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Sustainable Product Service System in Pakistan: Exploring the Barriers and Prospects for Adoption

Sajid Nazir*[1], Saba Ali[2]

[1]*Associate Professor, Institute of Administrative Sciences, University of the Punjab, Lahore, Punjab, Pakistan.

[2]Independent Researcher, Lahore, Punjab, Pakistan.

Corresponding author: sajid.ias@pu.edu.pk

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The current paper primarily intends to investigate the barriers encountered when implementing sustainable product–service systems (PSS) in the manufacturing sector for non-assembled products, considering both customer and provider perspectives. It also examines strategies manufacturing companies can adopt to address these challenges. The research employs an exploratory, case-based approach with an abductive methodology. Data were collected through 25 qualitative interviews conducted with individuals from various manufacturing industries. The interviews were carried out in two stages: an initial exploratory phase followed by semi-structured interviews. The collected data were analyzed using the proposed thematic analysis method. The findings are grouped into five overarching categories: three emerging from the providers' perspective—characteristics of the manufacturing industry, customer and market awareness, and specific information requirements—and two from the customers' perspective—core management practices and customer views on servitization. The results indicate that certain theories from existing literature cannot be directly applied to non-assembled products. Furthermore, the study offers new insights into managing several barriers not yet addressed in the current PSS literature.

1. Introduction

A Product-Service System (PSS) results from the co-creation of value within a partnership. Its effectiveness depends on a shared vision of desirable and feasible scenarios (Morelli, 2006; Yang et al., 2024). According to Goedkoop et al. (1999), a PSS is "a set of marketable services and products that together meet the needs of a user." A PSS may be offered by a single company or through a company alliance and can include one or multiple products alongside complementary services. Both the product and the service can play equally important roles in fulfilling the intended function.

The PSS represents a business model focused on delivering a combination of marketable products and services designed to be environmentally, economically, and socially sustainable, with the ultimate goal of meeting customer needs (Annarelli et al., 2016; Thapa & Iakovleva, 2023; Mihailović et al., 2025). Tukker (2015) defines a PSS as a combination of tangible products and intangible services aimed collectively at satisfying customer requirements. It represents a distinct form of servitization, where products' functionality is enhanced by offering additional services.

The development and implementation of Sustainable Product-Service Systems (S.PSS) offer an effective alternative to traditional service models. An S.PSS can be defined as a combined offering of products and services designed to fulfill specific customer demands, delivering a unit of satisfaction. Through innovative relationships among participants in the production system, the provider retains control over the product and its life-cycle responsibilities, allowing for the continuous identification of economically and socio-ethically advantageous solutions (Vezzoli et al., 2017).

Since the late 1990s, S.PSS has been recognized as a promising business and organizational model (Charter & Tischner, 2017; Bijma et al., 2001; Brezet et al., 2001; Cooper & Evans, 2000). Today, these models are particularly effective for expanding access to goods and services in middle- and low-income contexts, thereby enhancing social equity and cohesion. S.PSS represents a win-win approach by integrating the three pillars of sustainability—cultural, environmental, and socio-ethical—and delivering innovations at multiple levels (Vezzoli et al., 2017). As such, S.PSS continues to be a valuable framework for addressing modern sustainability challenges, as evidenced by research spanning from the late 1990s to the present (Brezet et al., 2001; Charter & Tischner, 2001; Goedkoop et al., 1999; Langley, 2022).

Though, the organizations face a number of barriers and challenges during the adoption of Product service system due to unseen necessities during the phase of product use, highly customization of the products and services, service process internal complication and conflicts in attributes of the design (Pacheco et al., 2019; Song &Sakao, 2017). Vasantha et al. (2012) stated that even though the domain of the Product Service System is organized in Sustainability's field, practical development of PSS is not yet mature is this field. The Product Service System was initially developed as a more sustainable alternative compared to old-style product-sales, mainly through the use of improved and extra intensive material (Sundin et al., 2015). Through

switching from a conventional approach to an advanced product-service model, Product-Service System was believed to be able to reduce the environmental impact and provide economic and social benefits to Product Service System suppliers and customers (Vezzoli et al., 2015). At present, however, there is an understanding in the literature that sustainability is not an intrinsic feature of Product Service System business models (Boucher et al., 2016; Pigosso & McAloone, 2016; Doualle et al., 2015). A number of recent research have shown that Product Service System' environmental efficiency can, in some conditions, be inferior to conventional offers of products (Pigosso & McAloone, 2016; Kjaer et al., 2016; Barquet et al., 2016-b).

1.1 Problem Statement

The existing literature shows that the shift to Sustainable Product-Service System is not easy to process and a number of challenges hamper success of manufacturing organizations. The purpose of this research study is to investigate in depth what type of issues companies are facing regarding adaptation of the sustainable product-service system in manufacturing industry internally and externally. The problems are explained partly in the sense of manufacturing organizations by the minimal literature on S.PSS. Operational deployment in manufacturing SMEs at a concrete level is therefore very limited worldwide (Clegg et al., 2017; Boucher et al., 2016; Li et al., 2021; Mihailović et al., 2025).

For businesses, it is more challenging to handle the adoption of Sustainable Product-Service System strategy than the established way of producing products on its own. Changes in corporate culture and organization need to be implemented in order to maintain a more structural innovation-and service-oriented organization (Manzini & Vezzoli, 2002); however, firms resist extending participation over and above point-of-sale with a product (Mont, 2002; Stoughton et al., 1998). Increased engagement needs new skills and strategies in structure and management. This needs investments with long-term and medium levels and is therefore fraught with cash flow uncertainties (Mont, 2004). In addition, another barrier is the challenge in measuring Sustainable Product-Service System savings in terms of environmental and economic to market innovation to the customers and users outside and inside the company or to strategic partners of the company. PSS environment sustainability attained by carbon reduction, packaging waste, EOL and recycling, social sustainability attained by supporting employees fairly, good community member and corporate social responsibility, economical sustainability attained by profitable business, proper governance and risk management. (Manzini & Vezzoli, 2002).

