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Product-Service Systems across Life Cycle

The Focus-Activity framework for evaluating PSS cooperation readiness of manufacturing firms

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Abstract

For manufacturing companies venturing the first steps on the Servitization roadmap, it may be difficult to imagine how an integrated approach of Product and Service elements could support the strategic goals efficiently. If Service tasks, roles, units and organizational structure are still developing and emerging from the Product business activities, the design of Product-Service cooperation as well is promising, as the way is unclear. For these companies, it seems to be important to understand their current status of Product-Service cooperation at first, before starting to design integration activities.

Therefore, this paper presents a framework which is designed to help companies identify their current status – and strategic objectives later on – at two dimensions: a) the Structural Focus of Product and Service business within the company, and b) the Cooperation Activities which are undertaken by Product and Service representatives. By the means of a case study in the Italian luxury textile sector, a first validation of the model is conducted, assessing the static and dynamic characteristics of Product and Service business with involvement of an Italian textile company.

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Keywords: Servitization; PSS; Cooperation; Framework; Dominance; Textile;

1. Introduction

The convergence of Product and Service into Product-Service Systems (PSS) is a major challenge for manufacturing companies worldwide. Indeed, one of the major obstacles, hindering the implementation of PSS among the European manufacturers, is to preserve the specific characteristics of Product and Service business in a value chain, without creating isolated and disconnected business areas. How can the heterogeneous characteristics of Product and Service business be harmonized within a company, without hindering them to do their business most adequately to the market? The answer to this question is connected to the modalities of cooperation between Product and Service Business, which are explored within this paper.

Particularly, two dimensions relevant for cooperation patterns between Product and Service business within a company are presented: Structural Focus for the foundation of either Product or Service within the company, and Cooperation Activity for the behavioural interaction between Product and Service alongside the phases of Product and Service lifecycles.

By deploying these two dimensions, a framework for understanding the levels of cooperation between Product and Service businesses is presented and validated by means\ of a case study of the textile sector.

2. Characteristics of Product-Service cooperation

Characteristics of intra-company Product-Service cooperation have been addressed for example by the model of Product and Service development [1].

It differentiates between four alternatives of cooperation patterns related to the development of Product and Service components. The alternatives illustrate how the development processes of Products and related Services can be allocated within a chronological timespan.

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In alternative A, Service components are developed after the Products have been developed they relate to. For this reason, there are no defined interfaces between both of them. Most often, Product components are successfully developed and even sold, before the company thinks of additional Services that could be offered.
Alternative B represents the situation that Service and Product components are developed in separated development projects each. However, there are touching and exchange points at defined cooperation interfaces, to align the respective development processes. Here, the objective is to develop synchronized Product-Service bundles.
In alternative C, the company has implemented a truly integrated development process. Continuous cooperation between Product and Service development ensures that a highly integrated bundle of Product and Service components can be created. In contrast to alternative B, alternative C maintains intense coordination efforts in all development phases, synchronizing Product and Service development frequently.
Alternative D represents the counterpart of alternative A: Only after the Service components have been developed, the Product components are getting engineered. However, in Product-oriented companies, alternative A should determine the majority of companies, as in manufacturing, mostly the Products are developed first and then appropriate Services are added (cf. alternative A) or both – Product and Service components – are developed in a parallel or integrated way (cf. alternatives B or C).
However, the model of [1] does not differentiate the kind of lead, which takes place between Product and Service development. Additionally, it is focused at development (or engineering) activities only, whereas cooperation can be viewed under more and different perspectives. Providing a broader scope of Product-Service cooperation, Table 1 illustrates the differences between the characteristics of chronological lead and dominance lead:

- Chronological lead: Only the aspect of time is regarded when examining the Product and Service activities. For example, in Type 1, Product activities precede some or all of the Service activities.
- Dominance lead: Concerning the Product-Service cooperation, in Type 1 it is not clear whether some or all of the Product activities dominate the Service activities. For example, Product activities could precede Service activities, however being dominated by Service.

