

Implications of the Transition to a Product-Service System on the Business Model

Aurora Dimache¹, Thomas Roche¹

¹ Dept. of Mechanical Engineering, School of Engineering, Galway-Mayo Institute of Technology, Galway, Ireland

Abstract

Product-service system (PSS) is a very complex concept that involves multiple aspects (e.g. business, environment and design). PSS have the potential to reduce the adverse environmental impact of manufacturing while simultaneously gaining economic benefit. When competition on the basis of price, time, quality, flexibility or environment has become insufficient for the success of a company, the adoption of a PSS business model can have a beneficial impact on company competitiveness. However, the shift from product to product-service is a major strategic decision which not only has implications on some of the classical components of a traditional business model, but other elements should also be taken into account. The authors approach the PSS business model from this perspective and identify two new components in addition to the traditional ones: business strategy as the driving force for all the other elements, and sustainability, because PSS are believed to have the potential to reduce the environmental burden.

Keywords:

Product-service systems (PSS), business model, sustainability, design, cost

1 INTRODUCTION

Today's global manufacturers are experiencing enormous competitive pressures. Traditional competitive dimensions such as time, cost, quality, flexibility or environment (1) are no longer sustainable for highly competitive organisations. Being first to market is no longer a valid competitive differentiator due to the innovative capacity of global competitors, coupled with the rapid pace of change in the marketplace. Cost is no longer a competitive advantage either, largely because of higher cost of manufacturing and market saturation, therefore reduced customer value. With all companies committed to delivering high quality products, quality is expected by customers; it is no longer regarded as a key differentiator in the marketplace. In a similar fashion, environment and flexibility are no longer competitive differentiators. Consequently, companies are increasingly looking for new dimensions on which to compete in the marketplace. One such dimension is based on service.

However, the transition from a product manufacturing company to a services providing one is difficult. Companies that are making this change more rapidly are likely to achieve enhanced foothold in the marketplace. This paper aims to point out the issues that have to be reconsidered when approaching a PSS business model, i.e. product design, customer relationships, supporting infrastructure and associated costs and benefits. PSS are believed to reduce the environmental impact, therefore a new dimension must be added to the business model – sustainability. The paper commences with a brief presentation of the PSS concept; next the PSS business model's components are addressed and conclusions drawn.

2 PRODUCT-SERVICE SYSTEMS (PSS)

PSS is a powerful concept because it takes a more holistic view of competitiveness on the basis of time, cost, quality, flexibility and environment, achieving more effective use of resources and lower environmental burden, and delivering higher performance than traditional products (2), (3), (4).

There has always been a link between products and services. It is generally accepted that a physical product is a tangible commodity (5), while a service is defined as any activity offered by a company that is intangible and does not result in the ownership of anything (6). A product-service ranges from the delivery of a tangible product with subsequent services (e.g. car plus maintenance) to the delivery of a service using the tangible product as medium to deliver that service (e.g. mobile phone), i.e. the core of the offering ranges from tangible (product) to intangible (service). If for physical products and services there are clear definitions, PSS have been defined in various ways. Some authors define PSS from an environmental perspective, regarding PSS as a way to enhance sustainability – e.g. 'systems of products and services that are developed to cause a minimum environmental impact with a maximum added value' (7). Other authors define PSS from a business perspective. For example, Goedkoop *et al.* define PSS as 'marketable set of products and services capable of jointly fulfilling a user's need' (5). Others see PSS as a functional business model centred on customers' needs (8), (2) or as a result of an innovation strategy (9).

In the authors' view, PSS is a specific business concept that focuses primarily on customers' demands and is meant to provide customers with all the benefits (functionality, utility, self-esteem) of the product without necessary ownership of

the product, while being less harmful to the environment. PSS is therefore a complex concept that requires multidisciplinary approaches: management, economics, sociology, psychology, engineering, design and environmental studies (10). In this paper the following definition of PSS was adopted: 'a system of products, services, supporting networks and infrastructure that is designed to be competitive, satisfy customer needs and have a lower environmental impact than traditional business models' (11).

