Integrative Service Innovation: An Industrial Use Case

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***Abstract*— Industrial production is evolving towards service orientation so as to enhance the manufacturing firm's competitive positioning and profit potential. This 'paradigm' shift by manufacturing towards service thinking calls for a suitable service design method and corresponding business model design to create a competitive product service system (PSS) for industrial production. However, an integrated method for innovation and business model design of a PSS is not well established nor understood. In this study an integrative innovation and business model design method, known as iSIM, is illustrated through two industrial use-cases from one coorporation to demonstrate its applicability. The results confirm the importance of integrative innovation and business model design methods and point to the applicability of the methods like iSIM in industrial settings for PSS.**

Keywords—service innovation; service design; business model; industrial applciation; product service System; PSS

I. Introduction

Increasingly, industrial production is evolving towards service orientation so as to enhance the manufacturing firm's competitive positioning and profit potential. This 'paradigm' shift by manufacturing towards service thinking calls for a suitable service design method [13] and corresponding business model design [2] to create a competitive product service system (PSS) for industrial production.

A PSS is an integrated product and service offering that delivers a range of product-related services whose values are determined in use by the customer [2]. These services may be designed and classified in accordance with their intended purpose or strategy [19]; for example those services supporting the supplier's product (SSP) such as technical (maintenance) and qualifying (operator training) services, and those services supporting the customers' actions (SSC) such as customer process-oriented services and logistical, information providing and financial services [2, 7].

The choice of service strategy for the PSS will influence its business model design [2, 17] and thus its revenue and profit performance [7]. However, an integrated method for service and business model design of a PSS is not well established nor understood.

This paper contributes new insights on integrated PSS-business model design by demonstrating the application of the integrative service and business model design method [5], known as iSIM [6], to two ABB industrial products. On the other hand, the use cases also shed lights on the complexity arising during the development of successful PSS.

II. Method: iSIM

The theoretical constructs of iSIM [6] are derived from the service dominant logic [20] and customer value co-creation [9] principles to the simultaneous design of service concept/system and business model to meet the target customer's value creation [16] and the firm's value capture [14] requirements. Thus, in iSIM, the customer is *proactive* in seeking value from the firm and its "Customer-side business ecosystem".

To co-create value with customers, the service concept (of the technology) and associated value proposition must *consistently* meet the customer expectations (including experiential requirements). This can only be achieved when the firm's technological product and service delivery system is designed to *align with* the same customer requirements [5, 6]. Insights on customer's product/service usage behaviors become a critical competitive business requirements of iSIM [6].

The iSIM is centered on meeting customer value co-creation needs. It consists of seven closely interrelated design practices, to be performed iteratively, holistically and coherently to ensure mutual alignment between all steps. Each iteration is accentuated on agile organizational and customer learning.

The seven steps[1] as shown in Figure 1 are: (1) define the business service strategy; (2) identify the customer types (e.g. 1, 2 or m-sided model) and designs the high-level value proposition for each customer type; (3) design the *service concept* and the attendant attractive value proposition for each customer type in line with business strategy; (4) design the *service delivery mechanisms* as part of the organization / business logic *activity system* to deliver on the value propositions (i.e. customer value co-creation); (5) design the requisite *customer experience* as part of service design to satisfy the customer value propositions through *alignment* of the provider's and customers' competences and learning regimes (to facilitate the customer's value co-creation process of integrating the provider's competences with their own), and (6) design and use the *service architecture* to *systematize* future new service design (via modularity and reusability) and (7) design the monetization mechanisms (earnings logic) with due consideration for mutual interdependency and inherent tension between customer value creation and firm value capture [5, 6]. The seven-step design processes of the iSIM method are summarized below [5, 6].

A. Step 1: Business Strategy

Strategy defines the *choice* as to which business model among many options to adopt for competition in the marketplace. It represents the firm's desired distinctive business logic (e.g. Dell's "build-to-order" logic) to differentiate the innovative technology's service value proposition (step 2) from the competition. The business logic is in turn defined by the end-to-end service delivery activities (step 4) by which value is co-created with customers, for which customers are willing to pay.

