

Product/Service Systems Experiences – an International Survey of Swedish, Japanese, Italian and German Manufacturing Companies

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Abstract

Product/Service Systems have recently grown in manufacturers' interest. This paper presents an international survey of manufacturers from Sweden, Japan, Italy and Germany. The results show that customer connection and demands along with increased competition were main driving forces for product/service systems. Also, most product/service systems include physical products, maintenance and repairs. Staff working with product development, marketing and after sales were the major actors in product/service system development. As in traditional product sales, most product/service systems still have the ownership of physical products transferred to the customer/user. Physical products used in product/service systems are seldom adapted for product/service systems.

Keywords:

PSS, IPSE, Service Engineering, Service Management, Functional Sales, Remanufacturing

1 INTRODUCTION

Competition continues to increase among manufacturing companies around the world, adding more and more competitors to the global market. This has put new requirements on manufacturing companies wishing to remain or become viable and with a competitive edge. Manufacturing companies around the world are striving to increase their revenues and profitability through, for example, obtaining a larger share of the market and/or controlling a larger share of the product value chain.

One proposed concept for achieving these wishes is Product/Service Systems (PSS) [1]. PSS can be defined as consisting of *"tangible products and intangible services designed and combined so that they are jointly capable of fulfilling specific customer needs"* [2]. In the PSS literature, there is sometimes a strong focus on the service content of PSS offerings, and PSS has e.g. been described by the environmental community [3] as a way to reduce the environmental impact from products and help dematerialize society. However, companies will never reach 100% in dematerialized PSS offerings. There will always be a need for at least some physical products and, as is discussed in Lindahl and Ölundh [4]. According to these authors, *the physical and non-physical content in a PSS offer must, based on a life-cycle perspective, be developed and related to each other and in relation to the defined customer value in relation to the life-cycle cost of the PSS offer*. Lindahl and Ölundh [4] show that there is no natural and automatic bias towards neither lower cost nor environmental impact when designing PSS offers.

The authors of this paper have conducted research on PSS in cooperation with companies since 1999, see e.g. Sundin *et al.* [5]. Their experiences have given them a unique perspective of the research and company development in the PSS area. They have experienced PSS as a growing concept in the industry (but still in its infancy), but have found a lack of empirical data about its practical application. There exist several papers

concerning how individual companies are working with PSS, i.e. case studies, but more data is needed in order to analyze how companies are approaching PSS in order to make it as successful as possible. The research literature and debate about PSS (e.g. Tukker and Tischner [6] and Mont [7]) also discuss several theoretical assumptions about e.g. driving forces for starting with PSS offerings.

The authors of this paper could not find, at the time this research was initiated, any other extensive quantitative studies comparing how companies are handling PSS offerings and their reasons for starting work with PSS. Therefore, they decided to undertake a survey with ***the overall goal of illuminating how the PSS approach affects manufacturing companies, especially their product/service design processes***.

2 OBJECTIVE

The objective with this paper is to present some of the results from our international research survey. The results are based on a survey of manufacturing companies from Sweden, Japan, Italy and Germany. The research questions (RQs) in focus for this paper are:

RQ1 – What driving forces do PSS providers have?

RQ2 – What is included in PSS offerings?

RQ3 – Who are involved and responsible for PSS development?

RQ4 – Who owns the physical products used in the PSS offerings?

RQ5 – How are physical products adapted to PSS?

3 RESEARCH METHODOLOGY

In order to carry out the survey, the authors choose to design a questionnaire.

3.1 Survey scope

The authors decided to carry out a wide-ranged investigation, rather than a narrow and deep one, in order to better understand the global situations of the various manufacturing industries in Sweden, Japan, Italy and Germany. Although numerous companies were approached, there was difficulty in finding survey participants, since relatively few PSS providing companies existed in 2005/2006.

All in all, the investigation included 46 PSS companies, of which 34 companies fully responded to the survey. The survey was conducted in two steps during 2005 to 2006; the first step covered Sweden and Japan, and the second step Italy and Germany.

