

Product-Service Systems across Life Cycle

A framework for PSS business models: formalization and application

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Abstract

In order to successfully move “from products to solutions”, companies need to redesign their business model. Nevertheless, service oriented BMs in product-centric firms are under-investigated in the literature: very few works develop a scheme of analysis of such BMs. To provide a first step into closing this gap, we propose a new framework to describe service-oriented BMs, pointing out the main BM components and related PSS characteristics. Thus, the proposed framework aims to help companies to take into account the relevant elements that need to be designed to successfully implement a service-oriented BM and thus guide strategic decisions.

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1. Introduction

In the current global economy, manufacturers can no longer rely on the traditional product-focused business models with competitive dimensions such as time, cost, quality, flexibility or environment [1]. In this environment, a transformation from a “traditional” business models (BMs), based on the product sales, to a “service oriented” one (e.g. selling either usage or performance) is an opportunity for gaining competitive advantage [2]. However, this transition is challenging [3] and requires fundamental changes in the structure, culture and competencies of the company [1, 2, 4]. As a consequence, a limited application of these new business models, especially in the capital good sectors, has been observed [5, 6]. This is due also to the fact that the shift from a product-oriented strategy to a combined product-service strategy seems to be still poorly understood [7, 8, 9]; the PSS literature has not discussed business models extensively [1, 10]. To provide a first step into closing this gap, we propose a structured and detailed framework that allows for a comprehensive description of PSS BMs. The proposed framework considers dimensions aligned with the general BM literature, by adopting as a starting point the BM Canvas [12].

2. Business models for the transition from products to solutions

2.1. Business model concept

Even though the topic has enjoyed great attention in recent times, research on BMs is considered at an early stage (for details see literature reviews by [13, 14, 15]). In particular, there is still no complete clarity in the literature about the definition of business model concept [14]: some definitions specify the interplay between business actors, value creation and revenue sources [16], others relate to innovations and how to generate revenues from them [17] while others again start from the theoretical essence of business models, that is, the minimum set of core components that must be common to all business models [18, 19]. In this paper we adopt one of the most comprehensive and popular definition that was provided by [19]: “A *business model* is a conceptual tool that contains a set of elements and their relationships and allows expressing the business logic of a specific firm. It is a description of the value a company offers to one or several segments of customers and of the architecture of the firm and its network of partners for creating, marketing, and delivering

this value and relationship capital, to generate profitable and sustainable revenue streams.” Thus, according to this definition, a business model describes the rationale of how an organization creates, delivers, and captures value [12] and can be used as a management method helping to comprehend and analyze the business logic of a company as well as to plan strategic decisions by designing new business concept.

2.2. Framework for PSS business model: overview

As discussed in the previous section, various authors have discussed the business model concept with divergent opinions: as a result, several BM frameworks that encompass different components appeared in the literature [12, 17, 20, 21]. Recent reviews show that the most agreement among the authors regarding the components in BM frameworks is found in few elements such as value proposition, resources, revenue and customers [18, 22]. Despite being highly emphasized, only recently the research community seems to have addressed the transition of manufacturers that move into the provision of PSS through a business model perspective. One of the first frameworks was proposed by [5]; they developed a BM framework for the characterization of service-based business concepts based on a set of parameters derived from the scientific literature. Then, [10] adapts the BM framework by [17] to outline the key aspects needed to facilitate the service innovation and how companies can best take advantage of a new service-based BM. Recently, frameworks were proposed also for the “integrated solutions” domain [23]. Other authors proposes a BM framework to point out which unique resources and capabilities product-centric firms need to develop and deploy if they want to pursue service innovation, investigating the nature and characteristics of BMs for successful service innovation [2, 19, 24]. These frameworks consider different components to describe PSS BMs that show a rather heterogeneous understanding. The analysis of existing literature on the topic show that there is little standardization in the terminology adopted in the studies about the BM framework, in line with a more general issue in PSS research, which obstacles a common framing and understanding of outstanding research issues [24]. Besides that, literature analysis shows that a grater detail in the description of the business model components is needed to further investigate and deeper understand the transition from products to solutions of product-centric firms from a BM perspective that is till under-investigated [10].

