Services as an Alternative Path to Sustainability

Marios Bisilkas
Universitat Jaume I
12071 Castellón de la Plana, Spain
al244114@alumail.uji.es

Aurora Garcia-Gallego
Universitat Jaume I
mgarcia@eco.uji.es

Ivan Barreda Tarrazona
Universitat Jaume I
ivan.barreda@eco.uji.es

Abstract

Transition to a service oriented business model makes sense in economic terms; it allows the company to enjoy a triple beneficial effect: a higher profit margin, coming from more transactions, with less uncertainty. The proposed approach aims to examine whether the transition from a product manufacturing business model to a service-oriented one can be coupled with improved performance concurrently in all sustainability aspects: financial, environmental and social. The interaction between the three components of sustainability can play decisive role in the final viability of the new approach, as they can moderate or intensify the expected financial flows. Identifying the nature of the interactions allows transforming the dangers of a holistic sustainability approach to an attractive business opportunity.

Keywords: Sustainability, Services, Profitability, Triple Bottom Line

1 Introduction

In the last decades, we see an increasing number of companies moving from being product manufacturers to a more complex business model that includes services. Car manufacturers offer repairing services to their clients, financial services (loans to finance the purchase) and leasing services (keeping the ownership of the fleet); personal care goods manufacturers engage in close relationships with their immediate clients (retailers) through vendor managed inventory systems; mobile phones manufacturers use their products as means via which customers contract services (downloading songs, information, applications, GPS mapping guidance, etc). Management literature suggests that product manufacturers should integrate services into their core product offerings (e.g. Bowen et al., 1991; Gadiesh and Gilbert, 1998; Quinn et al., 1990; Wise and Baumgartner, 1999) as the financial performance of their company is expected to be substantially improved. Since this expectation already fulfills one of the three aspects of sustainability - financial performance - we raise the question whether the other two aspects (social and environmental performance) can be concurrently improved. If such a condition is true, transition to a services oriented business model could constitute an alternative path to sustainability. The aim of this study is to examine under what circumstances can transition to services be coupled with an overall improvement in the sustainability performance of a company and what are the critical factors that determine the success or failure of such attempts.

The transition to a service provider business model makes sense in economic terms. The financial interaction between the firm and the customer moves from a one-off product purchase transaction to a long-term relationship with a continuous revenue stream; instead of a constant effort to attract new customers, the business model focuses on extracting revenue in a continuous manner as long as the customers make use of the product. Examining the ratio of the installed base to the new product sales one can easily see why this approach favors revenues (Knecht et al., 1993; Potts, 1988) - every time a new sale takes place, the installed base is expanding, making offering services an even more attractive option for the company. Services traditionally offer higher margins than products (Anderson et al., 1997); since limited physical material flows and production processes are involved, the costs and uncertainties associated with them are minimized. In addition, the revenue flow becomes less variant; since customers are bounded by long-term con-

tracts, cash flows become more stable, creating a more attractive financial environment to operate in. The company is enjoying a triple beneficial effect: a higher profit margin, coming from more transactions, with less uncertainty.

Services can be proven an important competitive advantage; they can be a great tool of differentiation from the competition. Services are designed to complement the product in its usage or facilitate its acquisition from the customers. Especially in the case of commodities, where there is little product differentiation per se, the additional services that can be contracted can be proven decisive for the final choice of the customers. Furthermore, by being less visible and more labor dependent, services are much more difficult to imitate (Heskett et al., 1997).

External conditions are another factor that drives companies to consider a transition to services. The increasing technological complexity of new products demands higher degrees of specialization from the manufacturer. Product development teams need to be manned by personnel with specialized skills and competences and higher spending in research and development (R&D) programs is required. The escalating costs of the process are inevitably reflected in the overall expenditure of the company. Business as usual is becoming increasingly costly and more difficult to handle. Narrowing the definition of the core competencies can help firms to focus on the aspects they are successful at; essentially, firms downsize their operations in order to increase their flexibility (Lojo, 1997).

Transition to a service oriented business model can be coupled with increased performance in environmental aspects. By doing so, a company can achieve the overall goal of sustainability - in environmental, social and financial terms. A prominent example of this approach is Xerox Corporation. Xerox has evolved from a copier and printer manufacturer to an on-site printing service provider. It no longer sells office equipment to its customers, but rather engages into long time relationship with them by offering printing capabilities though leasing the necessary equipment along with a series of add-on services. By closing the materials loops and recovering its products, it maintains a circulating system of components, or assets. Since the 1990s, Xerox has committed to the new business model focused on sustainability; its environmental goal is to become a waste-free company. This ideal permeates the life cycle of Xerox products: waste-free products from waste-free factories for waste-free offices. Through its environmental leadership program, Xerox has evolved a win-win-win scenario: improvements in environmental performance, customer satisfaction and improved company performance. A critical

point for the success is that customers were not asked to choose between a superior product and an environmentally friendly product. Instead, it was guaranteed that they would be provided this quality and the well-appreciated existing customer satisfaction. Xerox has witnessed numerous benefits from implementing this strategy; by using design-for-the environment principles, it has redesigned products and packaging to support product recovery and reduce resource and energy consumption. Implementation of an end-of-life equipment take-back and reprocessing program led to savings of $80 million in Europe alone (Maslennikova and Foley, 2000).

However, not all similar efforts have been successful. Interface Inc.'s attempt to improve its sustainability performance via providing services has not met the acceptance of the market. Developed and launched in 1995, the "Evergreen Services Agreement" was a revolutionary concept in the commercial carpet industry: it aimed to shift the model from selling carpets as products to leasing "long-term floor-covering services" (Oliva and Quinn, 2003). As part of this system, the floor covering services are leased to the customer, who pays a monthly fee for the service, rather than buying carpet tiles. While Interface would enjoy all the financial benefits of becoming a service provider and concurrently reduce its environmental footprint, the underlying costs would require that the customer bears a considerably higher expense throughout the life cycle of the product. Not surprisingly, the reaction of the market to such an offer was not welcoming. Therefore, it is crucial to examine the critical factors that determine the success or failure of such attempts.

The concept of a service-oriented business model has been openly discussed in the literature for over a decade (Goedkoop et al.; 1999; Mont, 2000; Meijkamp, 2000; Manzini and Vezzoli, 2003), yet the uptake of such ideas by industry appears limited (Baines et all, 2007). Collectively published articles have covered a range of topics, describing business benefits and drivers (Goedkoop et al., 1999; Mont, 2002; Manzini et al, 2001), reviewing the characteristics of product-services systems (PSS) (Mont, 2002; Oman, 2003), and mostly focusing on case studies and examples (Goedkoop et al., 1999; Mont, 2000; Manzini and Vezzoli, 2003; Morelli, 2003; Luiten et al, 2001; Brandstotter et al, 2003). Other topics are related to product life cycle (ELIMA, 2004; Aurich et al, 2006), service design methods (Tomiyama et al, 2004), and service engineering (Tomiyama, 2001).

Traditionally, many people have considered products separately from services. However, recent years have seen the "servitization" of products and the

"productization" of services. Morelli (2003) sees "servitization" as the evolution of product identity based on material content to a position where the material component is inseparable from the service system. Similarly, "productization" is the evolution of the services component to include a product or a new service component marketed as a product. The approach most frequently taken in the literature is to give a short description of a service oriented business model, and then describe the benefits experienced (Oman, 2003; Cook et al, 2006) - these mini cases tend to be qualitative. The focus of the benefit can be the customer (Manzini et al, 2001; Cook et al, 2006; Rocchi, 2005), the manufacturer (Goedkoop et al.; 1999; Mont, 2002) or the society in general by the circulation of less materials (UNEP, 2001) or the creation of jobs (Manzini et al, 2001). Countries like Sweden and the Netherlands tend to lead in the adoption of environmentally sustainable business (Baines et al. 2007); the first work in this area by Goedekoop et al. (1999), for example, was supported by the Dutch Ministries of Economics and the Environment.

Some studies examine the barriers to the adoption of a service-oriented business model (Goedkoop et al., 1999; Manzini et al. 2001; Mont 2002; UNEP 2001; Wong 2004; Wiliams, 2006) and propose ways to overcome them. Other authors proceed a step further by proposing tools and methodologies for designing such models. For example, the MEPSS Handbook (2004) offers a methodology and toolkit for developing a service oriented model. This was created between 2001 and 2004 with support from the European Commission under the Fifth Framework Programme. Partners included PwC Netherlands, Pre Holland and the Centre for Sustainable Design, UK. Similarly, Mont (2000) proposes that a service-oriented firm may be created step-by-step based on the Deming cycle; Aurich et al. (2006) develop a process for the systematic design of technical services supporting a product; and Goedkoop et al. (1999) offer a four-axis model for auditing a service-oriented business model. Many of these methods are presented by illustrating their intended use. For example, Goedkoop et al. (1999) gives examples of his approach against ten proposed product systems. Exceptions are authors such as Aurich et al. (2006) who test their approach with a case study. Nevertheless, in-depth and critical evaluation of these methods tends to be limited. Various methodologies are presented that are tailored to specific projects (Morelli, 2003; Luiten et al, 2001; Brandstotter et al, 2003; Maxwell and van der Vorst, 2003). There is a strong generic flavour to these methodologies with many having a clear heritage in Concurrent Engineering and Lean

Product development methodologies (Baines et al, 2007), i.e. identification of customer value, early involvement of the customer in the system design, effective communication, information sharing, and continuous improvement. It is argued by some authors that these may need further development to facilitate business-wide implementation of PSS. However, Mont (2006) in the editorial for the special edition of the *Journal of Cleaner Production* considers the development of generic methodologies as unlikely and unnecessary. According to Baines et al (2007), A range of tools and methodologies exist for designing PSS; however, these tend to lack a critical and in-depth evaluation of their performance in practice; they are typically a subtle development of more conventional processes; and there is a lack of evidence for the completeness of the set of tools and methods proposed. Our study aims to offer a more in-depth evaluation of the underlying relationships.