Table 1: Product and Service cooperation patterns

P-S cooperation patterns	Type 1	Type 2	Type 3	Type 4
Chronological lead	Service activities follow Product activities	Product activities follow Service activities	Product activities aligned with Service activities	Product activities integrated with Service activities
Dominance lead	Product activities dominate Service activities	Service activities dominate Product activities	Balanced dominance of Product and Service activities	No dominance of either Product or Service activities

The conceptual work about dominance in Product-Service cooperation led to the notion that dominance could be found in companies in two main dimensions:

- Dominance of either Product or Service business in the various structural elements of a company: Here called Structural Dominance as a static characteristic.
- Dominance of either Product or Service business in the behavioural cooperation between both of them: Here called Cooperation Activity as a dynamic characteristic.

In the following sections, two dimensions for defining types of Product-Service cooperation are presented: Structural Focus and Cooperation Activity.

2.1. Dimension A: Structural Focus of Product-Service cooperation within organizations

Regarding the first dimension “A: Structural Dominance” the question was how the structural elements of a company with relevance to Product-Service cooperation could be defined. Suitable approaches were found in the literature about challenges for manufacturing companies willing to step forward at the Servitization strategy [2, 3, 4]. For example, [5] argue that the challenges for the development of Product-Service system offers can be summarized in the following four categories: “Business strategy and decision making”. “Internal organization structure”, “Team composition” and “External networks and customer relationship” . Similarly, [6] summarises the challenges at the following levels:

- *Service strategy*: Alignment of organisation in changing markets and value chains
- *Service-oriented organisational culture*: Emphasising Service quality, centering operations around customers
- *Organisational structure/ configuration:* Defining Service business units, reorganising decision making
- Market-oriented Service development: Creating a well-defined Service development program, including co-Production with customers
- *Service offering*: Classifying Services, building a Service portfolio
- *Knowledge management and communication*: Fostering intrafirm collaboration, implementing marketing
- *Transition stages*: Defining the roadmap of the Servitisation process

A compact overview about structural elements within companies relevant for Product-Service cooperation, is given by the “Star model” by [7] as a framework for decision making in organization design.
As a synthesis of the approaches described above, ten dimensions of structural dominance are defined:

- *Strategy* is the constitutive signpost, setting the company’s way of what business to deal with and how to handle it successfully. In order to be supportive towards the management of Product and Service cooperation, the other organizational parameters have to be aligned to the strategy.
- *Network* addresses to the external ecosystem of a company, for example its value chain partners like supplier and customers. Also technology, research, or consulting partners may complement the network.
- *Capabilities* – or core competences of the company – are to be synchronized with the strategy, differentiating the enterprise, or its ecosystem network respectively, from its competitors by providing unique combinations of skills,

technologies, and processes.

- *Organizational structure* has to account for the different bias of Product and Service business units, defining division of work, and allocation of power and authority.
- The design of business *processes* should determine how cooperation between Product and Service units is managed.
- *Infrastructure* comprises the facilities of a company, which can be assigned to either Product or Service departments (or to both of them). Examples of infrastructure are IT hardware and software, rooms and Production halls, machines and tools.
- By means of *rewards*, behaviour is guided into the desired direction, e.g. to acquire more Service-relevant knowledge in customer interactions by valuing this knowledge by supervisors.
- While capabilities refer to competences on a collective level, the *people* parameter addresses individual skills and talents of employees and managers. For example, it could become relevant if crucial customer knowledge can be developed on the base of the present workforce, or if experts having that knowledge should be hired from the external labor market, additionally.
- Last, *culture* plays a decisive part for establishing Service business successfully, as Service-oriented values and behavioral patterns differ substantially from those of Product-oriented business.

Dominance of Product/Service may vary independently across characteristics of organizational structure. However, in a company located at a basic Servitization level, the correlation between the ten characteristics is likely to be higher, than for a company having developed a greater body of supporting Services, or even integrated solutions.

The subsequent discussion of the approach presented above, led to the perception that not only the categories of structural dominance should be regarded as being independent from each other, but also the relation of Product and Service business towards each other as a whole. This means turning away from the concept of dominance, as dominance implies that if the dominant subject (e.g., Product business) has a certain value in the structural categories, than the other subject (e.g., Service business) must have a lower value – or the other way round. Accordingly, the values of Product and Service business are in inverse proportion, as long as their relation is defined in terms of dominance.

