A comprehensive Engineering Environment to conceptualize, design and monitor Product Service Systems (PSS): an application case

Sala R.*, Sassanelli C.*,, Pezzotta G.*, Terzi S.****

** Department of Management, Information and Production Engineering, University of Bergamo, Viale Marconi, 5, Dalmine (BG), 24044, Italy (roberto.sala@unibg.it, claudio.sassanelli@unibg.it, giuditta.pezzotta@unibg.it)*

*** Department of Economics, Management and Industrial Engineering, Politecnico di Milano, Via R. Lambruschini 4/b, 20156, Milano, Italy (claudio.sassanelli@polimi.it, sergio.terzi@polimi.it)*

Abstract: The last decades have seen a remarkable evolution in customers' needs and requests. Their interest moved from purchasing the single product to receiving a prolonged support throughout the product lifecycle. In order to answer to these new requests, companies proposed a solution combining products and services called Product-Service System (PSS). In this optic, the role of service engineering grew over time. However, the supply of services not originally created for the considered product resulted into unsustainable economic positions on the companies' side and dissatisfaction on the customers' side. To prevent this situation, new methodologies considering not only the product and service design, but also their early integration, have been proposed in literature. Among these, the DIVERSITY project proposed the PSS Lean Design Methodology (PSSLDM), which considers the entire PSS lifecycle, from its conceptualization (stating form customers' needs) to the monitoring of its performance (once released on the market), in order to ameliorate its design and to identify possible future improvements. With the aim of supporting companies in exploiting the PSSLDM, the DIVERSITY design platform has been developed. The DIVERSITY platform is an aggregation of tools that cooperate to properly design a PSS. The consistency and maturity of the platform and of the tools were tested through an application case with the scope of collecting feedback and highlighting the next steps for the DIVERSITY platform implementation. This paper reports a description of the overall platform, summarizes the results obtained in the application case and proposes possible steps to improve the future platform implementation and usage.

Keywords: PSS Engineering Environment, Product-Service System (PSS), PSS Lean Design Methodology

1. Introduction

The market requests for the sale of services combined with products have constantly increased throughout the last decades [1]. For this reason, companies started widening their offering, proposing to customers the so-called Product-Service System (PSS) [2], which consists in the sale of a bundle of product and service, fostering the "servitization" phenomenon [3]–[5]. This new approach required, from the company side, a rethink of the PSS conceptualization and definition to avoid the "service paradox" [6] and, coherently with this, a new set of tools able to underpin the PSS lifecycle management [7], [8], starting from its conceptualization and design and continuing with its monitoring. In fact, the lack of tools supporting company along the PSS lifecycle can lead to the creation of solution suitable for the customers but economically unsustainable for the companies or, in the opposite case, the creation of PSSs economically sustainable for the company but not able to fulfil the customers' requests [9]–[11]. In this context, the DIVERSITY project proposed a PSS engineering platform [12] to enable companies in adopting a systematic methodology enhancing PSS design, the PSS Lean Design Methodology (PSSLDM) [13] (Figure 1). It enables to overcome the problems above, using the customers' needs as a starting point for the conceptualization of new PSSs. Moreover, it proposes a structured model and related methods to guide the design phase reducing wastes along it [10], [14]–[16]. After a brief introduction of the PSSLDM and of the tools composing the DIVERSITY Platform (section 2), the paper reports the application case carried out in an Italian B2B company (section 3) and discusses the results (section 4). Finally, it summarizes the work and proposes future research steps (section 5).

