Supporting Product-Service Development Through Customer Feedback

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Abstract. When developing product-services (P-S) it is important to take a collaborative and user-centric perspective to ensure that the P-S fits to customer needs. There are different approaches for the user involvement from intensive co-creation to the collection of customer feedback about the P-S design or P-S behavior. The feedback again can be collected using different methods and tools.

The paper discusses different methods for collecting customer feedback for product-service innovation and design. The context of the study is the Manutelligence project in which a P-S collaboration platform is developed, also to support interaction with customer. In the paper four Manutelligence use cases from different industrial fields are analysed to identify the different customer types, lifecycle stages of the feedback, feedback forms and how the platform can support the feedback collection and use. The benefits of the feedback collection in different cases are also described.

Keywords: Platform for collaboration:Co-creation:Product-Service engineering: Customer feedback:Manufacturing intelligence·Use cases

1 Introduction

Manufacturing companies are interested to better engage their customers and to deliver more benefits through offering product-services (P-S) or services related to their products. In this way they can also obtain additional business, which is often not as dependent on economic cycles as pure manufacturing. There are several definitions for a product-service (P-S). For example, it is defined as ”a mix of tangible products and intangible service designed and combined so that they are jointly capable of integrated, final customer needs” [1]. Another definition of a service in general (not only P-S) reveals the special nature of services –the intangibility and the importance of interaction with the customer: "A service is an activity or series of activities of more or less intangible nature that normally, but not necessarily, take place in interactions between the customer and service employees and / or physical resources or goods and / or systems of the service provider, which are provided as solutions to customer problems.” [2].

Collaboration with the customer is a vital part of any business network and moving into the P-S offering changes co-creation roles and requires different data. Relational coping strategies, including role clarification, role redefinition and role adaption, may be especially important during the co-creation process [3]. The data collected from the relationship for different roles has wide impact in the whole network. Therefore the quality and management of this data has a domino effect throughout the collaborative network.

The special characteristics address that developing P-Ss needs close collaboration with the customer. This has been discussed for example by the GloNet project which developed support platforms for effective operation of collaborative networks for service-enhanced products [4]. In principle the feedback from customers may come from different customer/user levels and the P-S providers would be interested to get the feedback as early as possible in the lifecycle. However, typically it is not as easy to get feedback from the user level (if not the first customer) in the lifecycle phase when the P-S is still in the design or manufacturing/ implementation phase. On the other hand, in the usage phase it is often more simple to get the feedback from the user.

This paper is focused on a specific subtype of co-creation: customer feedback. The paper context is the development of a P-S engineering platform in project Manutelligence ("Product Service Design and Manufacturing Intelligence Engineering Platform", H2020 636951). The objective of Manutelligence platform is to manage manufacturing intelligence; all data, information and knowledge related to the P-S and its lifecycle. In the project, product information is divided into definition data and feedback data [5]. The feedback information can be created in different life cycle stages, like P-S design and P-S operation/use and using different methods. The idea is that the Manutelligence platform supports the collection of customer feedback, for example by visualizing the designed P-S and offering the channels for customer feedback. The platform is based on the integration of existing tools and platforms.

It is clear that extracting customer feedback can make the P-S more attractive to the customers but that it is always not easy to get the feedback. Thus the objective of this paper is to analyze the approaches for customer feedback based on the Manutelligence industrial cases: four industrial pilots from different industrial fields (automotive, ship, smart house, fablab/3D-printing). From the point of the customer two of the pilot products are highly complex (automotive, ship), one is medium complex (fablab) and one is low in complexity (smart house). Respectively the data-richness of the feedback follows the complexity.

The following research questions are discussed:

- What kind of methods can be used to collect customer feedback of Product-Services?
- How can a digital Product-Service engineering platform support the feedback collection and utilization?

2 Approaches for P-S Feedback

Product-service customer feedback is typically linked to the specific, offered, often also customized Product-Service and its behavior. This may happen in the P-S design or manufacturing phase in which case the feedback may be used to modify the P-S according to customer comments. The importance of customer feedback is emphasized due to the co-created nature of value of P-S. Co-creation refers to the customer participating in value creation and value being jointly created by the company, the customer, and often other [6,7].

It is also possible to collect the feedback once the product is produced, i.e. once a product instance exists. From that moment on, the product instance is affected by loads caused by lifecycle processes (e.g. production, transportation and usage) [3]. These loads affect the degradation and the operation behavior of a product. Feedback information from the use/operation phase allows the producers to learn more about the users, the usage of products and the product behavior [8]. In principle, information about services can also be collected, but the channels may vary and the instantiation of a service is different compared to products. In Manutelligence, a service is instantiated once information is created about it (e.g. a contract or service request) [3]. This is different from the commonly mentioned characteristic that a service is produced and consumed at the same time– technically, the service is instantiated in computer systems before it is consumed.