3.2 Questionnaire design

Within this paper and the survey, a rather broad interpretation of PSS was used. The term for PSS used in the survey is "product service combinations". The questionnaire survey used for obtaining the empirical data consisted of 56 questions in total, and was mainly developed by the Swedish authors with support from the Japanese authors. Among the questions, 6 were strongly related to the research questions posed for this paper. When designing these questions, potential participants and expert groups were consulted in order to create a well-structured and understandable survey with relevant questions. The questionnaire was dynamically-structured, i.e. the respondents' answers affected which subsequent question to answer. By using these dynamic questions, most of the respondents did not need to answer all the questions, since many questions were not relevant for their kind of business. For example, if the company did not have any product remanufacturing included in their PSS, the respondent was not asked any questions about their remanufacturing business. Having this type of structure and these types of questions made the survey much quicker and easier for the respondents to complete.

In order to obtain answers from the participants that were as correct as possible, the authors decided to write the survey questions in the local language (except for the German survey, where the participants understood English well). Hence, the questions were first written in English and later translated into Swedish, Japanese and Italian, respectively.

Step 1 – Sweden and Japan

The survey was sent out as a web-based questionnaire to the companies in Sweden and Japan during 2005. The software used for the survey is called Survey Generator, and has been used with success in other surveys, e.g. Lindahl [8]. The web-based survey allowed the authors to monitor the different respondents' progress in answering the survey. One could see when the respondent started the survey, and when he/she had finished it. Due to this, the authors could send out reminders or call the respondents knowing if they had started the survey or not. The methodology and results of this survey is further described in [9].

Step 2 – Italy and Germany

The second step focusing on Italian and German companies was conducted during 2006. For this part, the questionnaire was paper-based due to the preference of the participants, yet with the same 56 dynamic questions as used in the web-based questionnaire for the Swedish and Japanese companies. This survey's methodology and results are further described in [10].

3.3 Company Selection

Since the PSS concept in 2005 was still in its infancy, and because it was still difficult to find companies working with PSS (no statistic register existed), the authors decided to identify manufacturing companies providing PSS based on previously established company contacts, as well as on tips from other researchers and company contacts.

Since the researchers have extensive knowledge about the participating countries' manufacturing industries, it was believed that a broader approach, i.e. approaching a greater number of companies, would not provide additional variety of answers.

4 RESULTS

This section describes the results by first revealing the response rate of the survey and the participating company profiles. Secondly, the results from the 6 questions related to the 5 research questions are described in graphics and text.

4.1 Response rate

Table 1 shows the number of respondents from each country and the response rate. The respondents at the companies were closely followed-up by reminder e-mails, and at times reminder phone calls. Reasons provided from the respondents as to why they did not answer the questionnaire or did not finish it were, for example, that they did not have the time or that the scope of questions did not seem relevant for their business.

Table 1. The participants' survey response statistics.

Country	Sent	Received	Return ratio
Sweden	18	13	72%
Japan	10	10	100%
Germany	6	4	67%
Italy	12	7	58%
Total	46	34	74%

4.2 Profile of the respondents

A general classification of the companies contacted in Sweden and Japan is that these companies are working mainly in the area of mechanical and/or electronic industries. The products manufactured by German companies include electromechanical equipment for business applications, expensive investment machines, and home appliances. Those in Italy, in contrast, consisted of credit cards, roasted coffee, pharmaceutical products, mechanical products, paper, supporting equipment for education and machines for the gaming industry.

Most of the respondents (24 of 34) in this survey are companies with more than 1,000 employees, and 10 of 34 had 1 to 500 employees. This means that the companies with PSS that were contacted for this research were for the most part large (> 1,000) companies.

4.3 Survey graphics

When reading the results, one should have in mind that there are a different number of answers that were received from each of the different countries. This is especially important to note from the German part of the survey, which only includes answers from a maximum of 4 participants. This could in some cases give a somewhat biased graph for the German companies. These issues

are solved to some extent by also showing the total response for all countries in the same graph. Therefore, the responses for each country are complimented with an overall black bar called "All Countries" to the right in the graphs. The number in brackets denotes how many answers were received for the specific question.

4.4 Driving forces for PSS

Figure 1 shows that, in all four countries, many incentives for PSS business exist and are connected to the customer. This result points out companies' attention to customer satisfaction, and also refers to the possibility to

establish closer and long-lasting relationships with business customers.