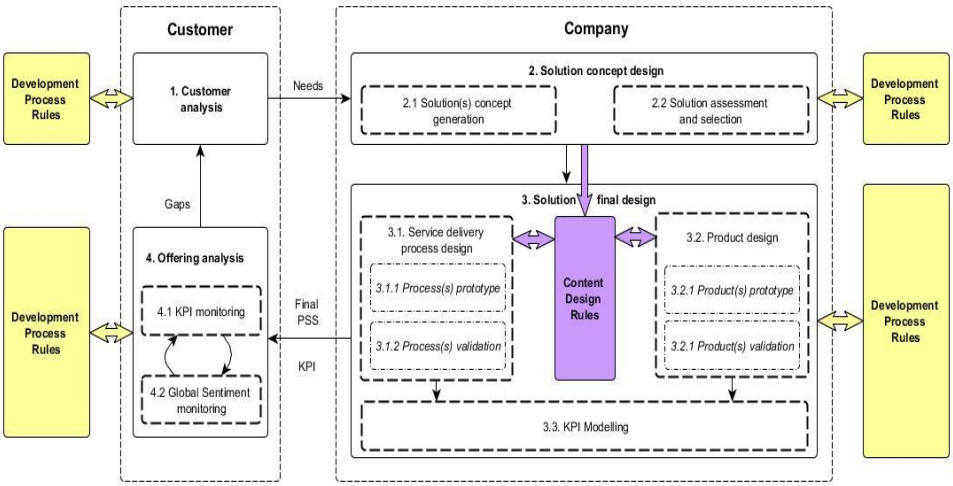

Figure 1 - The Product Service System Lean Design Methodology

2. Theoretical Framework and Tools

2.1 The DIVERSITY project theoretical framework

Most of the times the association of a service to a pre-designed product is not enough to guarantee the expected revenues [17]. As stated by [16] PSS design and development is a process that requires a huge effort in terms of technical specialization, business organization, data and knowledge management. This is due to the intrinsic complexity of the PSSs and to the different needs and expectations they are supposed to satisfy in a fast and adaptive way. In this sense, the framework used in the DIVERSITY project tried to overcome this gap, developing a Methodology aimed to reduce the wastes and guide the users throughout the process. Initially, the customers' opinions, based also on a sentiment analysis, are analysed to extract their Need(s), which constitutes the elements that the customers consider essential. Following this, the Need(s) are used to conceptualize the PSS, defining the Wishes (how the customers want their Need(s) to be satisfied), the Solution(s) (proposed by the company) that will satisfy the Need(s) and the Resource(s) supporting the Solution(s) provision. This phase is accomplished representing these elements in a tree format - the Product Service Concept Tree (PSCT) [18] - and pointing out the existing relations between them. If multiple Solutions are defined, these are evaluated in terms of impact (befits for the company and the customers) and difficulty (what does it takes to the company to provide the solution?), and the most suitable for the company exigencies is chosen. The selected solution is then designed, both in terms of product and service, using as a starting point the Resources listed in the PSCT. In order to reduce the reworks and increase the efficiency of the design process and to support the integration of service enabling features in the product, the designers are aided by the Lean Design Guidelines and Rules [19], [20]. The KPIs and the Sentiment to be monitored along the PSS lifecycle are here defined. The PSS created is then lunched on the market and monitored to support the company decision making process and guide the creation of new versions of the same PSS or new PSSs. The framework briefly exposed hereabove covers the entire PSS design within a lifecycle perspective. To foster its application, an Engineering Environment composed by eight tools has been created (Figure 2).

