ORTHOGONAL VIEWS ON PRODUCT/SERVICE-SYSTEM DESIGN IN AN ENTIRE INDUSTRY BRANCH

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ABSTRACT

Product/Service-Systems (PSS) is an emerging research area, with terms such as 'functional sales', 'servicizing' and 'service engineering' all contributing to the foundation and our current understanding of PSS as a phenomenon. The field is still in its formative stages and definitions, understandings and approaches to PSS are still fluid.

Much of the literature in the field of PSS has, until now, focused largely on the actual transition from product to PSS and has typically resided in the field of engineering design. Symptomatic of the current literature is the concept of service as the adding-on of non-physical activities and relationships between supplier and customer. There is evidence in the literature, that multi-stakeholder approaches, customer activity understanding, actor-network charting and value chain collaboration are important factors to include in PSS strategies. However, actual case examples of these factors are sparse and limited to conceptual examples.

This paper describes five orthogonal views on PSS design, fostering integrated product/service thinking across organisational boundaries, via a systematic approach to user-oriented product and service development.

Keywords: product/service-systems, product service engineering, innovation strategy, value networks

1 INTRODUCTION

PSS is an emerging business concept in industry. Industrial companies in "high pay" countries tend towards an intensified focus on core competencies and -operations locally, with a subsequent outsourcing of most other (labour intensive) operations and tasks to external suppliers or network partners [1]. This outsourcing of activities implies that the partnering supplier companies perform an alignment and development of customised solutions to fit the needs of their contractors. But also private consumers are readily subscribing to a rising number of service offerings, requiring companies to change their operations and products accordingly [2].

The notion of PSS design, -development and -operation requires a much broadened view of the design object for product development, resulting in *the product* being augmented with respect to time, infrastructure, value and artefact considerations [3]. A key question when considering PSS design is whom to involve in the design process and which competencies to ensure within the organisation, for both the design and the operation of the PSS. Augmenting the product offering in the *time domain* is particularly challenging for manufacturing companies that traditionally transfer both ownership of and responsibility for the product to the customer/user at point of sale. In terms of *infrastructure*, it is necessary for the PSS provider to ensure a system of support elements and ancillary operations that will allow the provider to support the customer and the customer to interact with the provider whilst using the product and/or experiencing the service. In the *value domain*, it is reported that a PSS offering can create interesting benefits to both the customer and the company, as new opportunity parameters arise, regarding the provision of value to the customer [4]. And in terms of the *artefact*, it is important to understand how augmenting the product into an integrated product/service offering actually affects the physical makeup (and therefore design) of the product; or seen from a different perspective, how to Design for Service?

Compared to straight product design, when designing a PSS, the company necessarily makes decisions that have direct and disposed effects on many more aspects of the value chain. The notion of life cycle thinking is therefore important to embrace, as is the idea of value chain collaboration [1]. Furthermore the insights gained by attaining a deeper understanding of user needs and activities, as currently in focus in the field of user-oriented innovation [5], seem to be central to the value-augmentation that a PSS strategy aims at bringing to the end-user. Current literature on PSS shows evidence, that multi-stakeholder approaches, customer activity understanding, actor-network charting and value chain collaboration are important factors to include in PSS strategies [4, 6, 7]. However, actual industrial cases particularly investigating these factors and their influence on PSS development and performance are sparse and limited to conceptual examples.

Taking the above status and conditions for PSS in industry, it seems that there is a need already now to consolidate some of the experiences and findings into a systematic way of viewing PSS design, which in the authors' view is an augmented view on product development, expanded in the domains of time, artefact, value and infrastructure. We describe in this paper a research project where an entire industry branch is under scrutiny, in order to allow for actual experiments in the area of value chain collaboration; complex user activity understanding; and experience exchange (as described in [1]), regarding PSS design and organisational modelling. The case we describe is the Danish maritime industry branch, where twelve industrial companies (mainly component manufacturers) are collaborating to improve their PSS ability, in recognition of the need to ensure sustained competitiveness, in a time where much ship production is moving East. We present five views on PSS design in an attempt to gain insight into PSS creation for a whole branch. We call these five views *orthogonal views* as we purposely refrain, in the first instance, from attempting to reconcile the five views in relation to each other. Our aim with this approach is to push the boundaries of product design theory towards new considerations when working on integrated product/service design, which is carried out across new organisational boundaries, in relation to traditional design.