Many research has shown that business models of Product Service System provide environmental advantages and could be a bottleneck (Barquet et al., 2016; Thapa & Iakovleva 2023). It is necessary to build a profitable Product Service System so that consumers are ready to pay for innovative values added in order to capture the market value (Mont, 2002). Simultaneously, it is important to control costs effectively. Therefore, Product Service System's productivity is hard to show because cash flows are unpredictable and it is difficult to quantify savings (Gebauer et al., 2005). Pricing and mitigating threats are major issues faced by producers when extracting interest from safe Product Service System (Reim et al., 2016; Baines et al.,

2007). By others as, there is a major potential to use the framework of a model of the business to coordinate the company's operations and practices towards a shared stated goal, use the framework as a guiding tool, and achieve internal and external alignment in the process to produce Product Service System that could have a beneficial impact on the company's performance (Ferreira et al., 2013; Li et al., 2021, Mihailović et al., 2025).

Product Service Systems are eco-friendly models that combine Business with sustainability. Nevertheless, a Product-Service System ability to offer its potential benefits has been debated lately, primarily for environmental concerns (Annarelli et al., 2016; Doualle et al., 2016). However, transferring from the existing system to Product-Service system is a challenging task for manufacturing businesses (Kjaer et al., 2016; Vezzoli et al., 2015; Salazar et al., 2015).

1.2 Research Questions

The main purpose of the current research study is to explore the barriers which may be faced by the Manufacturing industry during adaptation of the Sustainable product-service system and to identify the possible solution that can be implemented to overcome these barriers. The key research questions are:

- What are the key barriers involving the transition to S.PSS within the manufacturing industry into practices?
- How do manufacturing firms overcome these barriers?
- How can firms organize and control the switch regarding S.PSS-oriented business techniques?

1.3 Significance of the Study

This research is significant in terms of its theoretical-practical contribution to the existing body of research knowledge. The theoretical such as the academic support of barriers of Sustainable product-service system implementation used in the current research study. The previous researchers studied the Sustainable product-service system in different scenarios explained the advantages and disadvantages of transferring the business from a typical system to the Sustainable product-service system. However, previous research literature failed to explain the barriers that can be faced by the manufacturing industry while adapting to the Sustainable product-service system.

Because of lack of research study in the current scenario, this study has been aimed to explain the barriers of adopting the Sustainable product-service system in the manufacturing industry. There are many barriers faced by manufacturing companies in the implementation of S.PSS. These barriers could be Internal, External, Technical and non-technical. These barriers are associated with one another. The existence of numerous barriers and compound relationship generates a challenging situation for company management in designing strategic decisions. So, it is mandatory to clearly understand these barriers and their relationship so the company can

make a significant strategic plan to overcome barriers. This study will help the managers to cope up with barriers with resource utilization internally and externally.

2. Literature Review

An S.PSS model is a lower-resource commodity and a similar service mix for a company that increases profits while satisfying the same demand compared with the traditional commodity sales model. Cost reductions are caused by decreased product material volumes, simplified distribution costs and reduced costs throughout their use and storage due to longstanding product liability. This means that it is in producers' economic and competitive interest to promote continued innovation in reducing environmental impacts, as well as enhancing social equity and cohesion in the S.PSS approach in comparison with a traditional product-sales offer. During use, the volume of resources consumed by the producer can be reduced during the economic interest stage, as profit depends on the cost of the customer per service unit. Since the manufacturer prevails the "master" maintains at least responsibility for the product during its life cycle, financial support for the product's extended lifetime is given. In this way, the manufacturer delays both the cost of disposal and the production costs for a new product. Besides, at the end of the product life, the manufacturer can reuse or replicate ingredients to preserve waste on the premises and advanced output components.

Moreover, the manufacturer has economic reasons to examine other ways of extending material life, such as improvement, repair, reproduction and recycling. S.PSS reduced the initial investment and operational costs to the customer/user benefits. The advantages are related financial and more vastly sociotechnical since S.PSSs can extend approach to valuable goods and services to lower-income levels. In other words, the S.PSS recommend focusing on access, instead of possession: for example, if a solar panel smashes inadvertently, there are no quick repair costs, they lower or enable users to avoid the initial capital investment, and people with low incomes do not have to buy a solar panel at once. Moreover, S.PSS offers to focus more on the context of their use since they do not sell only products: the relationships between the end-users are opening (and/or extending). This should lead to more (more competent) local and not global stakeholders being involved, thus sponsoring and facilitating local economies' strengthening and affluence.

The Product Service System (PSS) is defined by the previous researchers as a set of marketable services and the products having the capability to jointly meet the needs of consumers. The ratio of the service and product in the group can vary, in economic or the service desire fulfillment terms (Mont 2002 and Goedkoop et al., 1999). Therefore, the old previously used material-intensive methods of utilization of the product are exchanged with the possibility of meeting the needs of the customers by delivery of even additional dematerialized services that may also frequently relate to the ownership structure changes. Towards the development of Product service system several trends and the approaches can be drawn:

- Instead of selling the product, sale of Product use (Stahel, 1991),

- Moving towards a "Leasing society" (Braungart, 1991),
- By the terms of service machines, the substitution of products (Schmidt, 1994),
- Instead of the "throw-away society" the Repair society (Blau, 1997),
- The variation in the user's arrogance to service orientation from the sales (Mont, 2002)

The researchers conducted studies on the concept of the "Sustainable product-service system (SPSS) that goes beyond the boundaries of the business and comprise all the stakeholders of the business into the process (Mont, 2002, Jansen &Vergragt, 1997). Another researcher suggests the idea to use the strategic design as an innovative method for businesses to involve in a progressively "turbulent" market. The strategic design emphasizes the process of the design on a combined body of services, products, and communications as a model for the businesses to report technological changes and consumer attitude along with the social attitude (Mont, 2002, Manzini, 1996)

2.1 Implementation of S.PSS

The existing literature highlights the urgent need to shift away from unsustainable development and social practices. Cleaner manufacturing alone cannot bring about short-term change unless environmental, cultural, and social dimensions are integrated into enterprise management systems (Almeida et al., 2017). Many organizations are actively pursuing such changes by offering high-value services as recommended by experts (Song & Sakao, 2016; Meier et al., 2010). These organizations are moving toward a closely integrated combination of products and services (Beuren et al., 2013).