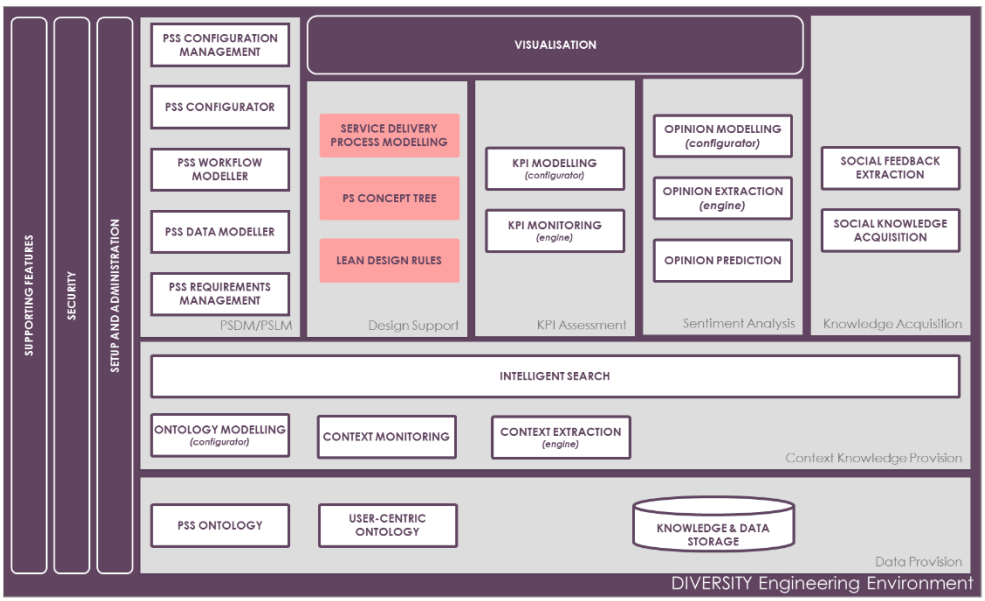

Figure 2 - The DIVERSITY Engineering Environment

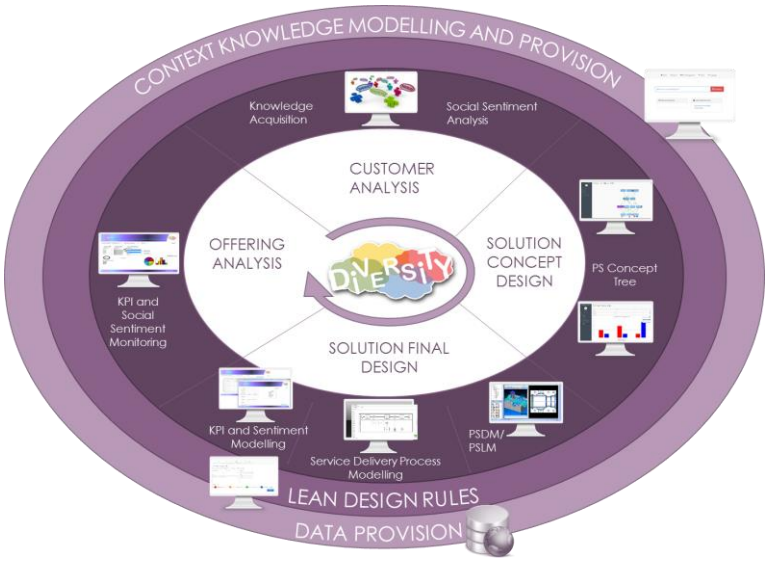

Figure 3 - The DIVERSITY Platform

2.2 The Tools Composing the DIVERSITY Platform

As introduced in the previous paragraph, the DIVERSITY engineering Platform has been developed starting from the project's general framework. Eight tools compose this Platform (Figure 3):

- The Product Service Concept Tree (PSCT) tool. Used in the second phase, its scope is to conceptualize the new PSS supporting the brainstorming around the possible solutions for the customers' needs and aiding the identification of the most suitable one.
- The Lean Design Rules tool, which aims at guiding the designers in the design phase and reduce the wastes along the whole project. The Content Design Guidelines and Rules [19], [20] are targeted for the design phase while the Development Process Rules regard the complete process.
- The PSDM/PSLM tool creates the link between the DIVERSITY Platform and the company proprietary design environment. It contains information about the product's BOM and the service map. This tool supports the third phase of the PSSLDM.
- The Service Delivery Process Modeller tool is used in the third phase of the process, to design the service delivery process map starting from the service resources identified in the PSCT. To facilitate the map design and comprehension, the BPMN and the Blueprint technique are used.
- The KPI Modelling and Monitoring tool [21]. As in the case of the Sentiment Analysis tool, it is used in multiple phases. At the beginning of the process, where the KPI performance are analysed to identify new customers' Need(s), in the third phase where the PSS's KPIs are modelled and finally in the las phase where the KPIs are monitored.
- The Social Sentiment Analysis tool [22], whose aim is to analyse the sentiment around a PSS in order to identify possible improvements. The results of the Sentiment Analysis are used in the first phase of the framework, while the modelling part (the model creation) is done in the framework' final phase.
- The Knowledge Acquisition tool, it has the scope to collect the knowledge retrieved from the customers and inside the company. Each company can adapt this tool to its exigencies. It supports mainly the first and the fourth phase of the process.
- The Context Knowledge Modelling and Provision Modules are used to retrieve all the knowledge shared in the company. These tools are meant to be used along all the process supporting every step of it [23].