The business logic of service oriented systems challenges the understanding of the role of producers and consumers. In the traditional industrial mindset, producers are seen as creators of value while customers are seen as value destroyers (Mont, 2000). In the functional economy, producers become providers of value while customers become users of value. It becomes in the interest of both parties to make sure that the function is incessantly fulfilled and the value is continuously provided. The entire meaning of value is changing. While in the traditional economy, value is directly associated with "the amount buyers are willing to pay for what a firm provides them" (Porter, 1985), in the functional economy value is co-produced and recreated and cannot be reduced to single monetary metrics (Hampden-Turner, 1990). In the traditional economy, the profit centre is tied to a material product. In the functional economy, profit is tied to the number of functional units the material product delivers and from the value generated for the customer. The point of transaction shifts from traditional sales to so-called functional sales.

In traditional sales the objectives of the main two parties - the producer and the customer - are conflicting, while in functional sales the interests of producers and customers become more aligned (White et al, 1999; Stoughton et al., 1999). In traditional sales, producers seek high prices while customers seek to reduce costs. This disparity of interests may eventually lead to a situation when producers offer more advanced products than those that customers actually need in order to make customers pay the premium for new functions. At the same time, producers seek to reduce costs of all non-observable product features while customers are looking for reliability and quality (Toffel,

2002). Producers always aim to sell more consumables, auxiliary products and spare parts, while customers try to reduce costs associated with these products. When selling the product producers strive to reduce the price that is observable to the customers, traditionally indicating only the purchasing price and not life cycle cost. As a result, customers often purchase products based on the initial price, although for a number of products this price might be as low as 35% of the total life cycle cost of product ownership (e.g. for a washing machine). If customers do not take good care of products they will soon be back buying new products, which is in the interests of the producers. Often in traditional sales, customers are paying for all the "faults of the system" developed by producers. For example, according to Fussler (1996), only 2% of the fuel energy that customers pay for and put into the car is going to the main function of a car - mobility.

To a certain degree, functional sales align the interests of producers and customers and create incentives for producers/providers to reduce, at least partially, the aforementioned nuisances. Since the unit of transaction is not a product but a function the product delivers, neither producers nor customers focus as much on the purchasing price. Incentives for providers are created to increase the number of functional units that the product delivers, since functional units are the price carriers, and consequently products become capital assets that are worth maintaining, just like production equipment (Braungart, 1991). For customers, incentives are created to know how much the product is used and thus the price of the use phase becomes the main concern. The key outcome of functional sales is that providers are concerned with securing function provision for as long as possible, and thus, potentially, incentives for product durability, upgrading, reuse and refurbishing are created. If providers are responsible for the operation of products during the use phase, incentives are created to reduce the costs associated with the use phase; including costs for consumables and auxiliary products, as well as costs for maintenance and upgrading services. All this may lead to reduced environmental impact through the reduced number of produced products, the increased number of repaired and refurbished products, reduced consumption of materials in the use phase and increased consumer awareness about actual costs of using products, which in turn may lead to a redefinition of needs. To sum up, although the shift from traditional to functional sales is at the core of the service oriented systems, per se it does not ensure the environmental soundness of the proposal. Functional sales create an opportunity to decouple economic value from consumption of energy and materials but do

not guarantee that this will necessarily occur (Mont, 2000).

The service oriented business model requires important reorganization of the company. Both internal and external relations need to be reconfigured in order to address the new requirements. This reorientation is subject to experience resistance from the different actors involved. Possible policy resistance may include (but not limited to):

Internal: from inside the company as the employees mentality has to change. Important actors may consider that the services are not part of their scope. For example, Digital Equipment Corp. refused for years to provide services as they saw computer design as their core competency (Oliva and Kallenberg, 2003). Furthermore, the established incentives within the operations may result in placing obstacles and need to be updated so as to match the new scope. A firm might realize the service market potential, decide to enter that market, but fail in deploying a successful service strategy (e.g. Ford Motor Co.'s attempt to enter pre-sales services was blocked by its network of independent dealerships).

Traditional metrics of manufacturing processes (throughput and efficiency) are no longer suitable; new comprehensive metrics that reflect that value is created through a service interaction and only when the customer so determines it, need to be developed. Finally, the knowledge management system of the company needs to change. Services imply a shift of the knowledge power within the company: from centralized knowledge centers (product design labs) and products that are intrinsic recipients of that knowledge (i.e., a car or a printer) to networks of service centers that require extrinsic knowledge to deliver the service.

External: from the customers that need to be convinced why to accept charges. Services need to be value adding (i.e. GM's OnStar program; Barabba et al, 2002) - they need to provide a better experience for the clients that are going to use the service. In addition, new products need to create dependency on the services - unless done so, a customer can easily change to a different service provider or quit the service overall. Furthermore, customers need to disconnect from the ownership focus and appreciate the service the products are meant to provide them: a person does not need to own a house in order to live into it - she can enjoy the same benefits by renting one. Finally, from raw materials and components suppliers that will see their market decrease substantially.

Crucial factors that are expected to contribute to the success or failure of the services business model include:

Total Life-cycle Analysis (LCA): the customers need to be able to evaluate the total cost the usage of a product implies. The total cost includes all costs from the moment of acquisition (purchasing cost), the operating costs (energy and raw material consumption, cost of clearing generated waste and emissions) to the final disposal at the end of its life (cost of recycling or disposal at landfills).

Critical customer mass: Creating and offering the relevant services implies important fixed costs; services need to be identified and designed, employees need to be trained, operations need to be scheduled and realized. The company offering them needs to realize that it will operate in a loss until enough customers subscribe to the services. Once the fixed costs are averaged out over the clients charges can reflect that, increasing the attractiveness of the services.

Trust: clients need to be certain that the service will be provided to them the moment they will require it and in accordance to what was promised. For example, mobility services have to be available in a similar manner that a car is waiting in the parking lot for its owner. Word-of-mouth may play a crucial role in the evolution of the critical mass of customers.

Costs and benefits stemming from incorporating sustainability considerations: Improved environmental and social performance will undoubtedly alter the costs involved in the processes, but are also expected to interfere with the more subjective factors involved (trust), contributing to reaching earlier the critical mass of customers that makes the services business model viable.

Because of the underlying characteristics of the crucial factors, we believe that a dynamic hypothesis approach would be more appropriate. The differential equations model presented in this paper incorporates the interaction among physical stocks (number of customers), information flows (perceptions of the provided service, trust) and costs structures and examines how does this interaction affect the financial flows a service-oriented business model generates. We form a dynamic hypothesis, whose purpose is to explicitly articulate how structure and decision policies generate behavior. We look into the operations of a single company with a stable customer base, which we assume will not change because of the offered services, in order to see the pure effect of the services on the financial flows. We begin the analysis from the initialization of product offering and follow the evolution of product sales over the services ratio and the generated cash flows under different scenarios regarding the quality of the service, the generated dependency on the services

and the life-cycle analysis capabilities of the customers.

The resulting dynamic hypothesis can be articulated as follows: *A services-oriented business model heavily affects a company's overall sustainability performance as expressed by the triple-bottom line, and concurrently determines the success or failure of a swift from the traditional product-based business model.* The study follows in the tradition of research in organizational learning and adaptation showing how organizational behavior arises from the interactions of physical and institutional structures with boundedly rational decision making, often leading to unintended and dysfunctional outcomes (e.g., Barnett and Hansen 1996, Forrester 1961, Levinthal and March 1981, March 1991, Masuch 1985, Sastry 1997, Sterman et al. 1997). We go beyond most existing studies, however, by developing a formal model that provides a tool to design and test policies to avoid or reverse the undesirable outcomes generated by existing structures and routines. The paper follows our research approach. First, we developed a formal model that integrates the structural elements of client interaction settings (2). We test the model following the guidelines of the System Dynamics methodology (3). We then use the model to understand the sources and implications of services on sustainability (4) and generate some policy recommendations that could induce a successful shift towards sustainability-focused operations. We use the proposed model to replicate two well known industry cases in order to build confidence in our model (5). Finally, we discuss the implications of our findings for organizational theory and the service industry in general, and identify future research areas.

