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Product-Service Systems across Life Cycle

Transition to product-service systems: principles and business model

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Abstract

The Product Services Systems philosophy has frequently been put forward as the ultimate form of customer-producer relationship, with mutual benefits in terms of cost, more efficient use of resources, improved performance for the customer, and development of innovative solutions to meeting customer requirements via holistic management of a suite of services for the customer, of which the products form a part. However, it is difficult for enterprises to begin making the shift to PSS without understanding the changes required to their current business models, how these changes may be undertaken in a progressive manner, and the potential benefits that may accrue along the pathway toward PSS. Firstly, this paper establishes a value proposition for PSS, with a set of key principles. These are then examined in terms of the well-established Business Model Canvas. A pathway is then established to assist firms make the shift by taking the necessary steps, and to understand the requirements and potential benefits associated with each step along the way. A case study of an SME is then described to demonstrate these steps in a practical way.

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Keywords: Value Proposition; Product-Service Systems; Resource Efficiency; Business Model Canvas

1. Introduction

The Product Services Systems (PSS) philosophy has frequently been put forward as the ultimate form of customer-producer relationship, with mutual benefits in terms of cost, more efficient use of resources, improved performance for the customer, and development of innovative solutions to meeting customer requirements via holistic management of a suite of services for the customer, of which the products form a part.

These days, PSS has assumed increased importance, due to demands to increase business competitiveness, increase entrepreneurship and innovation, foster start-ups and create more enterprises and jobs, reduce material consumption and carbon footprint, and respond to customer requirements with more tailored and cost-effective solutions.

However, it is difficult for businesses to begin making the shift to PSS without understanding the changes that may be required to their current business models, how to accomplish these changes in a progressive manner, and the potential benefits that may accrue along the pathway towards PSS. In this regard, use of the well-recognised Business Model Canvas (BMC) may enable firms to understand what aspects of their business may need to change. The BMC is a strategic management template for developing new or documenting existing business models. It is a visual chart with elements describing a firm or product value proposition, infrastructure, customers, and finances. Extant research largely focuses on applying business model concept and BMC to analyse and interpret adoption of PSS through the lens of business model innovation (see [1-4]). However, in these studies BMC serves more as a mapping tool and falls short of providing an effective decision support for making the business transition, as there is lack of integration between BMC and product-service design and management strategies

To address such limitations, this paper proposes to connect the value perspective and business principles for PSS development with the construct of BMC and the PSS transition path for firms to determine the creation and delivery of product-service offerings, how these are aligned with customer needs and their end goals, and what changes are

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required for the next step of PSS development in the context of the business.

The paper firstly establishes a value proposition for business transition to PSS. Next, a set of key principles are outlined, based upon an earlier research paper focused upon PSS within ICT industries. These principles are subsequently mapped in terms of BMC. A roadmap is then defined to assist firms make the shift by taking the necessary steps, and to understand the requirements and potential benefits associated with each step along the way. A case study on PSS development in an Australian SME is used to demonstrate these steps in a practical way. Finally, a number of considerations requiring further investigation are highlighted.

2. Value Proposition and Principles for Transition to PSS

PSS is a specific type of value proposition that a business offers to (or co-produces with) its clients. One definition of PSS is 'a mix of tangible products and intangible services designed and combined so they are jointly capable of fulfilling final customer needs' [5]. PSS is often referred to a leasing or renting society, where the producer retains ownership of products and provides these as part of a service to customers.

However, in its most sophisticated form, PSS is differentiated from leasing and renting by the holistic management of a suite of services and a fleet of products by the 'solution provider'. PSS involves a partnership between the provider and the customer (not consumer), where the outsourced provider manages and reports on the performance of assets that enable the customer/ business client to undertake its core business. The shift from procuring products to services also requires new sets of skills and fundamental changes underpinned by a more sophisticated relationship between producer and customer. Therefore, the transition from a product-oriented business model to a service-oriented business model often requires enterprises to identify what particular value can be offered to customers, how such value can be created and delivered through product-service bundles, how to develop and manage such bundles, how to interact with customers and other partners (if any) in value creation and value delivery [3].