Hence, in this paper, the term “structural dominance” is replaced by the term “structural focus”. This accounts for the independency of Product and Service business values across the structural categories. Accordingly, when assessing the ten categories of the structural focus four types of companies can be derived theoretically (Tab. 2):

- Type I: Product business AND Service business likewise, score high in structural focus. This could be the case with parallel or integrated Product-Service business.
- Type II: Product business having a high structural focus in the company, while Service business scoring low. Implicitly, this case resembles a company with a low Servitization level: Product business is actually dominating Service Business.
- Type III: Here, Product business is rated low in structural focus, while Service Business scores high. This type resembles a company located at a high Servitization level, probably offering mainly Services with a little share of Product components.
- Type IV: Product business as well as Service business show only a low level of structural focus in the organization. This type may apply to young enterprises with low general differentiation and formalization of its organization structure, for example.

Table 2: Independent structural focus types for Product and Service business

		Service business	
		High structural focus in organization	**Low structural focus** in organization
Product business	**High structural focus** in organization	Type I	Type II
	Low structural focus in organization	Type III	Type IV

2.2. Dimension B: Product-Service Cooperation Activity within organizations

The cooperation between Product and Service business within a company, has not yet been broadly stressed by research in terms of quality of cooperation. Some approaches deal with Product-Service cooperation in terms of:

- The presence or absence of interaction: E.g. [8] in terms of a Design Structure Matrix (DSM), opposing the Product Lifecycle Management (PLM) phases with Service Lifecycle Management (SLM) phases, and marking the cells of the matrix where interactions take place between both lifecycle phases.
- The direction of information flow: E.g. [9] use also a Design Structure Matrix (DSM), however indicating in the cells the direction of information flow, either coming from Product to Service or the other way round.
- Passive or active involvement in cooperation: [9] present a checklist with parallelized Product and Service development tasks, showing what company functions (e.g., Production, sales, buying) are involved in the tasks, in two different ways: a) being passively informed, b) taking actively part in Product-Service coordination.
- Information-related interactions: i.e. coordination, exchange of information, negotiation, and solving conflicts.

Extracting general characteristics of Product-Service cooperation from the approaches above, two categories are suggested to describe the quality of cooperation between Product and Service units: a) the passive vs. active quality of cooperation activities, and b) the domains which are targeted by these cooperation activities. Table 2 illustrates the two quality characteristics of cross-sectional Product-Service cooperation in an integrated model.

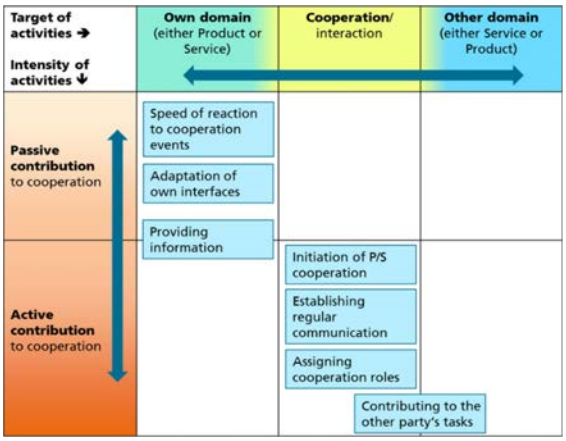


Fig. 1 Behavioural dimensions of Product-Service cooperation activities

The first dimension: a) passive vs. active quality of cooperation activities, is depicted in the first column of Fig. 1. It ranges from passive ways of cooperation, like reacting to cooperation events, to active cooperation activity, like proactively forwarding information to the other party (Product or Service). The second dimension: b) domains targeted by these cooperation activities, ranges from the own domain (depending on the perspective of Product or Service business) over the cooperation between Product and Service, towards the other domain (either Service or Product business). The activities positioned in Fig. 1 illustrate the range of qualities which can occur in Product-Service cooperation:

