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Product Service Systems and Supply Network Relationships: An Exploratory Case Study

Abstract

Purpose – In recent years there has been increasing interest in Product Service Systems (PSS) as a business model for selling integrated product and service offerings. To date there has been extensive research into the benefits of PSS to manufacturers and their customers, but there has been limited research into the effect of PSS on the upstream supply chain. It is this gap that this research seeks to address.

Design/Methodology/Approach – The research uses case based research which is appropriate for exploratory research of this type. In depth interviews were conducted with key personnel in a focal firm and two members of its supply chain and the results were analysed to identify emergent themes.

Findings – The research has identified differences in supplier behaviour dependent on their role in PSS delivery and their relationship with the PSS provider. In particular it suggests that for a successful partnership it is important to align the objectives between PSS provider and suppliers.

Originality/ value – This research provides a detailed investigation into a PSS supply chain and highlights the complexity of roles and relationships among the organisations within it. It will be of value to other PSS researchers and organisations transitioning to the delivery of PSS.

Keywords – Product Service Systems, Servitization, Supply Networks, Relationships, Case Study, Product Lifecycle

Paper Type –Research Paper

1 Introduction

Many industrialised nations are witnessing a contraction in their manufacturing sectors caused by a shift of production to low-cost economies. An example of this is the reduction in contribution of the manufacturing sector to GDP. In the period 1973-1997 the contribution of the manufacturing sector in the UK went from 30% to 18%, 34% to 21% in Japan and 24% to 16% in the USA (Department of Trade and Industry, 2002). In order to combat this, manufacturing firms have moved away from seeking competitive advantage through process or product innovation (Dickson, 1992; Ghemawat, 1986) to ‘servitizing’, by integrating value-added services with their core offering (Davies *et al.*, 2006; Slack *et al.*, 2004; Vandermerwe and Rada, 1988). Thus, the offering moves from a product to a Product-Service System or PSS (Baines *et al.*, 2007; Baines *et al.*, 2009; Spring and Araujo, 2009).

Product-Service Systems change the relationship between the manufacturer and the customer from a single point transaction in which the customer purchases a product from the manufacturer, to an ongoing relationship in which the manufacturer continues to provide services to the customer throughout the life of the PSS. There are well known examples of Product Service Systems in both a business-to-business context (e.g. Xerox’s document management) and a business-to-consumer context (for example mobile telephone handsets sold with service contracts).

There has been extensive discussion in the academic literature about the business drivers for a successful PSS. There is a commonly held view that the PSS model can offer a “win-win” for the supplier and the consumer of the PSS, potentially with an associated environmental benefit (Mont, 2002; Tukker and Tischner, 2006). However, to date there has been little consideration in the PSS literature of the effect on the upstream supply chain engaged in

delivering the PSS. It is this gap that we seek to address by exploring the differences between ‘traditional’ and ‘PSS’ supply chains using a case study in a supply network that delivers both ‘traditional’ products and PSS. We do this in order to determine whether there are changes required in terms of the characteristics of the supply network and whether there were counterintuitive behaviours.

The remainder of the paper is structured as follows. Section 2 of the paper reviews the relevant PSS literature with particular focus on the supply chain. In section 3 the research methodology is presented, followed by the results in section 4. Section 5 provides a discussion of the research outcomes and conclusions are presented in section 7.

2 Literature Review

2.1 The Motivation for Offering Product-Service Systems

The distinction between products and services is limited as most offerings combine physical and non-physical elements (Shostack, 1982). Levitt (1981: p. 94) stated: “*Everybody sells intangibles in the marketplace, no matter what is produced in the factory*”, and more recently Vargo and Lusch (2004) argued that physical products are only vehicles through which a service is delivered. Thus, products have become order qualifiers - a necessity to play a part in the market - with services becoming order winners that can differentiate the product-service package from the competition.

Vandermerwe and Rada (1988) propose that the move to servitization by an organisation allows deeper and longer engagement with their customers allowing greater opportunities. Furthermore, the provision of services through the life of the product also allows providers the opportunity for further revenues through the provision of maintenance and service parts

(Cohen and Whang, 1997; Wise and Baumgartner, 1999) as service parts offer a higher-margin than those used in production (Cohen *et al.*, 2006). The potential benefits of servitization have been discussed by several authors and are summarised in Table 1.

Table 1: Summary of the potential benefits of servitization.

	Penttinen and Palmer (2007)	Oliva and Kallenberg (2003)	Vandermerwe (2000)	Desmet <i>et al.</i> (1998)	Cohen and Whang (1997)	Vandermerwe and Rada (1988)
REVENUE ENHANCING BENEFITS						
Provides additional sources of revenue		✓		✓		
Creates more stable sources of revenue		✓				
Services tend to have higher margins		✓				
VALUE ENHANCING BENEFITS						
Customers are demanding more services		✓		✓		✓
Allows a better understanding of customer needs	✓					
Allows establishing and maintaining relationships with customers over the product life-cycle	✓				✓	✓
Allows a more comprehensive solutions to customer needs	✓		✓	✓		
Improves after-sales service				✓	✓	
Provides transparency of life-cycle costs for the customer				✓		
SUSTAINABLE COMPETITIVE ADVANTAGE BENEFITS						
Service is a differentiating factor (de-commoditization)	✓			✓	✓	✓
Services are more difficult to imitate		✓	✓	✓		✓
Facilitates customer lock-in			✓		✓	✓
Product-service packages can facilitate the diffusion of innovations						✓

Table 1 indicates that the benefits of a company offering product-service systems can be grouped into three categories:

1. Revenue enhancing benefits which allow the firm to generate greater revenues over the lifecycle of the product-service system.