We describe the five orthogonal views with the help of the industrial context of the maritime industry, in order to both gain real-world insights and to ensure the relevance of this work for industrial application. At the same time we reflect on our work's relevance for the design research community, by highlighting some initial observations regarding the process of PSS design.

2 CURRENT STATE-OF-THE-ART OF PSS

Within the design research community, the activity of expanding product development in the direction of service has been dubbed *functional products* as e.g. by Alonso-Rasgado et al. [8], *functional sales* as e.g. by Sundin and Bras [9] or *product/service-systems* as e.g. by Goedkoop et al. [10], Manzini and Vezzoli [11] and Mont [12], where each of the separate research groups have taken their own approach towards the phenomenon, focusing on different characteristics and types of PSS solutions. Based on a review of the emerging views on PSS, Matzen & McAloone [2] indicate four dimensions in current PSS research, which we subsequently interpret as follows:

1. A theoretical understanding of the operations related to opportunities inherent in PSS approaches to business, exploring and explaining opportunity parameters pointing towards e.g. the dematerialisation of offerings, optimisation of performance or consumption.
   This dimension can be interpreted as *PSS as a potential of benefit*.
2. A theoretical understanding of the phenomenon of combined product and service offerings, exploring and explaining the inherent virtues and inferiorities of physical products throughout their life cycles and how these can be supported and relieved by service offerings.
   This dimension can be interpreted as *PSS as an augmented product development theory*.
3. A prescription of the structures and management technologies necessary to enable companies and company networks to develop, deliver and operate PSS solutions.
   This dimension can be interpreted as *PSS as a strategy*.
4. A prescription of the processes which will enable development teams to identify and take advantage of the potential benefits referred to above. Furthermore a prescription of working tasks and documentation models aiding the development team in the concretisation, communication and realisation of PSS solutions.

This dimension can be interpreted as *PSS as design tools*.

These four interpretations are taken from a review of somewhat disparate research projects and individual cases, none of which have handled more than one of the four dimensions at a time. Besides the above four interpretations of PSS research, there is little coherence in the prescriptive PSS approaches or empirical insights so far, underlining that the field is still in its formative stages, with definitions, understandings and approaches to PSS still being fluid.

The majority of the current research literature on PSS originates from the design research or manufacturing research communities, whereas earlier work was founded in the operations/marketing [12] or sustainability/environmental fields [11]. In the domain of engineering it is important to trace and attempt to foresee the adjustments that organisations must undergo, in order to remain competitive in the business creation process, when the boundary conditions for business creation are in a state of change, in relation to a traditional production-sales situation. Tan [4] states that it is no longer sufficient to have a systematic approach in place for product development and production alone, when increasing proportions of revenue come from before- and after-sales service. Wise and Baumgartner [13] describe the necessity for organisations to transform what earlier has been viewed as a cost-centre (after-sales activities have been traditionally viewed in this way by many companies) over to a profit centre, where an adjustment of the relationship to the customer is necessary. Thus, as the business foundation for more and more companies is increasingly based on service revenues than on those gained by selling the physical artefact itself, there is reason and motivation to much better understand and control the processes surrounding such an augmented business model [14].

The current literature on PSS includes examples of procedures for the integration of product and service features in product development [8, 11], but these approaches do not consider a number of key areas for business, such as the commercial considerations, the strategic organisational issues, or the possibilities of collaboration across the value chain.

3 CASE AND METHOD INTRODUCTION

The Danish shipbuilding industry has traditionally focused on delivering products to their customers, based on the longevity and high technical qualities of their physical artefacts. But as with most industries, the continuing market globalisation in the shipbuilding industry both opens opportunities, in terms of a rising number of potential customers and represents threats, due to the growing number of competitors, worldwide. Maritime component manufacturers are experiencing a growing demand from customers with respect to after-sales service, and they also see a great business opportunity in creating more systematic and integrated product/service development activities.