3. Research Methodology and Application Case

The research has been conducted using the following research methodology.

3.1 The Research Methodology

The application case has been conducted with the aim of testing the DIVERSITY Platform stage of development and of collecting feedbacks from the company employees. To test it, two workshops have been performed with three employees of one company, supported by three academics. The tests involved a product specialist, a customer quality specialist and a lean manager. The company employees were instructed on the DIVERSITY methodology through three preliminary theoretical interactive training sessions each one focused on a specific part of the process. During the training sessions, all the data needed to assess the platform have been collected. The tests have been carried out with the aim of performing the same theoretical actions carried out previously in the platform environment, retracing the general workflow and verifying that the output achievable with the single tools were the same obtained though the methodology application. Different aspects have been assessed during the tests, such as the tools' completeness in terms of expected functionalities and their ability to perform the required actions. Moreover, also the general user experience was examined, requiring an

evaluation of the several aspects (training sessions, installation procedure, data entry, reports, support, etc.) with a particular attention to the user-friendliness. In order to evaluate these aspects two questionnaires were filled by the company employees involved in the test sessions, one focused on the platform's functionalities and one concerning the platform's user experience. The questionnaires results were then used to evaluate the maturity of the DIVERSITY platform.

3.2 The Application Case

The application case has been conducted in Company A, a B2B Italian company working in the fields of air-conditioning, refrigeration and humidification. The company sells its products worldwide and has a series of factories and subsidiaries around the world. The methodology training and the following test focused on a product belonging to the Climate Business Unit's portfolio. This division has been characterized by a strong focus on the product sale and has neglected the after-sale market for long time. The recent evolutions convinced Company A in expanding its offering also in the service market entangling the product sale to new services. In the test-bed for Company A, the firm is interested in improving the installation service for its product. This, because if a technician executes a bad installation the product performance will worsen and the final customer won't be satisfied. The solution identified by the company in the test-scenario implied the use of a Mobile APP able to read QR codes applied on the product to provide instructions using the augmented reality.

3.2.1 The DIVERSITY Platform Evaluation

The platform test was carried out in two sessions, the first required six hours and focused on the first three phases of the PSSLDM. This allowed the academics to solve all the doubts raised from the company's employees and at the same time to explore several of the tools' functionalities. The second session took place after the first one and interested the last phase of the PSSLDM. During the test, the PSS design workflow implemented in the DIVERSITY platform to guide the PSS development process, has been followed:

- Design Concept;
- Associate Lean Rules;
- Design PSS;
- Design Service;
- Validate PSS design;
- Model KPI;
- Model Sentiment.

Table 1 shows how the Platform workflow has been originated from the PSSLDM phases and the tools used in each step of the workflow. Feedback about the ability of the workflow to really support the PSS design, the coherence with the PSSLDM and the functionalities of the single tools have been also evaluated. The only exception is the Knowledge Acquisition Tool due to its noteworthy characteristic.