- *Speed of reaction to cooperation events*: This characterizes the time which is needed for either Product or Service personnel, to react towards triggers and critical events for cooperation, e.g. important customer feedback, newest information about competitors, critical development milestones, or period of delivery being at risk.
- *Adaptation of own interfaces*: This activity covers the change of process, IT, or other interfaces in the own domain, in order to enable a better synergy between Product and Service business. E.g., IT interfaces of the own software system are adapted towards the data requirements of the other domain, so that data transfer is made possible or more efficient, respectively.
- *Providing information*: This activity can be conducted passively or actively. A passive way of providing information could be the storage of data within the own domain, and making it accessible in case that the other party (Product or Service) requests the data. A more proactive way of this activity would be to take the initiative to send information to the other party, without waiting for the request.
- *Initiation of Product-Service cooperation*: By approaching the other party and starting the communication between Product and Service personnel, is meant by this characteristic. This can relate to single events, or even to the initiation of a systematic cooperation between Product and Service business.
- *Establishing regular communication*: This characteristic addresses the creation of regular and formalized information flow between Product and Service units, e.g. by scheduled coordination meetings, scheduled reports and presentations, or regular data exchange.
- *Assigning cooperation roles*: Roles for cooperation for example may be moderating, coordinating, management, or conflict solving roles. By assigning cooperation roles to Product or Service employees or units, tasks and responsibilities for the role owners are defined.
- *Contributing to the other party's tasks*: If mutual contributions between Product and Service representatives are agreed upon, for example Service could contribute to the ideation, requirements collection and evaluation of the Product components. The other way round, Product staff could support the portfolio management and the marketing of Service components. In both cases, the activities exceed the borders of the own domain, thus contributing to tasks of the other domain.

3. The Focus-Activity model for PSS

In order to visualize empirical values of the dimensions of Structural Focus and Cooperation Activity in an integrated model, two alternatives are seen: a) displaying the values of a company per item/question, or b) summarizing the discrete values into an index. Here, the option b) will be shown, as an index is more suitable to get across the overall picture of Product-Service cooperation.

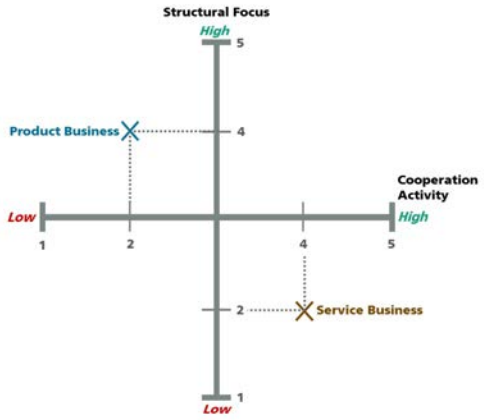


Fig. 2 Visualization of Product/Service Structural Focus and Product-Service Cooperation Activity (Sample values)

The X-axis represents the Product-Service Cooperation Activity dimension, while the Y- axis represents the Structural Focus dimension. The mean of the values has been used as an index for positioning Product and Service businesses in the chart. Besides, the values of Product and Service business can be determined separately at the two dimensions "Structural Focus" and "Cooperation Activity", as shown in Table 9. Opposing the extreme groups of high and low values, four types can be derived:

- Type I: High structural focus in organization combined with high cooperation activity
- Type II: Low structural focus in organization combined with high cooperation activity
- Type III: High structural focus in organization combined with low cooperation activity
- Type IV: Low structural focus in organization combined with low cooperation activity.

Tab. 3: Extreme groups of "Structural Focus" and "Cooperation Activity" and resulting types in a) Product and b) Service businesses

a) Product Business	**High Structural Focus** in organization	**Low Structural Focus** in organization
High Activity in Product-Service-cooperation	Type i *Well-established team player*	Type ii *Non-established team player*
Low Activity in Product-Service-cooperation	Type iii *Well-established individualist*	Type iv *Non-established individualist*

b) Service Business	**High Structural Focus** in organization	**Low Structural Focus** in organization
High Activity in Product-Service-cooperation	Type i *Well-established team player*	Type ii *Non-established team player*
Low Activity in Product-Service-cooperation	Type iii *Well-established individualist*	Type iv *Non-established individualist*

As Table 3 indicates, the four resulting types can be applied towards Product Business, as well as towards Service Business. Together, the combined model of the two dimensions is here called the "Focus-Activity-Model for Product-Service Cooperation". A first step of its empirical validation will be described in the next section by means of a case study in the textile sector.