2 Model Structure

In this section, we present a formal model that integrates the characteristics of the traditional product based and the service oriented businesses. The model allows us to test whether a transition of a product based business to a service oriented business can on the one hand be profitable, and on the other hand improve the overall sustainability performance of the process itself. Theoretical foundations and evidence for the hypothesized causal relationships are presented with each model equation.

The model consists of four sectors. The *Product or Service Choice* sector tracks the flows of customers orders and their choice on whether to purchase the traditional product or contract a service. Life cycle costs, customer's

PIB	Product installed base	N_e	Efficient number of employees
AIB	Add-on installed base	N_d	Desired number of employees
SIB	Services installed base	N_n	New employees
TB	Traditional Business	N_x	Experienced employees
AIS_i	Add-on services contracts rate	N_g	Employees gap
Q_A	Add-on services quitting rate	h	Hiring rate
SB	Services Business	β	Experience rate
Q_S	Full services quitting rate	δ	Experienced employees attrition rate
X_P	Product expiration rate	ℓ	Learning curve
X_A	Add-on services expiration rate	T_δ	Average attrition time
X_S	Full services expiration rate	R_P	Revenue from product sales
Q_S	Full services quitting rate	R_A	Revenue from add-on services
NSR	Normal sales rate	R_S	Revenue from full services
Φ	Product or services choice	R	Total Revenue
Z	Reputation of services	Π_P	Profit from product sales
F_A	Add-on services sales effort	Π_S	Profit from services
Ω^+	Successful stories rate	Π	Overall Profit
Ω^-	Unsuccessful stories	C_{PF}	Product fixed costs
G	Quality gap	C_{PV}	Product variable costs
t_{a^+}	Positive experience to reputation time	C_{SF}	Services fixed costs
t_{a^-}	Negative experience to reputation time	C_{SV}	Services variable costs
q_S	Quality of services	Ω	Scientific Research
q_i	Importance of quality	ξ	Customers' ability to perform LCA
D	Dependency on services	ξ_S	Total life cycle cost of Services
N_r	Existence of employee resitance	ξ_P	Total life cycle cost of product

Table 1. List of variables used

capability to perform LCA and service reputation determine the final choice between the two options. The *Service Reputation* sector models the way reputation about the offered services is created, based on past experience of previous customers, the availability of staff to ensure the service is provided timely and in accordance with the agreed performance. The *Personnel* sector models the way employees cope with the services offer and their experience and determination to provide services of high standards, affecting the reputation of services. Finally, the *Revenue* sector tracks the revenue that is generated by all company's operations, and the corresponding costs and profit from the simultaneous offer of both traditional product, add-on services and the complete service alternative.

Product or Service Choice. The flow of the customers is as follows: customers enter the system with a standard rate and they decide whether to purchase the traditional product or contract a service agreement for a duration equal to the useful life of the product. If a customer chooses to buy the traditional product, then there is a second chance for the company to offer complementary add-on services either immediately, or in a future point in time - the existing pool of clients that have acquired the traditional product

constitutes the *product installed base* (PIB). Similarly, we will refer to the pool of customers that choose to contract the services from the beginning as the *services installed base* (SIB) and to the clients that choose to contract add-on services as *add-on installed base* (AIB). After the useful life of the product is passed or the duration of the contract has expired, all former customers become potential new customers; for the purpose of this study we do not distinguish among new and repeating customers, assuming that word of both positive and negative experiences is adequately spread to all potential customers through special means (in a structured way through conferences or unstructured manner through market rumors). We also consider that the rate of customers is fixed, in order to see the pure effect of the offer of services on total revenue; we leave the case of a possible market expansion for future research. The product installed base is increased by the traditional business (TB) rate and is decreased by add-on services contracts (AIS_i) rate and the product end of life (X_P) rate. Similarly, AIS increases by AIS_i and decreases by the quitting add-on services rate (Q_A) and add-on services expiration rate (X_A), while SIB increases by the services business rate (SB) and decreases by the quitting services rate (Q_S) and the services expiration rate (X_S). The product end of life rate and the expiration rates of add-on and full services depend on the corresponding average life of product (L_P), add-on services (L_A) and full services (L_S). The quitting rates of both add-on and full services depend on the perceived quality of the offered services (q_S), the importance of quality (q_i) on the services and the dependency (D) the contracted services create on them and they are directly related to the magnitude of the corresponding installed bases.

$$(d/dt)PIB = TB - AIS_i - X_P \tag{1}$$
$$(d/dt)AIB = AIS_i - Q_A - X_A \tag{2}$$
$$(d/dt)SIB = SB - Q_S - X_S \tag{3}$$
$$X_P = f(L_P) \tag{4}$$
$$X_A = f(L_A) \tag{5}$$
$$X_S = f(L_S) \tag{6}$$
$$Q_A = q_i \cdot f(q_S, D) \cdot AIB \tag{7}$$
$$Q_S = q_i \cdot f(q_S, D) \cdot SIB \tag{8}$$

The traditional business and services business depend on the product or

services choice (Φ), services reputation (Z) and the normal sales rate (NSR). The product or services choice depends on the ability of customers to perform life cycle analysis (ξ) and the life-cycle costs of the traditional product (ξ_P) and the services (ξ_S). ξ_P is the sum of the cost of product purchase (C_{PP}), the cost of consumables during its useful life (C_{PC}), the cost of environmental pollution during its useful life (C_{PE}) and the cost of final disposal (C_{PD}), while ξ_S is the product of the monthly services cost (C_S) and the duration of the contract, which is equal to the product useful life (L_P). Finally, the add-on services contract rate depends on the add-on services sales effort (F_A)

$$TB = f(\Phi) \cdot NSR + (1 - f(\Phi)) \cdot NSR \cdot (1 - Z) \tag{9}$$

$$SB = (1 - f(\Phi)) \cdot NSR \cdot Z \tag{10}$$

$$PoS = f(\xi, xi_P, \xi_S) \tag{11}$$

$$AIS_i = f(F_A) \tag{12}$$

Service Reputation. The service reputation sector models the perceived quality customers expect to have if they contract an add-on or full service. The reputation is based on the experience of other customers that have contracted any type of service in the past and affects the decision of new customers on whether to purchase the traditional product or shift towards a service contract. As such, the services reputation is modeled as a stock that increases with successful stories (Ω^+) and decreases with unsuccessful stories (Ω^-). In order to decide on whether current clients will be added to the successful or unsuccessful parts, the model constantly compares the current quality offered to the service clients and with the existing reputation; if the quality gap (G) is positive, then current clients stories are marked as successful and vice versa. The quality of service (q_S) that is offered depends on the desired number of personnel (N_d) in order to perform the tasks correctly, the effective number of personnel (N_e) that is currently employed for offering services and the existence of resistance (N_r) from the side of the employees to offer services, because of an underlying belief that this should not be the company's core business or because of conflicting metrics and incentives, leading to poor performance. Either positive or negative experiences require some time in order to be transformed to reputation (t_{a^+} and t_{a^-} respectively).

$$
\begin{aligned}
(d/dt)Z &= \Omega^+ - \Omega^- && (13)\\
\Omega^+ &= \begin{cases} G/t_{a^+} & \text{if} G \geq 0, \\ 0 & \text{otherwise} \end{cases} && (14)\\
\Omega^- &= \begin{cases} |G|/t_{a^-} & \text{if} G \leq 0, \\ 0 & \text{otherwise} \end{cases} && (15)\\
q_S &= \begin{cases} N_r & \text{if} N_e/N_d \geq 1, \\ N_r \cdot N_e/N_d & \text{otherwise} \end{cases} && (16)\\
G &= q_S - Z && (17)
\end{aligned}
$$

Personnel. The personnel of the company that is connected to the offering of services consists of new employees (N_n) and experienced ones (N_x). The number of new employees increases by the new hiring rate (h) and the new employees are transformed to experienced ones with the experience rate (β), which depends on the learning curve (ℓ). The experienced employees leave the system according to the attrition rate (δ), that depends on the average attrition time (T_δ). We assume that new employees can render service in a lower efficiency than the experienced one, and namely we assume that on average that is about 50%. Therefore, the effective personnel size (N_e) is the sum of the experienced employees and half the size of new employees. The fraction of the experienced employees over the number of all employees gives the percentage of experienced employees (P_x). The hiring rate depends on the personnel needs gap (N_g) and the time required to search for personnel (T_N), while the personnel need gap is the positive part of the difference between the desired size of personnel and the effective personnel size. Finally, the desired size of personnel is the product of the average number of employees needed per company (N_s) and the sum of AIB and SIB.

$$(d/dt)N_n = h - \beta \tag{18}$$
$$(d/dt)N_x = \beta - \delta \tag{19}$$
$$h = |N_g/T_N| + \delta \tag{20}$$
$$\beta = N_n/\ell \tag{21}$$
$$\delta = N_x/T_a \tag{22}$$
$$N_e = N_x + 0.5 \cdot N_n \tag{23}$$
$$P_x = N_x/(N_x + N_n) \tag{24}$$
$$N_g = \{N_d - N_e\}^+ \tag{25}$$
$$N_d = N_s \cdot (AIB + SIB) \tag{26}$$

