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Business Model Development towards Service Management 4.0

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Abstract

There is an increasing interest to ensure operational and maintenance (O&M) operations from a strategic perspective, and there are opportunities for both producing companies and service providers to gain benefits. Research shows that the combined business models (products combined with services) have a positive effect on the business. Likewise, it is profitable to think strategically and in long term for enterprises offering maintenance services, especially using performance-based models. But for achieving these benefits the view of the business has to change. The focus should be on the values created and not in the offers in form of products or services. Moreover, the company needs to position itself as an actor not only in the value chain, but in a wider context referred to as the business ecosystem. Making such a shift of focus is hard though, and there is a need to understand both the current state of the business as well as the potential future directions.

The framework presented in this paper is an attempt to meet these needs. The framework describes business model development in four levels. From maturity point of view, the four steps could be seen as the logical development of the business model from a narrow technical perspective to a holistic product-service perspective. The four levels could also be connected to the industrial development where level four supports Industry 4.0. Level four is referred to as Service Management 4.0. In particular, four key concepts reflect the concept of Service Management 4.0: the mix of products and services in customer offers, performance-based contracts, partnering and the business ecology concept.

Keywords: Service management 4.0; Business model development; Integrated product-service models

1. Introduction

The area of business modelling and innovation has gained increased attention in the recent year due to success stories of companies earning big money by adapting new business models [1]. Business models describe the way a company creates, delivers and assimilates value [2], and defines how business should be conducted, for example in terms of strategy, customer relations, market segments and value creation mechanisms. It is also important to define the company’s role in the value stream chain [3]. Business models aimed at combined offerings, i.e. products combined with services, have been proved to have a positive effect on the operations, see for instance [4]. There are opportunities for both producing companies and service providers to gain benefits, but the view of the business must change in order to achieve the benefits [5]. The change in focus from what to offer to what value the offer brings for the customer is required, and to adopt a holistic approach on the value creation process [6, 7]. In [8] four main aspects are proposed as being important for the successful development of operations and maintenance (O&M) service models: the mix of products and services in customer offers (bundling), the need for a holistic view on the value creation process, relevant setup and metrics for performance-based business models and contracts, and Information and Communications Technology (ICT) as an enabler and a prerequisite for business model development. The latter connects the contemporary business strategies with modern production strategies referred to as Industry 4.0. Industry 4.0 implies that other revolutions have taken place. The first revolution happened in the 1800-1900’s, when production was mechanized. The production was moved...
from decentralized units to large factories and a new social class, the working class, was born. The second revolution occurred in the last century when the production became electrified and parts and processes were standardized. The digitization of production is usually called the third revolution. Industry 4.0 is referred to as the internet revolution and is characterized by intelligent factories through cyber-physical systems and the internet of things [9]. Cyber-physical systems are physical devices with components that are integrated in the devices for monitoring and control. These cyber-physical systems are connected and communicate with each other through internet technology for coordination purposes, thus creating flexible, dynamic and smart factories. Maintenance 4.0 is a subset of Industry 4.0 in the form of self-learning and smart system that predicts failures, makes diagnosis and triggers maintenance actions [10].

Industry 4.0 focuses on delivering advanced technical solutions to manufacturing problems and support new manufacturing philosophies such as lean production, but in order to become successful these technical innovations in manufacturing must be connected with the strategic business models. Flexibility in manufacturing requires flexibility and adaptiveness in the services such as maintenance and logistics which can be achieved by applying new business models. In this paper a framework for business model development is proposed that connects technological development with service needs and business modelling, transforming the O & M services, especially maintenance, from being a technical product into a concept of value creation and business creation: Service Management 4.0.

2. New industrial maintenance demands and possibilities

The current technical development in industry regarding information handling and digitalization leads to new ways of producing goods. The industry demands flexible, safe, environmental friendly and available production processes. At the same time production processes becomes more automated, complex and dynamic. A new environment for production is described in [11], which includes automation and very few human beings. Intelligence is built into the actual products and all things can be identified by RFID-tags and every object in the system is traceable. Through this the production becomes more flexible and difficult to anticipate both regarding when it takes place and where. This new situation puts demands on flexibility and automation in the maintenance management as well. At the same time, the ICT development enables new way of managing maintenance.