The concept of "servitization" can be understood as the ongoing process of transitioning from selling solely products to offering product-service systems (PSS), incorporating strategic innovations that enhance organizational capabilities. A PSS represents a structured network of players, services, and products delivered in a sustainable and economically viable manner (Mont, 2002; Tukker, 2004). It plays a key role in the servitization process and has been shown to improve resource efficiency (Tukker, 2015). Furthermore, PSS enables producers to differentiate themselves from competitors by providing unique and value-added offerings (Meier et al., 2010).

The Theory of innovative problem solving (TRIZ) is known worldwide for its ability to solve problems systematically and produce inventions (Pacheco et al., 2019). The SPSS objects were classified by PSS: 1 PSS, 2 use-oriented PSS, and 3 results-oriented PSS, respectively (Pacheco et al., 2019). Not all case studies contained sufficient information for defining S.PSS 'business prospects and company. Nevertheless, business relationship types could be identified, such as B2C and B2B. There were no tests for B2 G. Only a number of studies have shown the size of the organization investigated. Abdalla et al. (2005) analyzes the US machinery industry SME and the electromechanics industry. For instance, there was a heterogeneous category consisting of case studies. For example, Shih et al. (2009) discussed the PSS method for designing eco-innovation laptops to reduce their environmental implications. Also, Chen and Liu (2012) proposed an environmentally sound low-carbon PSS design method and used it for an all-embracing case in the physical life of a personal computer.

2.2 Barriers of S.PSS

The Sklet (2006) claimed in previous literature that "*A barrier function is intended for preventing, regulating, mitigating and preventing undesirable events or accidents*." These barriers categories can be internal or external and it can be managed in different ways. The internal barriers can be correlated to resistance towards change, organizational culture, differences of interest, absence of senior management support, lack of training and education, technical staff support and strategic planning. The external barriers can be correlated to consumerism growth, competition, and customer satisfaction, lack of demand, High labor prices and know-how about PSS. It is very important to find possible ways to overcome these barriers.

Bartolomeo et al (2003) point out many factors that could have an impact on the market growth of eco-efficient production services. Which include supply-side factors such as organizational heterogeneity, skilled labor, corporate participation, infrastructure and labor cost, and demand-side factors such as the short-term mechanisms for decision-making, translation, control rates, and user versatility? A number of studies have uniformly conducted a series of obstacles to S.PSS development in the manufacturing industry.

It is important to emphasize that the environmental benefits do not contribute to each modification of PSS: PSS must be specifically developed, produced and implemented in the case of a highly eco-efficient system (Vezzoli et al. 2018). The total cost of the fuel and its effect on the environment will make it unsustainable in some circumstances in the long term. For instance, schemes in which products are loaned and refunded in costs for the transport of fuel and polluting emissions over a product's lifetime or the following use. Furthermore, it has been noted that certain PSS adjustments can lead to unintentional side effects, typically known as rebound effects. The company has a complex, interrelated system that is not clearly understood.

As a result, there may be something that turns future environmentally sound solutions into a realistic increase in global environmental resource consumption. One example is the consumer behavior impact of PSS (Vezzoli et al., 2018). For example, outsourcing may lead to reckless (less ecological) behaviors rather than ownership of goods. However, the perceived creation of the S.PSS offers huge potential to generate economic and environmental advantages. Strategies for winning are important. It can provide the conditions necessary if not sufficient to allow companies to sprinkle into social and economic systems with less resource-intensive dematerialized (Vezzoli et al., 2018).

The development and implementation of S.PSS remain a problem for most companies. For this reason, previous studies have shown some barriers to overcoming this challenge (Rovida et al., 2009):

1. Users accept and adopt new alternatives.
2. Resolving contradictions and incoherence in this transition (for example, in the course of a sustainability-based service transformation trade-off between different sustainability objectives).

3. Adequate support was missing. The benefits of systemic methods will alleviate these problems.
4. The absence of technical training and education of personnel's regarding management, recycling of product and long-term cooperative relationship.
5. The lack of efficient management information system for EOL (End-of-life) product management.
6. The absence of involvement of senior management in developing strategies and boosts up company's performance.

TRIZ provides an insightful way of understanding the solution field. It shows how a potential paradigm will evolve and stimulate creativity to help break the mentalities and analytical inertia of conventional designers. The toolkit TRIZ fosters systematic thinking and stresses the importance of both hardware and software co-evolutionary approaches (Rovida et al., 2009).

2.3 S.PSS implementation and diffusion barriers

While possible advantages and drivers have been noted above, the S.PSSs tend to be a little diffused. One significant explanation is that this market idea faces major economic, cultural and regulatory challenges in the majority of cases. The following sections highlight the barriers to the implementation or dissemination of S.PSS solutions for companies and for those who accept these proposals. It is important to note that an interaction between the various factors, not the individual factor ones, determines the responsiveness of S.PSS (which resounds as an entity's willingness to embody, understand and use the concept of S.PSS) (Cook et al., 2006). The emphasis is primarily on industrial contexts since most research so far refers to the S.PSS and B2C.

The biggest internal challenge for businesses is that it is easier to execute a strategic S.PSS than the conventional distribution of just goods. This is why the company should have a PSS culture (Martinez, 2010). In order to support systemically increasing innovation and S.PSS-organizational enterprises (UNEP, 2002), changes in corporative attitude and organization are necessary. (Cook et al., 2006) has shown that the receptivity of S.PSS in organizations that have service transactions is more likely. Given the major gaps in the production and distribution capacity and know-how of S.PSSs, the company needs new skills and experience in management and design.