3. A framework for PSS business models

In order to contribute to the harmonization of the terminology, facilitating a common understanding of the phenomenon for researchers and practitioners, the Business Model Canvas (BMC) framework is used as a starting point. Since its introduction in early 2000s, the BMC [12] has gained consensus and diffusion in the academic literature and managerial communities, due to its clarity and simplicity. Therefore, the BMC has been recognized as a complete [15] and useful framework for mapping and analyzing companies’ requirements to implement new business models. Moreover, recent studies have adopted the BMC for specific applications

showing the usefulness and the flexibility of the tool and that it can be used to support the implementation of PSSs (see for example: [19, 25, 26, 27]). In this paper, in addition to previous studies, a set of elements has been elaborated in order to describe the key BMC components for PSS BM description, as briefly presented in Fig. 1 and described in the following, and this constitutes the conceptual contribution of this paper. In fact, a detailed description of each component is crucial to better describe and understand the distinctive characteristics of PSS BMs and how they can be configured.

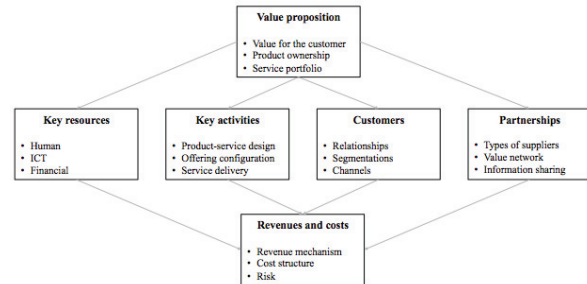


Fig. 1. PSS BMs framework – main elements

In the remaining of this chapter, the elements that form the PSS BM are briefly described for each component.

3.1. Value proposition

The value proposition is commonly described as one of the business model’s important elements [15]. In particular, value proposition component describes the bundle of products and services that create value for the customer by solving its problems or satisfying its needs and hence aims to define the value that a company is offering to its customers. In the context of PSS business models it is important to understand the nature of the value that can be generated and delivered to the customer: defining value for the customer(s) is the starting point of PSS design [28, 29]. The ability to create and capture added value over the product lifecycle is often seen as the key measure of success of PSS business models. A fundamental component of the value proposition is therefore the definition of the source of value extracted from the provider’s solution by the customer. Customers may perceive as a direct source of value the ownership of the product or, vice versa, using the product without having the ownership of it can generate value [30]. Thus, in PSS business models the creation of value has to be understood through the eyes of the customers [31, 32]: from a service perspective, the value creation occurs when the customer uses a good, a service or any combination thereof [33]. Moreover, in order to understand the nature of the provider’s offering it is necessary to measure its service portfolio. The service portfolio of a company maps the transformation of the offerings over different types of business models: the extension of service components in the total offering is a key trigger for providing solutions [31]. Different classification can be provided to describe the evolution of the offerings in different business models [for example: 2, 4, 34].

3.2. Key resources

Key resources indicate the most important assets required to make a business model work. Main key resources are human, ICT and financial and allow an enterprise to create and deliver to different customer segments the value proposition, reach markets, maintain relationships with customers and suppliers, and earn revenues [12]. Different key resources are needed depending on the type of business model. Therefore it is important to describe in the new configuration the most important resources that are required to make the business model work in practice, identifying also the capabilities that companies' human resources need to develop to successfully achieve the shift towards PSS [2, 11]. As an example, a stronger service orientation of human resources and a corporate culture, top management's commitment to the service business is required [19].

Shifting from ownership-oriented to PSS business models demand manufacturers to acquire higher financial resources to enable the new revenue model: in fact, usually in PSS models the payback period is longer than for physical product sales [7, 19] and companies must have the financial resources or receive support from its financing partners to bridge this period. Therefore, financial and accounting practices need adaptation since the timescale of the financial flows change considerably [28]. Another enabling resource of this paradigmatically shift are ICT [35], which allows companies to better manage, analyze and share the wider amount of data and information that have to be generated and controlled to sustain PSS models. Moreover, as the installed base of goods represents a unique asset for most manufacturing firms [5], managing the information from the installed based is salient in PSSs, as it presents valuable customer knowledge and creates critical insights about the operation enabling new PSS business model. Therefore, the level of control that a company has on data and information generated by the customer during the usage of the product is crucial [36].