Table 1 - Correspondence between the PSSLDM phases, the Platform workflow and the Tools

PSSLDM phase	Platform workflow	Tool
Development process phases	Make It Leaner	Lean Design Rules tool
Customer Analysis	Model KPI	KPI Modelling and Monitoring tool
	Model Sentiment	Knowledge Acquisition tool
		Social Sentiment Analysis tool
Solution Concept Design	Design Concept	Product-Service Concept Tree
	Associate Design Rules	Lean Design Rules tool
Solution Final Design	Design PSS	PSLM tool
	Design Service	Service Delivery Process Modelling tool
	Validate PSS	Lean Design Rules tool
Offering Identification and Analysis	Model KPI	KPI Modelling and Monitoring tool
	Model Sentiment	Social Sentiment Analysis tool

In fact, the company employees are able to access it in every stage of the engineering workflow and it is customised to support the company exigencies and collaborative issues. In the Application Case presented in this paper the Knowledge Acquisition Tool has been used to store the customer related information obtained from a survey involving companies' front-end actors.

3.2.1.1 Design Concept

This first phase regarded the creation of the Product Service Concept Tree (PSCT) using the PSCT tool. The data previously collected were then employed for the Platform test, aiming at assessing the capability of the tool to support the brainstorming and the design the PSCT and all its levels. The evaluation took place inquiring the possibility to enter the necessary data in the tool such as the customer information, identified Needs, Wishes, Solutions and Resources along with the connected information, organizing then them in a tree format. The Solutions evaluation functionality has been also tested, to each solution the degree of impact and difficulty was assigned. The tool provided a ease of use representation supporting the company while comparing and selecting the best solution suiting the company exigencies.

3.2.1.2 Associate Lean Rules

This second step, carried out using the Lean Design Rules tool, was aimed to select and/or generate the Lean Content Design Guidelines to be followed by the designer during the product design phase (carried out with the company's proprietary CAD/CAM tool), also defining the mandatory ones. In particular, the test verified that the tool was able to support a proper and easy search by filtering the Lean Content Design Guidelines on the base of the importance and the product. Moreover, the procedure to generate and add new Lean Content Design Guidelines and/or Rules has been also tested. In particular, besides the possibility to enter the definition of a Guideline/Rule, the test speculated on the possibility to define the different parameters used to classify the Guidelines and Rules such as if they are applied to all the products and/or services of the company or to a specific product/service, in the latter case also the opportunity to define the specific product/service was tested. Moreover, the possibility to define the ability characterising the Guideline/Rule was tested, along with the chance to define one or more tags (also entering new ones) and the Guideline/Rule importance. Moreover, only for the Lean Design Rules, the possibility to link a certain Lean Design Rule to a specific Lean Design Guideline has been tested.

3.2.1.3 Design PSS

This step is the one designated to be the link between the company's legacy systems and the DIVERSITY Platform. This connection has been created considering and linking the BOM of the product, designed using the company proprietary CAD/CAM tools, in the PSLM tool of the DIVERSITY Platform. In this way, the traditional PLM systems have been enriched with functions concerning also the service information: this was possible through the creation and introduction in the platform of the PSLM/PSDM tools. These allowed the company employees to define the product component (under the form of BOM) and the service component (under the form of a BPMN map) composing the PSS, starting from the solution selected in the *Design Concept* phase. Using these tools, for the company employees it has been possible to add to the product's BOM new elements aimed at supporting the service provision, fostering and highlighting the link between the product design and the service offering. The test carried out with the company employees verified the possibility for them to execute all these actions using the PSLM/PSDM tool.

3.2.1.4. Design Service

The tool associated to this fourth stage in the DIVERSITY workflow is the Service Delivery Process Modelling tool. In this case, the evaluation was related to the users' definition of service delivery process model by use of the service resources identified in the PSCT. The test verified the possibility to use the tool to design the map by using the BPMN and the Blueprinting technique. In particular, the possibility to define all the entities involved in the process, which means defining the actors, their activities, the physical evidences and the connections between them.