2.1 Contribution of PSS to business competitiveness

In the competitive environment of the twentieth-twenty first century, research has shown that innovations in competitive strategy have life cycles of ten to fifteen years (12), (1). This is due to the fact that, in general, as soon as an organisation has found a competitive advantage, its competitors struggle to understand the nature of this advantage and eventually emulate it, so that the competitive advantage soon becomes obsolete and a new innovation must be found. PSS is an innovation that contributes to business competitiveness because of the following:

1. *PSS attach additional value to the customer* because:
 - They can generate additional value to products by offering additional services, including upgrading, refurbishment, take-back.
 - They permit to tailor products to the customers' needs.
 - Consumers benefit from various combinations of products and services, various payment schemes and use schemes that suits them best.
 - The responsibility over the product life cycle which comes with product ownership is taken from customer.
 - PSS drive increased flexibility and better quality by use of innovative technology, an orientation to customer needs and customised offerings.
2. *PSS lower the total life cycle costs* because:
 - They can contribute to attaining economies of scope due to the phenomenon of related diversification.
 - Products are used more efficiently and intensely (e.g. in leasing or renting).
 - The manufacturer has the responsibility of the total life cycle cost and therefore has the incentive to optimise it.
3. *PSS improve the company position in the value chain* because:
 - Within a PSS, deeper relationships are developed with the customer and increased flow of information about its preferences is obtained, which leads to higher customer loyalty.
 - Manufacturer is involved in activities that used to be down in the value chain and which have higher profit margins than manufacturing.
4. *PSS lower the impact on environment* because:
 - They have the potential to decrease the amount of products on the market (e.g. by leasing, renting, sharing) thereby contributing to reduced material and energy consumption, reduced impact during use phase and less waste.
 - When they own their products, manufacturers become more responsible over the entire product life cycle, meeting legislative obligations for take-back and

treatment of waste products (reuse, remanufacturing, recycling).

3 BUSINESS MODELS

A business model shows 'how a company makes money' (13). A good business model is essential for the success of a company. It is a framework that describes the method of doing business, considering two areas of activities (14): activities associated with producing something (e.g. design, manufacturing, purchasing) and activities associated with selling something (e.g. finding customers, distributing products/delivering services). The elements that make up a business model can be summarised as follows (13), (15), (16):

- The offering or value proposition (the actual product or service).
- The cost structure and revenue model.
- The market segment to which it is addressed.
- The value chain necessary to create and distribute it.

Considering the definition of a PSS in section two as well as the components of a business model defined above, it is clear that PSS can be conceptualised in terms of a business model approach. However, putting a product-service on the market instead of a physical product only, changes the traditional value proposition which might have implications on the other components of the business model. That is the reason why the authors propose a detailed description of a PSS business model.

4 IMPLICATIONS OF THE TRANSITION TO PSS ON THE BUSINESS MODEL

The authors believe that the shift from a product system to a product-service system not only has implications on some of the classical components of a traditional business model, but other elements should also be taken into account. This section describes the issues that have to be given full consideration when approaching a PSS business model.

4.1 Business strategy

Whilst the terms strategy and business model are often used interchangeably (14), they are not the same thing. A business model is more than a business strategy. A business model provides a detailed description of how to do business and all the elements that contribute to the success of a company. The authors view the business strategy as a component of the business model, probably the most important, as it is the strategy that drives the other elements of the business model.

Strategy includes the formulation of a vision for the company and a set of strategic decisions related to the company's relationship with the industrial environment, whilst also developing the capabilities and competencies inside the company that sustain a competitive advantage (13). The shift to PSS is a strategic decision that is made at the highest managerial level. It requires managerial vision for innovation, to recognise new opportunities in product-service mixes which add value to a product life cycle, and an innovative organisational culture capable of promoting new internal organisation and external partnerships (9). Therefore, when a company decides to make the transition to PSS, its business strategy must be revised. This entails a detailed and critical analysis of the business environment and the organisation's

internal resources and capabilities. This analysis offers scope to answer the following questions: where to compete, how to compete, how to grow. In today's age of globalisation, rapid advances in the development of information and communication technology and the threat to the environment, the challenge to organisational strategy is to align production with the complex and diversified market demand. This requires a shift from the production of goods to the provision of PSS. Once the business strategy is developed, the other elements of the business model can be defined.