2.1. PSS Value Proposition

Whilst PSS within a leasing society may lead to economic benefits for both producer and customer, environmental sustainability is not automatically guaranteed. To achieve PSS transition, further careful design of business cases is required to increase resource efficiency, while even more consideration is necessary to increase social sustainability via affordability and generating increased employment. In this paper, PSS is viewed in the wider sense of integrated economic, environmental and social sustainability.

Thus, with a business model in mind, a value proposition for a PSS may be expressed as: '*Providing products to customers via an ongoing service contract can not only be more profitable than one-off sale transactions by means of repeat business and finding new profit centres, but also enable efficient use of manufactured products by take-back and reuse with commensurate environmental, financial and social benefits*'.

2.2. Business Perspectives and Principles for PSS

The key principles that support the realization of value proposition in PSS development are outlined based on [6]. These involve specific perspectives on product, service and management features, as follows.

Product Perspectives (P)

A key feature of PSS is the mitigation of environmental impact of product through "reduce", "reuse", and "recycle", which can be best achieved by a smart design of product function, structure, and materials. General guidelines for product design to facilitate PSS:

1) *The product is of a relatively high market value, or relatively high selling prices in comparison with other similar products*, which can make it worth for the company to take up stewardship over the life-cycle of the product.
2) *The product is durable and of a long physical life* which warrants the possibility for multiple use. The product and its components will be designed for durability and reliability to minimise the need for repair and enable use life extension. The lifespan of various components is considered and categorized, so that the quality of recycled/reused parts is equivalent to new ones.
3) *The product will be designed with minimal footprint* i.e. less material consumption, less energy and less water, and lower environmental impacts.
4) *The product's structure will be modular* to facilitate disassembly, maintenance, reuse, remanufacture, and material/component recovery. Design will also enable ease of technological updating/upgrading for function improvements.

Service Perspectives (S)

PSS aims at selling the services and functions of a product, rather than selling the product itself, to the customers. Typical business scenarios include *sell-and-service*, *product lease*, *product renting and sharing*, *product pooling*, and *pay per unit of service*. In the case of PSS, the following are some key principles:

1) *The ownership of product will be retained by service provider*. As the product is legally owned by the provider, the provider can better exercise 'extended producer responsibility' and devise an appropriate 3Rs (reduce, reuse, and recycle) logistics plan for the product.
2) *There must be some basic service options (e.g. leasing or renting, desktop support, performance monitoring, and maintenance contract) and their combinations as building blocks for PSS in place.* These service options focus not only on delivering the standard functions of a product, but also on customised solutions for user support with regard to installation, upgrading, repair and replacement, and collection. They focus on building a long-term customer relationship and brand loyalty through a comprehensive customer service.

3) *The service provider can manage a fleet of products for the customer*, leading to increased utilization and improvement of efficiency. The service provider can possess and manage the knowledge about how its product performs over its life cycle. The service will facilitate technological updating by the provider for the customer.
4) *A proper take-back system will be in place* to take back products for reuse, remanufacturing, or recycling. Regional service centres may be needed to provide logistic support for the retrieval, replacement, sorting, and disassembly of decommissioned or used products, involving reverse logistic activities.
5) *The service should contribute to increase of environmental values of ownership*. Provision of equipment by service provider should aim for zero waste. Product and service should also be certified as 'Greenhouse Friendly' and conform to ISO 14001: Environmental Management Systems.
6) *The service will lower the total cost of ownership* (cost of procuring, deploying, managing, maintaining and decommissioning). To keep the product operating at peak condition leads to *lowering the deprecation rate* of its product, which can bring financial benefits as an *increased residual value*, an increased recovery value or resell value of the product, and *tax savings*.