3.2.1.5 Validate PSS Design

After the PSS conceptualization and the product and the service design, before finalising the PSS design the designer has to validate his work, verifying to have considered all the mandatory Lean Content Design Guidelines during the design phase, being sure in this way to have created a PSS able to properly deliver its product and service functionalities as required by customers (represented by the PSCT's Needs). Given the scope of this phase, the tool under test was the Lean Design Rules tool. In particular, the assessment verified the creation of alerts for the Designer in case of some features not included in the final PSS. The alert had to be based on the Lean Content Design Guideline level of importance and on the hierarchical relation between them and the Rules (a Guideline is verified if at least one Lean Design Rule was taken into account). Finally, once validated the PSS design, the PSS has been saved in the repository in the PSLM, defining a new name for it. In this case, the test verified that the PSS saved after the validation was correctly added to the PSLM/PSDM list of PSSs.

3.2.1.6 Model KPI

The following step in the design process consisted in the selection of the KPIs to associate to the newly created PSS. From the PSSLDM application, four KPIs related to the PSS identification, implementation and development were identified after a brainstorming between the company employees. The test tried to verify the functionality, promised to the user, to associate these KPIs to the PSS under development. This functionality allows the user to select the KPIs in a pre-defined list present in the tool or, in case of necessity, add new KPIs to it. The tool used for the test was the KPI Modelling and Monitoring tool. Moreover, the second part of the test performed on this tool concerned the monitoring of these KPIs. In particular, the test analysed the possibility for the company employees to create a personalized dashboard showing the graphs for the interested PSS. Moreover, the possibility to compare the same KPI for different PSSs was assessed. The PSS profile for the association of the KPIs was created during the test.

3.2.1.7 Model Sentiment

The final step of the DIVERSITY workflow entailed the creation of a Sentiment Analysis model using the appointed tool. The technicians' answers collected using the questionnaires defined by Company A, and stored using the Knowledge Acquisition tool, should have been used by the model to compute the PSS's Sentiment. Due to the considerable amount of time requested by this tool to provide affordable and useful results, a set of data coming from a pre-analysed product were used for the test. This, consisted in the creation of a new Sentiment model, defining the PSS to monitor, the social networks to use for the gathering of the posts and defining the period for the monitoring. Moreover, also the instruments used to visualize the results of the analysis were tested.

4. Discussion

The employees selected for the test sessions belonged to different divisions of the company. This choice was not casual. As a matter of fact, the DIVERISTY design workflow covers the entire PSS lifecycle, because of this it was necessary to collect feedback from all the company actors involved in it. This allowed also to have a better and more complete overview of the actual impact on the entire PSS design process of the suggested framework. Data and opinions on the platform gathered from the employees entailed impressions on the everyday working method improvement, on the evaluation of the Platform's current development stage and on the future steps for the Platform's upgrades. Moreover, the company employees were well trained on the theoretical methodology but no trained on the Platform's functioning to test its ease of use. In fact, given the three training sessions they were supposed to be able to understand the scope and the functioning of each tool. Considering the stage of development, the company employees involved expressed positive feelings, mostly underlining how the majority of actions could be performed very intuitively. They praised the possibility of completing some passages very easily, especially in the PSS Conceptualization (Design Concept) and Design (Design PSS, Design Service) phases. Also, the possibility to retrieve the design knowledge rapidly (Lean Design Rules tool) and verify the product design effectiveness (Validate PSS) was really appreciated. However, some doubts raised from their side. For example, even though some parts and functionalities of the platform resulted to be very intuitive and user friendly, at the same time at the end of the test some others were reported as not really clear in their scope, and for this reason the necessity of hints to display on the page was underlined. Another aspect to be improved was the graphical aspect of the Concept Tree Map tab in the PSCT tool (Design Concept section), that exceeded the display, creating visualization problems. Concerning the Model Sentiment step, the company employees reported positive feedback about the general functioning of the tool, despite the limitation of using pre-analyzed data to shorten the execution. Since the data management was one of the main concerns of the company, a particular attention was dedicated to this aspect. The process for the data entering and manipulation along the whole platform proved to be acceptable for the company necessities. Finally, since the company's facilities are located in different regions of the world, they are used to approach the customers' problems and the design procedures in a different way. For this reason, the most important feedback interested the design and engineering workflow used along the DIVERSITY Platform, which resulted logically correct and could be really helpful in standardizing the company's PSSs development process. Indeed, this standardization is a direct consequence of a clearly defined workflow and of a continuous collaboration between the employees assigned to a PSS project. These two aspects can be easily found in the PSSLDM, since are two of the pillars on which it has been shaped. In this way, also the knowledge created in the PSS development process results to be correctly organized and can be spread easily all over the company, being transferred from a project to another one, and increasing even more the benefits descending from the methodology application. Knowledge and data sharing alone however are not enough, they must be integrated in an environment able to support a waterfall structure. In fact, connected to this consideration, the main improvement that has been identified during the discussions about the platform is the integration level between the different tools that, in the optic of a complete engineering environment, is fundamental. Moreover, given the DIVERSITY workflow, the interaction between the different tools became even more important, since not only each step of the framework is strictly connected with the following one but also the last and the first phase are strictly connected. This because the results of the PSS's performance monitoring became the inputs for the first phase, creating a continuous improvement loop.

