhrwall Rönnbäck, 2014). Early on, it was identified that the network establishment needed facilitation from the academy with the aim of transferring knowledge about PSS and Integrated Product and Service Engineering (IPSE) in combination with production research within the area of automation and production system. Furthermore, a steering committee consisting of regional business coordinators and the experienced PSS company's managing director was established, with an external chairman appointed from a national institute.

The action research was organized in a workshop series, structured according to the IPSE method (Sundin et al. 2007; Lindahl et al. 2006). Furthermore, the research where performed, inspired by Coghlan and Shani (2017), together with managing directors, often owners of their companies, from the automation supplier or integrator companies that met or were interviewed in a dynamic field of industrial changes, spanning over a period of more than six years (2012-2018). Here, the research was performed with voluntary participants from the automation suppliers or integrators, with extensive practical knowledge in the field of manufacturing at the time given for all meetings, where all participants were able to validate and transform new knowledge continuously during a series of five workshops. This is a philosophy for making action research according to Chandler & Torbert (2003), since action research builds on the past, takes place in the present with a view to shaping the future (Coghlan and Shani, 2017).

During the time span, two interview series were conducted, including factory visits at least at the first interview, with all participating companies; one in parallel with the workshop series during 2013 and one follow-up interview series two years later, and finally, a validation survey during 2018 by personal visits from a neutral person in order to collect long term effects. To prepare the workshops 10 years of financial data for each company was collected and analyzed. Furthermore, other external data was collected such as web sites and other publications. Specific questions were asked concerning if the IPSE workshop methodology had had any effect on the development of the company. The studied focal companies represent a special niche of small suppliers providing automation technology solutions to manufacturers, including innovative tailor-made engineered equipment for complete production systems or sub-systems, and attached services.

3.2 The workshop series

This workshop series consisted of five workshops, organized to assist the companies in developing their offering towards an IPSO. 13 of the companies attended at more than half of the workshops. The workshops were divided by themes, as shown in table 1. The overall purpose for the IPSE workshop series was to facilitate the automation suppliers or integrators towards business and market development for sustainability long term profitability. However, the aim here is to present how the IPSE methodology supported the focal companies to utilize their engineering competence towards a more sustainable offering process to provide manufacturing competitiveness for their customers.

Table 1. Workshop themes

Workshop 1	Value constellations as an automation supplier or integrator
Workshop 2	Map of automation supplier or integrator offerings i.e. service/products
Workshop 3	IPSE game and Business model canvas for each automation supplier or integrator
Workshop 4	System integrator identification and pricing as an automation supplier or integrator
Workshop 5	Industry mapping and automation supplier or integrator activities

4 Results

4.1 Business analysis of the cluster members

Based on own observations from visiting the focal firms in this study in combination with indepth semi-structured interviews with the managing directors the baseline for the different firms that built the cluster was mapped. In 2013, the automation suppliers or integrators studied struggled with low profitability and fluctuating income due to project payment routines. An analysis in Business Retriewer showed that the member firms in the cluster had a total turnover of 300 MSEK (year 2012) with about 300 employees all together. But the individual firms size was from one up to ~80 employees. The engineering diversity between the studied firms were large – some of them were focusing on a specific part of automation, such as control units, others focus developing complete automation solutions. Some similarities noted were that all of them were SMEs with customers representing both large, multinational firms as well as SMMEs. The firms in the established cluster did not belong to a specific industry, which could be traced back to their starting position, either electrical firm, mechanical firm, plastic firm etc. Furthermore, the studied automation suppliers or integrators most oftenly were the project manager in the development of an automation solution for their producing customer. A typical business relied on a system product, consisting of machines, tools, software and knowledge in form of how to manage it as well as maintain the system. The firms developed automation solutions for all kind of products as well as materials.