Management perspectives (M)

Successful implementation of PSS also requires organisational and inter-organisational changes involving both provider and client. Many of these changes are those established in the literature as necessary to implement changes in the management context:

1) *There should be a champion in the client organisation* who understands PSS and will lead its introduction, such as a committed chief executive.
2) *Change management principles* such as developing commitment through conveying the value of PSS across the client organisation will facilitate its implementation.
3) *Employees (e.g. procurement officers, marketing personnel) should undertake training in new skills associated with PSS*, e.g. customer relationship building, performance reporting, and life cycle analysis.
4) *Reward systems should be in place* to encourage proactive engagement across the client organisation that improves customer acceptance of PSS and personal habits in using products.
5) *Monitor and report the operation performance of the fleet in meeting service requirements*, such as by a tracking system, allowing the customer/ business client to undertake its core business.
6) A mechanism or tool should be in place to *measure and monitor environmental and economic performance in different operation and business scenarios*. Environmental (involving carbon emission, waste impacts, and resource efficiency) and economic (costs and revenues) performance can be assessed in terms of resource-efficiency. Such assessments can help both suppliers and customers understand their current standing, the economic and environmental implications of their strategies, and opportunities for further improvement.

3. Implications for Business Model

As indicated by those principles discussed above and argued by many researchers [3,7,8], the implementation of PSS brings a paradigm shift for the operations and management systems of a company. Such profound changes will lead to, and can only be achieved by, transformation or innovation in business model. Based on such a notion, the implementation of the principles for PSS needs to be linked with business model design to translate the product, service, management characteristics of PSS into particular business model attributes so that it is feasible for companies to perform business model changes.

3.1. Business Model and Business Model Canvas (BMC)

Essentially, a business model is a system framework that defines the nature and scope of a company's commercial focus, specifies the key resources, activities, and capabilities for its business operations, and reveals its positioning and worldview (or value proposition), corresponding to a particular market and socio-economic context in which the company operates. The narrative of business model needs to address who customers are, what customer values to serve, what processes (both internal and external) to engage and interact with customers, what resources and assets to possess and utilise, what and how revenue can be generated, and associated cost implications [2,9]. One of practical approaches for companies to analyse and design their business models is Business Model Canvas (BMC), which was proposed by Alexander Osterwalder [10] as an analytical tool to conceptualise and visualize Business Model Ontology. BMC applies 9 blocks to map and interpret key attributes of a business model and their connections, in terms of value propositions (VP), customer segments (C), customer relationships (CR), channels for customer engagement (CH), key activities (KA), key resources (KR), key partners (KP), cost structure (CS), and revenue streams (RS).

3.2. Mapping of PSS Principles with BMC

Following the concept of BMC, changes in a company's operations and management systems to transform from production-centric to service-oriented will certainly have impact on and be reflected in the configuration of the 9 BMC building blocks. Therefore, it is necessary to examine how the 4 product-related (P1-P4), 6 service-related (S1-S6), and 6 management-related (M1-M6) general principles for PSS are associated with those critical business model elements as defined by BMC to better inform business model design. This linkage analysis can be depicted as a mapping process (Fig.1) by examining the logics and implications of PSS through the lens of BMC. As illustrated in Fig.1, the value proposition is relevant to all the principles of product, service, and management perspectives across the board. This highlights that fundamentally the shaping of PSS and its characteristics must be aligned with and foster the value propositions of the company and its drive to shift from a product-dominant

business logic to a more engaging service-dominant logic and being resource efficient [2,5-7,11].