Other identified driving forces, besides those connected to the customer, include (in decreasing order); increased competition, decreased costs, and improved company brand. It is interesting to see that increased competition is a minor reason for Japanese companies in comparison to other countries' companies, especially Swedish companies.

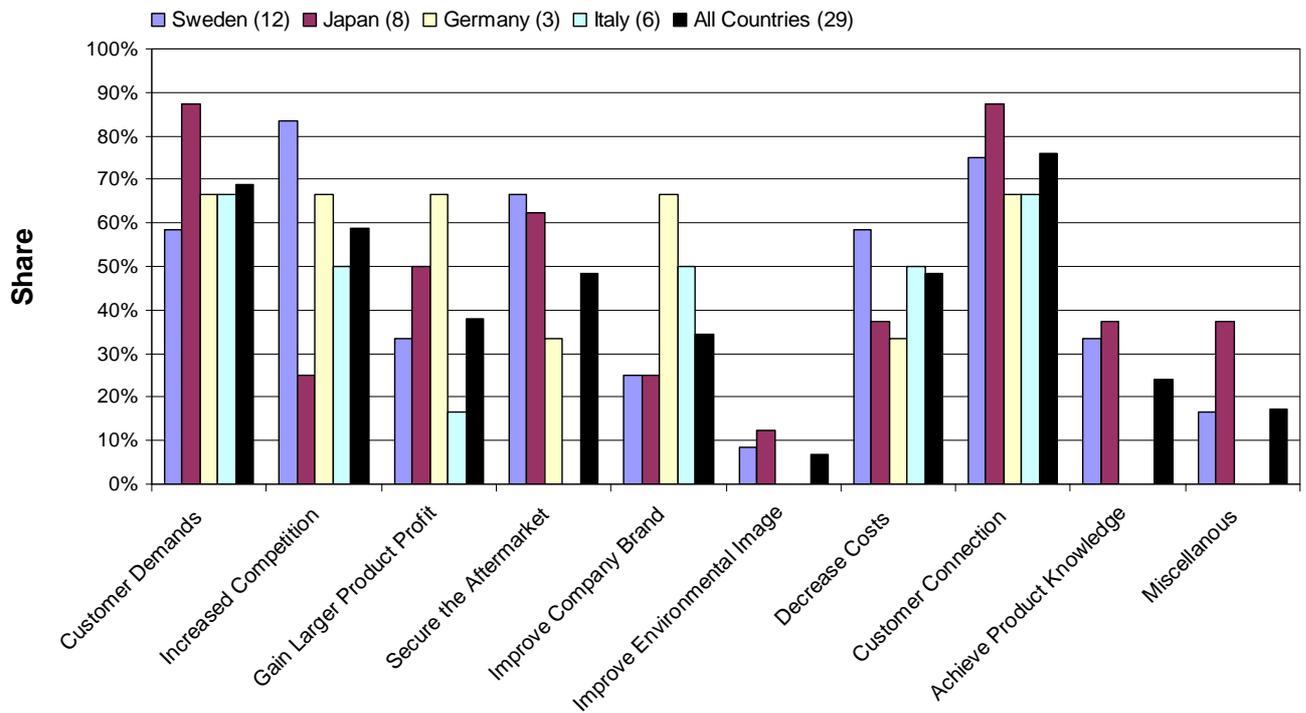


Figure 1. Driving forces for Product/Service Systems providers. (The graph shows each country's response along with the aggregated total, n=29.)