Based on this broad view of the business content in the established cluster, it is identified a possibility for all firms to start a transition towards PSS (Oliva and Kallenberg, 2003) but the companies need to be facilitated. The researchers introduced a customized, adapted variant of the IPSE methodology into the cluster, in order to support the possible individual transition of each firm. During this work it was identified that the automation integrators' or suppliers' product offering hence is a complete production systems or parts of a current production subsystems, delivered as tested equipment on customer sites (factory, FAT, and SAT, site acceptance test), i.e. they provided solutions. Therefore, we label these types of firms Automation Solutions Providers (ASPs). Customer requirements on such production systems or sub-systems solution can be split into three major parts: (1) operator interface requirements, (2) manufacturing technology requirements, and (3) requirements on integration and coexistence with a current production system.

4.2 The transition towards PSS

During the workshops' all managing directors at the Automation Solution Providers (ASPs) worked with their own material and knowledge from their own business. Based on this the discussions were facilitated by the researchers in order to both increase the awareness about PSS at the participating managing directors as well as increase the knowledge about the competence within the established cluster.

The transition set out with a mapping of value constellation (Normann and Ramirez, 1993) as an ASP. The first workshop (WS1) started with inspiration about trends in the robotic area including emerging technologies as well as trends in business models. Thereafter, the managing directors worked two and two (from different ASPs) with the value mapping tool. All managing directors presented their own value map for the whole group. Some managing directors were very open and some more restricted about details they shared.

To conclude WS1 – ***Value constellation*** – all firms had similar value maps including important keywords for their business. The value is in the know-how from idea to final solution. For an ASP this is a system product that automatically can perform a certain task in a production system – and this means that the delivery from an ASP is drawings/design solutions, developed and assembled hardware, identified standard components, programming and installation at the customer. Furthermore, it was noted that customers have high requirements on productivity rates and quality including late changes, which is a challenge for the ASP to manage in a business model in combination with flexibility in the development process.

In the second workshop (WS2) – ***Map of ASP's offerings as service/products*** – each firm identified its offering and sales process. During WS2 the discussion about customer value was intense and how to interact with customers during long term projects. The managing directors were asked to position its offering(s) on the continuum from goods (100%) to service (100%) (Oliva and Kallenberg, 2003). In this interactive mapping it became obvious that it is difficult to develop offerings related to knowledge-based services including to get paid for these. The ASPs all together have broad knowledge from machine design, robotics, machine development, production technology, virtual tools, 3D printing, electrical design, welding, etc. However, it was also understood that the experience in combining hardware with engineering know-how differed between the companies. The competence in combining production technology with automation solutions were and outstanding unique selling point at the ASPs, and the reason why their customers chose them. One vital issue that affects the ASP's business, and especially their financial figures, is when to send the invoice(s). This is critical especially since solution development projects often are long and include several subsystem and component suppliers. There is a risk to fall into the role as a bank for the customer, which is not manageable for the studied small ASPs. The substantial fluctuation in turnover and profit is related to payments for projects, which may be registered after closing a financial year. Since the discussion was intense and seemed highly valuable for the participants, it took longer time than planned and this theme continued in WS3.

The next step in the transition towards PSS included insights into offering integrated solutions through playing a board game. The third workshop (WS3) – ***IPSE game and Business model canvas for each ASP*** – were both more interactive as well as more individual for the managing directors. In combination with the interactive IPSE game, and the continued discussion about offerings (service/products) from WS2 a need was identified to increase the awareness of delivering value to customers as well as developing a payment framework adaptable to project deliveries. Knowledge-based services could be a concept developed for the early phases of understanding what to offer a customer, training after installation, adding some small add-ons after changes by the customer etc. Due to the challenge to identify and set a price on services, many of these kinds of services were provided free of charge. However, since the delivery from an ASP is combinations of hardware, software, and services in automated solutions adapted to a customer need, it is possible to develop offerings in modules, covering engineering design, hardware manufacturing/purchasing, assembly, programming, on-site-training, operation, etc.