	VP	C	CR	CH	KA	KR	KP	CS	RS
P1	√	√				√		√	
P2	√			√		√		√	
P3	√					√			
P4	√			√		√		√	
S1	√					√			
S2	√		√	√	√				√
S3	√		√	√	√				
S4	√			√	√			√	
S5	√	√	√					√	
S6	√							√	√
M1	√		√		√		√		
M2	√			√	√		√		
M3	√		√	√	√	√			
M4	√		√	√	√		√		
M5	√	√	√		√	√			
M6	√	√	√		√	√			

Fig.1. Correlation between PSS Principles and BMC

Like any business model, the adoption of PSS needs to be market-oriented and customer-focused, which is able to address a particular customer value network and to fulfill functional, economic, environmental and social demands. In PSS, both products and services are means for the company to reach and interact with customers. Together they represent the channels of engagement and determine both the forms and the content of communications through the channels in both directions. Furthermore, products are owned and operated as key resources, rather than goods, to generate and convey desired results. Meanwhile, service processes are part of the key activities in this business model to support product operations internally and customer engagement externally. The primary revenue stream is the financial arrangement for services options and service delivery, whilst the development, deployment and life-cycle management of physical products are the major contributors to the company's cost structure.

A defining relationship between the service provider and the customer that underpins the service-dominant logic and functions of PSS is value co-creation. Product value and service value offered by the provider are integrated with and enhanced by added value from the customer through their collaboration. Therefore, the management system for service capability, resources, and activities is essentially for governing the processes, monitoring the outcomes, and improving the efficiency of service result generation and service result consumption, based upon a provider-customer partnership.

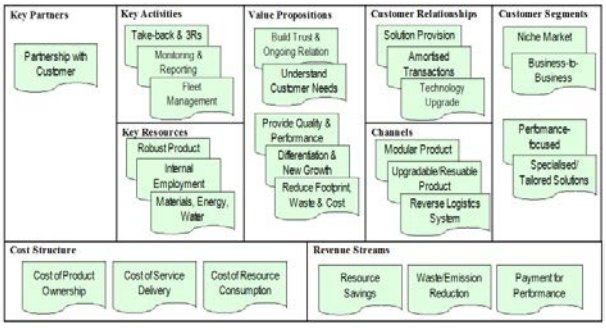

Fig.2. BMC of a PSS

By following the product-service-management principles and the mapping above, a typical business model of PSS in forms of BMC can be expressed as Fig.2. Linking the PSS principles with BMC enables an integration of the product, service, management and business perspectives. This not only can better direct the configuration of PSS as an operations system, but also make it easier and more practical to inform the design and analysis of the system's construct in a business sense.

3.3. Road Map

The drive for improving value creation and competency in a competitive market has led to increased integration between manufacturing and services, known as 'servitisation'. This transforms businesses from being product-oriented or product-centric (i.e. supplying a mass market with standardised products) to being service-oriented (i.e. proving integrated product-service solutions tailored to the needs of individual customers).

Pathways for product providers and their clients to follow in planning and implementing PSS require a progressive shift from product-oriented strategies to those that are more service-oriented, coupled with a shift from 'buy and own' to managed fleet, as shown in Fig.3 below.

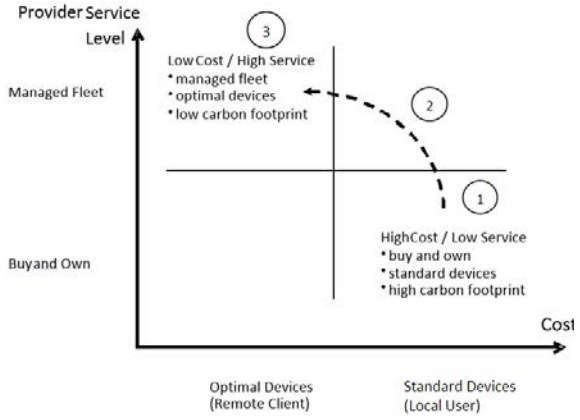

Fig.3. Path of PSS Transition [6]

An important aspect illustrated in the figure is that a change route for both the product-service provider and recipients (customers) must be identified and negotiated: this change is from the traditional sell/buy model (high cost, low service, high carbon footprint) to the PSS model (low cost, high service, low carbon footprint). Clients do not necessarily need to make a big jump to a complete PSS solution, but can take steps progressively and incrementally towards this. Whilst each of these steps should lead to service benefits, the total benefits of a combined PSS solution are greater once all the component areas are aligned into a single solution. Each of these individual steps can generate benefits in improved service or reduced support cost. The approach is consistent with ISO 9004: 2000, the international standard for quality management systems.