Advancements in technologies such as data acquisition technology, data technology, sensor technology, prognosis technology gives possibilities to work in new ways with maintenance and thereby increase the effectiveness and also better adopt it to the needs of the customer. Data and information at the right place in the right time are crucial factors for the techniques that give these new opportunities in maintenance. Data intensive technology also enables the development of smarter systems for prognostics to be built into machines; see for example [12]. The system described in [12] includes distributed diagnostic capability to assess the probability of subsystem faults and system faults. The system also includes capability to estimate remaining useful life. An approach to predictive maintenance of a plant based on timed hybrid automata of machines normal behavior is described in [13]. This is an example of a learning system. Input from sensors are used to let the system learn the machines normal behavior, and then compare actual behavior with the expected learnt behavior to identify anomalies in the monitored equipment. This approach relies on technologies for data acquisition and middleware technology.

Augmented reality (AR) is a way of using information and maintenance expertise exactly when and where it is required [14, 15]. AR is a way to better utilize human capabilities and allows experts to guide and train maintenance technicians on distance. This can increase the utility and flexibility of maintenance. New technology also allows for combining human capabilities with capabilities of intelligent maintenance systems; see for example [16] where a human machine interface is described. The purpose is to allow inclusion of human and context factors in maintenance, and thereby improve the planning capabilities of the system.

3. Value creation and business model development

Customer offerings are characterized by factors such as scope, time and bundling [17]. The scope describes how many different value promoting products or services an offer includes. The dimension of time describes the length of the relationship between customer and seller, which can be anything from a one-time offer to long-term relationships. Bundling describes in which way the offer has been put together, and what the customer therefore must buy. An example of bundled offer is a company producing fork lifts offer the customer availability of fork lifts instead of just fork lifts, then bundled together are the forklift and required service. The density of the offering describes the number of opportunities for activities and interaction within a given time and / or spatial dimension [17]. One aspect is the number of activities that have to be performed in order to take part of the customer offering and another is how close the offering is in time and space. Offerings are assessed by their ability to satisfy the needs and expectations of the customer and measured in terms of quality. Product quality dimensions are for example durability, safety, appearance, accuracy, environmental friendliness, maintainability, reliability and performance [18]. Common to these dimensions is that they are directly linked to the physical product and its characteristics. For service the physical aspect is only one of several other dimensions. Following service quality dimensions are commonly used [19]: reliability (the ability to deliver service dependably and accurately), assurance (expertise knowledge), tangibles (the physical appearance), empathy (consideration and individualization) and responsiveness (willingness to help customers and to provide prompt service).

One way to compete on the market is by focusing on the company’s internal strengths in form of competencies and resources [20]. The inside-out strategy is often technology-driven assuming that a market need can be filled through
technology innovation. The opposite of the inside-out perspective is the outside-in perspective, which implies that the company focuses on the environment in their development of offerings and their actions. In reality, both perspectives are interconnected. The relationship between internal efficiency and external effectiveness can be explained in terms of productivity and customer value [21]. In a customer-driven business development strategy, the company tries to analyze customer needs and then find a solution or product that fits this need. In a traditional production-oriented value chain the value creation process is mostly linear, in which the operators further up the chain refine the product further down the chain. It is easy to define who is responsible for which part of the value promoting process. In a service-based economy actor constellations are more complex and not necessarily linear. The relationships between actors in a service economy are characterized more by reciprocity [17]. A utility-driven business development strategy goes beyond the customer focus when understanding the true needs of the value offering, for instance in form of the value for the customer’s customer. It is not always easy to distinguish which player produces what part of the service offering. The value chain includes all actors that directly take part in the linear value creation, but the situation is often more complex than so, with outsourcing and n-party collaborations which connect players to each player in the value creation in a star-like or network pattern, see for instance [17]. Companies often interact in complex and geographically dispersed pattern changes and shifts over time, players come and go, relationships are broken and new ones created [22]. To enable looking outside traditional frameworks [23] suggests positioning the company in a business ecosystem, where development takes place together with other actors. In the business ecology, other actors than the direct ones representing the value chain are included, such as competitors, government agencies, standardisation organizations, politicians, and the public. The dynamics described in the business ecology concept also includes relationships in longer and shorter terms and a focus on the full product life cycle. Applying an ecosystem perspective on business processes include viewing consumers as co-creators of value, focus on network value instead of product value, and strategic focus on value networks where actors cooperate in complex patterns rather than compete [24].