4.2 Value proposition: product-service

One of the most important components of the business model is value proposition – the support that makes the delivery of functionality possible: product, service or product-service. If the nature and characteristics of the product/service are not clearly defined, it would be impossible to quantify costs, decide on pricing or distribution channels.

Product typology

The designation of a product typology from a PSS perspective can support the definition of the other components of the business model. The product typology can also serve as a support to decision-making when considering the transition to PSS in the case of product manufacturing or the upgrade of the business model to a superior type of PSS in terms of service content. The product typology developed for this purpose is shown in Figure 1. Eight dimensions are considered to be of importance within this typology: tangibility, product complexity, type of user, product ownership, product durability, innovation, production process, customer involvement.

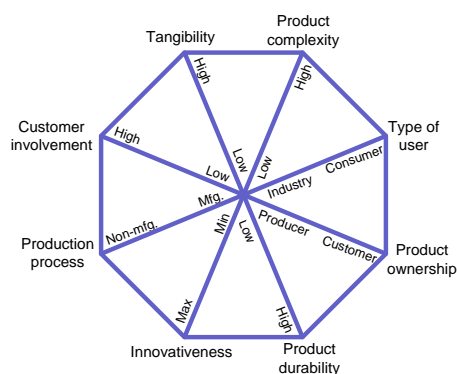


Figure 1: Product typology framework.

Tangibility – the proportion of tangible-intangible component in the product offering is important for the classification into product, service or product-service mix. A higher service proportion can be beneficial both for the success of the company and the environment.

Product complexity – the complexity of the bill of material: number of levels and number of constituents. Product complexity is an important characteristic that determines the capability of product recovery at the end of life. Product complexity plays an important role in product design, product reliability and serviceability, and in the design of the supply chain.

Type of user – a large difference exists between the needs of companies and the needs of individuals. First of all, companies are more likely to buy in large quantities. They may also require more types and more sophisticated

services; therefore the product-service package for companies might differ in terms of service content, design, marketing and delivery channel.

Product ownership – is an important characteristic in determining the category of PSS to which the manufacturer belongs. A product can be offered to the customer only as a support for delivering the service (e.g. car pooling), the physical product still being owned by its producer.

Product durability – durable products that can satisfy a certain need for a long period of time (e.g. cars, machine tools) are suitable for PSS, in comparison to fast-moving consumer goods (e.g. food, refreshments) which are consumed once. Product durability is closely related to product reliability, maintainability and serviceability when it comes to the decision of adding services to the offering.

Innovativeness – the degree of innovativeness of the product or service has large implications on all of the other components of the business model. A minor change of the existing company's product or service will have a lower impact on the design, supply, delivery and marketing of the product than a totally new product or service.

Production process – a company may perform manufacturing operations to produce tangible products or non-manufacturing operations. Even the non-manufacturing operations may deal with tangibles, although not producing them (e.g. wholesalers), while other non-manufacturing operations are concerned with projects (research or software projects) or pure intangibles (e.g. health care).

Customer involvement – the level of interaction with the customer and the level of customer involvement in the actual creation of the product/service is very important in PSS.

Defining the product type is the most important step in building a PSS business model. The value of each dimension within the product typology indicates a certain approach to the other business model components.

Product life cycle

From a marketing perspective, product life cycle is conventionally divided into four phases: introduction, growth, maturity and decline. Another perspective on the life cycle is the product perspective – see Figure 2 – which permits the product life cycle to be viewed both from the producer perspective (the upper part of the diagram) and the user perspective (the right side of the diagram – the cost of ownership).

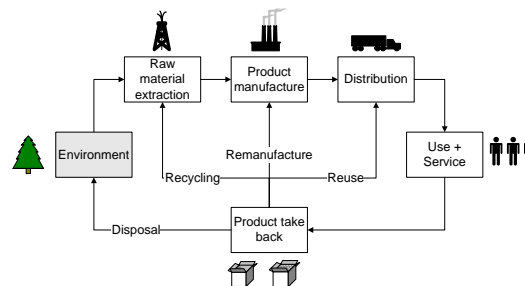


Figure 2: Product perspective on life cycle, after (17).