4. Case Study: Soniclean

The case study presented in this section is to demonstrate how the PSS principles, BMC, and the transition road map can be applied together to analyse the business model transition path, status and potential of a company from a product supplier to a more sophisticated product-service solution provider.

4.1. Case Context

The case company examined, Soniclean, is a small-sized Australian firm producing and supplying specialised ultrasonic cleaning equipment and products. The firm owns patents for key cleaning technologies and develops energy-efficient machines for end users in manufacturing, food, and medical and healthcare industries. The prices of these machines range from under 1,000 AUD per unit for bench-top ultrasonic cleaners to over 60,000 AUD per unit for some larger ultrasonic washer and modular cleaning systems. Most of Soniclean's ultrasonic products are designed with a modular structure and exchangeable component modules, making it easy to create special purpose-built products or for retrofitting or upgrade.

In recent years, Soniclean has also been exploring opportunities to include value-added services tailored to the needs of customers and the functions of products. The incorporation of services in its offerings and the orientation toward more service-focused business strategies are largely instigated by the following drives to attain and sustain business success:

- To strengthen competitiveness and differentiation in an increasingly competitive, highly price-oriented and commoditised market
- To make up the shrinking sales in the manufacturing sector and create opportunities in other market segments for new business growth.
- To improve communications and engagement with customers for building continuing relationship and achieving new profit centres.

4.2. Features of Main Services

Currently, the two main services featured in Soniclean's offerings are *Preventative Maintenance* and *Loan Units*. Preventive Maintenance is provided mainly for hospital and clinic customers and performed at the firm's site. Devices need to be sent to the firm for inspection/repair and be returned to the customers within 48-hour. Service contracts are on a 12-month basis and preferential price discount is offered to assist in understanding the value of compliance requirements and machine performance logged data, as part of preventative maintenance strategy.

Complementing the maintenance service, Loan Units are offered to customers as backup when they send their devices to Soniclean for overhaul, and to potential end-users as demo devices for experiencing the functions of the products. Such service is offered largely free of charge and the ownership of the units remains with the firm. Many loan units are actually made from retrofitting and upgrading models taken back from customers, contributing to resource efficiency and environmental benefits by establishing a closed-loop system and the reuse/life-extension of the retired units. Currently, the fleet size of loan units managed by Soniclean is about 5% of its total number of products.

In conjunction with those standard maintenance services, Soniclean is also planning to implement more function- or use-oriented tailored service solutions to suit the needs of some special customers. As core part of this customization effort, Soniclean has recently introduced *Contract Cleaning* services for research laboratories, medical clinics, ships, and food manufacturers to meet high quality cleaning standards and stringent certification requirements for health and safety concerns. Such services can be provided on the pay-for-results basis and are particularly suitable for customers who have special cleaning needs, but do not intend, or are financially constrained, to acquire own cleaning equipment.

4.3. Business Model and PSS Transition Path Analysis

Soniclean started as a traditional manufacturing firm focusing on developing and supplying physical products. The adoption of product-service integration is not only a response to the external challenges, but also in line with the evolution of the firm's value proposition, i.e. from "*being a leading supplier of high-quality ultrasonic cleaning equipment*" to "*continuously engaging customer needs and enhancing performance and user experience of ultrasonic cleaning equipment with flexible and value-added services*", and to "*being an innovative total-solution provider of sustainable products and services for ultrasonic cleaning results*". Such changes in value proposition affect the product, service, and management characteristics of the three services, as shown by the mapping against the PSS principles in Fig.4.