2. Value enhancing benefits related to the delivery of a better value offering to the marketplace leading to more satisfied customers.
3. Enhancing both revenue and value lead to competitive advantage, however, the third category –sustainable competitive advantage– groups the benefits that facilitate an organisation in maintaining competitiveness into the future.

2.2 Supply Network Relationships in the context of PSS

The nature of the PSS offering dictates that it is mainly provided by organisations which supply complex, long-life products that require through-life support (Voss, 2005). From the perspective of a network that supports the provision of PSS, the product is normally provided by one organisation, where services may be provided by members of their supply network (Cohen *et al.*, 2006). The effective provision of PSS requires “*the co-ordination of manufacturing systems, maintenance, spare parts, logistics systems and so on*” (Slack *et al.*, 2004: p. 384). Furthermore Slack *et al.* (2004) argue that the degree of integration between organisations should be similar to that of the products and services they provide. The reason for this is that the complexity of the customer offering involves not only more organisational functions but also many more actors in the external network. It is also important that the interests of all organizations in a supply network are aligned to maximise the performance of the network; as Lee (2004: p. 110) observes, “*Great companies take care to align the interests of all the firms in their supply chain with their own. That's critical, because every firm - be it a supplier, an assembler, a distributor, or a retailer - tries to maximize only its own interests*”.

The provision of PSS also commonly involves a transfer of risk from the customer to the supplier; “*By promising a result, the provider often faces difficulties in predicting and*

controlling risks, uncertainties and responsibilities that otherwise were the problem of the user” (Tukker, 2004: p251). In a supply network context elements of assumed risk may be further transferred from the PSS provider to its suppliers. The challenges associated with this risk transfer are more complex where there is a need to manage liabilities for potentially hazardous products and combat situations (Doerr *et al.*, 2005; Snir, 2001; Stoughton and Votta, 2003).

We suggest that from a supply network perspective, two further particularities of PSS provision are relevant for consideration: Firstly, the strategy of servitization is characterized with increased levels of customer centricity (Oliva and Kallenberg, 2003) and it encompasses two distinct elements when compared to manufacturing:

- 1) A shift of the service offering from services performed *on the product* (i.e. product-oriented) to services performed *for the user* (i.e. user-oriented services), and:
- 2) A shift in the nature of customer interaction from transaction to ongoing relationship.

Secondly, the content of exchange with product-service systems is considerably different to that of a product. The presence of a service component (i.e. installation, maintenance, training) in an integrated offering is classified as tacit know-how assets by Teece (1986: p.287). These are more easily employed through relational rather than transactional exchange between the members of the supply network (Helper and Levine, 1992; Zajac and Olsen, 1993). Therefore we suggest that the most effective mechanism for facilitating supply networks that support the provision of PSS is through effective management of inter-organizational relationships (IORs).

Empirical studies on the strategic role of IORs (e.g. Anderson *et al.*, 1994; Dyer and Nobeoka, 2000; Liker and Choi, 2004), shows substantial benefits from the effective management and building of cooperative relationships in supply networks. Relationships between firms provide a ‘bridge’ as they give one organization access to the resources of another organization (Harland, 1996) and cooperative inter-firm relationships provide the foundation for the successful management of materials and information flows across the supply chain (Handfield and Nichols, 2002).

Whilst there is a considerable body of academic knowledge on the role of upstream supply networks in the context of traditional manufacturing (e.g. pure product), there is less work in the context of PSS. Johnson and Mena (2008) suggest that supply networks which support the provision of product-service systems are different to those for the provision of products or services. Their empirical work pointed to information flow management (i.e. sharing of information between supply chain members) which further affects customer and supplier relationship processes as particularly important in the use of servitization strategies.

Throughout the PSS and servitization literature there is a call for closer downstream relationships at the interface between PSS provider and its customers (e.g. Davies *et al.*, 2004; 2006; Vandermerwe *et al.*, 1989; Wise and Baumgartner, 1999). Until recently, there has been little that examined upstream relationships. Gulati and Kletter (2005), suggest there is also a need to rethink the ways companies manage their relationships on the upstream side of their supply networks. This is because acquiring partnering competences enables a solutions provider to build alliances and partnerships with suppliers and deliver greater value to their customers.

There are also negatives to a proposed move towards partnering with suppliers. This includes the potential for the reduction in control over their suppliers due to ‘knowledge leakage’ allowing suppliers to develop new capabilities (Cook *et al.*, 2006; Rossetti and Choi, 2005;). Moreover, partnering can mean collaboration with potential competitors. The benefits of this collaborative approach include the sharing of risk, provision of skills in the services area, an innovative way to gain competitive advantage, and a means to moderate the political cost caused by moving into the services area (Mathieu, 2001).

This literature review has identified that, to date, the main focus of PSS researchers has been on the opportunities and barriers for companies wishing to develop and deliver a PSS. While there is some work on the potential effects of the PSS on the supply chain and supply chain relationships, the work remains mainly at a conceptual or exploratory level. Some of the empirical work shows that potential barriers to the development of PSS include unexpected competition between members of the supply network and concerns about knowledge leakage through the supply chain. While there is a clear thread of literature supporting the view on changes required in managing supply chain relationships, these are mostly approached from the PSS provider’s – or downstream - perspective. The current state of the literature calls for a more balanced approach and consideration of the upstream supply chain perspective. This is the focus of our research.