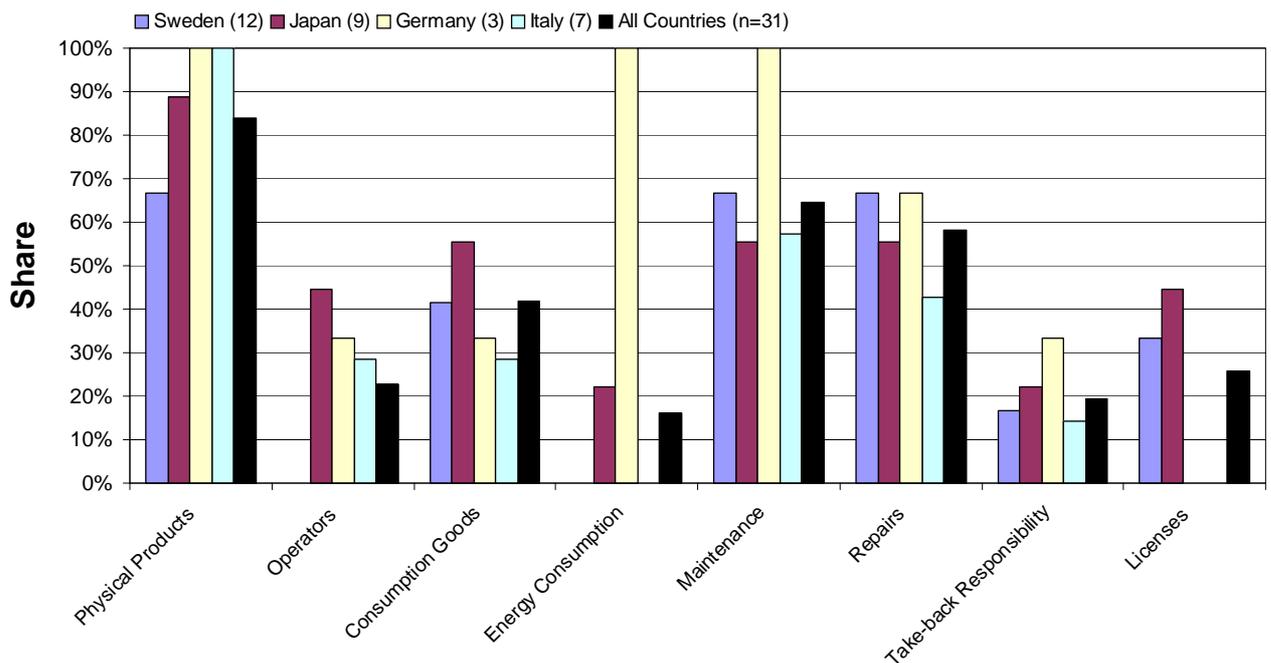


Figure 2. Contents of Product/Service Systems. (The graph shows each country's response along with the aggregated total, n=31.)

4.5 Contents of PSS

In the survey, contents of PSS offers were also investigated. Figure 2 shows that responses from all companies were quite similar. The three main parts of the offers seem to be physical products, maintenance, and repairs. The figure also shows that it is only the German companies that also often included energy consumption in their PSS; however, the average share for all countries which had energy consumption included in their offers was only 16%. Furthermore, it is interesting to see that operators are included by the PSS providers in more than 20% of the PSS offerings.

4.6 Actors in the PSS development

When investigating which departments were involved in the design of product/service offers, it was found that staff from product development, marketing and after-sale was most common for most countries (Figure 3). However, in Italy there was also a major inclusion of the production department. Answers for "Other" include sales department and product line management. It is interesting to see that both the product development and the marketing departments in German companies were often included in the development work but, as seen in Figure 6, the physical products were always standard products.

Almost the same pattern shown in Figure 3 is obtained when asking participants which department holds the