Revenue. The Revenue sector tracks the revenue that is generated by all company's operations. The revenue from product sales (R_P) is the product of the cost of purchase per product and the volume of the traditional business, with the revenue from add-on services (R_A) and full services (R_S) be the products of the corresponding installed bases and contract prices. The sum of the three, provides us the total revenue rate (R). The profit from product sales (Π_P) and the profit from services (Π_S) is the difference between the revenue generated from each case and the corresponding fixed and variable costs.

$$R_P = PIB \cdot C_P \tag{27}$$
$$R_A = AIB \cdot C_A \tag{28}$$
$$R_S = PIS \cdot C_S \tag{29}$$
$$R = R_P + R_A + R_S \tag{30}$$
$$\Pi_P = R_P - C_{PF} - C_{PV} \cdot TB \tag{31}$$
$$\Pi_S = R_S + R_A - C_{SF} - C_{SV} \cdot N_n \tag{32}$$
$$\Pi = \Pi_P + \Pi_S \tag{33}$$

3 Model Validation

Validation of simulations models in general and Systems Dynamics (SD) models in particular consists of two types of validity tests (Barlas, 1989):

1. Structural validity tests: the function of which is to check whether the structure of the model is an adequate representation of the real structure. Structural validation is typically achieved in two parts:
    - by comparing the model equations with the real system relationships ("empirical" structure validation)
    - by comparing the model equations with the available theory ("theoretical" structure validation)
2. Behavior validity tests: the function of which is to check if the model is capable of producing an acceptable output behavior. Behavior validation is also typically achieved in two parts:
    - tests to determine whether the behavior patterns generated by the model are close enough to the major patterns exhibited by the real system
    - examining the model behavior under different conditions, try to determine whether there is a major error in the structure of the model (extreme conditions)

The heart of a system dynamics model is a dynamic hypothesis that is illustrated by the structure of the model. The purpose of the dynamic hypothesis is to explicitly articulate how structure and decision policies generate behavior. A well formulated hypothesis needs to be (1) logically sound, (2) grounded in previous knowledge and (3) empirically testable. Furthermore, it must also say something interesting about the real world; it must be relevant - logic and consistency alone are not enough (Oliva, 2003). Models are built in order to understand an observed behavior and provide guidance on when does this behavior occur and the conditions under which it may be altered. The focus lies on the purpose of the model, not the model itself. Sterman (2000) provides and excellent guide to model validation; we provide a brief description of its main aspects and the corresponding results for our model below:

Boundary adequacy. Purpose of the boundary adequacy test is to examine whether the important concepts for addressing the problem are endogenous to the model. Indeed, the model incorporates an analytical description of customers' choice between a traditional product and a replacement service offering. We have also incorporated the reaction of the market to the

proposed configuration of a new product, both in terms of performance and price. In order to check for the adequacy of the system boundaries, we have modified the model to include plausible additional structure, made constants and exogenous variables endogenous, and repeated the sensitivity and policy analysis. The results indicated that by doing so the observed behavior of the system does not change significantly, apart from the timing of events, as expected.

Structure assessment. Testing the model structure consistency with the relevant descriptive knowledge of the system can be quite cumbersome, since our knowledge of the system behavior is limited; this limitation was one of the reasons motivating the current study. We have chosen to aggregate individual actors of the system (customers) into generic groups with common behavior and have approximated their individual preferences within the groups using probability distributions to describe their possible decisions when faced with the opportunity to acquire the new product. In addition, we tested the model in parts, to check for its consistency under different assumptions.

Dimensional consistency. We have examined that all equations are dimensionally consistent without the use of parameters having no real world meaning. We have used parameter values with real world counterparts, based on experts opinions and archival material and have conducted extreme conditions tests to check for unreasonable outputs when inputs take on extreme values, both alone and in combination. Finally, we subjected the model to large shocks caused by extreme values in random variables and different numerical integration methods.

Behavior reproduction and sensitivity analysis. We have examined the model for its ability to reproduce the behavior of interest and to endogenously generate the symptoms of difficulty motivating the study, namely the transition towards a services oriented business model. We also tested that the model generates the behavior observed in other instances of the same system, particularly when these interactions are neutralized, and its ability to successfully anticipate the response of the system to novel conditions. Univariate and multivariate sensitivity analysis allowed us to examine whether the numerical values, generated modes of behavior or policy implications vary significantly when assumptions about parameters, boundary and aggregation are varied over the plausible range of uncertainty, as discussed in the next paragraphs.

4 Implications of the service oriented business model

We compare the revenue stemming from the three types of business (product sales, add-on services, full services) as a function of the customers' ability to perform life-cycle analysis, the qualities of the services offered, the importance of services' reputation, the dependency on the services and the environmental performance of the product and services. The results of the analyses will allow us to understand the importance of each structural element in the final outcome of a transition from a traditional product based business model to a services oriented one and the conditions under which the expected outcome may be manipulated. All the scenarios examined in the following analyses are compared to the base case scenario that no services of any kind are offered, which corresponds to the traditional business model of product sales. Since we have assumed that the market is stable, and as a result the rate of new customers is fixed, the overall profit rate in the base case scenario is stable, coming entirely from the traditional business segment. In order to represent reality, we assume that there exist both fixed and variable costs for the production of items, as well as for offering services; therefore, unless the installed base of each segment reaches a critical size of customers the business unit will generate losses. The values of the variables have been chosen to correspond to a fictitious product and we have arbitrarily set the related costs in such a way that the life cycle cost of acquiring a product to be 8.3% higher than the life cycle cost of the alternative option to contract the full services, namely \$1300 and \$1200; the reason for doing so is to have a clear better choice available at all times, so as to be able to examine whether customers will be able to identify and take advantage of it, depending on each scenario assumptions. As previously mentioned, the base case scenario represents a market where only the traditional product is available; therefore, the profit rate from product sales is stable (due to the stable rate of new customers) at the levels of \$1500. Obviously, the profit rate from services is zero, as services are not available, and the overall profit from the company's operations is equal to the profit rate from product sales. The product buyers installed base increases over time, until it stabilizes at a value of 600 customers.

Ability of customers to perform LCA. When deciding about the acquisition of a product, customers need to be able to evaluate the total cost

the usage of a product implies. As indicated earlier, the total cost includes all costs from the moment of acquisition (purchasing cost), the operating costs (energy and raw material consumption, cost of clearing generated waste and emissions) to the final disposal at the end of its life (cost of recycling or disposal at landfills). The total cost should be compared to the corresponding cost of contracting services for the duration of the contract, in order to find the optimal solution cost-wise for their individual case. The ability of customers to perform this task, will influence their final decision towards the acquisition of the traditional product or the contract of the services the product was going to be used for. We examine three different scenarios, where customers have low ($\xi = 0.1$), medium ($\xi = 0.5$) or high ($\xi = 1$) ability to perform LCA and present the results in *Figure 1.* When the ability to perform LCA is low customers heavily discount the additional costs of product usage and disposal, focusing mainly on the price of acquisition, a miscount that is reduced as the ability increases.

For $\xi = 0.1$, most of new clients choose to purchase the product instead of contract services - however, since some clients do contract the services, the profit from TB is slightly reduced compared to the base case. SB results in heavy losses, as the generated revenue cannot cover the fixed costs offering services involves, and the overall profit of the company is drastically reduced - the company passes from generating profit to incur loses throughout the whole duration of the simulated period. It is clear that a company that will face such a condition will soon abandon the new business model that includes services and revert to the traditional model that guaranteed a certain volume of profit.

Things seem to improve for $\xi = 0.5$; about one third of the new clients decide to contract the full services instead of the traditional product reducing the profit of TB by about the same percentage. However, since services offer a much higher profit margin, SB revenue gradually increases, and after a certain threshold of SIB is reached, generates profit as well. The new overall scheme becomes profitable within a short period and it finally reaches levels close to the ones of the base case scenario. Again, it would be very difficult for a company to justify continuation of the new business model that includes services, as the final profit rate still does not reach previous levels. The investment and business risk associated with moving away from the company's know how are not worthwhile.