3 Methodology

3.1 Research Design

Research into the supply chain relationships in business networks that design, manufacture and support PSSs is immature, thus we adopted a case-based research methodology. Case-based research is appropriate for exploratory and theory building research, suitable for dealing with ‘how’ type questions (Voss *et al.*, 2002; Yin, 2003). The units of analysis for the research were two relationships between a focal firm and two members of its supply chain where the focal firm designs, builds and delivers PSSs. The relationships were analysed as part of a nested case design (Patton, 2002, pp, 298-299). The questions to the focal firm were posed in a general way (i.e. their approach to the supply chain) whereas questions to the suppliers were asked specifically (i.e. their approach to dealing with the focal firm).

We adopted a semi-grounded approach to data collection where we defined no a priori constructs and themes in order to prevent us from introducing bias (Lämsisalmi *et al.*, 2004). We used an exploratory semi-structured interview protocol that focussed on determining how and why the case companies had begun to deliver servitized offerings and the challenges that they were facing within their supply chain relationships. Copies of the protocol are available from the authors on request.

3.1.1 Data collection and analysis

Data were collected between June and November 2007 at each of the case companies sites. The interviews were conducted with key informants in each of the three case organisations by 2 or 3 researchers from different disciplines (e.g. engineering, manufacturing, management) to reduce the potential of subject area bias. As perceptual frameworks are innate to individual researchers (Meredith, 1998), the use of researchers from different disciplines allowed for

different avenues of inquiry to be pursued in the data collection. Theoretical triangulation (Jick, 1979; Yin, 2003) was achieved through the collection of supplementary data such as organisation charts, process maps and operating protocols in addition to viewing the operations within the business units of the key informants.

A total of 22 interviews were conducted with 16 informants and each of them lasted between 1 to 3 hours, which yielded more than 200,000 words of verbatim transcripts. Data was analysed using an inductive research approach (Cassel and Symon, 1990). An *analytical reflection* of the data was carried out by the *emergent identification of patterns* (Cassel and Symon, 1990; Glaser and Strauss, 1967; Yin, 2003). To identify the effects that the adoption of PSS had on supply chain relationships an open coding method - a process of data disaggregation into conceptual categories - was carried out to identify patterns in the data. According to Miles and Huberman (1994), codes are tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study. For the purposes of coding and arranging data we used the mapping software (Mind Manager™). To strengthen the reliability of our findings, the coding was performed by a multidisciplinary team of researchers (Miles and Huberman, 1994; Yin, 2003).

3.2 Sample frame and description of case organisations

In order to investigate the differences in relationships that occur between the provision of a product and a PSS offering we examined two upstream relationship dyads to a focal firm. Figure 1 details the structure of the supply chain and the size, turnover, role and business model within the relationship. The identities of the case firms have not been shown to preserve anonymity.

< Figure 1 >

The focal firm is a UK manufacturer producing complex engineered products in a business to business context. In the past they worked to a traditional manufacturing model and sold products to their customers, who then took responsibility for the products' maintenance and repair throughout their lifespan. In recent years the focal firm have developed PSS offerings for some of their product lines. In the PSS model the focal firm sells their products with an ongoing package of services, providing maintenance, monitoring and repair services throughout the products' lifecycle.

The system supplier is a supplier of sub-systems, spares and maintenance to the focal firm and other maintenance organisations. The system supplier has joined a risk sharing partnership with the focal firm for the delivery of their PSS offerings. The repair service supplier is a medium-sized company that provides repair services for high value components in the focal firm's products. It is a joint venture between the focal firm and another firm. Table 2 provides details of the participants interviewed in the research, including an identifier to link any discourse in the results section back to the informant.

Table 2: Key informants interviewed for the research.

Case company	Respondents	Identifier
ManuCo (Focal firm)	- Service Operations Director	FF 1
	- Repair Engineering Manager	FF 2
	- Services Marketing Director	FF 3
	- Operations Centre Manager	FF 4
	- Services Executive	FF 5
	- Supply Chain Manager	FF 6
	- Human Resource Manager	FF 7
	- Services Innovation Manager	FF 8
	- Customer Services Manager	FF 9
	- Project Manager	FF 10
RepairCo (Repair Service Supplier)	- Managing Director	RSS 1
	- Commercial Director	RSS 2
	- Operations Manager	RSS 3
SysCo (System Supplier)	- Commercial Director	SS 1

The remainder of this paper reviews the results of the case interviews, and discusses the results in the context of the PSS literature.

4 Results

The results are presented in two sections. Firstly the relationships and information flows for the studied organisations are discussed; then the case results are reviewed and classified using the themes that emerged from the data.

4.1 *Structure of Supply Chain Relationships*

Before presenting the detailed case analysis it is useful to understand the interactions between the companies for the studied PSS. The information and data flows involved in delivering the product and service offering have been represented graphically using system organisation maps as proposed by Manzini *et al.* (2004). The traditional manufacturing model used prior to offering the PSS is shown in Figure 2. It can be seen that in this scenario ManuCo may often interact with a customer only at the point of purchase and does not necessarily have any ongoing relationship with the customer. Once the product has been purchased the customer's main relationship is with the maintenance centre which coordinates the provision of spare parts and repairs from ManuCo, SysCo and RepairCo for the customer.

<Figure 2>

Figure 3 presents the changed relationships for the provision of the PSS offering. In the new model ManuCo, as the PSS Provider, has an ongoing relationship with the customer: starting from the order of the PSS, and continuing through the provision of ongoing maintenance and

repair throughout the life of the PSS. ManuCo also takes on a central role communicating with suppliers. In this scenario the previously independent maintenance organisation is now part of ManuCo. Furthermore ManuCo and SysCo have joined a risk sharing partnership for the provision of the PSS offering. RepairCo is a joint venture between ManuCo and one of their major suppliers.