The authors believe that the product perspective of the product life cycle is the most appropriate perspective in the context of PSS. The product life cycle offers many opportunities to reduce cost or to increase the utilisation and effectiveness of products during the use phase whilst at the

same time offering the possibility of exploring new and potentially successful business areas at various life cycle phases. New methods to manage products over the entire life cycle have emerged. Life Cycle Management (LCM) is an approach to organising the product life cycle which considers the product life cycle in a holistic manner and aims to achieve maximum product performance (18). LCM has a crucial role to play in the transition from product manufacturing to product-service systems as it organises the interaction between various players in the product life cycle using various methods and processes with the aim of minimising overall cost and maximising benefits, while also minimising environmental impacts through maximised functionality (18), (19). Product LCM perfectly matches the idea of *sustainability* as LCM offers a number of methodologies to assess various aspects of the product over its life cycle such as life cycle evaluation, design for life cycle, life time management and product life cycle management (18).

Product-service design

Product-service design requires a good understanding of how the physical product and additional services are combined to create the offering that meets the customers' needs. With respect to the design of product-services, the following principles apply:

- A new design reference: from product design to *function* design (20). As Komoto *et al.* say, "PSS design is to find a mapping between activities in a service environment and value, which is similarly observed in the relation between behaviour derived from the structure of a product and function requirements in product design" (21).
- The extension of the design sphere from product design to life cycle oriented product-service design. Since services can be offered in addition to products during the entire product life cycle – during purchasing (e.g. sales counselling), use (e.g. maintenance) or end of life (e.g. take-back) – manufacturers become responsible for the integrated life cycle design of both physical product and additional services (22).
- The extension of the design area from product to product-service implies a cultural change in the design perspective and requires new competencies (socio-economic, managerial) in addition to old competencies (technological and cultural) (23).

PSS require a re-thinking of the nature and role of products and therefore a new approach to design. Product-service design is a complex area that requires a multidisciplinary approach and new competencies for designers.

Product reliability

Two important performance characteristics that are considered during functional design are reliability and serviceability. As businesses move from offering products to offering product-services, the importance of product reliability and accuracy of reliability prediction increase as the producer assumes the financial risk.

The motivation for reliability improvement is driven by the cost of unreliability. Higher reliability reduces the cost of unreliability. However, an increase in reliability means an increase in design and manufacturing costs. Kimura *et al.* consider that the choice of realising either (a) products with high reliability and long life (but with expensive resource

usage) or (b) products with moderate reliability and life (but with less resource usage) is a critical design decision (24). From a life cycle cost perspective, there is a reliability level (called *optimum reliability level*) which gives a minimum life cycle cost (see Figure 3).

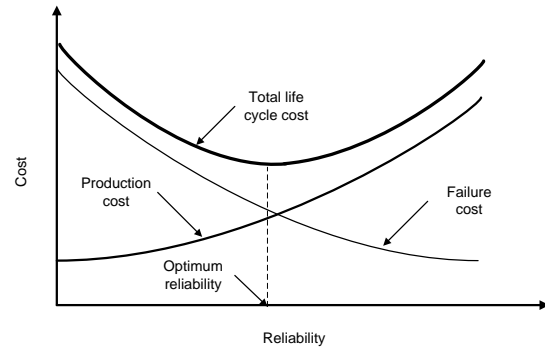


Figure 3: Total cost and optimum reliability, after (25).

Figure 3 shows that purchasing products having low acquisition cost may result in high failure and maintenance cost (left side of the diagram) whilst the purchase of products with higher initial cost will incur lower failure and maintenance cost during the use phase (right side of the diagram). Therefore, maintenance and unreliability costs can drive product demand. The diagram in Figure 3 is created for a physical product. The optimum reliability might change in the case of product-service systems. When manufacturers have the ownership of a product and have extended life as a goal, optimum reliability might move to the right of the diagram in Figure 3, with a lower life cycle cost.

Reliability and maintenance cost

The cost associated with maintenance tasks can be quite high. It is estimated that maintenance cost can be between 10 and 40% of the total operating expenditure (26). As a result, the area of maintenance has gained a lot of attention due to its potential in extending the life of a system, maintaining reliability, reducing the consequences of failure and, in fact, reducing the maintenance cost and, therefore, the overall life cycle cost.