A clear improvement is visible for the case of $\xi = 1$; the vast majority of new customers acknowledge that services are the optimal choice for their

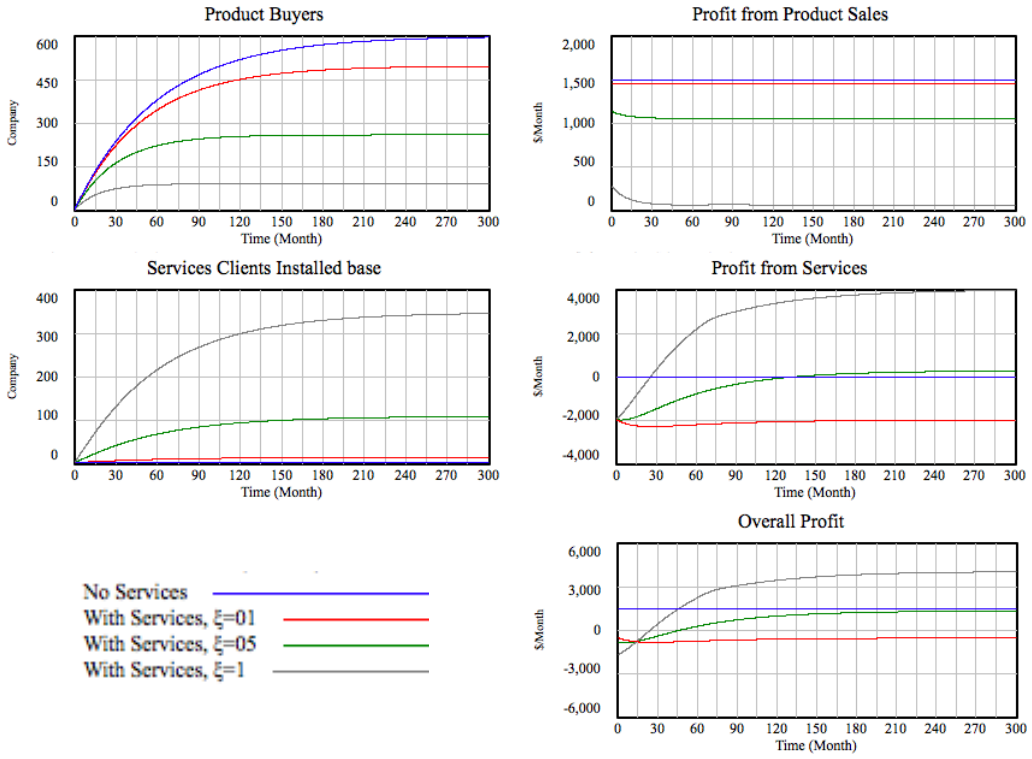

Figure 1. Results for different values of ξ

operations and choose this option, even if some customers will continue to purchase the product option instead, for special individual reasons. As a consequence, the profit rate of SB takes off on the expense of the profit rate of TB that is swamped to levels close to zero. SIB rapidly overcomes the threshold of profitability before reaching very high levels, and the overall profit rate of the company doubles compared to the base case. In this case, the transition to a service oriented business model is not only justified, but represents a great opportunity for the company.

Quality of services offered, Reputation and Dependency. The quality of the services that are offered to the customers that have contracted services (either add-on or full form) will play an important role in the profitability of the business oriented business model. By signing the contract, clients commit to a certain revenue stream towards the company for the duration of the contract; however, the company in turn commits to provide a

specific level of service, in accordance to what was promised in the services offer. When the company fails to live up to its commitment, the clients decide to break the contract, eliminating the obligation to provide the remaining amount of revenue that was part of the contract. Furthermore, the reputation of the services as an alternative is hurt - new clients that are considering the two available options of acquiring the product or contracting services will be more prone to follow the traditional path of product acquisition, even if full services are clearly a better choice for them. Clients need to be certain that the contracted services will be available to them the moment they require them, in the same manner that the product is available when they have obtained it; if they believe that this might not be the case, based on previous experience by other customers, then their final choice might be altered. It is useful to remember that one basic assumption of the model is that the information regarding clients' experience with the services is adequately distributed to all potential customers, through structured or unstructured means. We consider three scenarios: one where the quality of the services is not important to the clients ($q_i = 0$), and therefore, clients will remain for the duration of the contract, a second one where clients that are not happy with the offered quality of services will begin to break their contracts, quitting the provided services ($q_i = 1$), and a third one where services create a form of dependency on them when they are contracted and therefore, even if clients would like to quit the services, they are inclined no to ($q_i = 1$, $D = 1$). The results are presented in *Figure 2*. For all scenarios presented in this section, we assume that the ability of new customers to perform LCA is high ($\xi = 1$).

The red line in *Figure 2* corresponds to the case where $q_i = 0$; as new customers are able to acknowledge that the full services option is better than the product acquisition option, the vast majority of them decides to do so. The SIB increases over time, until it stabilizes in the highest possible levels and the profit from SB follows a similar path. The smooth evolution described is altered when the quality of the offered services becomes important ($q_i = 1$, green line). If the company does not respond quickly enough to reinforce its services department with adequate personnel, the department is overwhelmed by the workload, resulting in lowering the quality of the services that are provided to the customers (this is an indicative case, the quality might refer to a hardware update or a procedures' revision that requires time to be performed). The inferior quality causes existing clients to break the contracts and impedes new clients contracting services, reducing the rate of new contracts and the profit rate of SB. Eventually, once the company ad-

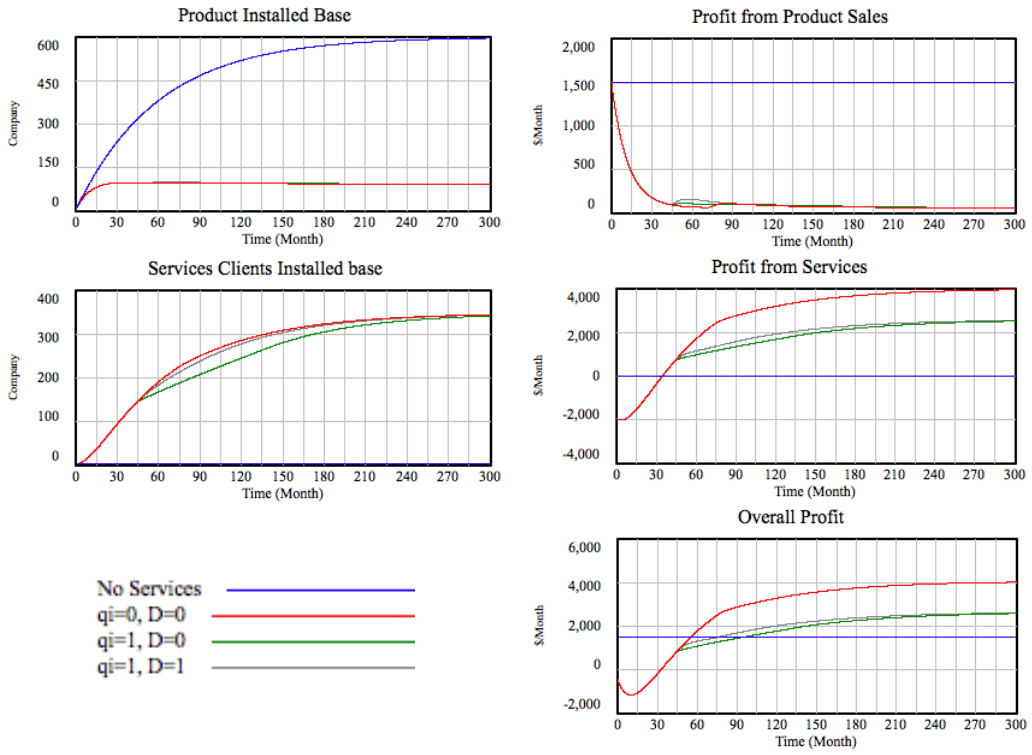

Figure 2. Results for different values of q_i and D

justs its abilities to cope with higher amounts of clients, and since the LCA is clearly in favor of the full services contracts, SIB catches up with the levels of the previous case where quality is not important, with the main difference being that in the meantime, the generated profit has declined substantially. However, in cases that the ability of new clients to perform LCA is not high the reduction in profitability may cause termination of the services oriented business model project.

Dependency in the contracted services seems to be decisive on the evolution of SIB and profitability. Dependency can be created in the cases where a quick switch to the traditional product is cumbersome; consider the case where a consumer goods company chooses not to create its own fleet of trucks that will deliver its products to the customers, but use a third party provider that will perform the deliveries instead. This sort of relationship with the third party provider creates a dependency on the services provided by the

third party, because it is not easy for the company to break the contract and switch to the product mode (use of own trucks) without significantly disturbing its operations for a period of time. Furthermore, important investment may need to take place (purchase or lease of trucks), and long learning curves may exist (train drivers, design efficient delivery schemes, etc). The grey line in *Figure 2* represents the case where dependency is created; we can observe that the existence of dependency results in an outcome closer to the case that the quality of the offered services are unimportant, both for the evolution of SIB and overall profitability. This last conclusion, can serve as an extremely useful tool for the success of the transition project towards a services oriented business model, especially if moments of services disruption and uncertain quality are possible to occur.

Environmental and CSR performance. In this part of the analysis we examine the influence of improved environmental and CSR performance of the company because of the services offering, consider separate scenarios. In the first one, we assume that because of incidents external to the operations of the company the legislation regarding the environmental aspects becomes significantly stricter. As a result, the cost of disposing the product at the end of its useful life doubles, because special treatment is required. The corresponding cost for the services part increases as well, but only by a smaller portion; this is due to the pulling effect that is generated because of the use of common means (products, materials) in order to service various customers and/or the know-how and economies of scale the company can take advantage of. In the second scenario we assume that the company improves its CSR performance in order to attract more skillful employees for its services operations. The skillful employees will be able to climb the learning curve of the job much faster, limiting the period of decreased efficiency of the training period. The results of both scenarios are presented in *Figure 3*, along with the base case and the quality importance scenarios.