3.3. Key activities

This component encompasses the most important/distinctive activities that make the PSS BM work. To meet new product and service design requirements, special emphasis is placed on aligning physical product characteristics with service [9]. Thus, designing a product using a service vision is a critical activity for successfully implement a PSS: several preferable product properties such as the ability to be maintained, upgraded, and reused easily, can be identified in order to increase the value creation of the new business model. Similarly, as literature shows, new service development and service engineering activities may help product centric-firm to successfully extend their service offering and its integration level with the tangible component [2, 37, 38]. Thus, there is also an increasing needs to define a customer specific goods and services configuration to create the defined value of the new offering for the specific customer. It is therefore critical for a company to find a way to sell their product-service systems and transmit the value of the new offering to the customers choosing from various strategies and methods (e.g. TCO, SLA) that might convince

potential customers of the value-in-use [11, 37, 38]. The delivery of product-service system and its installation into a customer's environment is another relevant activity for PSS business models. In these models, not only the actual service delivery, but also the planned service delivery defines the assignment of resources to service delivery processes [40], which should take place at a given location within a specific time window to generate value for the customer [40] and securing that integrated systems can be made available in an efficient manner [11, 37]. In addition to fleet operations and maintenance practices (i.e. maintenance activities a provider perform on product installed base) an important activity in this phase is also the value verification for both the provider and the customer [11].

3.4. Partnerships

Partnering is crucial in servitized environments [41, 42]. Providing services adds several new tasks to company operations [9], for which companies need to develop networks and partnership infrastructures [3, 43]. Therefore, it is important to understand the network of suppliers and partners that make a business model work in practice [12]. This business model component therefore aims to define who are the company's key partners and which are the key resources and activities that the company is acquiring from them. Consequently, companies need to understand how the duration and the nature of relationship with external partners have to be changed, moving from short to long term or from price based to strategic based, as well as to understand composition and structure of the value network in terms of typologies of actors (suppliers and partners) through which share responsibilities and value generated by the usage of the solutions. After choosing partners, much effort is needed to develop ways to coordinate the relationships and share the right information efficiently in the network [45]. Moreover, a crucial aspect to consider in PSSs is the extent to which provider has to share data and information with its partners in order to enable a more efficient and effective creation and delivery of value and strengthen relationships. In fact, strong relationships between the different companies, their position in the network and their network arguably can enhance the provision of services [41].

3.5. Customers

This component describes the type of relationships that companies establish with specific customer segments and the criteria adopted by a company to segment its customer base. Therefore, this component aims to define some key aspects that can be considered critical in PSS business model, such as: (i) the type of relationships each customer segment has with the company; (ii) the criteria that a company should use to segment its customer base and to evaluate different customer needs. Evidence from the literature shows that customer relationships are critical factors for success in servitized environments, where relationships with customers should become relational and long term [46]. In fact, a close relationship and an improved interaction between the provider and the customer facilitate mutual value creation (see for

example [7, 9, 10]). Thus, also the channels through which customers want to be reached need to be reviewed: as an example, moving from ownership-oriented towards service-oriented business models requires manufacturers to rethink the way through which they create awareness among potential customers and allow them to evaluate the PSS offerings. This can lead to a reconfiguration of the sales channel by either internalizing or externalizing resources as well as to acquire or develop new kinds of competencies [39]. A similar development path has to be followed also for service channels through which the provider delivers support to customers and their products [44]. As it becomes important to define which kind of interaction has to be established with the customer in order to enable the value delivery and maintain it throughout the product lifecycle, information sharing between the provider and the customer is an enabling element for the mutual creation of value [9]. Moreover, in order to define specific value propositions to selected segments, the company also needs to achieve an excellent understanding of customers, their operations and business [9, 10].