In the light of the above, a so-called *innovation consortium* named PROTEUS (PROduct/service-system Tools for Ensuring User-oriented Service) has been established and is working to jointly develop new knowledge about how after-sales service can be effectively integrated into business development and industrial organisations, so as to become a source of revenue, rather than a cost to the company. The innovation consortium is funded by the Danish research council to create research insights and innovation results simultaneously, throughout a prolonged (3-5 year) collaborative project, consisting of representatives from Danish research institutions, a technical service partner (consultancy), international university partners and twelve maritime companies. The twelve participating companies in the project are interested in understanding, through examples, how to effectively and systematically integrate service development into their product development and business creation processes. The idea with establishing PROTEUS as a research project has been to create a unique opportunity, both industry-wise and research-wise, to begin to address some of these issues on an entire industry branch. The project is organised into five work packages (Figure 1), each with its unique focus on PSS.

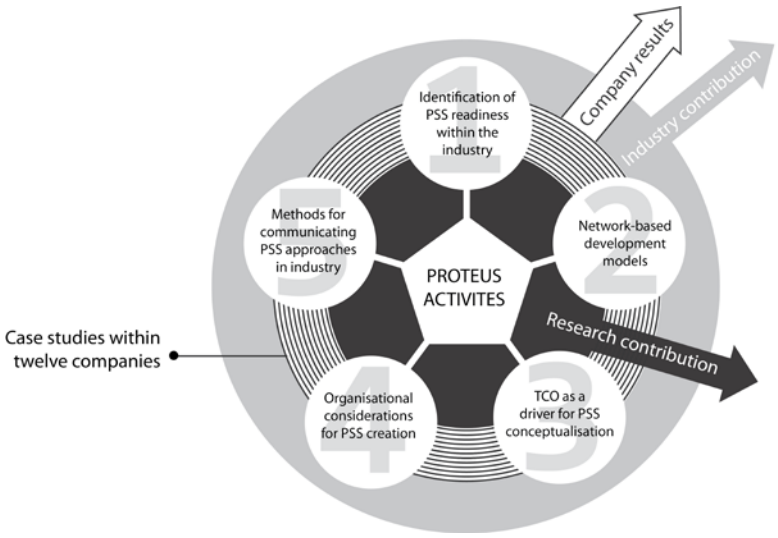

Figure 1 - The organisation of the PROTEUS project

The research method adopted for the project is one of participatory research, where high amounts of company interaction are necessary. Depending on the work package, the research tools that are applied in this project range from surveys and interviews (particularly for collecting insight into state-of-the art practice); workshops and case studies (in order to prompt new ideas and test hypotheses); and ethnographic studies (to gauge the validity and proportions of claims for methodology development and coordination in the individual companies). The overall research design follows Blessing and Chakrabarti's design research methodology framework [15], where a series of iterations of the framework are planned. The research is multiple and trans-disciplinary, carried out in collaboration between a technical university and a business school, in particular by four senior research staff, three PhD students, one industry consultant and several Bachelor and Master students (connected through case studies/student projects). When describing the research views in the following sections, we will therefore elaborate both the innovation activities and the research activities of the project.

At the time of writing this article the project has been running for approximately half a year of its total period of 3½ years. The explorative phase of the initial descriptive study of project, entailing an initial analysis study (21 interviews and 14 site visits), has been completed. Furthermore individual case studies are underway, and a catalogue of case projects are about to be launched. The five orthogonal views on PSS, described in the following sections provide the foundation for our research on this project – and therefore also for later publications on the results achieved.

3.1 PSS readiness and triangulation of companies, industry and market

The first view we take on PSS is to create an understanding of the readiness for a transition towards PSS, of companies, industry and market, with the purpose of establishing the boundary conditions for PSS, and to frame subsequent PSS strategies. By establishing the boundary conditions for PSS in the particular industrial context, it is possible to identify a set of questions to guide the research process within the industry. PSS strategies are of particular interest, both to the participating companies and as an object for observation, from a cross-company viewpoint. With this view we have identified a series of *PSS readiness aspects*, which help assess PSS readiness in the branch and in individual organisations.