4. A framework for service business model development

Industrial business modelling has gained increased attention due to the new industrial demands described above. Especially research on customer offerings that combines physical products and services is growing [1, 8]. Value can be offered as a physical product, a real or virtual service, or as the combination of products and services. The customer offering is the result, or output, of a value-system, and can be seen as an input for another party (the customer) or other (value creation) system [17]. [25] claim that the offer always is a combination of a physical product and service to different degrees. While the terminology is not fully consistent, most researchers agree that the product-service system (PSS) is a business model based on the integration of products and services applying a systems approach [26]. PSS is characterized by customer and life cycle orientation, and long term relationships between different parts in the value creating process. The transition from the traditional business model to the integrated PSS is in [27, 28] described in form of three value propositions: product or function orientation, use or availability orientation, and result orientation. The transition is a journey towards higher complexity and life cycle orientation that triggers a number of challenges originating from economic, technical and organizational uncertainties [28]. These uncertainties are huge barriers for the effective transformation; see for instance [29]. A complete change of the corporate mindset is needed in order to take advantage of the PSS business model. The PSS model is extended in [30] and a refined model is suggested which distinguish between availability-oriented and use-oriented PSS, and the result-oriented PSS is subdivided into the categories solution-, effect- and demand-oriented.

The framework suggested in this paper (see table 1) could be seen as the logical development of the service business model from a narrow technical perspective to a holistic product-service perspective. It addresses the core business logic and the fundamentals of the value creating process. Without a thorough understanding of the basics, the transition to a more advanced business model is hard. Describing the underlying business logic and expressing this in a number of explicit factors to consider when making the shift will increase the understanding of necessary changes and support the transformation. In the framework, seven factors derived from the description in section 3 have been included. The factors quality dimensions, type and density of the offering and the business development strategy reflect the company view on the value proposition, how this is developed and distributed. The other three factors (view on value creation and profitability, and the strategic perspective) reflect the company core business strategy, and are linked with the value offering by the business development strategy.

The framework applies an eco-systems perspective on value creation [22], which is consistent with and extends the systems approach in PSS. The value creation process is described in four levels, depicting the O&M service needs of the industry according to the development stages of Industry 4.0. Level one and two are narrow inside-out strategies representing the traditional product or function oriented business model, level three represents a customer-driven and use oriented business model, and level four represents a utility-driven and result based model. The levels thus correspond fairly well with the three value propositions in PSS [28] with one distinction: the treatment of the product oriented proposition in two separate steps. This extension has been made in order to better support the transition of traditional technology-driven companies towards PSS and to better understand the value of O&M service. In level one, the technical system is treated as a product, and aftersales services are not viewed as an important business opportunity. In level two, the O&M service is seen as a possibility to generate revenue, but the service is offered using the traditional product-oriented perspective, thus treated mainly as a product.

491
4.1. The service model development framework

In this section the four levels are presented and exemplified using maintenance and its management as service offering. Moreover, prerequisites necessary for achieving the different levels are discussed.

Table 1. Framework for service business model development

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of offering</strong></td>
<td>Technology</td>
<td>Mainly product</td>
<td>Product and service</td>
<td>Bundled offerings</td>
</tr>
<tr>
<td><strong>Density</strong></td>
<td>Low</td>
<td>High</td>
<td>Dynamic</td>
<td></td>
</tr>
<tr>
<td><strong>Quality dimensions</strong></td>
<td>Mainly product</td>
<td>Combination of product and service</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Business development strategy</strong></td>
<td>Technology-driven</td>
<td>Customer-driven</td>
<td>Utility-driven</td>
<td>Dynamic</td>
</tr>
<tr>
<td><strong>Strategic perspective</strong></td>
<td>Inside-out</td>
<td>Outside-in</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>View on profitability</strong></td>
<td>Productivity</td>
<td>Customer satisfaction</td>
<td>Customer satisfaction / relationships</td>
<td>(more or less formal)</td>
</tr>
<tr>
<td><strong>View on business in focus</strong></td>
<td>The own business</td>
<td>Value chain</td>
<td>Value star/network</td>
<td>Ecology</td>
</tr>
</tbody>
</table>