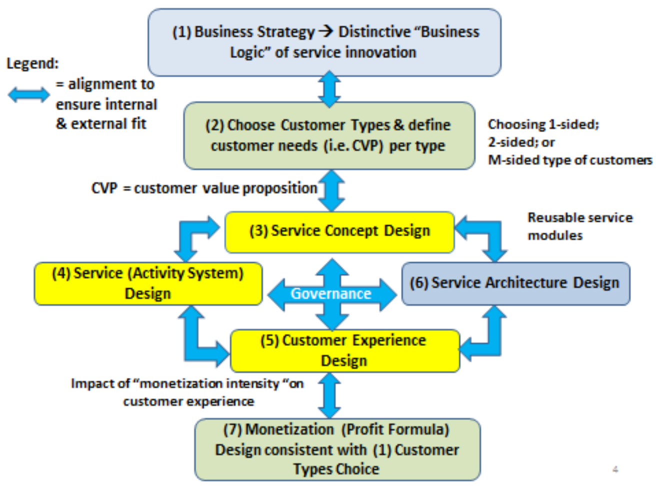

Fig. 1. Overview of the iSIM method and the interrelation between the steps (Adapted from [1, 2])

[1] For diagrammatic simplicity sake Figure 1 has not depicted all interrelationships between steps that are described in the section.

B. Step 2: Define Customer Types and Value Propositions

Customer types can be chosen by the business model as: (a) one-sided – only one customer-type; (b) two-sided – two customer-types; the end-users *that* use the service offered by the technology free, and the advertisers who pay the technology firm to target-advertise to the 'captive audience' of end-users; or (c) multi-sided – multiple customer-types, *A*n appropriate value proposition (this step) and service concept (step 3) must be designed (and delivered) to match the needs of each customer type.

C. Step 3: Service Concept Design

The service concept step designs the service logic in line with the business logic and strategic intent defined in step 1 in order to fulfill the high-level customer value proposition designed in step 2. The design process ascertains in detail, through customer insights analysis and/or customer co-production engagement what the expected customer value *to be co-created* is.

D. Step 4: Service System Design

Service system design starts with the customer/user and defines how the service will be performed and delivered using human-centered and user-participatory methods to model the service performance [15]. It could be exploratory requiring comprehensive service system radical redesign, or exploitative requiring only redesign of service delivery system and/or interface level. Step 4 usually involves designing new service delivery processes in line with the service logic of step 3 service concept and the strategic intent of step 1 to consistently fulfill the customer value proposition (CVP) by facilitating co-creation of the proposed value and service experience (in step 5) by the customer.

E. Step 5: Customer Experience Design

Service design excellence strives to achieve superior customer experience, which is defined by the usability and pleasurability of the service interactions [18: 84]. Customer experience is the outcome of the co-created customer value fulfilled by the service (delivery) system design *(step 4)* in line with the CVP of the customer type *(step 2)* in question. The desired customer experience envisioned by the CVP for each service type is analyzed as the (outside-in) objectives of service encounter blueprinting design [4]. The service encounter design is a critical element of overall service design, because from the customer's viewpoint "these encounters are the service" [4].

F. Step 6: Service Architecture Design

Service architecture is designed to systematize service design and innovation by providing a common language across different views on service design and a systematic way to operationalize and measure the degree of service architecture modularity [21]. It is designed in accordance with the principle of modularity [3] comprising five dimensions: components, the interfaces, degree of coupling, and commonality sharing between components, and service platform.

G. *Step 7: Monetization* / Earning Logic

Monetization design is interlinked with customer type design choice in Step . The monetization step is not only describing the revenues, but rather deals with the earnings logic and value capture. Customer types can be chosen by the business model as: one-sided, two-sided or m-sided. Monetization service experience can be further refined and customized by deciding when, what and how money is raised.

III. Industrial Use cases

ABB is a leading supplier for industrial automation and power technology. ABB operates in over 100 countries with its five divisions Power Products, Power Systems, Discrete Manufacturing, Process Automation and Low Voltage Products.

Being a product-oriented organization, ABB is making the shift to service dominant logic. Today 17% of ABB total revenues are generated by service business [1].