<Figure 3>

The process flows shown in Figures 2 and 3 highlight significant differences in the roles of the organisations in the provision of a PSS compared to a traditional product. In the PSS model ManuCo provides a central role for the whole PSS lifecycle, whereas previously the product support was led by a separate maintenance organisation. The following sections will investigate in detail the effects of these changed relationships on the PSS provider and supply chain.

4.2 Case Study Results

This section presents the case study results in the context of PSS and supply chain relationships. The patterns that inductively emerged from the data have been grouped in five themes. These are summarized in Table 3 and are: 1. Supplier engagement in PSS strategy and delivery; 2. Alignment of incentives between PSS provider and suppliers; 3. The effect of PSS on planned business developments; 4. Information sharing in PSS delivery and 5. Overall lifecycle considerations related to PSS delivery.

Table 3. Summary of Case Results.

	ManuCo		SysCo		RepairCo	
Brief Description of Role in PSS		PSS provider. Develops and delivers the PSS		Contributes to delivery of PSS as a risk sharing partner		Supplier of repair services to the PSS Provider
Supplier Engagement in PSS Strategy and Delivery	-	Defines PSS strategy	-	Working in partnership with PSS Provider	-	Supplier of repair services on a standard (non-PSS) basis
	-	Partners with supply chain to deliver PSS	-	Limited involvement in setting PSS strategy	-	No involvement in PSS strategy
Alignment of Incentives between PSS Provider and Suppliers	-	Recognises benefits of aligned incentives with supply chain through risk sharing	-	Benefits from aligned incentives with PSS provider	-	Incentives are not aligned with PSS Provider.
	-	Acknowledges not sufficiently achieved to date	-	Increased risks due to PSS partnership	-	PSS model has reduced the supplier's business with PSS Provider
Planned Business Improvements	-	Continued development of PSS model	-	Development of PSS with own customers	-	Expansion of customer base external to PSS
			-	Risk sharing with own supply chain	-	Development of new services for customers
					-	No plans to develop own PSS
Information Sharing	-	Need for information sharing with suppliers acknowledged internally but not yet executed.	-	Potential for cost savings through streamlining business with PSS provider, however current levels of information exchange are not always enough to enable streamlining.	-	The level of received data is not sufficient for effective support of the PSS offering.
	-	Concern about losing intellectual capital to supply chain	-	ManuCo is expected to change its information sharing practices and open up.	-	ManuCo is expected to change its information sharing practices and open up.
Overall Lifecycle Considerations	-	Change of organisation mindset from manufacturing to whole lifecycle view	-	Identifies risks associated with estimating whole lifecycle cost at the time of contract negotiation	-	Perceives that PSS provider has not fully assessed lifecycle costs when performing trade-offs
	-	Difficulties in performing whole lifecycle trade-offs				
	-	Recognition of the lifecycle cost of raw materials				

4.2.1 *Supplier engagement in PSS strategy and delivery*

The theme of supplier engagement in PSS strategy and delivery refers to the supplier's level of involvement in defining the PSS strategy in partnership with the provider and their level of

participation in delivering the PSS. The level of supplier engagement was found to be markedly different for the two suppliers RepairCo and SysCo.

RepairCo reported that they have no involvement in the PSS strategy definition or delivery and stated that they saw no real changes for their company due to the PSS model. RepairCo receives repair orders and payments on the same basis for both PSS contracted repairs and standard contracted repairs. A RepairCo respondent reported:

“if we see a product in here whether it’s from a [PSS] or [traditional] agreement, there’s no difference”. [RSS2]

In fact the most significant change reported by RepairCo was that they have seen an overall reduction in their business with ManuCo as a result of ManuCo’s move towards offering PSS. This was reported as being due to ManuCo fitting new – rather than repaired - components at each service. RepairCo’s formation as a joint venture between ManuCo and one of ManuCo’s major suppliers does not seem to have resulted in a closer relationship between the two companies. A RepairCo respondent highlighted the conflicting incentives faced by RepairCo:

“[ManuCo] want [RepairCo] to give cost reductions. The Board of Directors want us to make more profit and 50% of those Board of Directors are from [ManuCo]. So what do they want?” [RSS2]

SysCo described a much closer engagement in the PSS delivery through their risk sharing partnership with ManuCo. A SysCo Manager reported:

“we had a share of [ManuCo’s PSS Offering] and depending on how successful that was in the market place we both would reap the rewards in the long-term”. [SS1]

SysCo had made significant up-front investment in supporting the design and development of the PSS and recognised that they had the opportunity to profit from its success. SysCo did identify some risks associated with their involvement in the PSS. Firstly, their dependence on ManuCo to recruit sufficient customers to achieve a return on their investment and secondly the uncertain cost of raw materials, which meant that their expenditure could change significantly after the pricing of the PSS has been agreed. The risk sharing partnership between SysCo and ManuCo has engendered a spirit of collaboration that was not observed in the RepairCo/ ManuCo relationship.

ManuCo’s Service Operations Director acknowledged ManuCo’s dependence on their supply chain to help successfully deliver their PSS offering. He highlighted a number of risks associated with these relationships including a fear of being locked-in to a particular component or system developed by a supplier. The risks included the potential exposure to high component costs in the aftermarket and dependence on a poorly performing supplier who could not be replaced due to the lack of an appropriate alternative because of the retention of Intellectual Property by the supplier.