**Level 1:** At level one the manufacturer’s main business model is to provide physical products to the market, while the responsibility for service, maintenance and disposal is handed over to the customer. The business is driven by technical competence manifested in the physical product which is sold using traditional, low density, channels. The offering is promoted and validated using product-based quality dimensions, assuming that the product fulfills a market need without involving customers in the value creation. Instead, value creation is tightly connected to the company’s own manufacturing process, and therefore internal efficiency and productivity is seen as drivers for reaching profitability. Manufacturers who provide aftersales service mainly treat the service as a product offering derived from the technical competence. From a maintenance point of view, maintenance is not in any focus at all. Consequently, the main management form considered is run to failure, and the product might not be designed considering its maintenance at all. Aftersales services are manifested as products necessary for carrying out maintenance tasks, such as high quality and robust spare parts, or specialized technical competence. The manufacturer could earn revenues by supplying original manufacturer spare parts, but competes with low cost countries and additive production. The product could be designed so it is impossible to change spare parts without contacting the original manufacturer. Apple, for instance uses such a strategy for the iPhone battery.

**Level 2:** Another strategy is to include the aftersales activities in the business as a way to meet customer expectations and needs. The offering is packaged depending on the formulated needs of the customer. The density is typically high, but still allowing or even requiring the customer to participate in the value creation. The value creation is seen as a linear process where each part has a specific and well delimited role in the total value chain. The value chain model is well suited for traditional products, and the offering is also characterized by a “hands-on” appearance; it is easy to describe the scope and content, and the business is regulated in measurable terms such as amount, size or frequency. A manufacturer on level 2 could for instance sell a product together with a fixed maintenance plan that specifies preventive maintenance activities to be done in fixed time intervals under a predefined time period. The service is thus treated mainly as a separate product, and not as an integrated part of the system. Even if the customer satisfaction is a driving force for reaching profitability the company mainly makes savings by focusing on the internal effectiveness and efficiency in the planning and execution. Thus the strategic perspective is inside-out. The strategy that is adapted is mainly preventive, but the service provider has no true incentives for optimizing the planned maintenance, because there is money to be earned also by selling additional maintenance when failures occur. For this purpose, condition monitoring can be used as a technique for finding faults when on place, as a means to reach efficiency and cost reduction. This type of service offer is often referred to as the traditional maintenance contract.

**Level 3:** The use-oriented model combines products and services, and the product is sold together with services in order to assure the performance of the physical product. The performance can be expressed in different ways depending on the type of product: for example, the number of lifts per year, certain availability or a certain number of kilometers [26]. This type of offering is utility-driven, i.e. focuses on the explicit as well as the implicit needs of the customer. The offering is no longer characterized in first hand by its physical appearance, but by the function it provides, so the quality dimensions could cover both product and service quality dimensions. The density is typically high but the mode differs depending on the customer. The number of actors that are active in the value creation is also typically high, and the relationships are of n-type rather than a linear chain with 1-1-relationships between each sub-process. A company that offers the product as a function might for instance contract a third party service provider for parts of the maintenance work, while the customer takes care of daily cleaning and lubrication. In this scenario, there are at least three actors that together ensure the performance of the product; the producer, the service provider, and the customer. Relationships with the customer and other key partners become important, and the strategic outside-in perspective assures profit through satisfying the needs of the customer. At level 3, maintenance and is integrated as a part of the function that is offered to the customer. Predictive power in form of monitoring and diagnosing the condition of the system as well as possibility to predict failures becomes important for the manufacturer for ensuring the functionality. Systems for condition monitoring and analysis can be used for monitoring and control functionality and for planning and optimizing maintenance actions. Parts of the service, such as fault detection, monitoring and diagnosis, could be performed from distance, see for example [10].