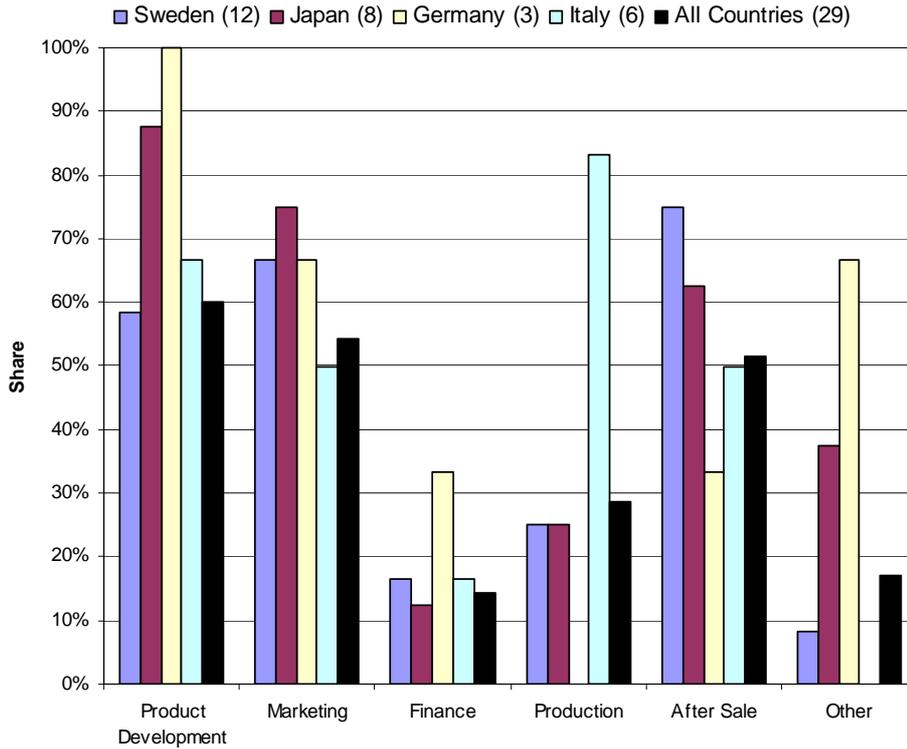


Figure 3. Participating departments in the Product/Service System development. (The graph shows each country's response along with the aggregated total, n=29.)

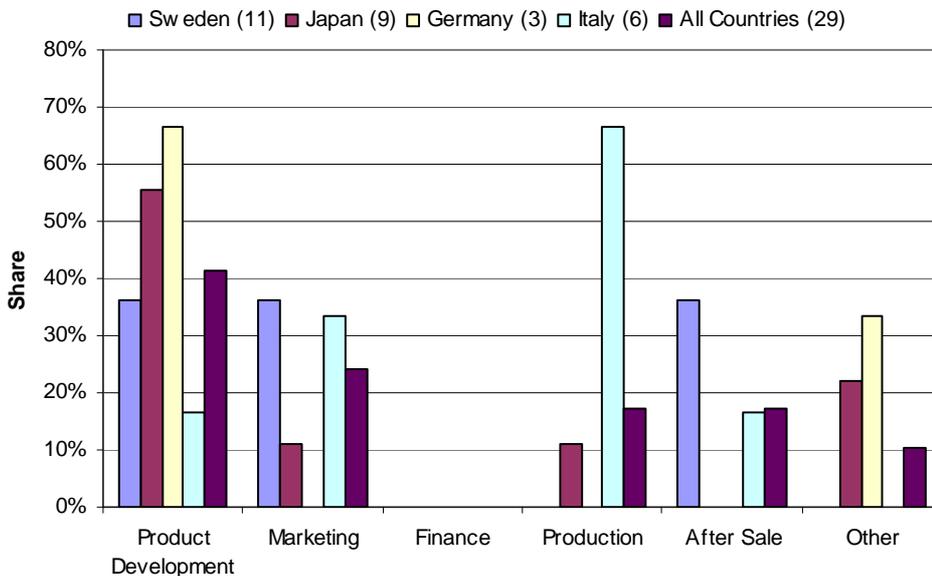


Figure 4. Responsible departments for the Product/Service System development. (The graph shows each country response along with the aggregated total, n=29.)

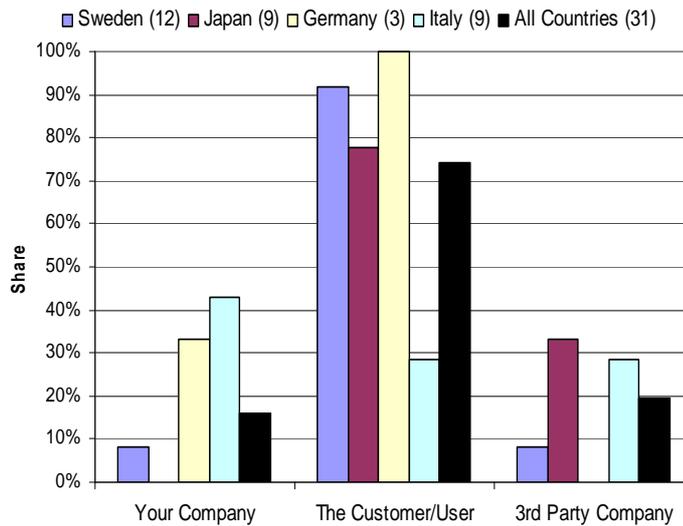


Figure 5. Ownership of physical products used in Product/Service Systems. (The graph shows each country's response along with the aggregated total, n=31.)