Preventive maintenance actions are carried out in order to reduce the likelihood of failure or to extend the life of a product. For products that become obsolete in short time (such as computers, electronics) it is important to reduce the likelihood of failure, whilst for products that are not overly influenced by technical progress, the main target is extending the life in addition to upgrading the product, thereby increasing the product value (27), (18) (see Figure 4).

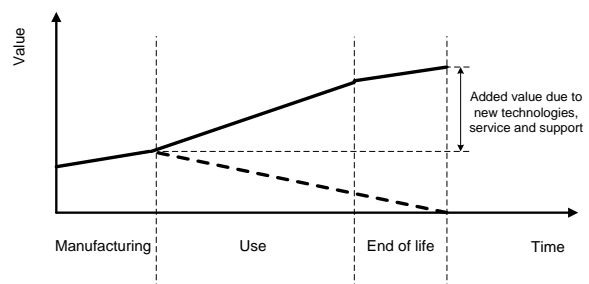


Figure 4: Value creation during product life cycle, after (18).

Although preventive maintenance has many advantages (e.g. preventing accidents, faults), it can be too expensive if components are replaced without an evaluation of their reliability. When it is possible to predict the time of failure and the failure rates, repair work can be scheduled before functional failure, thereby ensuring minimum disruption in the product's operation (26).

4.3 Cost/revenue

An important measure for the transition to PSS is life cycle cost (LCC) (28) which includes the costs of services and the end of life strategy (as no matter how good a product may be from an environmental perspective or how appealing the service may be, the product must be economically affordable). LCC permits an estimation of the total life cycle cost early in the design stage. It is well-known that 70-80% of the product cost is committed at the early design phase (29), (30). For example, cars fuel consumption is largely determined at the design stage and the recycling cost is also influenced by the decisions made at the design stage (e.g. choice of materials). Other high costs can appear during product use phase such as maintenance costs, due to lack of consideration of reliability and maintenance at the design stage.

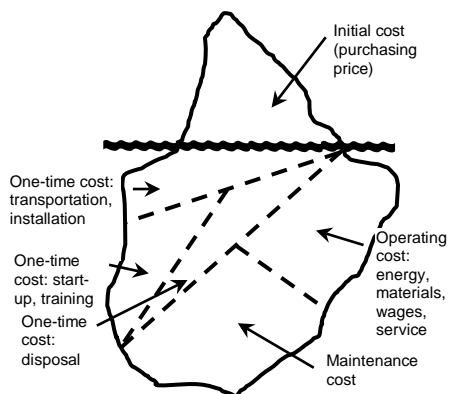


Figure 5: Iceberg life cycle cost, after (31), (32).

Life Cycle Costing (LCC) is a methodology that can be used to optimise the trade-off among all costs incurred during a the product life cycle (the costs of design, planning, installation, production, marketing, support, maintenance and end of life treatment – see Figure 5), to obtain the minimum total life cycle cost of the product (33). When manufacturers are considering the addition of services to their offering, they may be interested in LCC estimation, as costs can be controlled when committed, they cannot be minimised afterwards.

Revenue

Price produces revenue; therefore pricing decision is very important especially in the context of today's complex and dynamic markets, globalisation and ICT development. Pricing strategy is founded on three key elements: cost, competition and value to the customer (34). In today's market low prices rarely provide a sustainable basis for competitive advantage due to the international competition from countries with low labour cost. Customers are not interested in the cost to produce a product or the cost to deliver a service. They pay for its value to them. Price has a meaning to customers only relative to the benefits they get. A company can differentiate its products by offering additional services to their tangible

products, thus providing more benefits (more satisfaction) to the customer at a small increase in price – see Figure 6.

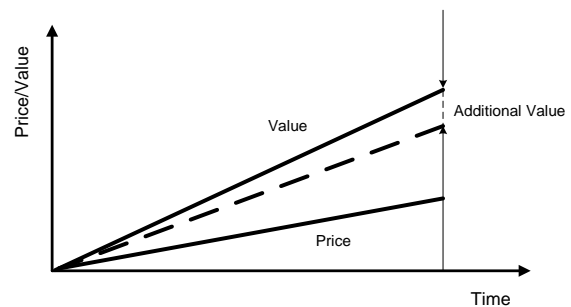


Figure 6: Creating additional value for customers.