5. Conclusions and Further Developments

Due to the current market exigencies arising from the customers, constantly forcing the companies to change and enrich their offerings, this paper has tested new methods and tools to develop new solutions suitable with the market requests. In particular, the methodology proposed to support the service infusion [24] in manufacturing companies is the PSSLDM, that in the context of the DIVERSITY project has been developed, enhanced and coupled to an engineering environment called DIVERSITY Platform. To inquiry the development status of the platform and define the next steps in its development a test has been carried out in a manufacturing company. The test, conducted in two sessions, reported generally positive feedbacks about advancement status of the platform that currently provides an acceptable user experience. Nevertheless, as of now, the information exchange between the tools is limited. In fact, the platform presents some constrains in terms of integration defecting so the application of the complete PSSLDM. In fact, as explained in section 2, because of the interdependencies existing between the four phases of the PSSLDM, this integration is essential for engineering workflow. For this reason, in the next months, the first objective will be the improvement of the single tools, in order to eliminate the bugs identified by the company employees during the test. Once done this, the effort will move on the complete integration of the different tools to enhance the Engineering Environment and to perform additional tests with the company.

Acknowledgements

This work was funded by the European Commission through Diversity Project (Cloud Manufacturing and Social Software Based Context Sensitive Product-Service Engineering Environment for Globally Distributed Enterprise), GA 636692. It is a European project funded under the H2020 program, started in February 2015 and planned to finish in January 2018.

Reference

[1] S. Vandermerwe and J. Rada, "Servitization of business: Adding value by adding services," *Eur. Manag. J.*, vol. 6, no. 4, pp. 314–324, Dec. 1988.

[2] O. Mont, "Clarifying the concept of product-service system," *J. Clean. Prod.*, vol. 10, no. 3, pp. 237–245, 2002.

[3] T. Baines, A. Ziaee, O. F. Bustinza, V. Guang, J. Baldwin, and K. Ridgway, "Servitization : Revisiting the State-of-the-art and Research Priorities," *Int. J. Oper. Prod. Manag.*, no. July, pp. 1–28, 2016.

[4] T. Baines, H. W. Lightfoot, P. Smart, and S. Fletcher, "Servitization of the manufacturing firm: Exploring the operations practices and technologies that deliver advanced services," *Int. J. Oper. Prod. Manag.*, vol. 34, no. 1, pp. 2–35, 2013.

[5] F. H. Beuren, M. Gitirana Gomes Ferreira, and P. A. Cauchick Miguel, "Product-service systems: A literature review on integrated products and services," *J. Clean. Prod.*, vol. 47, no. May 2013, pp. 222–231, 2013.

[6] H. Gebauer, E. Fleisch, and T. Friedli, "Overcoming the service paradox in manufacturing companies," *Eur. Manag. J.*, vol. 23, no. 1, pp. 14–26, 2005.

[7] G. Pezzotta, S. Cavalieri, and P. Gaiardelli, "A framework for an integrated management of After Sales Service," *Strateg. Manag. J.*, no. October 2016, 2007.