4.2.2 Alignment of Incentives between PSS Provider and suppliers

This theme refers to the degree of alignment between the companies engaged in offering the PSS. Interviewees from all three companies made a substantial number of comments in this area. ManuCo reported that they saw benefits in developing relationships that result in aligned incentives with their suppliers. A ManuCo senior manager commented:

“...there’s an intent to try and get to partner with our suppliers on a win/win basis” [FF6]

He went on to acknowledge that this had not happened enough to date. One example of successful alignment described by ManuCo is of another supplier which now provides systems to ManuCo on a PSS basis. This arrangement is beneficial to ManuCo due to the incentive for the supplier to increase the reliability of their systems and also because of the transfer of risk to the supplier:

“it’s incentivising them to make [their products] more reliable.” [FF8]

Both ManuCo and SysCo reported that a key achievement of their risk sharing partnership was improved alignment of incentives for the two companies. A SysCo respondent commented:

“one of the key aspects to this was to align the two business models ... and improve service level, reduce costs, improve bottom line for both businesses”. [SS2]

SysCo respondents also observed that by better aligning their business models they have jointly improved service levels and reduced costs. One SysCo interviewee highlighted the closely aligned views between ManuCo and SysCo commenting that:

“Today it’s much more in our interest to stop the unit coming back in the first place and making it more reliable”. [SS1]

This illustrates the change of incentives for his company to prioritise reliability rather than viewing spares and repairs as a potential income stream.

Conversely RepairCo reported a lack of alignment between their business and that of ManuCo. One specific example cited by RepairCo was ManuCo's policy on whether to replace or repair worn and damaged components in their products. RepairCo's business model is sensitive to ManuCo's policy on whether to replace or repair worn components, which changes under the PSS model and RepairCo is concerned that this could lead to a reduction in business for RepairCo. Repair Co's Commercial Director stated:

“they want to sell new parts, we want to overhaul parts” [RSS2]

RepairCo did identify one benefit of the PSS model for RepairCo which was the stability and contractual agreements with ManuCo's PSS customers which allowed them to build up a pool of repaired components that could be used to provide much faster repair turnaround times for these customers. Overall, RepairCo had made a significant investment in a pool of spare components and saw this as a benefit in the reduced turnaround time for the repair of parts for ManuCo's PSS customers.

4.2.3 The Effect of PSS on Planned Business Developments

The theme of planned business developments refers to the organisations' future plans for developing their own business, whether related to the PSS or not. The planned business developments of the two suppliers reflected their differing views of the benefits of PSS to their organisations.

RepairCo perceived that the PSS model had a limited impact on their company, except due to the overall reduction in business from ManuCo. One of their employees commented:

“Over the past 2 years we have reduced [our level of business with ManuCo] by 10% and we’ve got plans to reduce it even further”. [RSS1]

Their focus for the future was on expanding their customer base for repair services, which meant identifying new customers, and reducing their dependence on ManuCo for business. They also stated objectives to expand their services from offering only component repairs to managing the repair of systems:

“our strategy is to be more of an integrator” [RSS2]

This highlights a desire to expand their capabilities and move ‘up the value chain’. RepairCo did not believe that developing their own PSS would be part of their future strategy.

SysCo identified potential business developments within the PSS area. SysCo were focussed on continuing and developing their participation in ManuCo’s PSS but also saw business opportunities to sell their own products as a PSS and had started to develop capabilities in this area. SysCo also saw benefits in developing risk sharing partnerships with its own suppliers, but recognised that it would be difficult for smaller suppliers to take on the risks associated with this, stating:

“some of the smaller suppliers they just can’t take on those sort of size of risks”. [SS1]

SysCo respondents also reported a potential risk that developing their own PSS offerings could put them in direct competition with ManuCo.

4.2.4 Information Sharing in PSS Delivery

Information sharing refers to the exchange of information between the PSS provider and their suppliers, encompassing the types of information that are exchanged and the effect of this information sharing on their business.

ManuCo reported that they believed that there was currently not enough information sharing inside their organisation. For example they cited the need to improve mechanisms to capture feedback relating to common component failure types back to design.

“There’s virtually no feedback whatsoever from the [maintenance centre] that tells the guys who manufacture the part... what the [part] looks like after it’s been [used] ” [FF2]

ManuCo also highlighted a concern relating to information sharing with the supply chain and a concern that although suppliers need more insights in ManuCo business they were currently not providing more business relevant information to the upstream supply chain.

“The straight answer is no! We do not convey data from condition monitoring upstream to our suppliers. I did not come across the situation that we would trigger spares or repair requirements from a data captured during product’s operation.” (FF6)

RepairCo reported that in order to play an effective role in supporting ManuCo in the provision of PSS they will have to have much greater insight into ManuCo’s strategic as well

as operational decisions. However the mindset of more open information sharing with upstream suppliers is still rather the exception than the rule in ManuCo. This asymmetrical transparency is problematic for suppliers because they cannot effectively plan for future changes in demand from ManuCo.

“We don’t receive any forward planning or strategy of roles going to their market place and trying to win more customer business into [the PSS offering]. We read it in the newspaper.” (RSS1).

“For me, I think where we don’t get a view of and I think it would be important the bigger view around [ManuCo’s] relationship with key customers, which at our level we don’t see. So we don’t know what the key customers are pushing back and saying to [ManuCo], you know, these are the real concerns, so we don’t have the opportunity to say, well we can help you with some of those concerns, you know, we are almost taken away from that party.” (RSS2)

SysCo are more closely involved in the overall PSS delivery, but also highlighted a number of opportunities for improved information sharing which could streamline their partnership with ManuCo and remove duplication. A SysCo interviewee expressed frustration that ManuCo were sometimes not open to proposals from SysCo to work together and increase efficiencies.

“If they would provide us more information on their sustaining engineering bills, their modification bills, that would enable us to manage the risk. We would still face the problem

but we could manage it, we could be more proactive than reactive than when we get faced with the bill.” (SS3)

4.2.5 Overall Lifecycle Considerations Related to PSS Delivery

The lifecycle considerations relate to how well the companies are able to understand the complete lifecycle of the PSS and issues associated with evaluating costs/ risks across the lifecycle. ManuCo explained that by moving to the PSS model they have had to make a major shift in their organisation from a manufacturing mindset to whole lifecycle view. The Service Operations Director commented:

“now our business model’s changed; we make it once but we repair it four or five times”.