TABLE I. Overview of as-is ABB service thinking in terms of iSIM

	ABB
Step 1: Strategy	To further advance the role as leading service provider in power and automation and to increase service based revenues
Step 2: Value Proposition (VP)	Customer benefits: 1- Rapid Response; 2- Lifecycle Management; 3- Operational Efficiency; 4- Performance Improvement
Step 3: Service Concept	Eleven service categories that manifest themselves either at the hardware level, the software level or the ABB unique expertise level. These are: 1- Advanced services, 2- End-of-life services, 3- Engineering and Consulting, 4- Extension, Upgrades and Retrofits, 5- Installation and commissioning, 6- Maintenance, 7- Repairs, 8- Replacements, 9- Service agreements, 10- Spares and consumables, 11- Training. All except for "9 Service agreements" are SSP oriented addressing VPs 1 and 2. "Service agreements" cover all SSC addressing VPs 3 and 4.
Step 4: Service System	A system configuration of resident service personnel, field regional service centers, and remote service centers designed to coherently perform the above eleven service categories.
Step 5: Customer Experience	Customer senses empowerment by being engaged in co-creating value at an early stage of the service offering design, as well as in the delivery of the service offering.
Step 6: Service Architecture	A service lifecycle management process is in place as a governance means for the end-to-end service based business. Marketing, sales and operations activities are harmonized and modular system design is adopted both to allow for a systematic product-service design and delivery
Step 7: Monetization	Different revenues stream mechanisms are set-up and defined according to ABB pricing strategy

Table I provides an overview on the ABB service thinking and the way the service business is established. It articulates the high-level components of the servitization shift towards PSS the company is currently making. ABB adopts a service strategy that accentuates on ABB quality service experience through hardware, software and ABB unique expertise.

Although an overall strategy is in place and supporting mechanisms are defined, it is important to emphasize that only a part of what is described in the service concepts would be offered in the abovementioned five divisions. Indeed, a product specific business such as transformers would not offer the complete range of service categories but rather focus on the most important value-added activities. Likewise, a system based business would target a higher scope of supply to satisfy customer needs. We propose in the following to focus on two distinct examples, yet they illustrate the alignment with the high-level strategy described in Table I.

iSIM was applied retrospectively to the two use-cases described in the following two subsections. Thereby, the use-cases were analysed on how the various steps of iSIM applied to the use-case. Table II summarizes the findings of this exercise.

A. *Case 1: Remote Service in Discrete Manufacturing*

Industrial robots are widely used in the automotive sector and general industry for the automatized execution of recurring heavy duty tasks. Industrial robots thereby operate in extreme environmental conditions such as steel plants. They need to perform very precise motion trajectories e.g. for water jet cutting and continuously execute high speed tasks e.g. in the automotive production. Usually the robots are on the critical path of the production, such that the production holds when the robots stands still due to an unexpected problem. Regular maintenance can keep the performance of a robot at a maximum, but also requires a stop of production. Remote monitoring of the robots health status can be used to optimize maintenance schedules, synchronize maintenance of a fleet of robots at a production site and may predict irregular problems before they occur.

Production operators, customer on-site technicians and system integrators do usually not have the knowledge, expertise and direct availability of genuine spare-parts of the complex mechanics and electronics of modern industrial robots. In case of scheduled maintenance or unexpected problems, a service technician from the robot vendor or certified service provider needs to be called. This may prolong the downtime of the production and cause to subsequent problems in the supply chain.

ABB Robotics is offering Predictive Maintenance Services utilizing remote connections to the ABB robots to enhance the robot life cycle by continuous remote monitoring of each robot by experts, early identification of problems with the robots performance and advice for an optimal maintenance schedule. Intelligent data analytics algorithms support the analysis of the health status of the robot and monthly reports provide an overview to the customer about the health status of his robot fleet. Customers benefit from using this solution by an increased uptime of the robots, reduced unplanned production stops and a continuously optimal performance of the robots while not needing to worry about the health of the robots themselves.

Table II lists the results of the reetrospective application of iSIM to the use case.

