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## **Abstract**

The migration to a service based economy has led many firms to emphasize the service component of their product offerings. This shift has led to the emergence of a business model based on value creation through product utilization, where products are sold as a service, (often referred to as "Servicization" or product-service systems) The Servicization business model can be applied to both tangible and intangible, information intensive, products and is based on aligning customer and supplier incentives. A shift to a service based model leads to a variety of managerial questions that concern performance metrics, customer supplier relationships and contracting and resource optimization. The paper will review how current research on Servicization relates to these questions. We will also consider the implications of the Servicization paradigm for areas in information management such as cloud computing and decision support systems.

## **Disciplines**

Behavioral Economics | Other Economics

# Product Performance Based Business Models: A Service Based Perspective

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## Abstract

*The migration to a service based economy has led many firms to emphasize the service component of their product offerings. This shift has led to the emergence of a business model based on value creation through product utilization, where products are sold as a service, (often referred to as “Servicization” or product-service systems). The Servicization business model can be applied to both tangible and intangible, information intensive, products and is based on aligning customer and supplier incentives.*

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## 1. Introduction

The economies in most developed and many developing countries have become predominantly service based. Indeed services generate over 70% of the US GDP (Wall Street Journal 2009) and the World Economic Forum reported in 2010 that 70% of GDP is based on services in 25 out of 138 reporting countries. These developments have occurred against a backdrop of declining employment in manufacturing and rising employment in services.

The movement towards a service-based economy has coincided with a fundamental shift in manufacturing industries to a business model in which the service component of products, based on the value they provide to consumers, has become dominant. This change has led many manufacturing firms to put more weight on the delivery of services associated with the use of their products. Arguments to support this change include the role of services as a source of differentiation, the difficulty in imitating services due to their intangibility and ease of customization, their contribution to increasing customer switching costs, their high margin which increases revenues and profits for manufacturers, their role as a counter-cyclical source of revenue, and the observation that after sales customer service should be an integral part of a firm’s competitive strategy (see Cohen et al [2006] and Cohen and Guajardo [2011]).



**Figure 1. Product-service Value Offering to Customers**

It is a truism that all products are a bundle of tangible goods and intangible services. In the context of the continuum proposed in Figure 1, many companies are shifting the balance to the right, where the role of services dominates. The extreme case, where products are actually sold as services, has been referred to as Servicization, (first introduced by Vandermerwe and Rada [1988]), and recently has been the focus of a considerable amount of debate and research. In this paper we focus on performance based business models that are based on the concept of Servicization. Our goal is to develop an understanding of the managerial implications of this model especially in information intensive contexts.

We begin by considering the question; what is a performance based business model based on Servicization?

While many definitions have been offered in recent years, we submit that it is essential to consider the following elements:

1. incentives and contracting for the delivery of products and after-sales support of those products
2. customer-supplier relationships throughout the supply chain affecting asset ownership,

decision making control and coordination, information sharing and visibility

3. optimal deployment of resources affecting the cost, quality and availability of products throughout the life cycle of ownership and use
4. metrics based on product performance and value creation from the perspective of the end-user customer

In this paper we explore these aspects of Servicization by considering a number of specific questions associated with the management of supply chains in an environment where a Servicization based business model is being adopted. Our goal is to provide an overview of relevant current research and to identify issues that should be of interest to both managers and researchers.

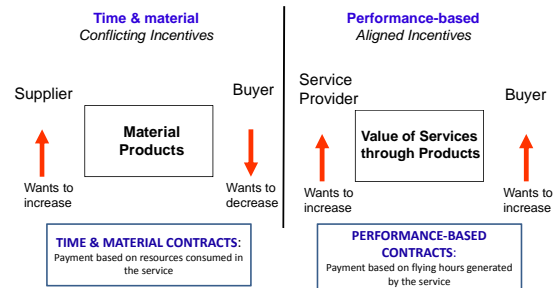
## 2. Managerial Questions

- a) *Can product support contracts be designed in a manner that increases overall value for both customers and suppliers?*