3.6. Revenues and costs

Profits generated by a business model depend on how the revenue model and the cost structure are defined. Therefore, it is necessary to define pricing and revenue sources, volumes and margins. Moreover, it is necessary to understand how business models elements affect the cost structure. Based on the nature of the value proposition, many forms of revenue generation are possible to sustain a PSS business model [10, 15]: generally, moving to PSS business models, instead of one-off payments, companies can structure their sales in different ways, depending also on the customer maturity in buying services [10]. In fact, as customers become more and more mature, different revenue mechanisms can be put into place: for example, payment may be based on the availability of the product and/or service, on how often the product and/or service is used, on the end result of the use of products and/or services [7, 8]. Consequently, moving from cost-plus pricing to value-based pricing requires the development of a new pricing discipline in which the definition of reliable outcome expectations to meet contractually agreed performance thresholds is crucial [46]. In servitized environments, traditional contracts are no longer valid in this scenario due to the influences of various factors especially in terms of risks and uncertainties. Therefore, there is a need for the company to manage new offerings through the composition of specific and structured agreements that can also describe how rights and liabilities are distributed among the involved parties [9].

Risks and economic potential are hard to predict but new pricing models are essential to ensure profitability [4]. In fact, moving into service oriented business models implies accepting more responsibility for the customer's operations, there is a significant risk issue to consider [45]. Therefore, assessment and management of risks have significant meanings for further development of service oriented business models [46]. Moreover, when a function is sold rather than product ownership, cost structures should be arranged to

support a new demand of cash flow and accounting practices need adaptations [8, 47].

4. Framework application: RoboComp

RoboComp is a SME that designs and delivers robot systems, increasing the industrial productivity with help of robotics and automation since 2000. As recent report provided by the International Federation of Robotics states [48], the robotics/automation industry is still growing, both in production and in consumer context (e.g. robots for domestic use). Today, the company sells robot systems and offers basic services such as maintenance and spare parts. The customer relationships are very tight at the early phase of the project (system design), but become loose after system delivery, or may end totally in case the customer decides to get the after sales services from competitors. As the main focus of company's business is the system delivery, today the income share from services is small and services are not sold proactively. In order to increase the service business, achieve new competitive advantage against large competitors and to strengthen the relationship with current customers, the company has started to think about changing the business model moving towards a new "pay per X" concept, where customers will pay on the basis of the usage or produced units. In order to better understand what this will imply in terms of changes for the company, this idea has been translated into specific business model characteristics, structuring and mapping the new concept using the proposed framework. The framework served as guideline in several meetings arranged between managing director, sales director, R&D manager and after sales personnel. Some thoughts and ideas were shared and discussed with other personnel (software developer, robot specialist, mechanical engineer) of the company, to get a wider opinion and revise initial idea or solve problem and criticalities.

RoboComp decided to apply the new BM to "Standard Robot Units" that include: the machine vision (camera & intelligence), an "intelligent" gripper, the robot controller, the robot and the safety system. The new service oriented configuration of the main business model element for the defined product is presented in Table 1.

Table 1. RoboComp - new service oriented business model configuration

Configuration	
Value prop.	Customer will gain the benefit by the usage of the product. Value for the customer will be generated by the reduction of initial investment and functional guarantee. Since RoboComp will be the owner of the system and thus responsible for all lifecycle services, an important value for the customer is generated by the minimization of operational costs and risks. New services will be introduced, such as: remote monitoring and control, condition based maintenance, on-site training.
Key resources	Data gathering will be critical as it will be the only way to know what is happening or what will happen with the system. RoboComp will collect and manage service-related, product/process related data and data related to customers' use of the product. ICT becomes crucial, and specific software will be implement (i.e. new ticket system for service is needed). Data interpretation capabilities will be developed for service technician. Moreover service technician will need to be trained in different fields (e.g. marketing, relation, use of ICT, ...). Mindsets will need to change towards more customer centric vision. Financial sources are needed to cover the investments in personnel (people, training, knowledge, ...), investments in system building/fleet and in R&D and marketing initiative.