The improved environmental performance of the company leads to better results for the services oriented business model; this is due to the fact that the stricter legislation regarding the final disposal of the product at the end of its useful life time becomes a decisive factor favoring services at the moment customers consider the life cycle costs of both available options. As a result, more new customers will be inclined to contract the services instead of acquiring the product, increasing SIB and the corresponding revenue from services more than in all previous scenarios. Therefore, if a company expects that environmental legislation in general is going to be intensified in

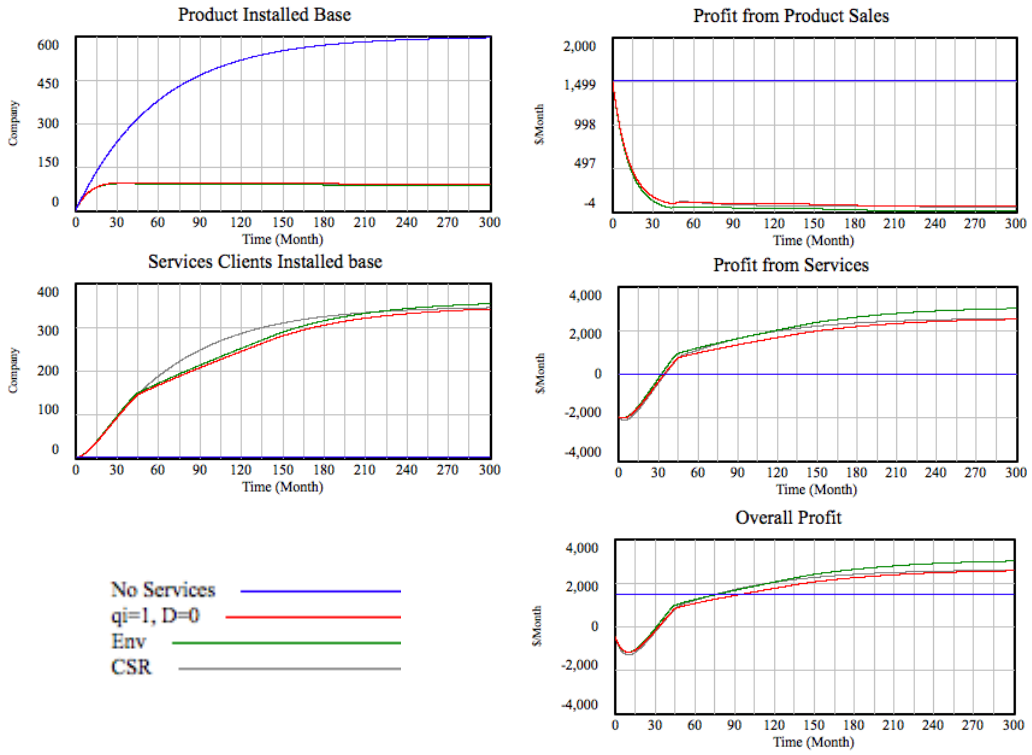

Figure 3. Results for improved Environmental and CSR performance

the future, it could identify an interesting business opportunity approaching. Improved CSR performance offers another beneficial effect: the company increases its ability to cope with increased workload and therefore improves the quality of services offered to its current clients, and consecutively its reputation. Even if the same final levels of SIB and revenue from services are reached in equilibrium, the evolution is smoother and higher initial revenue rate can be achieved in earlier stages. This result may be critical for companies that are examining the effects of a transition to a services oriented business model before equilibrium is reached, and may make the difference between continuation or rejection of the project during the first period of application.

5 Case studies replication

We will examine the applicability of the proposed approach with the help of two case studies relating to products that are sold in a business-to-business environment. The case studies will allow us to create theoretical constructs, propositions and/or midrange theory from case-based, empirical evidence (Eisenhardt, 1989). Case studies are rich, empirical descriptions of particular instances of a phenomenon based on a variety of data sources (Yin, 1994). In order to examine the applicability of the proposed model in a real business environment, we will be using data from two of the most well known examples, the Xerox case and the Interface case discussed briefly below. The first represents a successful transition to a services oriented business model, while the second represents an unsuccessful one. The purpose of using these cases is to examine whether the true outcomes are replicated qualitatively - individual characteristics of the market and the available competition are unknown to us, and therefore do not form part of the model. The data used in the models are taken from previous published documents (Maslennikova and Foley, 2000; Oliva and Quinn, 2003) and other sources, and are adequately scaled in order to be directly comparable through the current model.

Xerox has evolved from a copier and printer manufacturer to an on-site printing service provider. It no longer wants to sell office equipment to its customers, but rather to engage into long time relationship with them by offering printing capabilities though leasing the necessary equipment along with a series of add-on services. By closing the materials loops and recovering its products, it maintains a circulating system of components, or assets. Customers were offered the opportunity to either purchase the traditional copier and the consumables needed over the period of useful life, or to lease printing services from Xerox, where the copier would stay in possession of Xerox and the client would pay a specific price per page printed, with all maintenance and consumables costs incurred by Xerox. After the contract expired, Xerox would retrieve the used copier which would be adequately dismantled and the different pieces would be used as parts for new copiers (remanufacturing) or disposed in a safe manner.

In 1995, Interface introduced the "Evergreen Services Agreement" (ESA). As part of this system, the floor covering services are leased to the customer, who pays a monthly fee for the service, rather than buying carpet tiles. Interface retains responsibility for the maintenance of the carpeting throughout its lifetime; renewing and replacing damaged tiles or exchanging heavily worn

tiles in areas of heavy traffic for less exposed tiles under desks or furniture. At the end of its useful life, the carpeting is recovered and recycled, downcycled or repurposed rather than disposed of in landfills. Through the ReEntry system, Interface arranges for used carpet tiles to be retrieved. If the reclaimed tile is in good condition it is cleaned and donated to a non-profit organisation for reuse, tiles in a lesser condition are reprocessed. Interface retrieves the nylon facing, which is either recycled back into carpet tiles or downcycled to produce secondary products like moulded car parts or underlay, while the backing is ground up and remanufactured into new carpet tile backing. Through the ESA, Interface would keep ownership of the carpet tiles, and be responsible for its maintenance, but the customer would have to contract all cleaning services by Interface.

The new business model of both companies is a full transition to a services oriented business model; however, this was not done overnight - they had to pass through a period when both traditional and service business were active. We model exactly this stage, in order to observe the period necessary for the new scheme to result into absolute profits (at first) and to reach or overcome previous levels of profits (at the end). *Figure 4* and *Figure 5* offer graphical representations of the results for the Xerox and Interface cases respectively. The blue lines correspond in the traditional business model of the companies as product manufacturers and sellers, while the red lines correspond to the case of offering the option of leasing services instead.

Looking closely at the simulation results of the Xerox case, we can understand why the transition process was successful. The vast majority of new clients choose to contract the services instead of acquiring the product for two main reasons: first, the life-cycle cost of leasing services is clearly lower (about 10%) and the market is educated enough to be able to recognize it, and secondly the clients do not have to realize an important initial investment of acquiring the product. The SIB grows quickly, along with the revenue and profit from services, on the expense of PIB, and the overall profit within a short period overcomes previous levels, before equilibrating in significantly increased levels. The dynamics of the expected revenue and profit are clearly visible from the first period of the services offer; Xerox has every incentive to allow the project to continue and watch it flourish over time.

A different picture is observed for the Interface case. Because of the terms of ESA, clients that choose to lease services will have to face increased expenses on maintenance, cleaning and replacement services that are probably