The strategic importance of after-sales product support services that enable the availability of mission critical products has been recognized in industries where products are complex and the consequences of product downtime can be severe. Moreover, when products have relatively long life cycles (e.g., aircraft, engines, semiconductor fab equipment, medical imaging devices, etc.), firms supplying after-sales support have the opportunity to provide repair and maintenance services. As many manufacturers in such industries reposition themselves to adopt a Servicization business model, they have found it necessary to evaluate and define contractual relationships with their customers for the provision of after-sales support. Traditionally, after-sales services have been performed under time and material contracts (T&MC), under which the supplier is compensated for the amount of resources consumed (such as spare parts and labor) whenever product maintenance is required. However, a new form of a support contract has emerged in recent years: performance-based contracts (PBC). Under PBC, also referred to as Performance-based Logistics (PBL) in the defense sector and Power by the Hour<sup>®</sup> in the commercial sector, a supplier is paid based on the realized outcome of customer value. For example, an airline customer pays an engine service provider in proportion to the number of aircraft flying hours, which is affected by engine up-time (i.e., the number of hours the engine was available for use), and which

determines the value derived by the customer. Another example is software as a service, where the customer pays the software provider a monthly fee based on usage of the product.

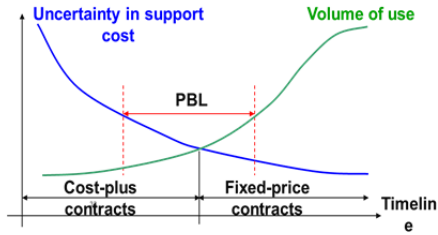
The fundamental idea behind PBC is the concept of incentive alignment between the customer and the provider of support services. As depicted in Figure 2, T&MC relationships have the potential to misalign incentives (“pay me when it is broken”), whereas PBC can act to align incentives, (“pay me when it works”).



**Figure 2. Contracting Affects Incentive Alignment**

Kim et al [2007] developed an economic model of the contracting problem for after sales product support, in an environment where suppliers are to be rewarded on the basis of the performance generated through the use of the product. Their model, which is based on a principal agent framework, determined that the optimal contract design consists of three elements; a fixed payment, a payment based on the sharing of costs generated by provision of support services and a bonus payment based on the value received by the customer through use of the product. The optimal mix of these three components, moreover, varies throughout the product life cycle. In particular, they found that the optimal contract design includes a small performance bonus and more emphasis on cost recovery in the initial risky phase of product deployment and a fixed payment with a larger performance bonus in the mature phase when uncertainty associated with product support is reduced.

	Small performance bonus	Large performance bonus
Limited cost sharing (Fixed Price)		Product maturity
Extensive cost sharing (Cost Plus)	Product deployment	

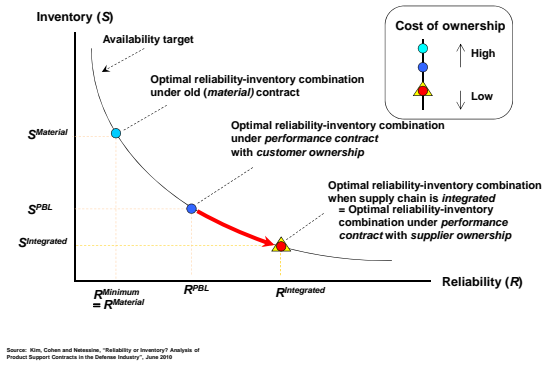


**Figure 3. Optimal Contract Design for After-Sales Support**

Figure 3 illustrates the key findings of this paper.

- b) *How should customer-supplier relationships be designed and maintained in terms of coordination, cooperation and asset ownership?*

In another paper that deals with the product support environment, Kim et al [2011], considered the tradeoff between investment in service parts inventory and in product reliability improvement. Their model posed the problem for a supplier who had committed to a fixed level of customer service, (based on product availability) in an environment where failures occur randomly. This model indicated that the optimal solution to the underlying game theoretic problem was dependent on the nature of the support contract, i.e. T&MC vs. PBC. Their model results indicated that the tradeoff between inventory and reliability also depended on the ownership of the underlying inventory asset. In particular a first best solution with maximum reliability improvement resulted when a performance based contract was in force and when parts asset ownership was transferred to the supplier.



**Figure 4. Reliability-Inventory Tradeoffs to Achieve an Availability Target**

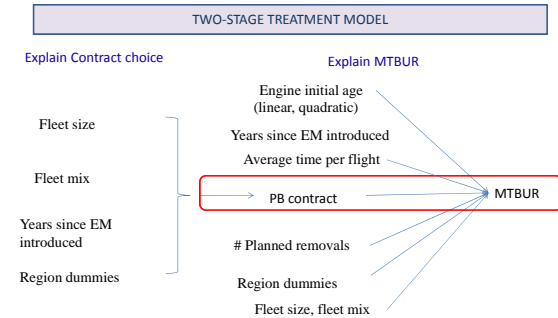
Figure 4 summarizes how inventory investment, reliability improvement and contract design interact in this model. The key result here is that the service supply chain performs best under a PBC contract with ownership of the inventory assets transferred to the supplier.