	Preventive Maintenance	Loan units	Contract Cleaning
P1	√	√	√
P2	√	√	√
P3	X	√	√
P4	√	√	√
S1	X	√	√
S2	√	√	√
S3	√	√	√
S4	√	√	√
S5	X	√	√
S6	X	√	√
M1	X	X	??
M2	X	X	??
M3	√	√	??
M4	√	√	??
M5	√	√	??
M6	X	X	√

Fig.4. PSS Mapping of Soniclean Service Options

The preventive maintenance service solutions are largely based upon or linked with sold products, to maintain quality and to improve their functional performance. This pattern of adding services to the offering of goods represents a product-oriented service. In contrast, the loan unit service is more in line with product sharing and aimed at influencing user experience with the firm's products. As for the new contract

cleaning options, the services are basically processes and results focused, while business transactions are only related to the quality of service results rather than physical products. The mapping in Fig.5 shows that total environmental performance and resource efficiency can be better achieved with Loan Units and Contract Cleaning, as life-cycle design and life-cycle management strategies are more explicitly applied to ensure reuse and reduce waste and energy consumption of cleaning equipment.

Meanwhile, although customer engagement is core to the value proposition of the firm, customers are still largely treated as receipts, rather than co-creator, of the extant services. It is identified that the extant services of Preventive Maintenance and Loan Units have fallen short of having customers participate in the process as key partners, committed to the "service thinking" and collaborating with their knowledge and capabilities in the service design and delivery. These also remain as critical areas for the new Contract Cleaning service to address in the development of its service management system, as indicated by the mapping.

The characteristics of the product-service systems, their alignment with the firm's value proposition, and their current gaps in business models can be further examined by using the BMC analysis to identify changes needed. Fig.5 depicts the basic business model of the Contract Cleaning service based on its current design, with the elements requiring further actions highlighted.

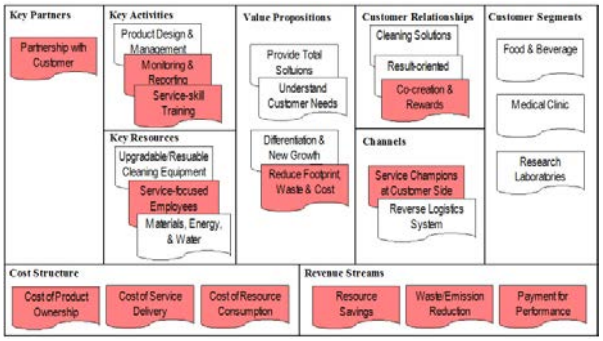

Fig.5. BMC Analysis of Contract Cleaning

By analysing the evolution of value proposition and business models of Soniclean's product-service offerings, it is clear that the company is currently at the Stage 2 of transition to PSS (as shown in Fig.3), with some potential to achieve more reduced total cost of ownership and lower environmental footprints. Soniclean's technologies, being housed in robust and modular units, are very suitable for takeback, remanufacture, recycling and reuse. By this means, more services can be provided to customers with less units and less wastage, leading to savings in manufacturing costs and resources per unit of customer service provided [11]. In addition, savings in carbon footprint can be achieved and reported upon, which is an increasingly important advantage for business customers in the current post-COP 21 domain.

5. Conclusion

Main difficulties for enterprises to begin making the shift to PSS lie in their lack of understanding of the changes required to their current business models, how these changes may be undertaken in a progressive manner, and impacts on the pathway toward PSS. Aimed to address such challenges, this paper establishes a value proposition for PSS, with a set of key principles. These are then examined in terms of the well-established BMC. A pathway is then established to assist firms make the shift by taking the necessary steps, and to understand the requirements and potential benefits associated with each step along the way. A case study of an SME demonstrates that a combination of PSS principles, PSS roadmap, and BMC can be used to analyse and identify the business model evolution path, status and potential of transition to PSS in a practical manner. However, for a more effective and coherent application, a structured model is still necessary to provide a framework to have the three approaches more integrated and a methodical process for their implementation. It will also be necessary to include the risks (especially financial risks) and benefits associated with taking each step along the change path, so that a company such as Soniclean may more confidently transition towards PSS. Moreover, the new model should also incorporate a systematic innovation mechanism to enable an integration of product, service, and business model designs.

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