The first PSS readiness aspect is to identify prerequisites for companies, which create a foundation for PSS development. Within this case these prerequisites consist of companies' competences; know-how and product embedded knowledge; experiences with after-sales and service development activities; insight into the ship's lifecycle; and ship owner's activities. Many of the employees of the case companies, (e.g. from Sales, After-sales, Operations, etc.) have backgrounds as ship mechanics, superintendents etc. which provides insight into the user activities, such as requirements, needs; customer's considerations; and mindset. The main question here is: What prerequisites are needed in an organisation to introduce PSS development?

The second aspect is to elicit a set of criteria for introducing PSS development and measuring the changes made. The criteria should emphasise the main targets for PSS development, both within the individual company and in collaboration across a number of companies within the same industry. Hence, how should a PSS be shaped in order to fit the current practice of companies, meeting the needs and requirements of the customer and the movements in the markets?

The third aspect identified is to define the market movements that drive the need for PSS introduction. PSS thinking can be used for targeting new market segments, (e.g. offshore, in the maritime case) or to change current market dimensions, e.g. towards integration of service into current activities and customer relationships. Research shows increasing competition on low-cost products as a driver for finding alternative market segments, e.g. offshore [6]. Asian companies now dominate the shipbuilding industry, forcing Western companies to find new entry points to their market, e.g. through European ship owners [16]. To meet market demands, European companies could develop PSS offerings to meet the needs and requirements of the European ship owners' activities, e.g. throughout the life cycle of a ship. Hence, what are the market dimensions for current markets and how are these market dimensions changed towards integrating service as part the offering to the customer?

With the identification of these three PSS readiness aspects as lenses for viewing PSS readiness of companies, markets, and industry, we aim to describe the prerequisites, success criteria and market dimensions necessary for the foundation of a framework for introducing PSS into existing industrial situations. This framework is planned to be developed based on the empirical experiences from workshops and case studies. It is our aim to create a generic framework, targeting the key elements for a successful implementation of PSS design, but customisable dependent on the specific strategy of the individual company.

3.2 Value chain collaboration

The second view we take on PSS focuses our attention towards a new understanding of value creation, where the product and service are seen as a system, contributing with a combined value proposition/offering, by sustaining and enhancing the utility of the offering through the whole product/service life cycle [4]. In this view the value creation process is prioritised to be the main parameter of customer satisfaction, in place, perhaps, of product quality. Porter explains value creation as occurring through a company-centric approach, defined and strengthened through value-chain analysis, where the company is the producer and the customer, the receiver of the value [17]. However, as the business landscape is changing through (among other things) globalisation and dematerialisation, Porter's concept of value creation neither encompasses the creation of intangible products, nor the possibility of the customer as a co-creator [1]. Research is revealing how Porter's definition of the classical sequential value-chain is insufficient when focusing on creating competitive advantage within the service economy [18]. Normann provides an alternative to the sequential value-chain model by describing a so-called *value star* [19], where the value creating system consists of input from multiple actors in a network, rather than a sequential chain, and where the customer is seen as a vital stakeholder, providing resource input to the system. Adopting the value star metaphor provides a mental model of how to exploit and promote the resources and knowledge of multiple stakeholders (including the user) within the early stages of the innovation process and through the whole life cycle [20]. Approaching PSS as a value network/value star is not seen before in literature.

Within the PSS conceptualisation activity a proactive approach towards creating value chain collaboration is one of the elements that will be investigated within this research. One of the hypotheses for this view on PSS is: The competitiveness of a PSS offering will increase when the significant stakeholders within the value chain or potential new value contributors are identified and involved in the co-development of the offering. Within this view the following research questions are of importance: By what techniques can the value chain structure be identified? Thereafter, how can the stakeholder network, the value perception and their relations be visualised and reconfiguration possibilities be explored and exploited?