Often both users and sensors create data about the system. A possibility to manage and compare all data creates new possibilities to understand and verify the system behavior. Zolkiewski et.al. [9] say that "In support of this focus on outcomes-based measures, we contend that other data, beyond user's perceptual data, should be employed to enhance customer experience measurement and management." and they mention sources like Big Data, IoT, Cloud and smart assets

3 Methodology

The platform development is based on existing platforms and their adaptation according to the needs of four use case pilots (automotive, ship, smart house, fablab). The needs were collected and analysed in a requirement engineering process including phases: elicitation, structuration, analysis and validation. In the elicitation phase each of the pilots specified the use scenarios, that is: descriptions of processes or process parts which could be supported by a P-S engineering platform. The description included the objectives, challenges, lifecycle stage and the use cases included. Each scenario could have more than one use case. Each use case again was described with a common format including for example actors, precondition, postcondition, systems involved, diagram and the main steps. The number of scenarios and use cases defined in the first phase was the following:

- Automotive pilot: 3 scenarios and altogether 6 use cases
- Ship pilot: 3 scenarios and 6 use cases
- Smart house pilot: 3 scenarios and 5 use cases
- Fablab pilot: 5 scenarios and 17 use cases.

Thus altogether 14 scenarios and 34 use cases were defined in the first phase of the project. At this time point the companies had not yet decided which use cases will be implemented during the Manutelligence project but the focus was on the identification of future opportunities. Also during the project some new use cases emerged. The scenario descriptions were used in the elicitation of requirements for the Manutelligence platform.

Currently the project is in its final phase. Most of the use cases have developed into pilot demonstrations. Some of the defined use cases have been left out of the current project and some new use cases have emerged. Validation of the pilots against requirements will take place during the last six months of the project.

This paper describes the analysis of the use case scenarios from the viewpoint of customer feedback. The analysis included the following steps:

1. Identification of the use scenarios and use cases in which customer is involved as an active or passive source of feedback. As a whole in 7 of the 14 scenarios and 9 of the 17 use cases some kind of feedback was included.
2. Analysis of the identified scenarios and use cases using a common approach and template. The main points of the template are presented in table 1 and as a whole in [10]. It was not possible to find all the information for all the cases in the basic source documents. In some cases prototype presentations and discussions with the use case representatives were needed.
3. Consolidation of the analysis results. This was performed for the items considered most important, like the customer / user type, objectives and benefits, lifecycle stage, feedback type and channels or tools, how the feedback is used and what could be the role of the Manutelligence platform.
4. Identification of similarities and differences; developing a mapping framework and conclusions.

Table 1. Use case analysis framework

Use case name, Scenario, Date, completed by
Product-Service (P-S) delivered
When is the feedback collected? In what P-S lifecycle phase? How often is the feedback collected?
Who is customer or use of the P-S?
Objectives. Why is the feedback from customers needed?
Type of customer interaction? (E.g. B2B, B2C, C2C/P2P, P-S production)
Dimensions of feedback. What does the feedback concern?
What does the feedback include? What is the feedback content? E.g. textual, visual, audio, data, proposition/ requirement, free/ specified or other format
How is the feedback given? What are current (and future Manutelligence) cannels for delivering feedback? E.g. Listening and asking customers, build with customers, in a meeting/ e-mail / platform / IoT
What happens after the feedback is given?
What is the Manutelligence Platform role in customer feedback? How it could help and support in enhancing the use of customer feedback?

4 Results – Feedback Case Analysis

Even if the Manutelligence cases significantly differ from each other in size and complexity, they all express, in different ways, one common objective for the collection of the customer feedback. It is the improvement of the P-S, either of the P-S instant (a specific P-S) or the future P-Ss. The improved P-S is expected to influence the customer satisfaction and thus to improve the competitiveness of the company. Additionally it is expected that the interaction including the feedback and the potential to influence the P-S design strengthens the customer relationship and enables better understanding about the future needs.

The availability of life cycle analysis (LCA) and life cycle cost analysis (LCC) on the platform allows the user to give feedback if the P-S performance is sufficient. The end user can make the decision based on sustainability assessment and long term costs. For example, the customer can predict future energy consumption and adapt.

In addition to high quality P-S, one benefit expected is to speed up the design, P-S specification and implementation processes, and to decrease the costs. Efficient feedback tools enabled by the platform allow faster fixing of the design decisions, but also avoiding errors in the design. Thus there is decreased need to waste time for the correction of errors and the subsequent manufacturing / implementation phases may be more efficient.

In one specific case, fablab, the community of customers (users) is seen important for the manufacturing activity as a whole. The feedback supports the optimization of the use of production machinery for additive manufacturing, sharing knowledge amongst users, design improvement and design reuse.