In addition to the traditional pricing methods, Revenue Management (RM) (35) comprises a collection of methods, techniques and concepts aimed at maximising expected revenues or profits. RM is likely to be beneficial when a company decides to adopt PSS. Customers value the product-services mix differently, they have preferences for different additional services, therefore there is a potential to exploit this heterogeneity to improve revenues. Product demand can vary over time, which makes demand-management decisions difficult. Offering additional services (e.g. maintenance services) eliminates this problem because it lessens the effect of cyclical markets by strengthening the recurring revenue. For some products (mainly luxury goods) price is a sign of quality and in this case manipulating the price may damage the product status. Therefore RM is more suited to products/services for which price is not a status symbol – where price and quality are not associated. For example, customers may not have quality preferences among suppliers of car inspection services. Small differences in price, location and availability may outweigh the quality of the service.

4.4 Market segment

Customers in a market are not homogeneous. They differ in needs, size, the quantity they buy and the price they are willing to pay. As a single product or service cannot satisfy all customers, companies segment the market and address each segment with a customised offering. In order to do that, the characteristics of the customers and product must be identified and matched. PSS permit an organisation to tailor its products to the customers' needs, thereby providing better solutions for each segment. At the same time, segmentation permits identifying unexploited opportunities, effective communication, price raise and enhanced profits (36), (37). In a product-service system, the manufacturer is involved in activities that used to be up or down the value chain and which are more profitable than manufacturing. In this case *vertical segmentation* or *profit pool mapping* (37) – a technique for analysing the vertical structure of profit – can be of use. With this technique profit is estimated for each activity in the range of value-adding activities.

Addressing the right product-service mix to the right customer is only the beginning. The real challenge lies in building a relationship with the customers. In the new economy products will not matter as much as the producer-customer relationship (38). As Peter Drucker stated, the aim is 'to understand the customer so well that the product or service fits him and sells

itself' (39). Especially when offering services, it is difficult to separate delivery from relationship building. An important role in building good relationships with the customers is to have good and effective bidirectional communication and information exchange. Active information exchange will result in a better understanding of the customers' needs, product and process innovation, customised offerings and long-term value of the company.

4.5 Value chain

When a company has to decide on the transition to a product-service system, it is important to ascertain where its products are located in the value chain. The value chain analysis permits the evaluation of the company in the context of the overall chain of value-creating activities and offers a vision of the possibilities of moving downstream and upstream along the value chain – vertical integration (37). A generic value chain for a manufacturing company proposed by Porter includes (40): primary activities that start with inbound logistics (raw materials handling), continue with manufacturing processes, marketing, sales and after-sales services that enhance the product value. These activities are supported by the organisational infrastructure, human resources management, purchasing and technology development which ensure the efficient and effective operation of the primary activities.

The examination of the primary and supporting activities can help managers decide which activities can be undertaken by the manufacturing company to enhance its competitive advantage. As services tend to provide higher marginal utility than products (36), manufacturers can focus on activities down the value chain such as transportation, maintenance, take-back. They can take over functions provided by other firms or create partnerships with buyers. Vertical integration can help organisations in developing distinctive capabilities in different independent vertical activities. It allows for flexibility but involves the strategic management of different businesses and represents a compounding risk as problems at one stage in the life cycle can influence other stages. To avoid the disadvantages of vertical integration, the company may choose to form relationships with other companies, each contributing value in the network of companies, thereby increasing customer value and also enhancing profitability of the company: costs may be cut, quality of product/services increased, delivery time reduced, overall business performance improved.

4.6 Sustainability

There are various opinions regarding the benefits of PSS for the environment. Some authors consider that PSS has the potential to reduce the environmental load by:

- Increased resource productivity through using new technologies and/or new organisational models thereby contributing to dematerialisation (19), (41).
- Preventive maintenance and upgrade services that contribute to product's physical and functional life extension and closed loop manufacturing (42), (43).
- Lowering the level of material use in lease/reuse systems, thereby contributing to waste reduction (44).
- Re-orienting current unsustainable trends in consumption practices (9).