[8] M. Abramovici, Y. Aidi, and H. B. Dang, "Knowledge-Based Lifecycle Management Approach for Product Service Systems (PSS)," in *IFIP International Conference on Product Lifecycle Management*, 2013, pp. 239–248.

[9] G. Pezzotta, F. Pirola, A. Rondini, R. Pinto, and M. Z. Ouertani, "Towards a methodology to engineer industrial product-service system - Evidence from power and automation industry," *CIRP J. Manuf. Sci. Technol.*, vol. 15, pp. 19–32, 2016.

[10] C. Sassanelli, S. Terzi, G. Pezzotta, and M. Rossi, "How lean thinking affects: Product service systems development process," *20th Summer Sch. "Francesco Turco,"* no. Industrial Systems Engineering, pp. 97–104, 2015.

[11] A. Weinstein, "Market definition in technology-based industry: A comparative study of small versus non-small companies," *J. Small Bus. Manag.*, vol. 32, no. 4, p. 28, 1994.

[12] M. Lazoi, G. Pezzotta, F. Pirola, and A. Margarito, "Toward a PSS lifecycle management systems: considerations and architectural impacts," in *Enterprise Interoperability VII*, 2016.

[13] DIVERSITY Project, "D2 . 1 Specification of the DIVERSITY Methodology and of Lean Design and Visualization Tool," 2017.

[14] M. Rossi, M. Taisch, and S. Terzi, "Lean product development: A five-steps methodology for continuous improvement," in *18th International Conference on Engineering, Technology and Innovation*, 2012.

[15] M. Rossi, E. T. Kerga, M. Taisch, and S. Terzi, "Proposal of a method to systematically identify wastes in New Product Development Process," *2011 17th Int. Conf. Concurr. Enterprising*, no. Ice, pp. 1–9, 2011.

[16] C. Sassanelli, G. Pezzotta, M. Rossi, S. Terzi, and S. Cavalieri, "Towards a Lean Product Service Systems (PSS) Design: State of the Art, Opportunities and Challenges," *Procedia CIRP*, vol. 30, pp. 191–196, 2015.

[17] A. Neely, "Exploring the Financial Consequences of the Servitization of Manufacturing," *Oper. Manag. Res. Oper. Manag. Res. Oper. Manag. Res.*, vol. 1, no. 2, pp. 1–50, 2008.

[18] A. Rondini, G. Pezzotta, F. Pirola, M. Rossi, and P. Pina, "How to design and evaluate early PSS concepts : the Product Service Concept Tree," in *26th CIRP Design Conference*, 2016, vol. 0, pp. 0–5.

[19] C. Sassanelli, G. Pezzotta, R. Sala, A. T. Correia, and S. Terzi, "Testing the methodology to generate Design for Product Service Supportability (DfPSS) Guidelines and Rules: an application case," in *9th CIRP IPSS Conference*, 2017, vol. 0, p. Accepted.

[20] C. Sassanelli, G. Pezzotta, F. Pirola, and S. Terzi, "The Design for Product Service Supportability (DfPSS) method: Guidelines and Rules generation to enhance Product Service Systems design," *Des. Stud.*, p. [REVIEW], 2017.

[21] D. Mourtzis *et al.*, "PSS Design Considering Feedback from the Entire Product-service Lifecycle and Social Media," *Procedia CIRP*, vol. 47, pp. 156–161, 2016.

[22] R. Neves-Silva, M. Gamito, P. Pina, and A. R. Campos, "Modelling Influence and Reach in Sentiment Analysis," *Procedia CIRP*, vol. 47, pp. 48–53, 2016.

[23] D. Stokic and A. T. Correia, "Context Sensitive Web Service Engineering Environment for Product Extensions in Manufacturing Industry," in *Service Computation 2015*, 2015, pp. 9–13.

[24] S. Brax, "A manufacturer becoming service provider – challenges and a paradox," *Manag. Serv. Qual. An Int. J.*, vol. 15, no. 2, pp. 142–155, Apr. 2005.