The feedback or data coming from the P-S use phase also supports the failure management and reduction of repair time as well as activities through predictive maintenance. All this can contribute to the keeping the products in a good shape and thus achieving a longer life for the products.

When analysing the customer feedback, two main distinctive features could be identified:

- The P-S lifecycle phase in which the feedback is collected and analysed. Main phases identified are P-S design/ implementation and P-S operation/ use phases. The end-of-life phase was not visible in the scenarios.
- The type and method of feedback: type meaning the information type (unstructured information, structured information, data) and method how the feedback is given (customer manual input, customer selection from predefined options, automatic (for example) sensor data). It seems clear that in most cases these are not independent but interlinked: The unstructured information requires some customer activity while the bigger amounts of data are coming automatically from sensors, for example via IoT. The structured feedback (for example selection between options) can be derived either from the customer or from automatic devices.

Thus the main dimensions against which the use cases can be compared and analyzed are: P-S lifecycle phase and the source of feedback: customer activity/ automatic retrieval. The customer activity may mean feedback given through platform, email or discussions in a meeting etc. In Manutelligence the focus is on feedback which could be supported by the platform; this may be automatic or action-based. In table 2 the Manutelligence use cases including feedback in some form were analyzed in relation to these dimensions.

Table 2. Use case feedback analysis

	Life cycle phase				
	Sales	Design	Manu-facturing	Use/ Operation	End of life
Action-based	Ship1 Ship2 Smart-house1	Ship1 Ship2 Smart-house1	Ship2	Automotive1 Automotive2	
Automatic		Automotive2	Fablab1	Automotive1 Automotive2 Fablab2 Fablab3 Smart-house2	

The table shows that the different use cases had a different focus in their scenarios and collaboration with customers. The main focus of the ship case was feedback from the ship owner in the design phase, based on virtual models, gamification and augmented reality. As this kind of feedback cannot be automated, the idea was to utilize the virtual models for the easy issue of the observations and again use these as the basis for a managed change management. The smart house scenario included some configuration ideas for the design phase but the main objective was to collect automatically data from sensors to monitor the product behavior and to develop new services. In the automotive case the main point was automatic data collection from testing even if also customer opinions were collected. The fablab case was a specific case where all the lab users (manufacturers) are customers.

Thus, analysis of the Manutelligence case scenarios brings out that there is a need for retrieving customer feedback in all lifecycle phases even if no end of life scenarios were available in the current project. It is clear that an IT platform utilizing IoT (Internet of Things) is needed to collect and manage the large amounts of data given by automatic sensors. The data can be used for use phase services and for further design. Often there is also a need to compare the real data against designed performance (for example energy consumption models).

To receive feedback from the customer through customer actions the P-S provider needs to make the feedback action attractive for the customer. This means that it should be easy and interesting for the customer, for example to understand the current P-S version in the design phase, and also easy to give the feedback. In the use cases this was implemented through visualization, even experimenting through gamification, supported by the platform. The feedback could be directly appointed to the visual models or given by more traditional means, like in meetings. Thus also here the platform is needed both to present the P-S for which feedback is needed but also to save and analyse the collected, often heterogeneous information.

In the fablab case there is a user community which is interested to interact and give feedback to the P-S provider but also to share experiences. Thus the platform needs to offer tools also for this communication and collaboration.

As an important function of the platform in relation to customer feedback is to take care that the customer feedback is handled and used for the current P-S instant or for future P-Ss. Thus systematic change management process, supported by the platform, is needed. The change process also takes care about informing the customer about the results of the feedback process: what changes were made.

Based on the findings in the project a P-S platform may have different roles in the customer feedback process:

- The platform should manage the rich P-S data and information throughout the lifecycle.
- The platform should offer the P-S information to the customer in an understandable interface.
- The platform should offer the customer a possibility to give different types of comments.
- The platform should integrate to IoT to collect data from different types of sensors.
- It should be possible to analyse the feedback data and information using the platform, for example to compare real and designed data.
- The platform should support the change management process.
- The platform should allow communication between different users or different actors.
- The platform should support organizational change management by enabling dynamic changes required by changes in roles and tasks.

5 Summary

This paper is focused on supporting P-S design through customer feedback. The paper is based on Manutelligence pilots (H2020 no. 636951) and their needs and experimentation of the Manutelligence platform. The aim of Manutelligence platform is to manage manufacturing intelligence; all data, information and knowledge related to the P-S and its lifecycle. Even if the main requirements elicited in the beginning of the project were focused on other needs, the customer feedback and collaboration with the customer were visible in 7 out of 21 aggregated requirements [11]. Customer feedback is expected to improve the P-S, customer satisfaction, process efficiency and overall company competitiveness. New methods and channels for customer feedback require that the platform is able to integrate and manage the rich feedback data.

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