[FF1]

ManuCo now experience maintenance as a cost to their own company instead of a cost to their customer and this has significantly changed their view of maintenance management.

One example of the difficulty of achieving this lifecycle view is the need to trade-off the cost of replacing worn components against the cost of repairing them; taking into account the full lifecycle costs including the value of the raw materials and the time taken to repair. Two ManuCo interviewees presented differing views on whether it was more cost effective to replace or repair worn components. The view from Manufacturing Operations was:

“we’ll manage them by fitting new parts: it costs cheaper”, [FF2]

Whereas the Service Operations view was that:

“world economics force you to think differently and [with] a large [component], you are not going to throw [it] away with the amount of material value”. [FF1]

RepairCo respondents also presented views on ManuCo’s decisions about whether to replace or repair worn components. Their major concern is that they believe ManuCo’s decisions on whether to replace or repair worn components are being made on the basis of a limited evaluation of the whole lifecycle costs. RepairCo’s Operations Manager stated:

“[ManuCo] are throwing away material that’s repairable” [RSS3]

RepairCo believes that ManuCo are not incorporating all of their internal costs into the lifecycle cost analysis which means that some repairs could be viewed as less competitive than they actually are.

SysCo respondents also believed that ManuCo has difficulties in measuring the entire lifecycle costs of the PSS. In particular they commented that it would have been very difficult to fully understand the lifecycle cost of the PSS at the time the contract was negotiated and that this could expose them to future risk if the initial estimates prove to be inaccurate.

5 Discussion

This paper has presented a detailed investigation into the delivery of a Product Service System by a large manufacturer and two of its suppliers. Whilst it is difficult to generalise from a single case, the results have identified some interesting characteristics of network relationships which provide an increased understanding of the delivery of a large, complex

PSS by a supply chain and will help to inform future research. The discussion is presented in three sections: the first section provides a review of the results in the context of the PSS literature, then the following two sections provide a more detailed discussion of the two strongest themes from the case results: the **need for incentive alignment** and **effective information sharing** in PSS supply networks.

5.1 Comparison of Research Findings with PSS Literature

- i. PSS is “*an excellent vehicle to enhance competitiveness*” (Tukker, 2004: P246). Our results have shown that the proclaimed benefit of PSS to enhance competitiveness may not be necessarily achieved by companies in the PSS supply chain. The case results show markedly different attitudes to the Product Service Systems model between the two suppliers that were studied. It is clear that SysCo (which has a risk sharing partnership with the PSS provider) has much greater investment in, and support for, the PSS than RepairCo which is not a partner in the PSS. Even though RepairCo is a ManuCo joint venture company it has seen very limited benefits from the PSS business model, and in some respects it has had a negative impact on their business and led them to expand their business in other areas.
- ii. PSS can help “*promote sustainable patterns of consumption*” (Mont, 2002: p. 240). In our research we found that the PSS business model had actually reduced the number of repairs performed during the product’s lifecycle and encouraged a policy to fit new components, even though this is a less sustainable solution. This is contrary to the expected environmental benefits of PSS, and highlights the difficulty of achieving a whole lifecycle view of a PSS across a supply chain. It would be interesting to undertake a more detailed investigation into this outcome to determine whether this is an isolated instance, or whether a similar pattern is seen in other large, complex, PSS.

- iii. PSS can *“improve relationships with consumers because of increased contact and flow of information about consumers’ preferences”* (Mont, 2002: p 240). Whilst relationships with the consumer may be improved by PSS, relationships and information flow are not necessarily improved with the upstream supply chain. All of the respondents recognised the importance of sharing information through the supply chain, and both suppliers expressed frustration at their lack of input into the PSS provider’s strategy. ManuCo’s reluctance to share information with the supply chain may be in part due to their concern that the intellectual capital for their PSS is being distributed through the supply chain. This is in accord with Cook, Bhamra and Lemon’s (2006) findings that organisations may be reluctant to outsource services due to the risk of knowledge leakage to third parties. ManuCo also identified a related risk that they may become locked-in to particular suppliers, even if those suppliers do not perform well.
- iv. *“A manufacturing company [implementing a service strategy] should consider the collaborative option, meaning forming partnerships with potential competitors”* (Matthieu, 2001: P466). The case study identified that there is increased complexity in customer and supplier relationships due to the PSS model. In the studied case the PSS provider had a mix of PSS and traditional customers, and some of their customers purchased a mix of PSS and traditional offerings. Furthermore, one of the PSS suppliers acts as a PSS provider for their own PSS offerings, sometimes selling to the same customers as the PSS provider. Our findings are in alignment with Mathieu’s view that service providers can benefit from partnering with potential competitors, but will also need to manage the risk of finding themselves in direct competition with their partner. For any PSS delivered by a large supply chain this complexity in customer relationships will be a challenge for the future.

- v. “*Product pooling*” Tukker (2004: P. 249) is proposed as an archetypal PSS business model. In our case study both suppliers have invested in a pool of repaired components that can be supplied to any PSS customer and reduces the turnaround time for repairs. Even though RepairCo is not contracted to supply services to ManuCo on a PSS basis, they have still benefited from the PSS business model in this regard. This benefit has been achieved due to the ongoing contractual relationship between the PSS provider and its customers (in which the customers agree to accept components from a repaired pool), and perhaps also due to the increased stability in the demand for repair services achieved through implementing a PSS business model.