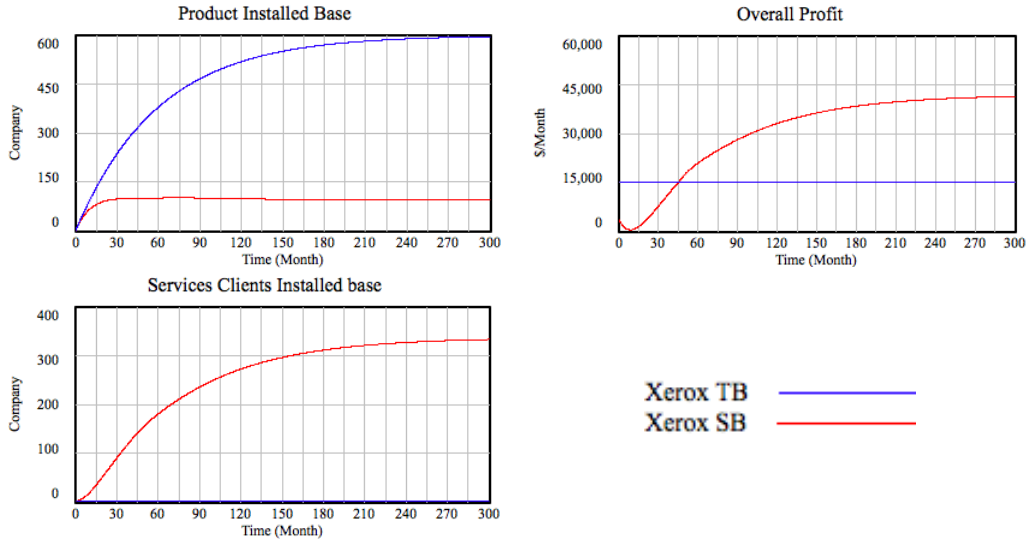

Figure 4. Results for the Xerox case

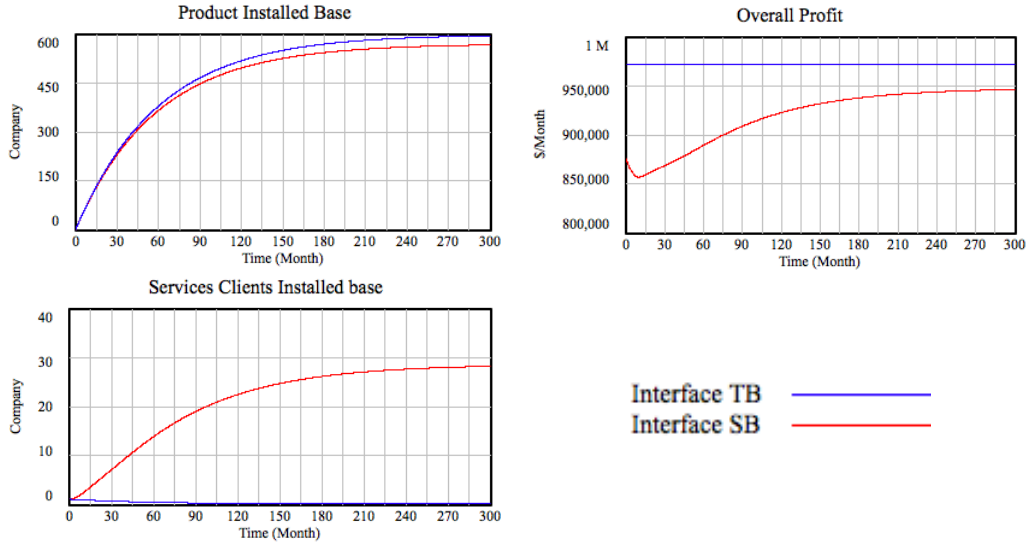

Figure 5. Results for the Interface case

not incurred when the traditional product is acquired. The services lease offer suffers from two main problems: firstly, the life cycle costs of services signif-

icantly exceeds the life cycle costs of the traditional product, and secondly, since the product or service in question (floor carpeting) does not interfere with the everyday operations of the customer, it is difficult to be considered as operating expenses, making the services offer even less attractive (the PoS inclines towards the traditional product). Indeed, the simulation shows that very few customers choose to lease the offered services, with the vast majority continuing to purchase the traditional product. As a result, the corresponding overall profit of the new business model is significantly lower when compared to the traditional business model throughout the entire simulated period. The first stages in particular reveal a large reduction in profits, because of the fixed costs involved, making the project of transitioning to a services oriented business model highly questionable.

6 Summary and policy recommendations

Transition to a service oriented business model makes sense in economic terms: it allows the company to enjoy a triple benecial effect: a higher profit margin, coming from more transactions, with less uncertainty. The proposed approach aims to examine whether the transition from a product manufacturing business model to a service-oriented one can be coupled with improved performance concurrently in all sustainability aspects: financial, environmental and social. The interaction between the three components of sustainability can play a decisive role in the final viability of the new approach, as they can moderate or intensify the expected financial flows. Identifying the nature of the interactions will allow us to transform the dangers of a holistic sustainability approach to an attractive business opportunity.

A service oriented business model requires important reorganization of the company. Both internal and external relations need to be reconfigured in order to address the new requirements. Traditional metrics of manufacturing processes need to be replaced by comprehensive metrics that reflect the creation of value for the end customers, incentives within the organization may need to be reconfigured in order to correspond to the importance of providing high service levels to the customers, and all related actors need to realize that knowledge (and therefore power) shifts from intrinsic knowledge centers (product design labs) and products that are intrinsic recipients of that knowledge to networks of service centers that require extrinsic knowledge to deliver the service.

We have identified several important factors that contribute to the success or failure of the transition towards a services oriented business model. These factors include the ability of customers to perform life cycle analysis of all costs involved in their operations, starting from the acquisition of a product, the operating costs throughout the useful life of the product and the costs of disposal, the critical customer mass that will provide a profitable operating environment for the company, the reputation of the offered services and the need of customers to be confident that the contracted services will be available to them in the same way a purchased product is, and the costs and benefits stemming from incorporating sustainability considerations like the environmental and social responsibility performance of the product and the company.

Because of the underlying characteristics of the crucial factors, we believe that a dynamic hypothesis approach is appropriate. The differential equations model presented in this paper incorporates the interaction among physical stocks (number of customers), information flows (perceptions of the provided service, trust) and cost structures and examines how does this interaction affect the financial flows a service oriented business model generates. We form a dynamic hypothesis, whose purpose is to explicitly articulate how structure and decision policies generate behavior.

We begin the analysis from the initialization of product offering and follow the evolution of product sales over the services ratio and the generated cash flows under different scenarios regarding customers ability to perform life-cycle analysis, the qualities of the services offered, the importance of services reputation, the dependence on the services and the environmental performance of the product and services. The results of the analyses allow us to understand the importance of each structural element in the final outcome of a transition from a traditional product based business model to a services oriented one and the conditions under which the expected outcome may be manipulated.

While most of the components in our model have already been discussed in existing literature, this is done in an individual manner: authors examine dyadic relationships between services and profitability (Knecht et al, 1993; Anderson, 1997, Heskett et al, 1997, Manzini et al, 2001), sustainability and profitability (Goedekoop et al, 1999), services and environmental performance (Kassinis and Soteriou, 2003). In this paper, we go beyond most existing studies by developing a formal model that brings the main ideas together and examine their interactions. The formal model provides a tool

to design and test policies that aim to avoid or reverse the undesirable outcomes generated by existing structures and routines. By doing so, we gain understanding on the underlying reasons why some attempts to offer services have been very successful, while others have failed. As discussed, the results indicate that improving the environmental and social performance of the company through services is tightly linked to improved financial performance, satisfying the three pillars of sustainability.

We find that the most important factor for a successful transition is the ability of customers to perform life cycle analysis of the costs involved; services make the corresponding costs immediately visible, as the total cost for the duration of the contract is a simple multiplication of the period fee and the number of periods. On the contrary, calculation of the life cycle costs of the traditional product can be complicated, as it may include hidden costs of consumables, generated pollution and final disposal - customers may not be in a position to calculate with certainty some of them, or heavily discount future costs. It would be essential for a company that is considering a move towards a service oriented business model to understand whether their clients would be in a position to perform the LCA tasks adequately. In the case that the ability is questionable, the company should consider the possibility to assist their clients in developing the required ability and do so with transparent methods.

Assistance in LCA tasks can also be valuable to weather a second important factor of success: help build trust among the potential customers that the services will be offered as promised, focusing on the availability of the contracted service in same manner as the traditional product. Furthermore, it could also be proved useful in cases that the reputation of the offered services are in danger of being hurt, affecting the imminent new contracts - an initial positive experience may moderate possible subsequent problems.

Finally, two secondary factors of environmental performance of the services agreement and the corporate social responsibility performance of the company may be used in order to influence the final decision of a potential customer between the traditional product and the services contract. Recognized high CSR performance and corresponding techniques help attract skillful employees in the services department, reduce the learning curves, provide good quality services and may generate new proposals to improve existing services or create new ones for the clients. In addition, the environmental performance is expected to be of growing importance over the following years, and services embed the opportunity to escape from tradi-

tional operations with low performance in terms of environmental aspects.

We examined the applicability of the proposed approach under the complete framework by two case studies of products that are sold in a business-to-business environment, representing both a successful transition to a services oriented business model (Xerox), and an unsuccessful one (Interface). We used data taken from previous publications and other public available sources and compared the model outcomes with the real outcomes of the companies' past operations. The model managed to replicate the qualitative characteristics of the transition attempts, indicating the success of Xerox's proposal and the probable failure of Interface's intent. The replication of the existing results builds confidence on the ability and the suitability of the model to predict the expected outcome of similar intents.

A model is, by definition, an abstraction of reality, and as such, has several limitations. The most important limitations for this model come from the boundaries of the model structure, as were described in section 2. The first one refers to the fact that we have set the rate at which customers arrive constant; once they arrive they make their individual choice between the traditional product and the alternative offer of services. The constant rate choice for the model is justified by the need to examine the pure effect of the services offer on the overall profits of the company. As the same number of customers interfere with the company, the financial results of the different scenarios examined (only the traditional product, traditional and services products) are directly comparable, allowing the extraction of valuable conclusions. Therefore, an interesting extension in this research would be the effect of market expansion or decline, as a result of the services offer. Such a possibility could respectively further enhance or dampen the expected outcomes that are suggested in the current study. Going a step further, one could also examine the actions of the competition; introducing rival companies in the model can provide valuable insights on the ease of replicability, and therefore the sustainability of the competitive advantage the first mover can obtain.