The innovation content of this view on PSS aims to aid (the maritime) industry in appraising the benefits of focusing on co-creation of value between several stakeholders within a value system, and to ultimately provide normative approaches towards the orchestration of value stars. The creation of

new business models, capable of encompassing the opportunities of collaborative inter-organisational networks within the conceptualisation activity of PSS will be in focus, together with the whole life cycle perspective of re-conceptualising the value proposition. The case companies will be facilitated in the transformation of strategy, *from value chain towards value star*, together with other relevant companies from the branch. The insight required to create these normative tools will be created via a series of research activities, such as mapping the companies' technology- and service platforms; charting the companies' competencies and organisational structure profiles; and studying the affinities of the companies in the dimensions mentioned above.

3.3 Total Cost of Ownership & PSS Conceptualisation

Total cost of ownership (TCO) is a concept whereby the economical costs occurred throughout the whole life cycle of a product or system are considered up-front, as opposed to e.g. first purchase cost. TCO has been studied within the PSS field before, where the lack of ability or willingness of customers to think in terms of TCO has been found to be a significant barrier for PSS implementation in a business-to-business setting [6]. By removing the focus from first purchase cost to the total cost of ownership, new business ideas and product/service solutions can arise that not only satisfy the customer but also create a so-called *customer lock-on* [7]; the achievement of continued/prolonged relationships between company and customer.

In the maritime case there is a new tendency for the customer (the ship owner) to move towards TCO as a concept when procuring ships. This gives a great opportunity for the companies to create and present integrated product/service offerings to the ship owners. The main questions to be explored in this third view on PSS are therefore: How to utilise TCO as a driver for PSS concept creation? How to go about PSS conceptualisation, given that the customer is willing and able to operate their products on a TCO basis?

Due to the complexity of the maritime industry, development and implementation of TCO concepts has thus far proven difficult. An example of one of the challenges met is the fact that sub-suppliers' customers are most often not the end users, since the products are first sold to the shipyard and subsequently to the ship owner. Furthermore the definition of "a ship owner" is nowadays much more diffuse than just a decade ago, as it today ranges from one large company, running all aspects of the ship, to a capital investment group owning the ships and outsourcing the operation (e.g. ship management, crew management, spare parts purchase, maintenance) to many different companies, thus resulting in a scattered ship responsibility. The latter type of ship owner makes TCO concepts difficult to sell, since the one paying is seldom the one benefitting.

Nevertheless, there is a great desire to become competent in creating TCO-driven concepts in the maritime industry, both from the sub-suppliers' and the ship owners' points of view. It is therefore also the goal of this view on PSS, to create examples of actual TCO concepts for application in the maritime industry which can: (i) serve as an illustration of how TCO concept development can lead to financial and/or environmental improvements (environmental impact is a very new but rapidly increasing concern in the maritime industry) and thereby serve as an argument to invest in service, both for sub-suppliers and users/customers; and (ii) give the participating companies examples of tools and methods that can be used for TCO-driven PSS concept development.

3.4 Organising for PSS

As yet the PSS research activities charted through the academic literature do not cover the role of the organisation for PSS. Literature indicates that there are different processes involved in PSS development, compared to traditional product development [2, 4], but not how this may affect the requirements on the way in which the PSS development and operation process should be organised.

This fourth PSS view concentrates, therefore, on the tasks of product development organisation for PSS and PSS organisation in the company. The hypothesis is that a successful shift in focus from technology/artefact-based business creation over to service-oriented business creation will demand a redefinition of tasks within the organisation, as well as a re-evaluation of competencies inherent in the company and competencies needed, together with a re-definition of the organisation and management structure in the company. The research will focus on how to enable companies to efficiently integrate

service performance into their product and business development processes, including an understanding of the types of changes that this will cause on an organisational/management level.

While research has studied the theory behind and methods towards PSS development and also into the business part of PSS (e.g. revenue models) there has been no research into the cross-functional setting in which the above should be incorporated, i.e. the organisation. The research activity connected to this PSS view is building on the empirical insight of the experiences of companies already attempting or carrying out PSS development, and on literature regarding the organisation of product development. The aim here is to identify and extract organisational considerations and activities that are unique to a PSS situation.