- c) *What impact is there on outcome metrics such as the cost of product ownership, product performance and product reliability?*

There is significant debate concerning the actual impact of PBC on these metrics, i.e. does it really lower costs, improve product performance (availability, reliability) and enhance customer perceptions of quality leading to a higher level of satisfaction? This debate became critical when the adoption of PBC was mandated by the US Department of Defense for all weapon system support contracts. We report here on two recent empirical studies which shed some light on the issue. We in particular consider the impact of PBC on product reliability and the challenges associated with measuring quality in a Servicization environment.

In Guajardo et al. [2011], we use a proprietary dataset provided by Rolls Royce, a major manufacturer of aircraft engines, to empirically investigated how product reliability is impacted by use of T&MC and PBC contracts. The paper offers a number of competing arguments based on the theory of incentives that establish why product reliability may either increase or decrease under PBC (including double moral hazard). The key results of the paper, which are based on a two-stage econometric model that explicitly accounts for the endogeneity of contract choice, provides evidence of a positive and significant effect on product reliability created by the

incentives under PBC. The estimation of the model indicates that product reliability is higher by 25-40% under PBC compared to under T&MC, once the endogeneity of contract choice is accounted for. The results, moreover, are consistent with two mechanisms for reliability improvement under PBC, i.e. more frequent scheduled maintenance and better care performed in each maintenance event.

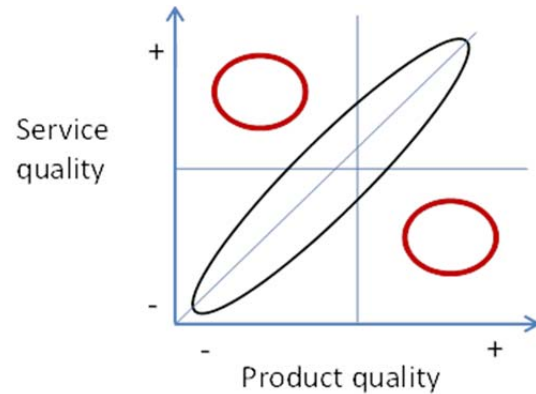


**Figure 5. Econometric Model to Measure the Impact of PBC on Product Reliability**

Figure 5 illustrates the structure of the two stage econometric model that was used in the analysis to analyze the impact of PBC on the Mean Time Between Unscheduled Removals (MTBUR), which was the reliability metric used in the study.

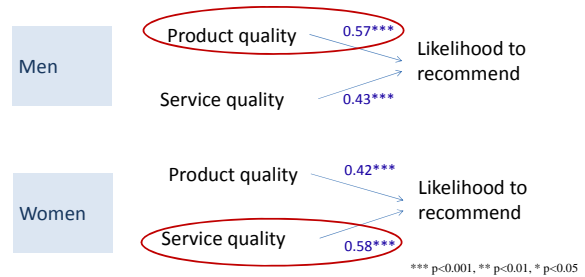
In Guajardo and Cohen [2011], we introduce a product/service quality perceptions map (Figure 6) to guide the discussion. The upper-right (bottom-left) quadrant represents consumers who perceive that both service and product quality are good (bad). Consumers with a high perception of product quality but a low perception of service quality will be located in the bottom-right part of the graph, and those where product quality is perceived to be low but service quality is high, will be located in the upper-left area of the graph.

The analysis was based on survey data provided by a major manufacture of consumer electronics products. The company was adopting a more service focused strategy and was interested in how their customers perceive quality based on both product attributes (e.g. reliability) and the provision of customer support services (through call centers and in-home repair services). The data was based on high-definition customers who had recently interacted with the after-sales support system.



**Figure 6. Map of Product/Service quality Perceptions**

Figure 6 summarizes a key finding in this study concerning the impact of customer heterogeneity on the importance of both product and service quality. In particular, we estimated how product and service quality jointly affect the likelihood that the customer would recommend the product (brand) to others.