The second important limitation with regard to the fact that possible internal or external policy resistance are not explicitly articulated. Part of the resistance can be considered included in the quality of the services offered (internal) or in the reaction of customers on the perceived quality (external) through the full services quitting rate, however the real interaction is rather more complicated. Future areas of research can be focused on the internal operations of the company; it would be very interesting to examine

the internal changes the company has to undertake in order to provide the services. New metrics that will become effective in order to measure services performance may be in contrast to existing traditional metrics - attempting to balance both old and new metrics may lead to important inefficiencies on both sides. Therefore, it would be crucial to examine the application of metrics that will induce a shift towards the new services oriented business model. Furthermore, the interaction with the clients could be another extension of the current model, examining its effect on the overall success of a transition towards a service oriented business model.

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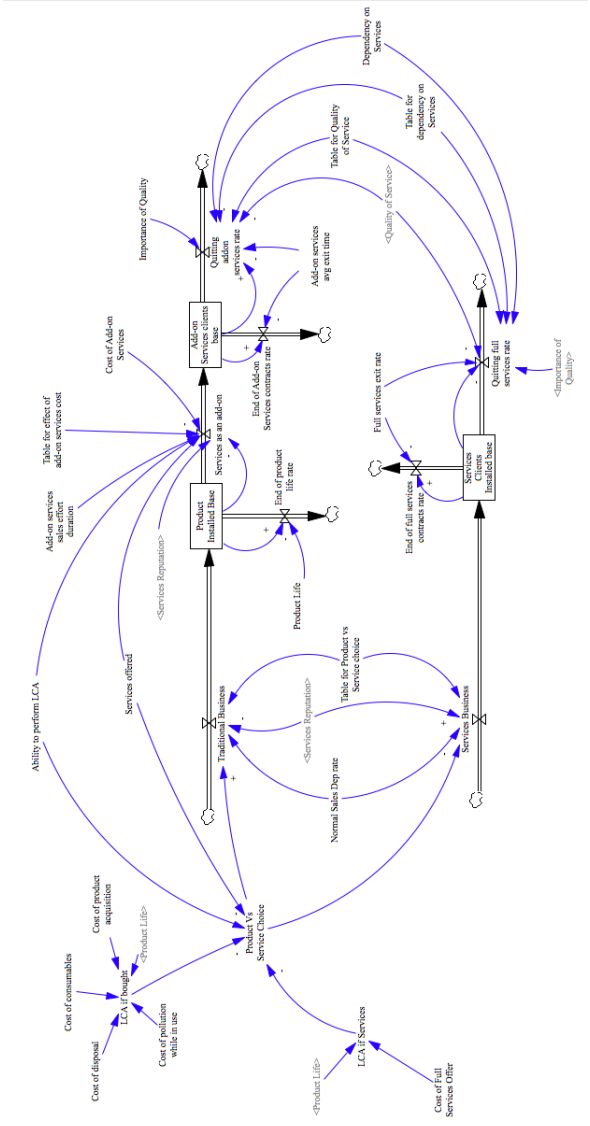
Appendix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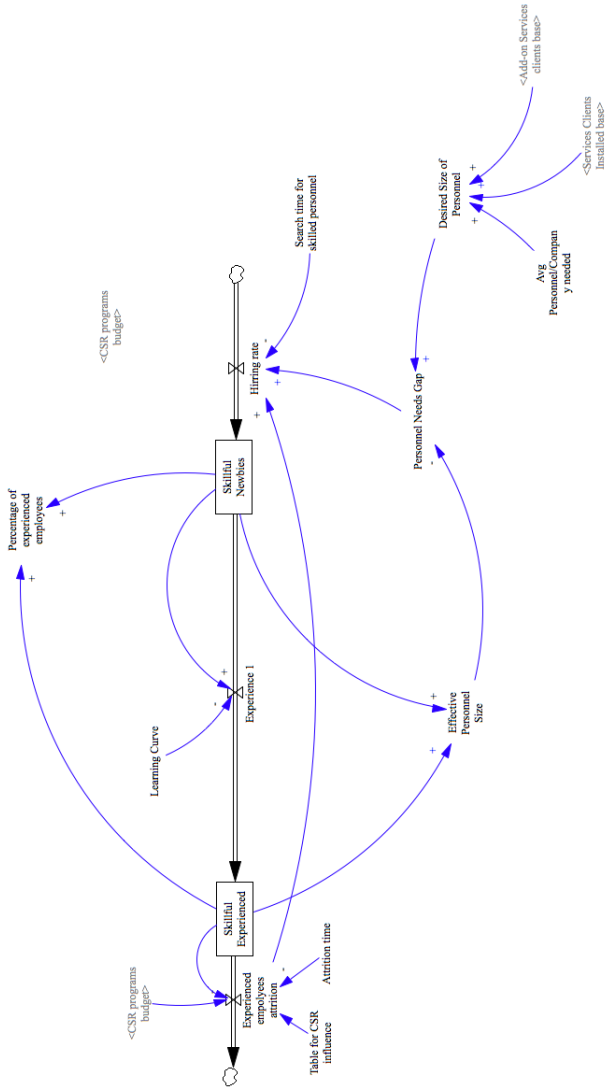
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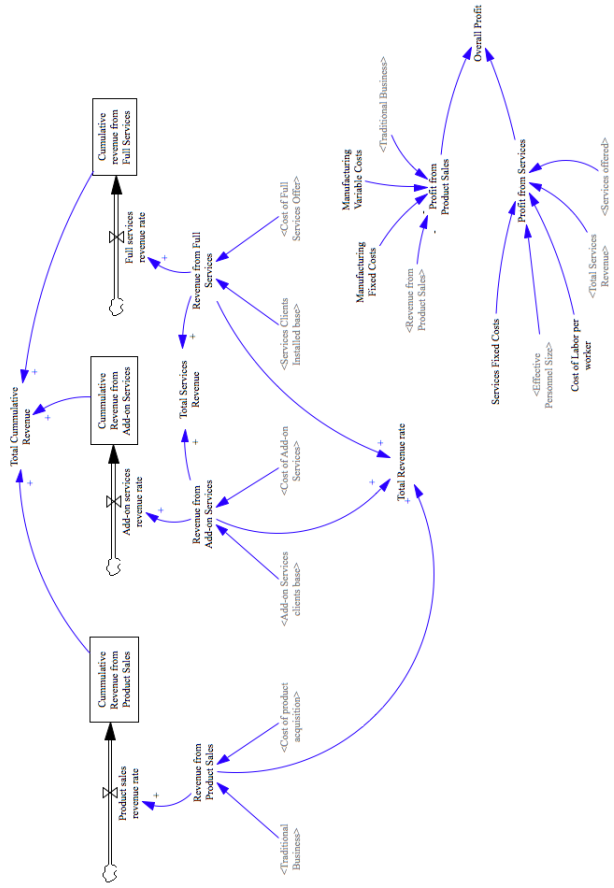
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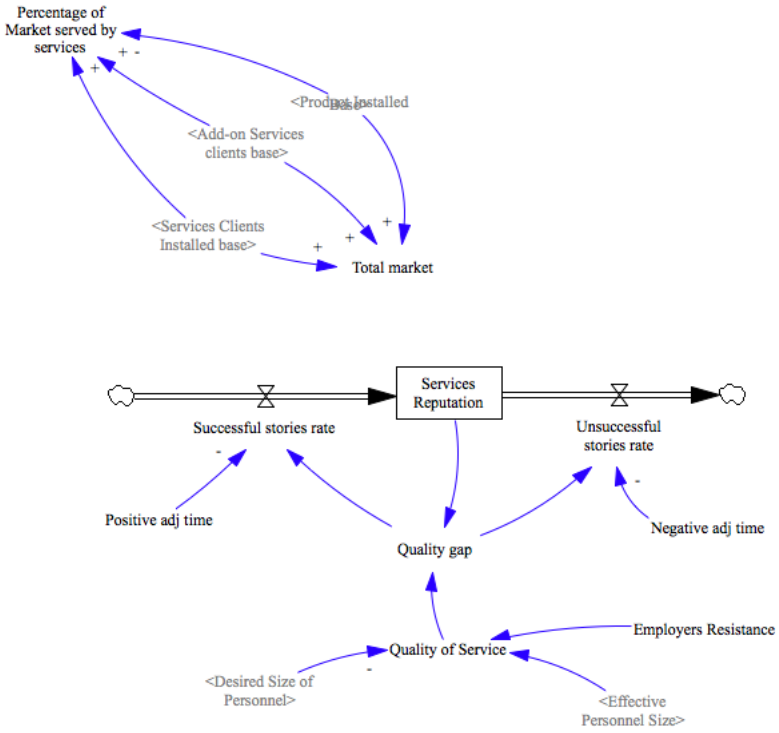
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