The innovation-oriented content and goal is to develop concrete tools, methods and organisational/ business models for industry use. The sizes of the participating companies vary greatly and solutions should be suitable for them all. The focus is therefore on creating a generic framework that can enable small as well as large companies (no matter what type of business model or organisational structure they have), so they can make the necessary changes to approach PSS development. Results, such as the above framework, are to be tested and further developed, in collaboration with the participating companies during the project, giving them the opportunity to evaluate the usability, e.g. relevance and shortcomings of models and tools. It is expected that the project and the ongoing collaboration with the companies will positively affect their readiness for PSS implementation.

3.5 Implementing change in the Product Development process

In order for intended changes to take effect in real-life contexts, it is necessary to focus on implementation in the daily routines of the involved organisations. Especially this aspect, however, seems not to have been fully successful in known PSS projects so far, since actual up-and-running industry cases are very sparse, let alone PSS cases for an entire industry branch. We therefore take a fifth view on PSS, specifically focused on how to effectively and systematically integrate service development into product development and business creation processes.

From a research perspective, we see two key tasks: firstly, the development of measurable parameters to control and monitor PSS processes; and secondly the development of methods to disseminate such parameters and related experience within the industry. As we deal with a multitude of stakeholders, we understand and treat ‘dissemination’ both in terms of ‘organisation-to-organisation exchange’ (e.g. along the value chain) and in terms of ‘within one particular organisation’ (e.g. among different departments of a company). One challenge here is to cover *all* the involved stakeholders in the Product/Service-System design, as the lack of only one stakeholder’s commitment can make the whole PSS fail. Having an entire industry represented in our project, very favourable preconditions are in place to succeed on this task.

From an industrial perspective, we see the actual dissemination of the above methods and experience as the main challenge. Therefore, we have allocated this key task to one dedicated consortium partner, who is used to transferring research-based knowledge into industrial innovation. Dissemination activities will, for instance, comprise freely accessible information on a dedicated homepage, general as well as tailor-made workshops and printed media such as handbooks and executive reports.

With the entire industry represented through the case companies, plus their branch organisation, we have created not-seen-before preconditions to capture and facilitate experience exchange amongst and within the involved industrial companies and organisations regarding PSS design, PSS development and PSS operation.

4 CURRENT STATUS AND INITIAL INSIGHTS

With an initial descriptive study having recently been completed, the project has now moved into a prescriptive phase, where individual projects, e.g. case studies are underway or about to be launched. The initial observations were carried out over a period of six months, conducted via semi-structured interviews of multiple representatives from all twelve participating companies, site visits and workshops. Various models have been generated of the industry as we observe it, from analysing the observation data. These models include *Ship life cycle* (charting the whole life cycle of a chosen ship); *Customer Activity Cycles* (charting the activities of the ship owner, from recognition of need, e.g. for

transport vessel, through activities related to the logistics, operation, maintenance, etc.); *Actor Network* (a representation of the relational exchanges between all stakeholders in the shipping arena); and *Strategy map for service design* (initial considerations elicited from the twelve companies, regarding their considerations or plans for service). The models act both as aids for the analysis of the initial observations in the companies and as visualisation aids, regarding the missing data and information, still needed to complete a coherent and consistent picture of all twelve companies. In the following we reveal some of the first insights from the research, followed by the planned next steps for the prescriptive work ahead.

First impressions

General lack of systematic product development processes: Only (the largest) three of the twelve companies have a formalised and systematic product development approach, and this even only to a certain degree. The development in the remaining companies is highly personalised and relies heavily on the know-how of the employees, who commonly have a background within the maritime industry, often with previous employment on a ship. New development tends to be based on the companies' past experiences and ideas of what the customer may want, rather than systematic analyses of current and future user needs. Very little research has been carried out regarding market and user needs, since it is commonly accepted that the employees' comprehensive knowledge of the industry is sufficient. Many minor and major redesigns are developed and made on the factory floor by experienced production workers. This type of development is possible due to the know-how of the workers and the fact that many of the employees are former ship mechanics and due to the products' relatively low complexity. The reasons for redesign are normally a specific set of requirements requested by a specific customer. Otherwise new concepts and redesigns chosen for development are currently based on the potential profit generated through direct sales, not from projected service revenue. For the most part, the product development activities are based on informal conceptualisation, rather than by a systematic (e.g. technology-/user-driven) approach to product development and are mostly redesigns.