In the fourth workshop (WS4) – ***Systems integrator identification and how to set price as an ASP*** – the discussion was intense about how the business model can evolve in relation to the role as an ASP that acts as a systems integrator. By using the Business Model Canvas, BMC, as a framework (Osterwalder and Pigneur, 2011), each company prepared its own map over the business – identifying the nine important areas in order to achieve a valuable business:

Key partners	Cost Structure	Customer relationships
Key activities	Value proposition	Channels
Key resources	Revenue streams	Customer segments

Some of these areas were easier to fill in with a high level of details, while others were more difficult to map, and were eye-openers for some of the managing directors. The structure of the business model canvas was appriciated and it clarified the differencies between the areas in a helpful way. It was identified as a tool that supporteded the managing directors in mapping the business "as is", and to facilitate the companies in their ongoing strategic work.

Finally, in the fifth workshop (WS5) – Industry mapping and ASP activities – the industry was mapped focusing on the delivery of automation solutions to customers at large, i.e. taking into account the copmetition, suppliers and partners, in a discussion focusing customer value and profit pools. Here all companies contributed from there own experience and there personal understanding about what activities/competencies that are needed for developing an automation solution. Furthermore, the participants estimated the volume in sales as well as the profit in each profit pool based on personal experience. It should be noted that the companies have long experience in the industry. Several of the managing directors have been active more than 20 years in the business, and have extensive knowledge about “the rules of the game”. Some important points from WS5 were:

- If the ASP calculates wrong (too low) price in its offer, it is difficult to achieve profit
- The prerequisite for obtaining profitability is correct design and development
- If the ASP can own the design or solution it is possible to reuse it and therefore increase the profitability
- And of course, sales that you can not get paid for is unprofitable

The industry mapping through profit pools (Gadiesh and Gilbert, 1998) based on the participants in WS5 is presented in Table 2.

Table 2. Industry mapping relevant for ASPs

Industry mapping relevant for ASPs through profit pools							
Project manage-ment	Needs, Quality, Concept-ual ideas, Finance	Design (Mechan-ical, Electrical, Software)	Manufact-uring / Assembly including purchasing	Machine assembly and test	Installation and validation	Training on-site	Service and After sales

4.2 Reflections over the initial steps towards PSS

Indications that reflects the value from the five workshops aiming to inspire and guide the start of a transition towards PSS for the participating ASPs can be summarised, based on observations during the workshops, as well as the follow-up afterwards in 2018, as follows:

- The companies improved their marketing communication in several ways:
    - The offerings changed, e.g. regarding when sending invoices during a long project
    - Broschures describing the company including focus on the role as an ASP
    - Increased utilization of digital platforms, such as youtube for films showing solutions
    - Networking with researchers in order to prepare presentation for a fair
- Business models:
    - A few of the companies were bought by larger companies, but still act as stand-alone firms, but with support from the aqcuisitor company group, which means that their role have changed for their business rather into a division
    - Some companies have followed their customers abroad and increased their export
- The companies collaborate within the cluster for different purposes
    - Regular “breakfast“ meetings with different themes, e.g. export, machine directive
    - Several ASPs performed joint customer projects
    - Technology benchmarking

This method with five workshops established a PSS platform for the participating ASPs. The next step is to leverage on this for full realization of PSS and improved business to deliver services related to the installed base at the customers. Noted is that several of the ASPs have increased, or started to, export their automation solutions to Asia, Europe as well as to US.

5 Analysis

To explore the transition of small automation suppliers into offering PSS, there are several tasks to be reflected upon. Based on the five workshops, the participating companies started their transition towards PSS, as the IPSE methodology facilitated for the managing directors to review their businesses and identify services that are possible to offer, or are already offered, unpaid. It was clear that the companies offer already many services such as providing knowledge-based services e.g. engineering and analysis. After applying the IPSE methodology, the managing directors were able to categorize these and set a price on each. An analysis of the companies that fulfilled the five workshops gave – all together – if their financial data are collectively addressed, at hand an increased common profit with 10% between 2012-2016, and at the same time reduced the number of employees with nearly 8%. At the same time one company was bought and integrated into a huge organization and one company was divided into two companies, where the new company did not attend the workshops. These two "dropouts" from the original set up is not included in the figures above. The increased profit indicates that the vulnerable situation described in the beginning has stabilized. This is probably a combined result of high demand from customers and better quality in offerings with more PSS focus.