B. Case 2: Maintenance Optimization Energy Sector

Generator circuit breakers (GCB) are a critical safety element in power plants. They protect electrical circuits and the generator in particular from damage due to short circuits or excess current. GCBs can be equipped with condition monitoring equipment (e.g. GMS600) which tracks their usage over time. This information can be used to estimate the residual life of the breaker, i.e. how good its current shape is. Residual life can be expressed as a percentage (with 100% being as good as new) and can act as an indicator for required overhauls and inspections. Furthermore, the history of the breaker's residual life can be used to predict the time when maintenance action is required.

Customers typically do not have the knowledge to predict the right time for the next overhaul and often rely on fixed intervals which include a substantial safety margin. This means that they potentially perform too much maintenance. GCB maintenance is expensive because it requires a shutdown of the generator which leads to missed revenue.

ABB Service in Zurich, Switzerland offers sophisticated data analysis as part of the Value Based Customer Care offer (VBCC) generating trending charts and estimated service due dates using prediction algorithms. Results are visualized in a comprehensive Condition Report, which will be reviewed and complemented with service recommendations by ABB Breaker Type Experts. The benefit for the customer is that he can now plan his maintenance (regardless of whether it is performed by ABB or the customer himself) on the actual condition of the breaker. Furthermore, synergies within a fleet of breakers can be used to minimize the downtime cost, so this service falls into the SSC service category.

Table II lists the results of the reetrospective application of iSIM to the use case.

TABLE II. ANALYSIS OF THE INDUSTRIAL USE CASES

	Case 1	***Case 2***
	Robotics Remote Service in Discrete Manufacturing	**Maintenance and Retrofit Optimization in Energy Sector**
Step 1: Business Strategy	Increased service business through advanced services based on remote technology	Increase revenue associated with long-lived assets through customized service business
Step 2: Customer type and value Proposition	One-sided customer type. Increased uptime, expanded lifetime and maximized performance of the customer's robots.	One-sided customer type. Reduced maintenance cost and reduced downtime cost for the customer.
Step 3: Service Concept	Based on the continuous remote monitoring of the robots maintenance and usage, recommendations are provided proactively to the customer enabled by advanced data analytics. Additionally, periodic reports on the customer's installed base health status are either delivered to the customer via established channels or accessed directly by the customer via a website. These mechanisms enable the customer to manage his installed base to co-create the values proposed in step 2.	The customer receives periodic service recommendations (action required and timeframe) based on the residual life of the equipment. Typically, these timeframes are on the scale of years. Thus, the customer can schedule required maintenance in time slots where scheduled downtime already occurs (e.g. due to maintenance on other parts of the power plant). This means that the overall downtime is reduced. Also, in the case of good asset health, premature maintenance can be avoided, which reduces the maintenance cost.
Step 4: Service System	Integrated systemic configuration of the following building blocks: Physical setting: Connection between a monitoring system in the asset at the customer site and a back-end data analysis system at ABB (cloud). Service process: Remote monitoring system to collect key data. The data is transferred to a central back-end system, where it is analyzed to identify irregularities in installed base health. Experts provide proactive advice on robot maintenance alongside periodic fleet health condition reports. Local ABB unit located in more than 50 countries contacts customers. Job design: Data analysis by ABB expert supported by automated data analytics algorithms. Staff selection: Experienced personnel in remote expert center. Regular service staff in regional offices for customer contact and physical service delivery.	Integrated systemic configuration of the following building blocks: Physical setting: Connection between a condition monitoring system at the customer side and a cloud-based analysis system Service Process: Condition monitoring system collects key data. The data is transferred to the server where it is used to estimate residual life and predict the time for inspections and retrofit. Experts use this output to discover synergies which allow the bundling of multiple assets' maintenance actions in order to reduce downtime. Job Design: Automated analysis is given as input to a breaker expert Staff selection: Regular staff is supported by analytics algorithms, so no extra training is required