Internal/external lack of communication: Internally in the companies there is a common lack of communication between the departments concerning product development and offerings related to service. Better communication between organisational departments around the potential of integration of service offerings in the development process, sales activities, etc. is required. For example, the After-sales departments of many of the case companies handle feedback from customers regarding product-related service claims, such as repairs, maintenance, spare parts etc. These departments have important and obvious potential inputs to the development process, communicating the knowledge from After-sales into the early identification of user needs, as well as the later dispositions in the development process. A significant barrier to improving organisational communication is an inherent organisational deviation in perceptions of service, ranging from "an after-sales add-on" to "a central opportunity for future sources of income/profit". This seems to be due to, for instance, different cultural compositions in the companies' global organisations, e.g. the difference between Asian and Western mindsets towards service. Furthermore, poor internal communication about service causes a neglect of external communications of service offerings towards the customer, e.g. when the sales department neglects to promote and sell the developed product/service offerings.

Traditional product-oriented business structure: Eleven of the twelve companies have a classical product and company-centric business structure and are part of a classical supply chain, where the vast majority of value-adding activities are within the company. Three of the twelve companies have integrated product/service offerings as part of their business portfolio. One example is a large company offering both product and application expertise. This company offers management of a repair during docking of the ship, based on the competencies and geographically dispersed location of the company's application advisors. In this case, amount of man-hours used is reduced, due to optimised, competent application, and the service offering of *management of ship docking and quality assurance of the application* is introduced.

Advantages of locally sourced production facilities: The majority of the companies retain parts of their production facilities in Denmark, despite the competition of Asian suppliers with low-cost production. As a reason, local production is stated to enable the companies to maintain a handful of competitive parameters, such as high quality, time, maintained know-how and flexibility in supply. Also, local production enables high flexibility in supplying spare-parts to e.g. an urgent need in a

break-down situation, demanding overnight production and shipment of products/components. Many of the companies also have large parts of their service networks in Denmark. Though the market is flooded with low-cost products, there is still a demand for high-end quality products, e.g. some ship owners demand that the product is produced in Europe. The years of knowledge accrued at the local production facilities ensure the product's reliability and stability in performance that is essential for the company's image and reputation within the industry. Product certification regarding quality and safety is an important component of the maritime industry and it is a way for the high quality production companies to position themselves on the market against low cost/low quality producers.

Multiple shared offerings, affinity indication and collaborative opportunities: One third of the companies have already indicated an interest in collaborative activities through e.g. shared service stations, but are not yet capable of pursuing this. The companies have a large overlap of offerings, both product-wise and service-wise. The companies, however, have not been aware of many of the overlaps identified in our initial study, since currently no complete overview of the offerings exists for the branch (at least, not according to the interviews). Furthermore, most of the companies are involved in several of the same activities within the customer activity cycle and the ship's life cycle, supporting the same customer needs. Their product and technology portfolios overlap in various places, indicating a possibility for horizontal value chain collaboration. Opportunities for vertical collaboration in the value chain also exist through, for example, the market need for training academies for service technicians, which many of the companies offer. These academies are used to train technicians in performing certified installations and maintenance overhauls as part of enhancing the skills and competencies of the technicians in order to ensure correct installation of the product and thereby optimise its performance. However, barriers that complicate alliances between the companies are at the same time emerging due to different expectations; visions for the outcome of the partnership; willingness; and readiness, plus issues connected to the responsibilities of a product's performance and shared distribution.

Reflections of future needs

The next activities within the PROTEUS project build on the common denominators existing between the companies. These will be identified through charting the companies in further detail; by creating a structured overview of the companies' portfolios of offerings; by exploring collaboration opportunities; through the creation of a shared language of services; and by creating knowledge-sharing on new technologies and product improvements. Besides this, a structured overview of the companies' organisational structure, resources and competencies is important, in order to gain a better picture of the company readiness regarding transformation towards a PSS approach. Furthermore, a mapping, structured in relation to the activities of the ship owner, will reveal the areas of potential new business for the companies, where they may already have the necessary competencies inherent to meet this customer need.