Configuration	
Key activities	New strategy and roles are needed to agree the procedure or service actions and also to enable new service offering. Moreover, new techniques will be introduced in the design phase in order to facilitate maintenance and service activities and improve lifecycle. In order to enable remote monitoring, new sensor will be designed/implemented on the robot. The remote diagnostics and product condition analysis will enable predictive maintenance that becomes a crucial activities in the new BM to minimize maintenance costs and maximize the value generated by the product us.
Partnerships	Relationships with suppliers will increase and will be more involved in the system also after the delivery has been done. The key issue for RoboComp will be to find new financial partners and strengthen the relationships with key suppliers, such as: robot manufacturers, component suppliers and subcontractors. RoboComp's suppliers becomes therefore partners that may adapt their revenue model to the new one.
Customers	Customer relationships will need to be much more closer than in current BM. Thus, customer information sharing will be very important: information to be shared will depend on the customer: some customers want to know everything, some are only interested in the physical result. Moreover, Being up-to-date with customers' preferences, needs, problems, worries, interests is a prerequisite in the new business model. Thus, also new channels will be introduced in the new BM (email advertising, service brochures, etc.) that will require improvement on the website and CRM update to find right contacts. After-sales service personnel should be mainly internal and highly integrated in every step of the product lifecycle with sales channel, providing the customer with a unique and direct touching point which holds all the customer related knowledge
Revenues and Costs	Income will be gained through production output by "pay per X" contracts. The contract will consist of prepayment (initial cost) and the rest will be based on a fee that can be variable depending on the production time. The importance of different cost items will change in the new BM: it is expected to have, along a 5 years contract, 40% of cost related to the system (raw material, labor,...), 50% service (maintenance, spare parts, condition based monitoring, ...), 10% others. Costs related to the new SBU will increase. Moreover, RoboComp will need to implement new risk management practices.

As Table 1 shows, the application of the framework allows management to develop a clear understanding of the business model concept and of the transformation needed. In particular, several actions need be carried out by the company to achieve the expected results from the new BM. In fact, current company operational capabilities and human resources will need to be aligned to the requirements of the new value proposition: as an example, sales and marketing personnel need to develop new capabilities to communicate the new offerings to customers and need to be more integrated with service function. Moreover, changes will be required also outside the company: the establishment of new strategic partnerships (service provider, financing, insurance) involved in the delivery of the offering (financial, logistics, manufacturers, offer, operations and maintenance) will be needed to sustain the new BM. Respecting the promises is vital for the achievement of customers' objectives in pay-per-x, and the service process will be redesigned to be fault-proof. In the new BM, service delivery becomes more than providing spare parts, operational information and routine maintenance: remote diagnostics and product condition analysis will become crucial for the company in order to minimize maintenance costs and maximize the value generated by the product use. Accordingly, data processing and interpretation capabilities and the development of remote monitoring and condition-based maintenance systems will be therefore needed. Thus, the formalization of the new BM

through the framework helps defining the main changes that will be required for its successful implementation.

5. Conclusion

In business practice, despite the acknowledged importance of service business, product-centric companies frequently fight with PSS development as they may find difficult to understand how they should reconfigure the elements of their business models. In fact, the move "from products to solutions" is not only related to the evolution of the offering from product-centric to a product-service system, but can also imply the redesign of the business model [2]. PSS BMs in product-centric firms are still under-investigated: in particular, very few works develop a scheme of analysis of such BMs, identifying the relevant components for describing and formalizing the BMs of companies that move into PSS [9].

Despite that a business model reasoning can be useful for company to successfully leverage, coordinate and align all the changes required to "servitize". In this paper we propose a framework to describe service oriented BMs: the proposed framework considers components aligned with the general BM literature, by adopting as a starting point the nine building blocks of the BM Canvas [12]. The framework proposes for each component a service-oriented configuration, identifying the elements that need to be taken into account to govern the implementation of PSS BMs. In this way, the framework becomes a tool that can be used by companies to understand the transformation needed towards servitization, guiding new PSS initiatives. In particular, companies can use the proposed framework to understand where they want to go and thus point out and address the relevant gaps needed to successfully deploy the new BM configuration. Moreover, the case application shows how the new service-oriented business model framework can be used as a management method that helps companies to comprehend and formalize in a structured and integrated way a new service oriented business idea. This paper presents some limitations that suggest future research developments. First of all, further research is needed to refine and empirically test the comprehensiveness of the proposed business model framework. A second research direction concerns the use of this framework to develop and configure a spectrum of different BM options between pure product sales and pure service provision.

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