S.PSS provides the S.PSS with methods of design and assessment (UNEP, 2002) and with methods for costing life cycles to develop performance metrics for evaluating the organization's competitive and efficient potential for productive S.PSS bids. The company also needs to be structured in such a way that it can prepare, manufacture and deliver (Martinez V, 2010). That is why corporate personnel need training and additional personnel may be required. The internal disputes between the roles in the organization will prevent such changes. The lack of an internal common language and the synchronization of thoughts will intensify these conflicts (Martinez, 2010). An additional aspect of S.PSS success and failure on the supply side

was its lack of organizational participation (Bartolomeo M, 2003). The shift in income processes is also an internal obstacle: medium to long-term investments are part of the S.PSS business models in comparison with short-term profits produced at the sales point. S.PSSs is thus related to cash-flow uncertainty which could lead to producers considering S.PSS companies to be riskier than products. Moreover, SMEs often cannot finance these types of business models because of their usually limited financial resources. (K, 2005). The challenge of quantifying the S.PSS's savings in economic and environmental terms is another obstacle to marketing development both internally and externally or to the strategically relevant partners of the business. The development and distribution of PSSs ensures that the stakeholders in the value chain work closely with each other. The fear that sensitive information about business processes, products and technologies will be shared may present a potential barrier to this, another obstacle to decreasing regulation of core competence and the effect on cooperation and sector interdependence of client decision-making (UNEP, 2002). As regards the supply chain, potential disputes between companies aiming at lowering market volumes and traditional retail interests, which can raise sales, represent a further barrier (Cooper, 2000).

On the other hand, there are certain implementation barriers for customers. For instance, M (2012) claimed that the S.PSS definition is not popular or popular with customers. The consequence is confusion as to the risk; cost or liability and the benefits of SPSS from its customers may be misunderstood. A large number of customers (particularly in the field of B2C) lack general understanding (Bartolomeo M, 2003). The possible economic benefits of S.PSS-based approaches are hard for them to understand. S.PSS-based transactions, while they may be reverse, are often seen by the end-user in comparison to product purchases as costly: the initial cost of acquisitions can be higher and the overall cost of ownership, including usage, maintenance, repairs and disposals, which is typically not covered by the end-user in the purchasing of a product. In fact, in his S.PSS study, (Mont, 2008) it pointed out that human and social psychological, social and institutional behavior is much more nuanced than simply a rational price reaction because customers are affected by several domestic or external drivers. The main obstacle in this respect is that cultural change is necessary so that the way without ownership can be appreciated rather than owning a product (Goedkoop, 1999).

The problem is that solutions based on access (e.g. sharing) contradict existing, well-established ownership standards, thus making it difficult for clients to consider proprietary solutions (Goedkoop, 1999). This is especially valid for the different types of needs (e.g. we do not use the concept of a washing machine in the house that does not belong to us when washing our clothes); while in other situations we have entered into our routines with no owners (e.g. public transportation). In contrast to private clients, it is important to note that business customers prefer practical sales rather than ownership of the goods (Alexander, 1997). Moreover, as emphasized by (Wong, 2004), the expansion of S.PSS on the consumer market is heavily influenced by the sensitivity of its culture. For example, S.PSSs have been accepted more readily than in many other countries in community organizations such as Scandinavia, the Netherlands and Switzerland (Wong, 2004). It is an additional obstacle to the diffusion of

proprietor fewer solutions that the quantities and quality of the stored goods are seen to be a measure of life progress as it indicates a certain place in society. In addition, as (Halkier, 1998) stresses, the current trend of individualization is stepping up demand for consumer goods, given that a person's identity is no longer defined by a community but by goods. In this sense, the renovated goods and systems for sharing can be regarded as second-class citizenship. However, development and collective use of the sharing economy was regarded as a way of using incentives to encourage adoption of solutions driven by S.PSS. (Mont, 2004a) has indicated that some S.PSS groups have a responsibility to establish control and product condition management systems at consumer sites. It includes access to client records and consumer details. A sensitive data protection problem may occur for many customers. In addition, the autonomy of the goods, their hygiene and their expectations of intimacy may also be combined with concerns regarding uncertain access and sharing offers (Management, 2012).

The cost of social and environmental consequences are important background factors which contribute to strengthening traditional product offerings and preventing PSSS solutions given that they do not form part of SPSS market prices, this means that S.PSS solutions can find it difficult to compete with the manufactured products since the environmental and social cost associated with a product does not form part of their market prices (Mont & Plepys, 2003). That is why government interventions are necessary to implement policy measures that can internalize externalities and thus encourage sustainable innovation in the environment and society. As pointed out by (O, Mont, 2001), traditional policy tools that target product environmental performance are not sufficient. Governments must participate in policy actions that can encourage, directly or indirectly, the spread of S. PSSs.

Moreover, labor costs are increasing, so customers can buy products specific offers (e.g. purchase a washing machine) rather than labor-intensive solutions such as PSS services at a lower price. Furthermore, there may also be context-based barriers to the lack of outside facilities and technology (e.g. for commodity processing, reprocessing or processing) (UNEP, 2002). Product-service systems require close collaboration with their manufacturers' suppliers, service manufacturers or end consumers. While standards and ecological purchasing practices of ISO 14000 deal with provider relationships, EPR and product management concepts are used to address downstream practices. Integrated Chain Management deals specifically with several participating actors to improve the environmental performance of products. However, issues with ICM can also impact PSS, since they are on the same basis in the life cycle. The problem of selecting the wrong actors who are not capable of changes or influence (while the major player is chosen for the product-service systems – producer of a service provider and related service); sharing information and transparency; material flow barriers although ownership free consumption ideally offers many benefits and hopes, they have their own problems, For example, study to date shows that multiple applications do not automatically have fewer environmental effects. The impact on the atmosphere depends largely on the conditions, schemes and uses. For example, if leasing products that would otherwise not be affordable for customers the environment may have a significantly greater impact.

Without the rental option, the purchases should be postponed until the next day, a cheaper version would be purchased, or other alternative usage concepts would be used without this option. However, leasing can facilitate returning of an old device, as it monitors the duration of use and returns once the lease is finished if the purchase option is not available. The confidence of producers in their goods could be increased and the economic situation for the closing cycle of the economy improved significantly. Different structures and profits may discourage producers from using this principle because profit is derived partly from the lease and rent of goods, partly by the exchange of goods with communities in which producers can create various schemes and alternative uses of goods. Where the point of sale is an ongoing point of operation, classical rewards cannot represent the real drivers of profit for the business and therefore the transition from short to medium- and long-term profit-making is a special issue. In addition, the opportunity to increase revenue and profitability not via sales but by energy efficiency services (DSM) and CMS (Command Side Management). Moreover, the possibility is another aspect of PSSs, which impacts usual profit-raising options. These cases can become especially difficult for companies when PSS decouples the volume of products from profit. Companies' aversion to extending their interaction with a product beyond the point of sale and historical experience has been described as a significant barrier to expanded production responsibility for the environmental effects of a product.