A major task for the project is to continue to enhance the understanding of the maritime industry, regarding PSS opportunities. The maritime market is in a particularly high state of flux in these years, due to the migration of maritime business to the East and the effects of the global financial crisis (leading to cancelled orders of new-build ships and increased retrofit activities), and the companies need to be prepared for future changes. Product/service portfolios ought to reflect this, with regards existing products and new market potentials. The companies interviewed did all consider their position in the market and the decision could be to withdraw from one market segment and focus on a new segment, where competencies were put to better use, or to limit competition, e.g. entering offshore markets. This could also be the strategy behind implanting product/service-systems into companies' business models, as the companies are already competing in an area where a holistic perspective and understanding of customers' needs and requirements is a competitive dimension.

5 NEXT STEPS

After the first descriptive phase of the project, we have initiated several steps towards new activities bringing the project into its next phase. First of all, a number of concrete case studies have been identified through a close and intensive dialogue with all participating companies – combined with project suggestions from a research perspective. Three case studies have been initiated and will be commenced in January 2011. For the future of the project, the research methods will increasingly

target specific issues identified that call for different approaches, due to the nature of the area of interest. Issues that cover a span of in-depth research into the managerial, communicational and structural composite of the organisation using an action research approach, to the other end of the spectrum, to issues demanding a broader understanding of the interests and requirements for establishing a cross-company collaboration to fulfil the future, presently unacknowledged customer needs. Hence, the orthogonal views on PSS in the industry branch are needed, in order to understand the different aspects through different projects with the shared goal of researching the development of integrated product/service offerings and the characteristics related.

6 REFLECTIONS/DISCUSSION

This paper has presented five orthogonal views on the field of product/service-systems focusing on a specific industry. While one can argue that there exist other views than the ones presented in section 3.1-3.5, these five views were chosen based on earlier and current research, as well as an in-depth dialogue with industry representatives. While other views would contribute with further relevant aspects, research has shown a need for further exploration within the selected areas as well as their potential to unlock new possibilities within the field of PSS. It has been our aim to present these orthogonal views on PSS, together with some initial insights, seen from a whole industry perspective, which has not been seen in PSS literature hitherto. We believe that this approach is of high value for anyone interested in this research field.

The fact that the research seeks to take an entire industry approach has many benefits, but has also proved challenging, with respect to research methods, data handling and company relations. The mere act of coordinating meetings with each of the participating companies; keeping them informed and engaged in the project, while still providing them with industry relevant results; and at the same time creating scientific results, has proven an exercise in itself.

The maritime industry in itself is challenging, in terms of complexity, conservatism and the fact that it operates on an international playing field. But it is also an industry where western suppliers are rising to face the competition from Asia and are ready to look beyond the traditional solutions. This compels the industry (and certain researchers!) to think innovatively for creative solutions that can inspire a new type of innovation into the industry. The fact that representatives from the industry acknowledge the need and the potential for PSS solutions is a reason to focus on this challenging industry.

The empirical studies within the research project have shown that customers' activities are part of the value creating process in multiple ways, both adding and decreasing value. The shipyard, which is a bottleneck for any product/service-system implemented in the maritime industry, is at this time the strongest influencer of choice of supplier, and thereby also of the choice of product and quality and price of it. The decision parameters of the shipyard, which are typically based on *first purchase price* or contract with specific suppliers, are not always beneficial for the ship owner, and can result in a decrease of the overall value system. The ship owner and ship crew are in multiple ways directly part of the value creating system, as they decide the service-level agreement; maintain the ship; choose service supplier; and are therefore the direct influencers of the utility of the ship within its whole life cycle, which indicates a possibility of structured customer value creation.

The Danish suppliers have a great opportunity to create value propositions through their existing knowledge and competencies, aimed directly at the customer's activities. This can support the customer need during maintenance and create possibilities for e.g. preventive maintenance, with the main goal of retaining a unique customer experience. Hence an opening is created for opportunities regarding the creation of new relationships and different networks of stakeholders, through reconfiguration. Barriers within the companies' different motivations for change, their organisational structures, company sizes, and their individual understanding of market need is important to understand, before starting to re-position the firm towards a PSS - individually or collectively in alliances.

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