4. Case study in textile sector

A case study in Italian luxury textile sector, i.e Piacenza, has been adopted in order to test the combined Structural Focus – Cooperation Activity model as well as the questionnaire developed. To test a questionnaire means to understand if it presents five features [10]: simplicity and viability, reliability and precision in the words, adequate for the problem intended to measure, reflect underlying theory or concept to be analysed, capable of measuring changes. For empirical assessment of data, the questions' validity and reliability are crucial [11, 12]. Reliability is defined as the repeatability, stability or internal consistency of a questionnaire. In this sense, by testing and retesting reliability, questionnaire stability of a measure over time can be assessed.

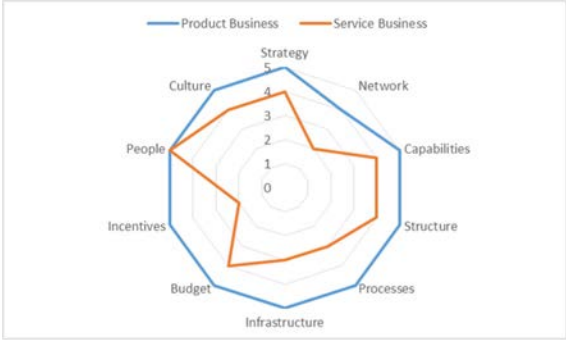
Questionnaire validity is a characteristic which comprises the following three different aspects [11]: Content validity, Criterion-related validity and Construct validity. Therefore, the expected outputs of this validation phase are summarized in the following points [13]:

- Understand how long the questionnaire took to complete and clarity of instructions;
- Identify questions unclear or ambiguous;
- See if respondent felt uneasy about answering;
- Find any major topic omissions from the interviewer's viewpoint;
- Control if questionnaire layout is clear and attractive;
- Obtain any other additional comments.

5. Results

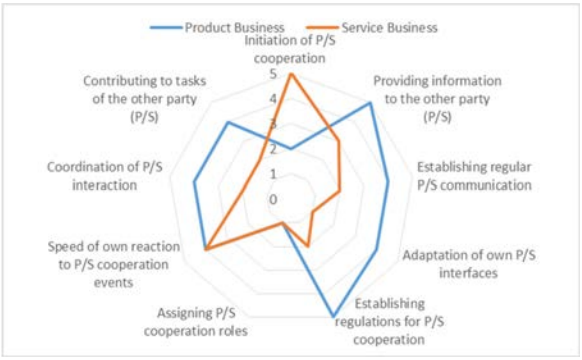
Numerical results of the first questionnaire validation with Piacenza are shown in the next two Figures, visualized in the form of a radar diagram. Figure 3 shows the pattern of the Piacenza validation on the dimension of Structural Focus, comparing the values attributed to Product business at the one hand, and to Service business at the other hand. The greatest deviations between Product and Service values appear at the characteristics of network, incentives, processes, and infrastructure. Except from the people characteristics, the Service values turn out to be always smaller than the Product values. This is in accordance with the fact that Piacenza is a manufacturer with little formalized Service structure within its organization.

Fig.3 Piacenza- Structural Focus profile



In Figure 4, a more heterogeneous pattern is identified: At the dimension of Product-Service Cooperation Activity, Service business is assessed higher or same as the Product business in terms of "Initiation of cooperation", "Establishing regulations for Product-Service cooperation" and "Speed of own reaction to Product-Service cooperation events". At the other characteristics, Product business possesses higher values.

Fig.4 Piacenza- Cooperation Activity profile



Altogether, the distance between the Product and Service values mostly is bigger than it is at the Structural Focus dimension. According to the discussion with the respondents, the higher values in Cooperation Activity are due to the fact that separated streams of cooperation are not yet implemented, as there are no domain-specific shares of communication, regulations, interfaces etc.

Figure 5 shows that Piacenza is focused more on the Product business than on the Services, thus depicting the enterprise as a manufacturer with a basic Servitization level. At the same time, Product business appears more prepared to cooperate than Service business. These results are aligned with a manufacturer with a basic level of Servitization like Piacenza, where the Product still represents the core of the company strategy.