The increased participation leads to changes in the organizational sector and inter organizations, for example, closer interaction with other actors in the product service chain. This occurs partly because of inertia and fear of innovation. The redirection of businesses to product-service structures demands a radical change in organizational culture and in consumer participation, which takes time and money to help change. Modifying the company's orientation means changing the traditional marketing concepts. Psychological barriers in large companies are frequently encountered. Furthermore, risks such as lack of information and qualifications, errors and disruptions from new activities and processes, costs of adaptation and adjustment are likely to impede readiness for changes in the services offered. There are still a variety of very small PSS apps. PSSs are usually utilized for a small range of usage, limited use, high cost in purchasing or maintaining the product (e.g. computer copying machines), or where specific knowledge is required to maintain a product.

Furthermore, purchasing and ownership appear in the longer term to be the cheapest option, which is becoming increasingly expensive. Due to the differences in service reporting in national and international statistics, the shift in services or manufacturing industries is hard to trace. For manufacturing companies, support divisions such as human resources, restaurants and workforce health centers are needed. In general, a range of resources and additional services for all products was developed and produced. Incorporating environmental factors into the product development process is often viewed as an increased market time. The entire product-service system should also be developed according to the criteria of environmental efficiency. Consumers' ownership is not very exciting. There has been little encouragement for private business initiatives by several concrete examples of introducing product-service technologies in

the commercial sector. The famous models, such as car-sharing, are still restricted to market niches. The customers' requests and purchases proved more complex or incomprehensible. It reflects no reality that the consumer is more interested in use instead of ownership or seeks use rather than goods. Of course, access and psychological factors play a much bigger role than size, cost, functionality and design as regards ownership. Only by developing and integrating organizational and social circumstances can a sustainable innovation potential in consumption without ownership be realized to make society more accepting.

2.4 S.PSS Research Agenda Main issues

Research hypothesis, studies and experiments have been submitted, but the S.PSS approach is only limited. However, it was hopeful that no author, including S.V., argued that such a model of offering clearly would not be a solution for the further promotion of societal sustainability whatever constraints were described as restricting implementing and distributing S.PSS. This optimism is one of those reasons for the adoption and dissemination of this Paper from the Cleaner Production Journal: a cross-disciplinary research system must be accepted and encouraged by guest authors. The purpose of the last section is to identify key issues that the publication editors should focus on on the Draft Research Agenda, with a view to further disseminating and implementing sustainable product services systems from this perspective and in particular in design.

Some contributors to have cross-cutting such problems while the research group has not yet addressed others. Due to the useful results and experience of numerous project projects financed by the EU focusing on sustainable service and development, the Sustainable Learning Network (LeNSes) and the Literature Network of Sustainable Energy Systems (LeNSes), several problems have been established. Such research guidelines can be used in the following areas: S.PSS knowledge generation user; b. Disclosure to knowledge and know-how organization's significance creation to support S.PSS.

3. Methodology

For the current research, the manufacturing industries are the priority industry as they have relevant interest in product services system (PSS) for the non-assembled products. The industry can be the producer be of steel, iron, glass, automotive manufactures and many others. This research is about sustainable product service system for manufacturing products and qualitative research approach through interviews is used. Data has been collected from thirty managers from procurement department, Supply Chain/Logistic distribution department and production department etc. from different companies by conducting interviews.

To gain a deeper insight and knowledge regarding the problem, 12 interviews were conducted during the first phase. The barriers which are identified in the literature review were discussed during the first phase of interview, whereas an open discussion about PSS was held simultaneously with the respondents. The respondents were the individuals who are working in different manufacturing companies as it is significant to realize the practical exposure more

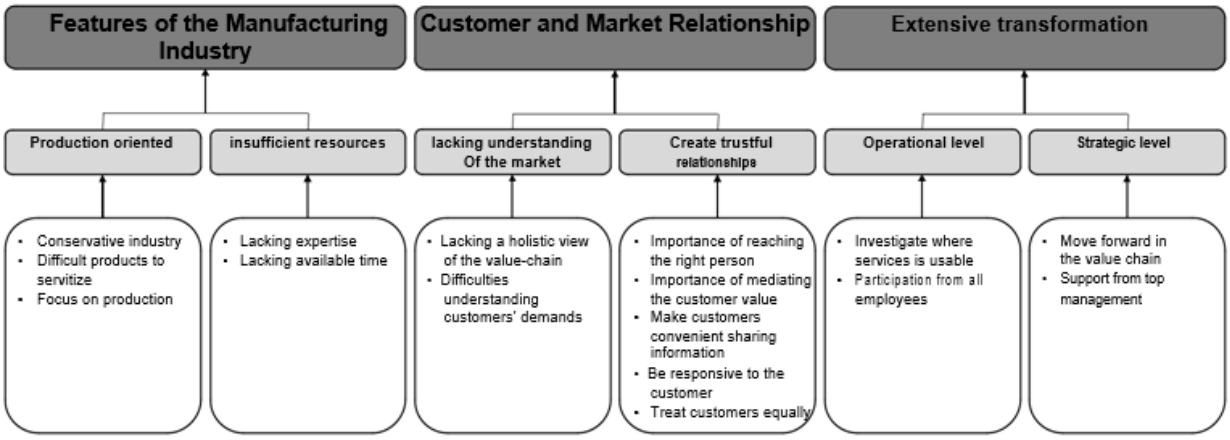
widely. Around 13 interviews were conducted during the second phase, the respondents were identified from first interviews and snowballing method, with the search for participant with suitable competence. To objective of this phase of interview was to get in depth knowledge of the gaps that were identified during the exploratory interviews with the research gap. An interview guide was developed just before the second phase of interviews initiated and designed with assistance from the explorative interviews and the literature review. The average length of these interviews ranged 25-50 minutes and conducted via Skype, face to face or telephone.