**Level 4:** The fourth level represents a value proposition that goes beyond the physical product and the requirements on functionality. Instead, the needs of the customer, or even the customer’s customer, are in focus. The offering is an integrated solution that could be manifested as a “black box”...
solution, and the outcome is measured in terms of utility, for instance productivity of the customer in produced amount per hour. The offering requires trust, openness and long term relationships between seller and buyer, as both parts take a business related risk when entering this kind of contract. The process is typically data driven and knowledge intensive. The manufacturer has extended opportunities to modify the product to fit the after-sales services for increasing its knowledge capabilities. A product can for instance be sold with built-in intelligence enabling that all aftermarket activities will be planned and carried out based on real conditions, i.e., based on field data [31]. The density of the offering could vary depending on customer needs and technological solution, but in general the density could be kept high through remote intelligence such as monitoring, diagnosis and decision support. While the density in the actual value creation is higher other activities require lower density. Face-to-face meetings, on-site appearance and personalized support are important activities for building up and strengthening the relationship between seller and buyer. At level 4, maintenance is a fully integrated part of the offering and the value it could provide for the customer is in focus. The value for the customer is related to how well the supplied bundled offer support the customers productivity, profitability, etc. and that is what the customer pay for, as well as for the additional business related risk the service provider takes when assuring the performance. It is therefore of highest interest that maintenance is optimized for lowest disturbance of the production by applying a proactive maintenance strategy. This is enabled by intelligent systems, which predicts failures, makes diagnosis and triggers maintenance actions, and self-adapting systems, which adjust themselves according to true conditions of the system and its environment.

5. Service Management 4.0

The necessity of new business models for the successful implementation of predictive and proactive maintenance is pointed out in [32], especially for reducing problems related to high investment costs and risks connected with the new technology. For being able to monitor the systems health investment in condition monitoring technology is required, but the customer might not be willing to share this investment cost with the service provider. To overcome the problem holistic service packages against a fixed, time-based fee is suggested [32]. Service Management 4.0 moves beyond this kind of problems. By providing integrated and holistic product-service offerings the manufacturer takes large business related risks but has also the possibility to take full advantage of their technical competence when designing the system for optimal operational and maintenance performance. The required data capture and intelligence is an integrated part of the offering, which reflects a technology-driven business development strategy.

New kind of problems occurs though: being able to deliver utility or value for the customer data not only regarding the system itself, but also from its surroundings, such as environmental data and performance data is required. The service provider has to interact with other actors in the ecosystem, and especially trust between the provider and the customer becomes crucial. Therefore, three key factors, in addition to the mix of products and services in customer offers, reflect the concept of Service Management 4.0: performance-based contracts, partnering and the business ecology concept. The offering could be regulated using performance-based contracting forms, see for instance [7], where alignment of information and social interactions such as training and relationship building, are key value drivers [33]. This reflects a utility-based business development strategy. A common understanding of expectations is also important. To be able to actually monitor the delivered service impact on the profitability or productivity, openness and access to data at the customer company is required, and that in its turn is enabled by trust in the supplier-customer relation. This implies a cooperative form of collaboration such as partnering where all involved actors must gain from this close collaboration, see for example [8] and [34].

The cooperation is not limited to the manufacturer and the customer. The manufacturer might need to cooperate with suppliers of surrounding systems for reaching the necessary information. The condition of a train is for example affected by environmental conditions as well as the conditions of the rail. Assuring utility for the train owner, the train manufacturer thus requires data not only regarding the operations and health of the train, but of the rail as well, and the weather conditions. The complexity increases if the train owner and the operator are separate actors. Moreover, the behavior of the business ecology is the driving force in creating value offerings, taking into consideration actors outside of the traditional customer-seller dyad, see for example [35]. This requires good understanding of the different actors, and their relative power, comprising the ecosystem.

6. Conclusions

Service management 4.0 refers to delivering value to the customer, where the physical product and maintenance management are fully integrated and followed up based on its ability to deliver value for customer. The performance of the delivered physical product or the delivered maintenance is, in a sense, not important. What matters is how well it supports value for the customer, and what is sold is this customer value. Service management 4.0 aims the efforts to what is important for creating value for the customer, and thereby it becomes obvious that maintenance must be seen as something related to value creation, and not only as a cost-factor which should be minimized.

Industry 4.0 and Maintenance 4.0 focus on technical performance and the manufacturing strategy while Service Management 4.0 focuses on the business strategy. The common denominator is the focus on value creation for the involved actors. The technical performance of maintenance is of importance for reaching this value since the technical condition at a given time is a prerequisite for delivering utility. Cyber-physical systems and the internet of things, for example manifested as e-maintenance supporting effective
condition-based maintenance, and integrated business offerings support Service Management 4.0.

The framework presented in this paper could serve as a help for companies to understand the current business model and as an indicator of what is needed in order to move towards Service Management 4.0. As future research, the framework should be extended with detailed descriptions of the transformation process. In addition, key performance indicators for measuring the transformation should be developed. It is also possible to extend the framework with additional sub-levels, for instance reflecting the refined model suggested in [30].

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