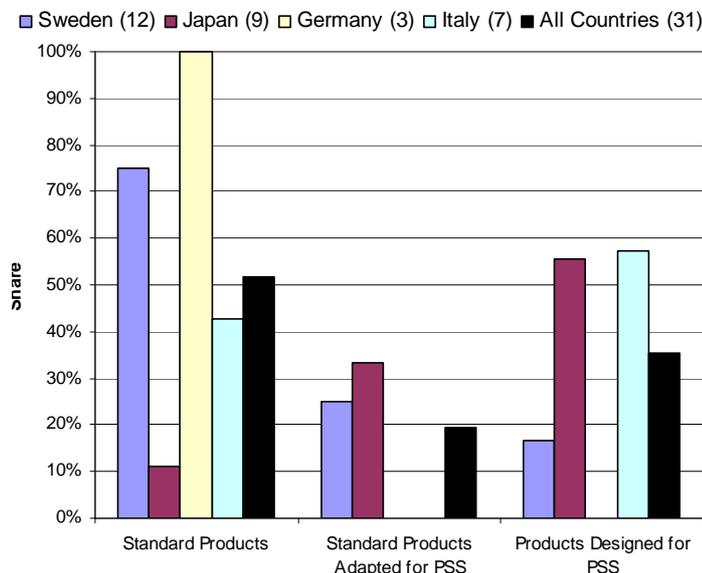


Figure 6. Adaptation of physical products used in Product/Service Systems. (The graph shows each country's response along with the aggregated total, n=31.)

responsibility for the development of product/service offers, as Figure 4 shows.

4.7 Ownership of physical products used in PSS

The ownership of the customer reduces the possibilities and potential profits for the manufacturer to adapt their physical products for the use and remanufacturing phases, since improvements for these phases will not gain any profits for the manufacturer. In addition, the control over the products during use is worse if the ownership is transferred to the user.

Looking at the ownership of ingoing physical products included in the PSS offer when the contract had been signed, Figure 5 shows that the traditional sales-type contracts seemed to be the norm in Sweden, Japan and Germany, while other various types of contracts were found in Italy.

4.8 Adaptation of physical products towards PSS

Figure 6 shows the manner in which ingoing physical products are adapted for PSS. The result shows a mixed

picture, e.g. companies in Sweden and Germany mostly used standard products for their product/service offerings, while in Italy and Japan, the companies more often specifically adapted or designed products for PSS.

The reason to why these differences between the countries exist is not clear. A strong involvement from the responsible departments "product development" and "production" in Japan and Italy could have had a strong influence on the product adaptation (see also Figure 4).

The participants were also asked what kind of adaptations they had made to their physical products. Here are some of their answers:

- "The products are adapted for our business strategy."
- "We have designed surveillance systems in order to reduce production stops for the customer and to maximize the maintenance intervals to reduce our costs. Machines all over the world are monitored."
- "Realization of on-line service by designing a new device to integrate subsystems and adding communication functionalities"

5 DISCUSSION

In sections below, the results obtained from the survey are discussed and summarized with some conclusions.

5.1 Method, response rate and companies

The low number of respondents (n=34) makes it hard to draw any general conclusion of PSS providing companies based on only this survey. However, it is a good starting point for further studies, and the results give an indication of how a number of manufacturing companies in Sweden, Japan, Italy and Germany are working with PSS. The results from the Japanese and Swedish part of the survey are judged to be the most reliable, since the authors of this paper have best overview over those two countries' industry.

Although the questionnaire was sent out to the recipients in two different ways (web-based and paper-based), the authors are convinced that accurate answers were received from the recipients. This is because the authors had previous contact with the companies, and because the surveys were sent out in their own language. The relative high response rate indicates that the selected approach has been successful.