The thematic analysis is used in thesis when evaluating the data. According to Braun and Clarke (2006), it is the most effective method which is widely used for handling qualitative data. In this study, we have made abductive approach. The thematic analysis is well matched for this research due to its flexibility. The steps which are used for analysis like familiarizing with the data, generating initial codes, searching for themes, reviewing themes, comprehensive naming categories and producing the report. To line up with the research analysis, to ensure acquired data is collected, coded data for easier management, suitable themes, clear sense of categories and final report.

4. Data Analysis and Results

The data collected from the interviews are then analyzed and inclined to fulfill the objective of the research in this chapter. The analysis is divided into two segments; one analysis is for the customers and one for the providers. Firstly, in the providers' section, the analysis from the 13 respondent's collected data from six different manufacturing industries is presented. The assessment is built on three key categories which are associated with sub-themes and main themes. The figure for a thematic map below represents the perspective of the provider. Sub-themes are presented at the bottom of the map.

Figure No 1: Thematic map for providers



4.1 Overarching Category 1: Features of Manufacturing Industry

The first category identified is the characteristics of the manufacturing industry, which includes the main themes of "insufficient resources" and "production-oriented" practices. Table

1 presents quotations from respondents that correspond to the associated sub-themes. The theme of being production-oriented emerged prominently, with most respondents emphasizing that production remains the primary focus within the manufacturing sector. At the same time, some respondents expressed both positive and negative conservative views. This focus on production can act as a barrier to implementing Product-Service Systems (PSS). Additionally, several significant challenges exist in sustaining a Sustainable Product-Service System (S.PSS), which must be addressed to successfully advance servitization in this industry. One respondent illustrated this scenario as follows:

"Let's suppose you are operating a small sport boat within the ocean, you can do whatever you want, if something went wrong, you may just turn around the cause. But we act as big armor, if we transform courses we should plan in good time and if we have a transformation, it is challenging and time to go back again. This is the reason we are reluctant while implementing innovations in the manufacturing industry" – R4.

Table No 1: Overarching Category 1

Production Orientation			
Research Question	**Plaintiff**	**Response**	**Sub Theme**
1	R12	*"In the process industry, the emphasis is heavily on maximizing output per ton, as that is where the revenue lies—and it's something you simply have to manage."*	**Focus on production**
1	R15	*"These are high-value bulk products, and when it comes to such items, finding alternative services is not an easy task."*	**Difficult products to servitize**
1	R4	*"The systems in these industries operate at a slow pace, meaning that any decision must be made with absolute certainty. The potential consequences are significant, leaving no room for trial-and-error; once a choice is made, it must be the right one."*	**Conservative industry**
Insufficient Resources			
Research Question	**Plaintiff**	**Response**	**Sub Theme**
1	R10	*"…a shortage of competence is a challenge. These industries place heavy emphasis on production, with very limited investment in developing expertise within other departments."*	**Lacking available time**
1	R1	*"A critical mass of skilled employees is essential—people who can both enhance existing offerings and develop new products and business opportunities. Achieving success depends on acquiring this level of expertise quickly and at a high standard. At present, we have not yet reached that point."*	**Lacking Experience**

Alternatively, the manufacturing industry can indeed be observed as a quite conservative industry where the organizations have a main focus on current situations and that's why they prevent making major challenges. The feature of this industry, though due to the several features of this industry high fixed costs and large investments and the environment of minimizing the risk seems to be logical and there are no particular methods to manage these barriers that have been recognized.

The next main subject is insufficient resources, which reflects that the manufacturing industry is lacking resources in both forms i.e. competence and employees. When elaborating this point, R4 and R10 commiserated that their companies need innovation. One respondent state that.

"One of the biggest barriers in the manufacturing industry is the resources, the companies are often very thin which leads to challenges to allot time to investigate or develop new ideas like servitization. – R10"

R8, a senior manager in the manufacturing industry, echoed this concern, emphasizing the importance of hiring skilled personnel with specialized product knowledge. The majority of participants shared a similar view, underscoring the significance of competence. This highlights the need for manufacturing organizations to strengthen their capabilities if they wish to overcome such barriers.

4.2 Overarching Category 2: Create trustful relationships and lack understanding of the market

The next overarching category is customer and market awareness comprise of two key themes. Creating trustful relationships and lacking understanding of the market are those two themes.

The point which urges service providers to examine the market and search for probable service opportunities. The common thing in which many of the respondents states that the provider should look ahead to the core-product and core-process of service opportunities. Because of this action, the barriers which are difficult to manage can easily be managed, but it requires a lot of effort. One respondent stated that:

"It is about the feasibility of the market if the market is flexible so you can give away as much as you want but when the market gets competitive and tougher and the demand increased, you should be able to do innovate in line with this. If you cannot bring innovation during the period, it may be difficult for you to go through. Have you initiated with this when it is a tough time on the market, then the customer must stay even when the market becomes flexible" – R12?

These points alternatively lead us to another significant sub-theme which is challenges while understanding customer's demand, many respondents. Today, many organizations in the manufacturing industries are lacking both competence and resources to be involved and learn

about the process of the customer. It is the critical barrier when organizations must have an opportunity to develop PSS. To manage this difficulty, some respondents stated that providers should take participate and gain knowledge about the perspective of consumers.