	Case 1	***Case 2***
Step 5: Customer Experience	Customers are handed periodic reports, which are branded in the ABB corporate style and are delivered via established communication channels (ABB Robotics Service). The customer manages his installed base utilizing the information and advice provided to him to achieve higher uptimes, longer lifetime and maximized performance of his robots. Customers can also access the robot health data, analysis results and reports over a dedicated platform on-demand for more detailed production and maintenance planning. Customers experience a sense of empowerment being able to take proactive control of the product service system and customize usage to maximize its performance and lifetime.	The customer is supported with regular reports which are branded in the ABB corporate style and come to him via the established communication channels (ABB GCB Service) in a regular fashion. The customer co-creates use-value by providing their historical usage data and possibly future plans for the use of the power plant (base load plant vs. peak load plant) which can be assessed by the vendor for a prediction. Furthermore, customer data will help the vendor to further refine their prediction algorithms. The report is useful to easily plan and optimize the maintenance schedule. The customer experiences this service as a lot less intrusive than an on-site inspection.
Step 6: Service Architecture	Modular components, the interfaces, degree of coupling, and commonality sharing The connection hardware can be used with many robot series and could in general also be used for other assets. The underlying data analytics system works for various robot types. The reports are tailored to the customer's situation and harmonized to the regional and local environment. The customer website is built on a platform which is used by several ABB units. Interfaces: Remote monitoring – back-end system – Experts – local ABB units – customer; back-end system – customer website – customer	The services provided for the GCB share a common service infrastructure. A re-usable service module is the GMS600. GMS600 is a modular hardware platform that monitors key parameters in the breaker which can be used as input for intelligent algorithms in other services. A logical extension would be to harmonize the condition monitoring hardware for all breakers as a common service-supporting hardware. Another logical extension would be to introduce a common (even company-wide) protocol for the transmission of condition monitoring data from the devices in the field to ABB. Interfaces: GMS600 – Cloud Software – Experts
Step 7: Monetization	The robot is generating revenue (one-off purchase). Additional revenue is created through service agreements utilizing remote technology as well as additional service business such as pull-through business from break & fix or preventive maintenance.	The GMS is included as a component in the GCB, so it is typically not bought separately. The customer does pay for each individual report (pay-per-use or subscription). However, the revenue model does not rely on these payments as the service itself does not create significant revenue. Instead, revenue is generated through additional service business (cross-selling).

IV. Managerial Implications / Discussion

From the application analysis summarized in Table II, managerial implications were drawn. The experiences of the industry experts during the application of the iSIM steps to the use-cases as well as their experience with service and product innovation in large corporations build the basis for the derivation of the managerial implications listed below. In particular, we frame below the implications of adopting iSIM from the perspectives of the core underlying challenges faced by manufacturing firms that intend to adopt a PSS servitization strategy.

A. Complexity

Integrated service innovation is a complex task but has also the potential to sustainably advance offerings. The integrated service innovation framework used in this study (iSIM), which includes cross-disciplinary design activities, requires senior management championship and endorsement. This can be a challenge, especially in global, product-focused corporations, as first an understanding for service-dominant logic needs to be present in the senior management to enable the necessary change processes including mindset change.

Service innovation strongly depends on customer co-development. As such, the investigated approach also requires open-minded customers who are willing to participate in service co-development and see the benefit of value co-creation. In the traditional and conservative automation and power sectors this is a challenge as the corresponding markets are product-focused. Customer education including appropriate product-specific service training to enhance customer competencies could to be a desirable strategy for arresting a product's margin decline and enhancing long-term profit growth through innovative service.

B. Ecosystem perspective

Create a common service infrastructure in the form of a common underlying service architecture across organizational units and products is crucial for sustainable service business. As in the all automation and power corporate players, ABB has little common infrastructure due to the latest mergers and acquisitions. On the other hand, it is more cost-efficient in some cases to maintain individual systems where for example a generic solution is too complex and adaptations are skills and time-intensive.

A unified service infrastructure bears additional potential as it may be also opened to partners and suppliers, creating a larger ecosystem to provide greatest possible value to the customer. This is a strategic opportunity that demands senior management attention as well as understanding the role of the ecosystem entities.