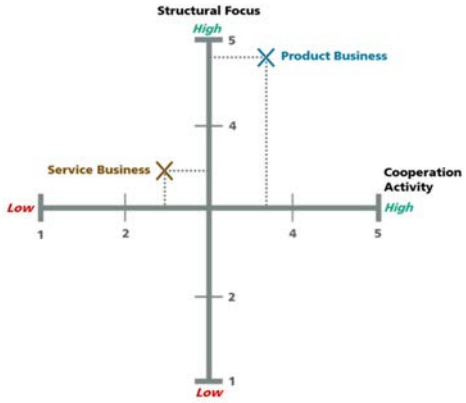


Fig.5 Piacenza: Focus-Activity profile

6. Conclusion

The Focus-Activity Model and its application for empirical assessment in terms of the questionnaire seem promising to help manufacturing companies identify their current status of cooperation between Product and Service business. By comparing Product with Service business, As-is with To-be values, or the own company with competitors, extensive information can be attained on the Structural Focus and Cooperation Activity dimensions. Combining the static view of structural implementation with the dynamic view of cooperation between Product and Service businesses, the strategic alignment of a company's Servitization activities can be supported. For example, in a company with a low Servitization level, Service business might be less represented in the structure of the company in terms of resources, network and culture. However, it could be more active than Product business in terms of initiating Product-Service cooperation, providing information to Product representatives, and even contributing to their tasks. Comparing Product and Service business by the Focus-Activity framework, a) strengths and weaknesses of each can be identified as well as b) imbalances between Product and Service resources. Proving that e.g. Service is assigned less resources than Product business, however is trying even harder to cooperate with Product representatives, could pave the way for strengthening the position of the "junior partner" by the management of the company. E.g. improvements could address management decisions to better include the Service strategy into the overall business strategy, to integrate existing Service ecosystems more tightly into the Product business networks, or to implement joint Product and Service processes to enhance coordination and synergy effects.

Future development of the Focus-Activity framework will be focused on a maturity approach, combining maturity levels with management guidelines for P-S cooperation.

Another aspect to be further investigated will be the relation between the four types identified within the focus-activity framework and the a) business models and b) Servitization levels of companies.

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References

[1] Spath D, Meiren T, Münster M. F&E-Management für Lösungsanbieter. zfbf Sonderheft 2012; 65/12:73-87.
[2] Jungiger S, Sangiorgi D. Service design and organizational change: Bridging the gap between rigour and relevance. In: Proceedings of the 3rd IASDR Conference on Design Research. Seoul, South Korea: Korean Society of Design Science, 2009. p. 4339-4348.
[3] Gebauer H, Fischer T, Fleisch E. Exploring the interrelationship among patterns of service strategy changes and organizational design elements. Journal of service Management, 2010, 21.1: 103-129.
[4] Martinez V et al. Challenges in transforming manufacturing organisations into product-service providers. Journal of manufacturing technology management, 2010, 21.4: 449-469.
[5] Wallin J, Chirumalla K, Isaksson O. Enabling organizational changes for development of product-service system offers. In:Proceedings of the 19th International Conference on Engineering Design (ICED13). 2013.
[6] Kinnunen RE, et al. Servitization of manufacturing companies-Framework for analyzing servitization capabilities. 2011.
[7] Kates A, Galbraith JR. Designing your organization: Using the STAR model to solve 5 critical design challenges. John Wiley & Sons, 2010.
[8] Kremer, D.; Lambert, S. (2013): Service Engineering Methodology for Product-Related Services. Deliverable 12.4 of the EU project MSEE, ManufacturingService Ecosystem.
[9] Aurich JC, Clement MH (ed.). Produkt-Service Systeme: Gestaltung und Realisierung. Springer-Verlag, 2010.
[10] Garcia de Yébenes Prous MA,Rodriguèz Salvanés F, Carmona Ortells L. [Validation of questionnaires]. Reumatología clínica, 2008, 5.4: 171-177.
[11] Cooper DR, Schindler PS, Sun J. Business research methods. 2006.
[12] Rattray J, Jones MC. Essential elements of questionnaire design and development. Journal of clinical nursing, 2007, 16.2: 234-243.
[13] Stolovitch HD, Keeps EJ. Handbook of human performance technology: Principles, practices, and potential. John Wiley & Sons, 2006.