Table No 2: Overarching Category 1

Lack of Market Understanding			
Research Question	**Plaintiff**	**Response**	**Sub-Theme**
1	R3	*"…the key is to adopt a broader perspective, potentially moving beyond our core business, where our product forms just one component of a larger system. We must step back and consider how our products function, as well as the benefits and drawbacks they create for our customers."*	**Lack of general view of the value-chain**
1	R14	*"I believe the biggest barriers today are the lack of appropriate expertise and an incomplete understanding of our customers' processes. As a result, we often do not fully grasp what customers truly want, which makes it especially difficult to servitize our offerings."*	**Hitches in considering consumer demand**
Trustful Relationships Creation			
Research Question	**Plaintiff**	**Response**	**Sub Theme**
1	R14	*"One challenge is that my main contact is often the customer's purchaser, who rarely possesses the technical expertise needed to appreciate the value of adding services. I believe it's important to involve a broader range of competencies in meetings—for instance, representatives from both purchasing and production departments—so that communicating the value becomes easier."*	**Importance of reaching the right person**
1	R1	*"It is crucial to demonstrate that the service is unique and clearly communicates the value it creates for the customer. Quantifying that value in monetary terms—regardless of whether you charge for it—offers a significant advantage, as it allows customers to see its true worth. Without this, there is a risk they may fail to recognize the service's value, making it harder to sell."*	**Importance of mediating the customer value**
1	R6	*"There is always a fear of giving up what you perceive as a competitive advantage, and this barrier will always exist. Even with an NDA in place, complete security is not guaranteed. You may have processes you are reluctant to share. In our case, it's about building a strong relationship with the customer—an NDA can open the door, but developing that level of trust takes considerable time and is not an easy task."*	**Make customers convenient** **Sharing information**

One responded R 10 said that:

"We should access resources and dedication to this kind of work. The resources will always be required for problem-solving in the manufacturing process and the problem is that we have

not enough time to compete on new product development and implementing new concepts and innovations. We need committed resources that just operates in this region." – R10

4.3 Overarching Category 3 – Extensive Transformation Required

The next category is extensive transformation reflects the significant changes that are required both on a strategic and operational level which are the two main themes in table 3 below:

Table No 3: Overarching Category 1

Operation Level			
Research Question	**Plaintiff**	**Response**	**Sub Theme**
2	R11	*"We have been following this approach for some time, striving to engage in the customer's processes to identify where our potential services could add value."*	**Investigate where services are usable**
2	R14	*"I believe it's essential to have a well-defined plan—identifying the key resources and determining where services can be integrated into your products. This should be carefully considered before deciding to adopt this concept."*	**Investigate where services are usable**
2	R3	*"In some of our projects, multiple companies are involved, making it crucial to share a common vision. The same applies within our own organization—if we are to implement a change like this, we need a unified perspective, with everyone participating in the decision-making process."*	**Full Employees Participation**
Lack of Market Understanding			
Research Question	**Plaintiff**	**Response**	**Sub Theme**
2	R3	*"I think a current challenge is that you can't just take a portion of the opportunity—you need to take it as a whole. One possible solution could be forming a joint venture, where everything is shared, including revenue, costs, and responsibilities."*	**Move forward in the value chain**
2	R10	*"I believe it is essential for top management to have the willingness to change, making a strategic decision to expand and grow in the area of service offerings as well."*	**Support from top management**

Overall, the data from respondents, supported by the relevant literature, indicate that implementing a Product-Service System (PSS) requires a significant organizational transformation. Another key insight is that many respondents emphasized the importance of first having a strong core product before considering the addition of complementary services. This

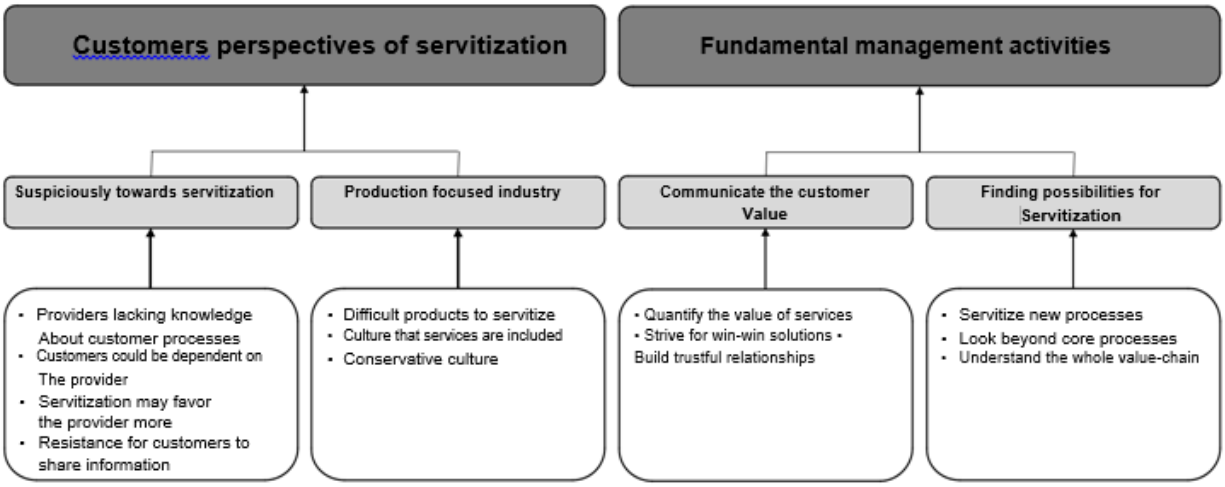
substantial transformation, as highlighted by the majority of respondents, represents a major barrier to adopting PSS within manufacturing organizations. Respondent R-12 stated:

"A major transformation is required to do, if you want to succeed with this we need to have a concrete trust internally, thus, we should allocate time internally to include everyone that is affected. We will fail quickly if everyone has not possessed a common view"

4.4 Customer's Perspective

This chapter analysis is presented with the data collected from our six different respondents who have collected from four different customers. Figure 2 illustrates the thematic map for the customers' perspective; the same structure is discussed in Figure 1.

Figure No 2: Thematic map for customers



4.5 Overarching Category 4 – Customer Perspectives of Servitization

The fourth overarching category, reflecting the customer perspective on servitization, is a critical aspect highlighted by respondents in the process industry. This category is divided into two main themes: skepticism toward production-focused industries and attitudes toward servitization (see Tables 4 and 5 for details). From the customers' perspective, high requirements are emphasized when involving a provider in their products and processes. Respondents also noted that the process industry places strong emphasis on price, volume, and production. Many respondents explicitly rejected sharing any sensitive information about their processes, which represents a significant barrier to implementing PSS. Several customers observed that the benefits of servitization often favor the provider, who may gain greater access to the customer.