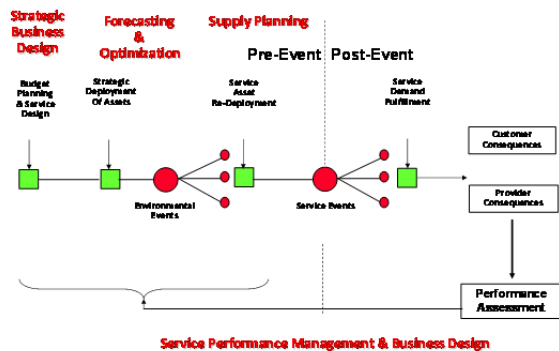
**Figure 7. Impact of Customer Gender on the Relative Importance of Product and Service Quality on Customer Satisfaction**

Our results indicated that perceptions of both product and service quality contribute positively to the likelihood to recommend. Moreover we found that the relative importance customers attached to these factors was influenced by gender (as depicted in Figure 7) and income level. We did not observe any important differences, however by age or education level of the customers.

- d) *How should planning and control of the resources required to enable value creation be optimized specifically in the areas of after-sales service and customer relationship management?*

There has been considerable research on the design of decision support systems to optimize supply chain resource management for after-sales service support that is relevant to Servicization, (see [www.mcasolutions.com](http://www.mcasolutions.com) for an example). A key aspect of this aspect of the problem is the fundamental uncertainty associated with the need for those resources which are used in response to random events such as failure of the product in the field. In Cohen et al [2006] we introduced a model framework, (see Figure 8), based on the theory of real options to illustrate the underlying challenges associated with responding to such events.

As Figure 8 illustrates, there is a feedback loop between realized performance of a product in the hands of a customer and an array of resource decisions that are made before the event occurs. Indeed, it can be argued that the ability of a firm to respond appropriately to the occurrence of random service events (by providing the appropriate resources to restore a downed product in the field in a timely manner), is largely determined by the quality of these pre-event decisions. Thus a key challenge associated with successful implementation of a Servicization business model is the use of support systems to optimize such decisions.



**Figure 8. A Real Option Model Framework for Risk Management in the Service Supply Chain**

e) *What is the environmental impact of Servicization?*

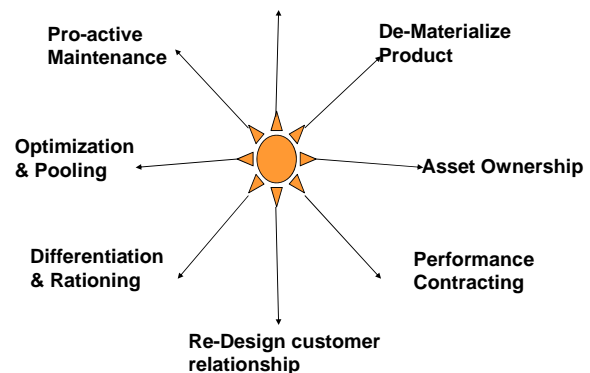
Another aspect of Servicization is its potential to have a positive impact on the environment through more efficient use of resources. The underlying idea is that as customers and suppliers align incentives to produce product value, they will find it mutually beneficial to make decisions that support sustainability of the environment. Listed below are

several examples of Servicization which have had, (or have the potential to have) a positive environmental impact.

- *Interfaces* provides a lease based floor covering services including installation, maintenance and disposal. The environmental impact here is based on better recycling of materials at the end of product life.
- *Better Place* is setting up electric vehicle battery swapping stations. The use of these stations will promote the adoption of all electric automobiles which are more fuel efficient and produce less harmful emissions.
- *Cloud Computing and Software as a Service* – Intuit will submit your income tax after you submit the data. It has been argued that this mode of software delivery has a lower environmental footprint.

f) *What are the implications of the Servicization business model for product design (both tangible and services)?*

Figure 9 illustrates a set of managerial interventions that can support the adoption of Servicization. They include decisions affecting the design of the product, processes to maintenance and support the product, better management of resources, and the relationship between the customer and supplier as determined by ownership and management control of assets and contracting based on performance.



**Figure 9. Servicization Interventions**

- g) *How will emerging technology to monitor products in real time and to provide end-end data visibility impact answers to the above questions?*

Current technology developments can have a profound impact on Servicization in terms of how they will affect answers to the questions we have posed. As noted above material product can be replaced by information (leading to “de-materialization”), and better visibility of real time product monitoring supply chain transaction based data can lead to improved resource deployment decision making including the use of pre-emptive maintenance to avoid product failures in the field.. The fundamental changes to the customer-supplier relationship noted in our discussion can also be facilitated by better communication and sharing of information among all of the players in the service supply chain.

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