In order to build a platform for supporting PSS the companies were defined to be Automation Solution Providers (ASPs) instead of Automation suppliers or integrators. The meaning of being a provider is important, since that indicates an active role both in the engineering phase, during concept studies and customer value-added offering activities, as well as maintenance, training and possible up-grading and modifications after installation, depending on changed customer needs. Furthermore, some of the companies will be able to increase their technology skills by including new knowledge areas, such as vision technology or advanced virtual tools. For others their knowledge depends in certain specific technology segments.

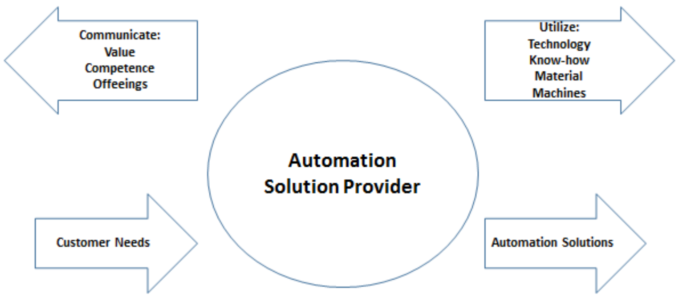

Figure 2. The insights of knowledge communication and utilization for an Automation Solution Provider

The discussions during the workshops contributed to a common view of the industry and that all shared the same insights about challenges to convince buyers about benefits in investing in automation, train the customers, especially their purchasing organizations, in how to buy automation. The insights about the importance to communicate value, competence and offerings to customers and understand their needs as an Automation Solution Provider in order to understand how to utilize technology, know-how, material and machines in developed automation solutions, are important in future business that rely on PSS (see figure 2). This insight is supported from different perspectives, such as the need for extended offerings in order to contribute to customer value (Barton and Thomas, 2009), the relationship between business and manufacturing strategies (Beach et al., 2000) and how to collaborate with different companies in order to reduce risk while developing an automation solution, and providing a PSS (Oliva and Kallenberg, 2003). BMC (Osterwalder and Pigneur 2011) is in this study included as an analysis tool for the participging in the transition towards PSS. A similar use of the BMC is presented in the research performed at two Norweigian SMEs (Frick and Ali, 2013). However, the strategic support for outlining future strategies needs to be more in depth analysed according to Frick and Ali (2013). In this study the to facilitate SMEs to utilize the BMC in a strategic way as is the case of this paper.

6 Concluding discussion

The applied IPSE method includes integrated business and technology development and addresses especially the liability of smallness that the automation suppliers were suffering from, such as contractual issues, and the articulation of value for the larger market towards their customers, which may be both small and larger manufacturers. The result was a transition from being regarded as stand-alone automation supplier companies towards becoming a valueadding automation service providers (ASPs) within a cluster of ASPs.

Now, in 2018, the trend of automation and higher utilization of robots evolves, and even from the governmental level, there is a large focus on supporting the new industrialization trend with programmes supporting increased automation through implementing robots, digitalization implementation etc. These are initiatives that can facilitate SMMEs to invest in time for investigating emerging technologies in automation solutions for future competitiveness. The studied ASPs are skilled in developing automation solutions but have an exposed position in the value constellation. Their position and role is still unclear, and one challenge is to get paid for knowledge and accessibility to e.g. knowledge, maintenance and training, so called more tacit knowledge, in already established business relations where this is taken for granted, towards both large and small customers (manufacturers). Another challenge for the future is to facilitate co-production of smart, innovative automation solutions in order to provide offerings from the ASPs to SMMEs that is feasible from a business perspective for both sides.

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