Table No 4: Overarching Category 1

Servitization Shadiness			
Research Question	**Plaintiff**	**Response**	**Sub Theme**
1	C1	*"…it is very challenging—we simply purchase a basic bulk product and handle it ourselves, and in doing so, we prefer not to let the service provider access our confidential processes. I believe this is definitely one of the biggest barriers."*	**Resistance for customers to share information**
1	C4	*"One barrier to this type of cooperation is the dependency it creates on the provider, making it very complicated if we ever wish to switch to a different one."*	**Consumer's Dependence on provider**
1	C2	*"It is crucial for the service provider to understand why we operate the way we do and why we offer different quality levels to various types of customers. However, involving them in our processes is challenging, as they often lack the necessary competence and understanding."*	**Lack of Provider's awareness about consumer processes**
1	C2	*"Allowing the customer into our processes leaves us even more exposed. It often feels as though the provider benefits more from this arrangement than we do, which makes it difficult for us to accept."*	**Servitization will errand provider**
Production focused industry			
Research Question	**Plaintiff**	**Response**	**Sub Theme**
1	C4	*"Perhaps it's human nature to resist change. I also think it relates to the metrics we use—everything is measured, monitored, and rewarded in terms of tons, and anything that disrupts that is seen as negative. That's simply how we track performance. However, significant changes are possible when major problems arise; otherwise, they rarely happen."*	**Conservative Culture**
1	C3	*"…some providers could certainly become more involved in our processes and move further along the value chain, and this is feasible from a practical standpoint. However, the biggest issue is that neither we—nor anyone else in the industry—are willing to pay for it, as this is not a common practice in our sector."*	**Culture that services are included**
1	C6	*"Working with bulk products is undoubtedly challenging. Maintaining quality is generally easier with other types of products."*	**Difficult products**

Two respondents noted that to mitigate dependency, the goal is to have each product supported by two providers, reducing the risk of being tied to a single provider. This barrier can

be managed by creating a win-win arrangement: as stated by R4 and R5, if a provider is involved in the customer's processes, they must guarantee a reduction in total costs, or else compensate the difference. Overall, customers require solid assurances before allowing providers to engage in such servitization. One respondent summarized this by stating:

***"The provider must deliver on their promises; they must commit firmly rather than relying solely on examples from previous cases. As a purchaser, the term 'hard guarantees' is what truly captures your attention."* — R5**

In accordance with these two hindrances, most of the respondents have stated another obstacle about the information at the provider's side, it is that the customers lack expertise regarding processes and processes of their customers as well. It is clear that the respondent does not want to be bound to one provider by sharing their secrets in their processes. Customers have suspicious views regarding servitization, they or of the mind that it is very hard to comprehend what basic belief PSS might bring to them.

5. Discussion and Conclusion

This research provides a clearer understanding of the barriers encountered in implementing PSS for non-assembled products, along with strategies for managing them, summarizing the study's key findings. There are mixed opinions and some uncertainty regarding whether communicating the value of servitized offerings poses a problem. Nevertheless, a significant number of respondents identified it as a notable barrier. Both customers and providers agreed that the development of service offerings requires the value of services to be explicitly quantified. This is closely linked to the difficulty customers face in communicating value; however, both parties emphasized the importance of engaging the right stakeholders. For instance, if the service offer is presented only to the purchaser, there is a risk that it may be rejected outright. Such barriers can be mitigated by having a solid understanding of the service's value and its impact on total costs. Additionally, involving individuals with diverse expertise in these discussions is a key factor in overcoming such challenges. Both sides also highlighted that establishing a trustful and strong relationship is essential for successful PSS implementation. Change within the process industry is generally difficult, and the conservative culture may act as a barrier. While there is an inherent resistance to change, the cautious approach is largely due to the structured and rational nature of companies in this sector. As a result, both customers and providers must navigate this barrier carefully. In summary, changes should ideally be supported or implemented with careful consideration and reliable data.

In academic literature, Product-Service Systems (PSS) are well-documented in relation to products and the process industry; however, these two areas have not previously been integrated, representing a significant gap in current research. Recent studies on PSS have explored business models, implementation, barriers, and benefits primarily for assembled products. Kallebber and Olivia (2003) noted a lack of knowledge regarding PSS in the process industry, a gap later pointed out by Azarenko et al. (2009) and Martinez et al. (2010) which is addressed by this research. It contributes to the existing literature by investigating this underexplored area and

offering new insights for future research. Specifically, prior research is extended in two ways in this study:

Firstly, this study examines whether knowledge of PSS in relation to assembled products can be applied to non-assembled products, while also contributing to a deeper understanding of the concept. Our findings suggest that certain aspects of the literature are indeed transferable. For instance, barriers related to information sharing, highlighted by Vezzoli et al. (2015) and Mont (2002b), as well as resistance to organizational change, identified by Oliva and Kallenberg (2003) and Martinez et al. (2010) among others, were confirmed as applicable to non-assembled products. In addition, our research identifies unique barriers specific to the process industry that have not been addressed in previous literature (Oliva & Kallenberg, 2003; Martinez et al., 2010; Mont, 2002b). Examples include the need to account for technical support in pricing structures and the challenges posed by the purchasing department.

In total, the non-assembled products are somewhat transferable to assembled products as we have confirmed the barriers related to PSS. Furthermore, there is an assumption that non-transferable products can easily transfer other parts of the PSS literature, which is an assumption, which provides the basis of future researchers to consider this as well. We support former scholars Lager (2017) and Frishammar et al. (2012) since literature is partially transferable, empathizing while doing these cautions consideration should be taken. The process industry is regarded as a distinct sector characterized by its production-oriented nature, where stakeholders generally avoid taking risks. This cautious approach, along with the focus on basic products, influences the applicability of PSS literature and raises questions about its transferability to this context. Moreover, in this research, we have further elaborated existing theories and literature in Figure. 3 and addressing the PSS area with new intuitions with regards to how we can manage barriers and what specific actions are required for every identified barrier.

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