The two strongest themes identified through the case study were the need for incentive alignment between a PSS provider and their supply network and the need for information sharing through the network. These topics are discussed in more detail in the following sections.

5.2 The Need for Alignment of Incentives across the Supply Network

The need for incentive alignment provides a strong theme throughout the case data. PSS is not unique in this regard, and it is clear that there is a need for companies to align their incentives in all supply chains (Lee, 2004). However, the alignment of incentives is more challenging in a PSS environment, because the supplier takes on risk from the customer and may wish to further transfer some risk to its own supply chain. ManuCo has successfully achieved incentives alignment with SysCo through their shared investment and profit from the PSS. However, despite RepairCo being part owned by ManuCo, there is only limited incentive for them to invest in, and reap the rewards of the PSS. In fact there is a conflict of

interest between RepairCo's desire to undertake more repairs, and ManuCo's policy to fit new components.

The observation that RepairCo did not realise an increase in business due to the adoption of the new business model indicates that ManuCo had made decisions without consulting their supplier. By fitting new components ManuCo ensured that the asset was always returned to an 'as new' condition. Moreover, ManuCo ensured the ongoing utilisation of capacity at its own manufacturing facilities. This choice also impacted the profitability of the offering because new components were more expensive than refurbished and potentially had an impact on the success of RepairCo, a joint-venture organization. There would also be the environmental impact of discarding components that were repairable. If the incentives had been aligned with members of the supply chain from the outset then these trade-offs would have been avoided. The need to align incentives across the supply network can be seen as an extension of Stoughton and Votta's (2003) conclusion that the incentives of the PSS provider and customer must be aligned for a successful PSS.

5.3 The Need for Effective Information Sharing

Whilst ManuCo changed their attitudes, behaviours and information sharing routines on the customer-facing side of the organization, the change on the supplier-facing side was rather limited. This was manifested in ongoing tensions between ManuCo and its two suppliers as a result of a mismatch between expected and actual levels of information exchange. Both suppliers perceived an increase in levels of information exchange as a necessary condition to effectively support ManuCo's PSS offering. This observation corroborates the link between the adoption of PSS business models and the need for more intensive information exchange between key members of the supply chain. For example, Johnson and Mena (2008) and Wuyts *et al.* (2004), all showed that in technology and knowledge intensive environments

higher levels of information exchange are required for effective support of complex integrated offering.

The adoption of the PSS model will not only require changes in levels of exchanged information, but also in the nature of relationships between the actors in the network. Information sharing and the relationship nature, however, are part of a mutually reinforcing circle. Namely, closer and more collaborative relationships will likely involve higher levels of information exchange, and higher levels of information exchange will breed more collaborative relationships (Hakanson, 1982, Anderson and Weitz, 1992). The evidence from the case companies showed that the nature of relationships between ManuCo and its two suppliers did not really change. As relationships stayed largely unchanged so did the information sharing routines. For example, both suppliers were concerned about the lack of information sharing from ManuCo in order to understand and consequently respond to ManuCo's operational and strategic decisions that directly impacted their business.

ManuCo should recognize three things. Firstly, that if they require suppliers to support their PSS offering they should enable them to have the access to relevant information. Secondly, that higher levels of information exchange will necessitate changes in the nature of relationships between supply chain actors. Thirdly, and finally, that information exchange and the nature of the relationship (i.e. arms-length or partnership) are mutually reinforcing. As Helper and Levine (1992) and Zajac and Olsen (1993) suggest, the exchange of services related information (i.e. know-how) is more easily employed through partnering type relationships characterised by trust, commitment and mutual adaptations. This is because information needs to be effectively exchanged between parties.

6 Conclusions

This research has undertaken a detailed investigation into a supply network delivering a complex PSS and provides a foundation for future research into PSS supply networks. The key conclusions drawn from the research are:

- (1) The proposed benefits of PSS are not necessarily achieved by the extended supply network. Our results have shown that the adoption of a PSS business model can have a negative effect on companies in the supply chain if the suppliers are not well integrated into the PSS delivery. Customer/ supplier relationships in supply chains delivering PSS may become extremely complicated, with companies playing multiple roles in the supply network.
- (2) The alignment of incentives between a PSS provider and its suppliers is important for a successful PSS but can be difficult to achieve due to the differing objectives of each company. Furthermore, the transfer of risk in PSS delivery makes incentive alignment more difficult to achieve than in a traditional supply chain. In our case study we found it was not sufficient for the PSS provider to develop a formal relationship with a supplier for the delivery of PSS, they also needed to align the profit incentive between them to achieve a successful partnership.
- (3) Effective information sharing across the PSS supply network is essential for a profitable and sustainable PSS, but this can be very difficult to achieve in practice, particularly if the PSS provider is concerned about knowledge leakage into the supply chain.

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Figures

System Supplier (SysCo)

No. of employees

10,000+

Turnover

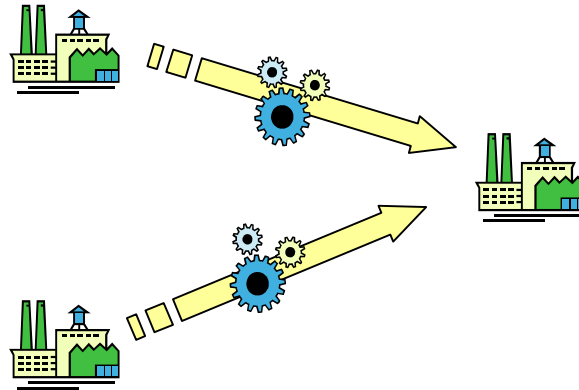
£2bn +

Role in relationship:

Supplier of systems, parts and services.

Business model:

Risk and revenue sharing partner.