C. Internet of things enabled business

The production industry is currently undertaking a significant change in production and automation technology. Production processes will change as communication will be ubiquitously present in manufacturing and process. These trends surface in initiatives like the Industrial Internet or Industrie 4.0 [12]. Alongside the internet technology entering the production also disruptive changes in business models will occur [11, 8]. The majority of the new business opportunities will be in the service sector [10] which requires product-based companies to make the shift to service-dominant logic. ABB through its initiative "Internet of Things, Services and People" (IoTSP) is leading the way together with other major players. The iSIM method utilized in the present study can support the organization to put in place the IoTSP strategy.

D. Role of Product-Service Systems

PSS integrate products and services. In established corporations, like the one providing the use-cases in this study, traditionally products have been the core of the business. With increasing servitization, these products are being combined or extended with services other than maintenance. PSS can in this way mark an intermediate step towards pure service business, which emerges parallel to the PSS in large corporations. The role of PSS as a bridging element between traditional product business and stand-alone service business poses specific needs to the design and development process. Especially, product and service organizations need to be aligned and business strategies as well as underlying architectures need to be synchronized. iSIM forms a possible solution approach here. The presented use-case analyses show that iSIM has very good potential to address the PSS specific needs, mainly because iSIM focusses on the integrative service design.

E. Adapting iSIM in global corporations

In this study the iSIM framework was applied retrospectively to two PSS use-cases within a global corporation. There was a challenge in retrospectively analyzing the use-cases, as aspects of the iSIM approach were not applied according to iSIM principles in the original design of the PSS. This retrospective analysis brought nonetheless important learnings about the PSS offerings and future PSS design processes. While the integrated service innovation approach highlights the benefits of corporation-wide congruent service business strategies, the approach might not be applicable for the whole organization at once, and in particular in addressing the challenge around the common service architecture.

Various challenges during the introduction of the iSIM approach for the development of PSS within global corporations might occur. First, top management championship is crucial for the company to embrace a service-dominant logic. Second, personnel to support the application of iSIM in terms of consulting and workshop facilitation needs to be in place and accepted by the peers. Third, specific methodologies for each step of the framework are required to make the approach tangible for the people involved in the process. For some steps such methods are present and already well-established within global organizations such as Service Process Blueprinting [4] or the Business Model Canvas [14]. Fourth, clear benefits from only working on individual steps or separate iterations (akin to agile development method) need to be visible to the organization, as service development process can be time consuming in global corporations and tangible intermediate results are necessary to keep such processes alive.

PSS marks the first step towards a service-focused business. However, the majority of global corporations in the automation and power sector have a strong product base and PSS helps to exploit the new revenues potential.

V. CONCLUSIONS

ABB has taken the strategic step to transform its product-oriented business into service orientation. As is typical with large industrial production companies, the transformation is a gradual process. Initially some product lines, such as the two case products studied herein, are developed and marketed as product-service systems (PSS's) [13, 2, 7, 19]. The two PSS's were embarked on with clear, albeit disparate, service strategies due to the organizational structure of ABB – e.g. a mixture of SSP (focused on supporting the product) and SSC (focused on supporting the customer's actions) strategies with respect to product usage [2, 7]. PSS value is determined by its usage by the customer [2, 7] and business model [2, 17].

In order to advance service business transformation in a systematic manner, this paper retrospectively explored the applicability of iSIM (integrated method for service and business model design) [5, 6] on two industrial PSS's, namely, (1) robotics remote service in discrete manufacturing and (2) maintenance and retrofit optimization of generator circuit breaker in energy sector. This was performed by ABB service R&D scientists.

The resultant iSIM design analyses of the two PSS's are tabulated in Table II. The results confirm the importance of the iSIM design approach and point to the applicability of the iSIM in industrial settings for PSS. However, not all aspects of the iSIM approach have been regarded in the original design of the PSS. This helps shed light on all facets of the PSS and yields important learnings about the PSS offerings and future PSS design processes. For instance, it draws attention to importance of customer involvement both in the design and delivery phase of PSS, and highlights the benefits of corporation-wide service architectures and congruent service business strategies. Therefore, we argue that iSIM is suitable as a PSS design method. However, the aforementioned managerial implications would need to be addressed in order to assure iSIM's effective deployment in larger corporations.

Future research work will need to apply iSIM right from the start of a PSS design and development process, after the managerial implications have been addressed, in order to verify the iSIM usability in PSS under real-life circumstances.

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