One of the challenges the authors had when starting the survey was to identify companies offering PSS to their customers. The PSS concept was relatively new, and few companies had experience with PSS. This is also quite obvious when reviewing the early literature in this area, where some company examples are raised over and over again. Another challenge, still existing, was that even though companies work with PSS, they very seldom use the term PSS, and it was and is still therefore tricky to identify them. However, since the survey, the concept has become more mature, popular and widespread in industry, making it easier to identify companies. The authors' experience from projects [11] and seminars with companies is that companies' interest in participating in research about PSS has increased between 2005 to 2007. This implies that today it would have been easier to find more participants for this type of survey. This have also been indicated by the possibility to start up a company network of large-sized companies in Sweden [12].

It is interesting to note that the Swedish and Japanese surveys mainly consisted of companies with more than 1,000 employees. Since the authors before the surveys in Japan and Sweden did their best to identify companies working with PSS, the domination of major companies indicates that large companies have been the first adopters of PSS [9]. Not only is this PSS survey dominated by large companies, but so are other studies from this time, see e.g. Windahl [13] and Lakemond Ebbens and Magnusson [14].

A reason why large companies are dealing with PSS is that they can afford to spend some resources on testing new concepts like PSS, and also because the knowledge transfers from academia to major companies is faster and easier than to small companies, since major companies and researchers often have experience working with each other. The Italian survey is an exception, since that survey mainly consisted of small companies with fewer than 100 employees.

5.2 Driving forces for PSS

The presented result shows that the main incentive for companies to work with PSS is connected to their customers, i.e. these companies' attention to customer satisfaction in order to increase the possibility to establish closer and longer-lasting relationships with business customers. The highlighted driver "improved company brand" is in line with this. A good company brand is

important when developing longer and closer relationships. At the same time, a closer and longer relationship has the potential to imply that the amount of contact between company and customer will increase. This also implies that the providing company will have more opportunities to improve their customers' understanding of them. Having a close relation between the manufacturer and the customer has been shown as the most preferable relation to have if the manufacturer wishes to remanufacture its products [15]. This is due to several reasons; one is that better control and knowledge of the product being used is achieved. The connection between PSS and remanufacturing was elucidated early by researchers [5] but and in recent years the connection have been adopted by industry e.g. for PSS sales of forklift trucks and soil compactors in Sweden [16] and photocopiers in Australia [17].

Both previous drivers, "*the possibility to establish closer and longer-lasting relationships with business customers*" and "*more opportunities to improve their customers' understanding of them*" are related to the driver caused by increased competition. A closer and longer-lasting relation with the customer, and a stronger company brand, are means to increase a company's own competitiveness and decrease the opportunities for other competitors to approach a company's own customers, since they are more closely tied through the PSS offer. Furthermore, there seems to be diverse incentives (see Figure 1) for manufacturers in these four countries to have a PSS business which is in line with other PSS research studies e.g. [18].

Decreasing costs are another and quite often mentioned driver for companies to work with PSS. However, this driver is quite obvious and not unique for, PSS since cutting costs is a core activity in more or less all companies. This also is in line with other concepts like e.g. lean product development [19] and lean production [20, 21], which have also become popular in recent years within the industry since those concepts match companies' drivers to cut costs.

Even though many authors, e.g. Mont [3], have highlighted PSS from an environmental point of view, these results show companies do not consider improving environmental image and achieving more product knowledge to be important driving forces for PSS. However, since the results show that a major driver for PSS is to build up a good level of customer satisfaction, this lack of interest in environmental image might change if the customer starts to focus more on environmentally related issues. Since these studies were done, there has been quite an increased focus from customers and society on environmentally related issues; it would, therefore, have been interesting to study further if and how this driver has changed.

5.3 Contents of PSS

As shown in the results, the three main parts in PSS offers are physical products, maintenance and repair (Figure 2). It should be noted that when conducting maintenance and repair, physical products are used and subsidiary products are consumed. Also, all other alternatives answered shows that physical products and/or consumables are provided. This is also in line with Lindahl and Ölundh [4].

The results also show that the content of a PSS offer can vary significantly, depending on how the contracts are written between the PSS provider and the customer. A contract can e.g. beside the pure physical products include more or less maintenance, spare parts, operators and energy consumption.