Repair Service Supplier (RepairCo)

No. of employees

100+

Turnover

£10mn +

Role in relationship:

Joint venture, supplier of repair services.

Business model:

Payment per repair.

Focal Firm (ManuCo)

No. of employees

30,000+

Turnover

£5bn +

Role in relationship:

Focal firm, provider of high value manufactured products and services.

Business model:

Provider of both PSS and 'traditional' contracts.

Figure 1: Structure of the supply chain investigated.

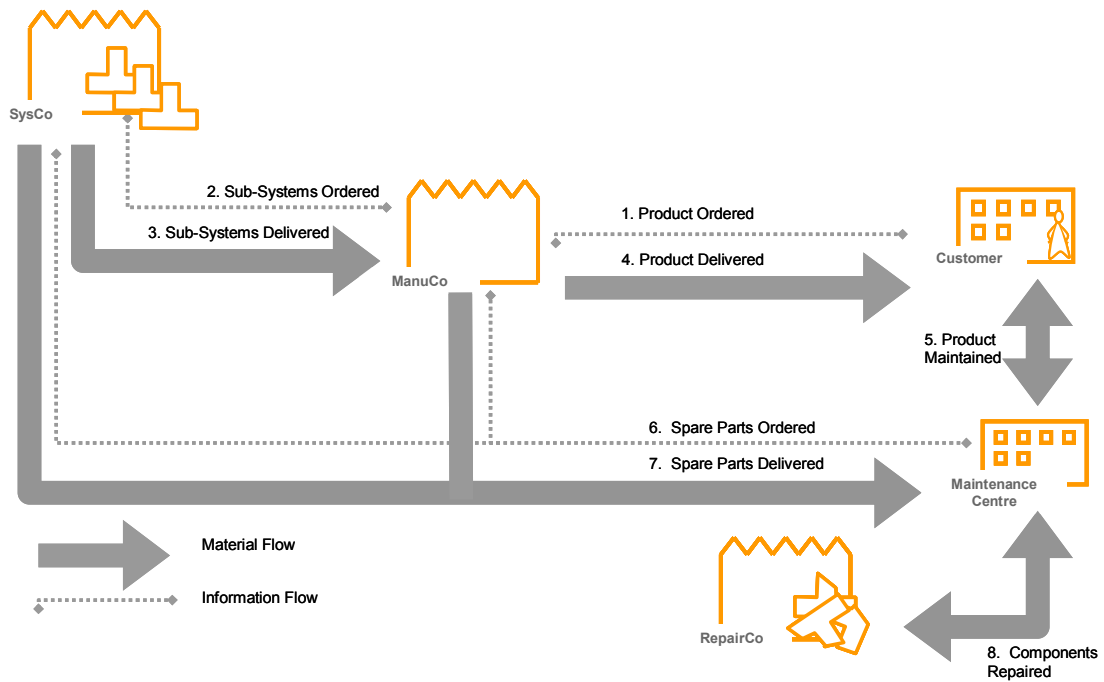


Figure 2: Flow of Material and Information within the Traditional Supply Chain.

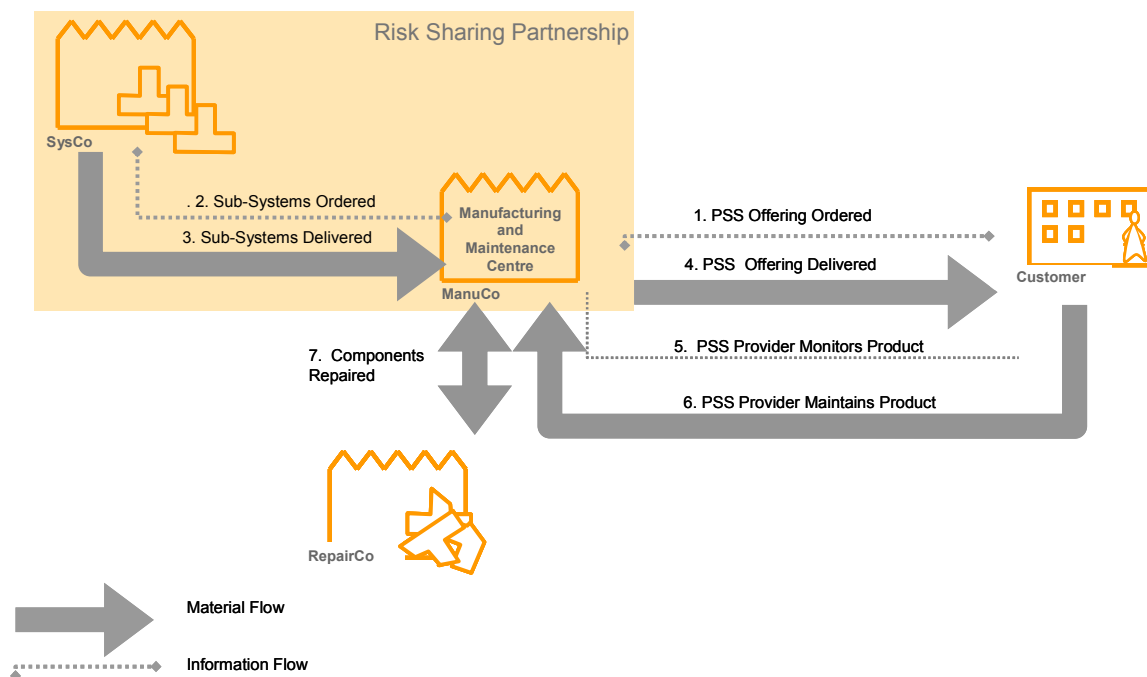


Figure 3. Flow of Material and Information within the PSS Supply Chain.