However, many authors doubt that PSS are more sustainable than physical products. The argument brought by these

authors is the 'rebound effect' – total consumption increases faster than environmental efficiency (44) – and it is concluded that PSS are not 'inherently environmentally superior to traditional products' (45), (2). Some other authors suggest that the sustainability potential of PSS should be analysed by types of PSS or even on a case-by-case basis (8), (42).

The authors believe that PSS have the *potential* to reduce the environmental impact by stimulating creativity and innovation in the way of doing business and encouraging companies to find solutions for environmental improvements while gaining economic benefits. Therefore a new dimension of the business model is proposed: sustainability. The sustainability potential of the product-service can be assessed and used as a competitive advantage. Companies who offer the product-service have the incentive to produce or use efficient product-services (as they are paid by the result) and to extend the product's lifetime (when they remain the product's owner). For example, a company who offers machine washing services would use reliable and energy-efficient washing machines as it would be interested to use these machines for a long time and to have as low a usage cost as possible. The use of laundry services involves other benefits for the environment as well. These include the reduction in the stock of washing machines needed to satisfy demand and, therefore, a reduction of the amount of materials consumed in manufacturing, as well as the energy consumed during the delivery, operation and disposal of the washing machines.

4.7 The PSS business model

This section has discussed the implications of the transition to a PSS on each component of the traditional business model and revealed the necessity to introduce two new elements: business strategy and sustainability. The authors propose a PSS business model as illustrated in Figure 7, which comprise all the six components: business strategy as the driving force for all the other elements, value proposition (product-service), cost/revenue models, target market, value chain and sustainability.

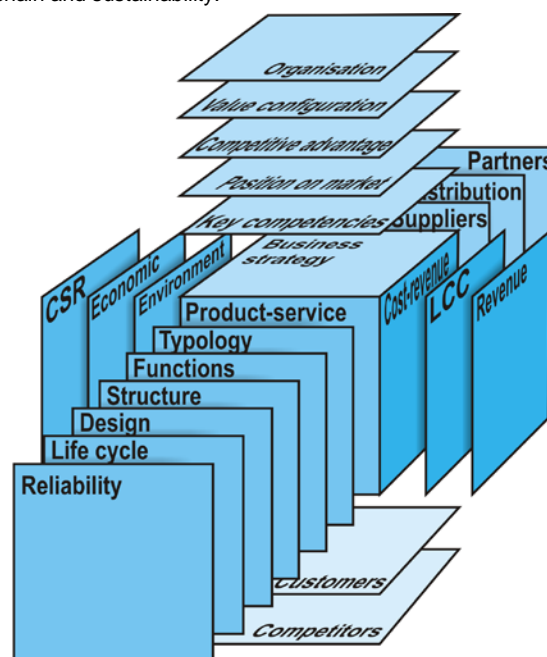


Figure 7: The PSS business model.

Each facet of the cube is detailed with various aspects that have to be closely examined when the decision of adopting a PSS model is considered. The geometrical form used in Figure 7 to represent the PSS business model (cube) was chosen by the authors to show that the six elements of the business system are inter-related. They influence one another and work together for the success of the company.

5 CONCLUSIONS

PSS is a complex business concept expected to help companies gain a competitive advantage while reducing the impact on the environment. The transition from a classical manufacturing system to a PSS is a strategic decision that must be taken at the highest managerial level as such a shift has implications on all of the elements of the business model. This paper proposes a PSS business model (see Figure 7) that synthesises all the aspects that have to be considered when making the decision regarding the transition from product manufacturing to PSS. The implications of such a shift on each element of the business model are discussed.

Although some authors consider that business strategy and business model represent the same thing, the authors of this paper see the business model as more complex, with the business strategy being one of its core elements, which drives all the others: value proposition, cost/revenue model, target market and value chain. As PSS are believed to have the potential to reduce the environmental burden, the authors see sustainability being introduced as a sixth dimension to the business model.

The PSS business model presented in this paper is intended to support the evaluation of the position of a manufacturing company on the route from a product system to a service system and to offer a vision of where it could be on this route. Tools and methodologies to help the company make the leapfrog from one system on this route to another will be the subject matter of a subsequent paper.

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