5.4 Ownership of physical products used in PSS

It is interesting to note that the normal case in the studied companies' PSS offers is that the ownership of the physical products are moved away from the providing company to the user or a third party. This is interesting since some researchers, e.g. Mont [7] and Baines *et al.* [22] consider that ownership of products should not be transferred to the customer for it to be a PSS, while others consider different types of product-related services as a PSS. For example, Baines *et al.* [22] state that "*with a PSS, asset ownership is not transferred to the customer*".

The structure of the ownership is important for the control and logistics of the physical products during use and take-back. If the ownership stays with the provider, there are many benefits to achieve. For example, the product take-back and remanufacturing issues are much more easily dealt with [15].

5.5 Adaptation of physical products used in PSS

From this survey and others similar to it e.g. Ölundh and Ritzén [18], one can conclude that the included physical products were standard products not adapted for PSS. The Italian companies, along with Japanese companies (as opposed to the German ones), seem to be advanced at adapting their physical products for PSS. One potential problem with having PSS offers with non-adopted products, i.e. standard products, is e.g. if they not are designed to enable easy service and maintenance and this is included in the contract.

The incitement for adapting the PSS offerings' ingoing physical products increases if the manufacturer maintains ownership during the use phase. The issues of how physical products could be adapted for PSS and remanufacturing is further described in general in [23] and more in detail in [16].

5.6 Actors in development of PSS

The results indicate that PSS are developed in a quite traditional way, i.e. more or less in the same way as traditional product offers. Participating departments are the traditional ones, with the product development department acting as the stronger and often responsible actor. This might also be a reason why most companies still use standard products in their PSS offers (Figure 6)

In the Italian-German part of the survey two departments, product development and marketing were primarily involved in the product/service offer development, whereas among the Swedish and Japanese companies, the department of after sales had an equally large share of the involvement. In Sweden, the after sales department also had responsibility for the development of the product/service offering at one-third of the companies, in contrast to the results from Germany and Italy. Further, the mix of people in the development teams surely affects the degree of adaptation of both physical products and services of the PSS; this is for example due to the team members' personal experiences and their own departments' incentives. In Sweden, the authors recently have noticed a trend among PSS providing companies that are trying to incorporate more knowledge from service/maintenance and product take-back phases even more now than before when having traditional product sales. Some challenges found for this are the company departments' different goals of their business [12].

6 CONCLUSIONS AND FUTURE RESEARCH

This paper contributes with quantitative data and discussion regarding companies' work with PSS offerings, and gives a good starting point for further studies. It shows that the development of PSS offers has many

similarities to ordinary product development, since driving forces are alike. The result can be used as a base for developing PSS methodologies for Industry. The objective was to find answers to the following research questions. These answers are provided in brief below.

RQ1 – What driving forces do PSS providers have? – Customer connection, customer demands and increased competition were the main driving forces.

RQ2 – What is included in PSS offerings? – Most PSS include physical products, maintenance and repairs. For some (40%), PSS consumption goods are included, and in rare cases (15%) times energy consumption is included.

RQ3 – Who are involved and responsible for PSS development? – The departments of "Product Development", "Marketing" and "After-Sales" are the major actors in PSS Development. In most cases, the "Product Development" department was in charge of the PSS development.

RQ4 – Who owns the physical products used in PSS offerings? – In most cases the ownership is transferred to the customer/user using the PSS similar to traditional sales.

RQ5 – How are physical products adapted to PSS? – Standard products are mostly used in PSS, although the Japanese and Italian companies are more likely to provide products designed/adapted for PSS.

Furthermore, since the number of companies providing PSS has increased during the last few years, it would be interesting to follow up this survey and also include some of the new issues that have been identified in order to get more reliable and stronger data about how companies are working with PSS. Comparison with the activities in the tertiary industry would be interesting as well. The researchers of this paper will continue to conduct surveys regarding PSS in their respective countries. In parallel, the authors of this paper invite other researchers to initiate complementary surveys in line with this survey in their own countries. Future research may also include specific investigation of the operational maintenance methods to be offered by the providers (e.g. breakdown or corrective maintenance, planned maintenance, condition-based maintenance). This includes what kind of support which is needed during the life-cycles of product/services.

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