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Continuous Improvement of Industrial Product-Service Systems

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Abstract
Industrial Product-Service Systems (PSS) are realized within the value creation network of the PSS-provider in close cooperation with customers. Thereby, the organizational and operational structure of the value creation network as well as the customer interaction itself must be designed in order to guarantee the PSS-provider continuous product and customer feedback. This feedback provides the basis for a continuous PSS-improvement process, comprising customer specific and customer spanning improvement measures. This paper analyzes demands on the value creation network structure in order to enable a PSS-provider to implement a continuous PSS-improvement process. Based thereon, a continuous PSS-improvement process is provided.

Keywords:
Product-Service Systems, Design Process, Development Process, Improvement Process

1 INTRODUCTION

Industrial customers are increasingly expecting to be provided with services such as maintenance, upgrading, operator trainings or process improvement. These services do not only contribute to keeping up existing product functionalities [1] but also provide additional ones along the whole life cycle [2].

Since in the past capital goods manufacturers have largely focused on design, realization and distribution of high quality products, a gradual change of traditional manufacturing companies to producing service providers [3] that focus on customer solutions in terms of benefit oriented industrial Product-Service Systems (PSS) becomes necessary. To support this change, processes for product and service planning, design and realization need to be integrated [4].

Because of focus in the phase of PSS-realization lies both on providing the customers with a desired benefit through a specific configuration of products and services as well as on the establishment of measures for continuous customer specific and customer spanning PSS-improvement, both organizational and operational structures of the value creation network have to be designed in order to enable the manufacturer to operate the processes connected therewith.

This paper analyzes the demands on the organizational and operational structure of the extended value creation network of a PSS-provider in a first step, complemented by a description of the demands on a systematic performance measurement of PSS as well as the processes of information exchange connected therewith. Based on these two points, an approach for the implementation of a continuous improvement process for PSS involving all members of the extended value creation network is provided by this article.

2 INDUSTRIAL PRODUCT-SERVICE SYSTEMS

Industrial PSS are defined as customer life cycle oriented combinations of products and services, realized in an extended value creation network, comprising a manufacturer as well as suppliers and service partners [5], [6]. Industrial PSS, as provided in the capital goods industry, are made up of a complex physical product core dynamically enhanced and individualized along its life cycle by mainly non-physical services. Thus, a PSS represents an integrated product and service offering that delivers value in use [7].

A PSS comprises customer and manufacturer related sub-systems with multiple interrelations (Figure 1) [4], [8].

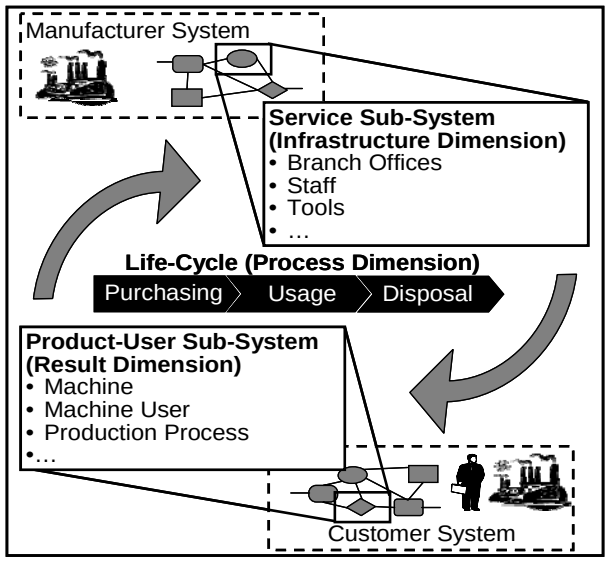

Figure 1: Product-Service Systems.

The aim of the product-user sub-system, comprising the physical product core as well as the staff of the customer responsible for its operation, is to provide an expected set of functions during a production process.

The second sub-system is represented by the service network with its elements: branches, service partners, personnel, technical equipment etc. By means of the delivery of services its main functions are on the one hand to keep up and enhance the above mentioned functionalities in a customer individual way and on the other hand to continuously provide the manufacturer with customer feedback [9]. For example, maintenance services contribute to the preservation of the functional level of a product, while trainings provide the user with the

competencies, necessary for conducting different applications. Besides, due to their delivery implying direct product and customer contact, information on e.g. product reliability and usability can be obtained.

Taking these sub-systems into consideration, a distinction between two life cycle perspectives needs to be drawn [2], [4]. From the point of view of the product manufacturer, the product life cycle starts with product design, followed by product manufacturing, servicing and remanufacturing. From the point of view of the customers it consists of product purchasing, usage and disposal. Since the PSS aims at enhancing the performance of industrial products by corresponding services, the non-physical service components must be provided with respect to the customer's point of view.

Considering these perspectives, the manufacturer has to design both physical products, optimized for manufacturing, servicing and remanufacturing as well as non-physical services that support his customers during product purchasing, usage and disposal. Following PSS design and the production of the physical product core at a limited number of production locations, the services are delivered at the place of product usage by the service partners of the manufacturer [4].

With respect to designing and realizing PSS, three dimensions need to be distinguished (Figure 2) [4]:

- The physical and non-physical product and service components together provide the customer with a certain set of expected functionalities that represent the product or result dimension of the PSS.
- PSS realization is based on different processes such as product maintenance and training that continuously change the state of the product-user sub-system and the service sub-system along the life cycle, e.g. in terms of improved machine or service components. They represent the process dimension of the PSS.
- Finally, the service network provides the resources for executing the state changes as well as for providing the manufacturer with continuous product, customer and market feedback. It thus represents the infrastructure dimension of the PSS.

The realization of information retrieval processes represents a basic function of the service components of the PSS and aims at providing the manufacturer with widespread product, customer and market feedback. It thus represents the basis for a continuous optimization of the product and service offerings as well as the corresponding processes and resources by complementing the already existing knowledge of the manufacturer [10]. Although the information aspect plays a key role in designing and realizing of PSS, there is not any separate information dimension described. This is caused by the interdisciplinary character of information. Thus, the necessary specification of information exchange processes can be covered by the three dimensions presented above [11].

A systematization of information retrieval processes builds the basis for the implementation of a continuous improvement process. Therefore, a detailed organization of the extended value creation network, comprising both organizational and operational structures, is required. While the structure of the extended value creation network in practice mostly varies between the different PSS-providers, there are general requirements of the organizational and operational structures that result from already existing PSS-Life Cycle Management concepts.

3 PSS LIFE CYCLE MANAGEMENT

In order to promote the implementation of PSS in practice, physical product focused Life Cycle Management (LCM) can be taken as a promising starting point [11]. LCM aims at organizing the interactions between the different partners within the value creation network along the life cycle by a set of methods and processes for the design and realization of physical products [12]. Based on current physical product focused LCM concepts, the following fields of action are addressed by already existing PSS-LCM concepts [4]:

- Methods and processes for customer-oriented PSS-planning that support the proactive specification of Life Time Management measures in terms of services.
- Methods and processes for integrated PSS-design that allow the specification of the different models required for describing the three dimensions of a PSS.
- Methods and processes to exploit the service potentials for providing the manufacturer with product, customer and market feedback.
- PSS Performance Measurement Systems for customer individual Life Cycle Evaluation and definition of consequential PSS-improvements.
- Life-cycle oriented process management based on standardized process descriptions to get all partners in the extended value creation network having a common understanding of the necessary design, production and servicing processes.

Based on the manufacturer point of view concerning the PSS life cycle, the framework for PSS-LCM underlying this paper [11] consists of four phases (Figure 3).

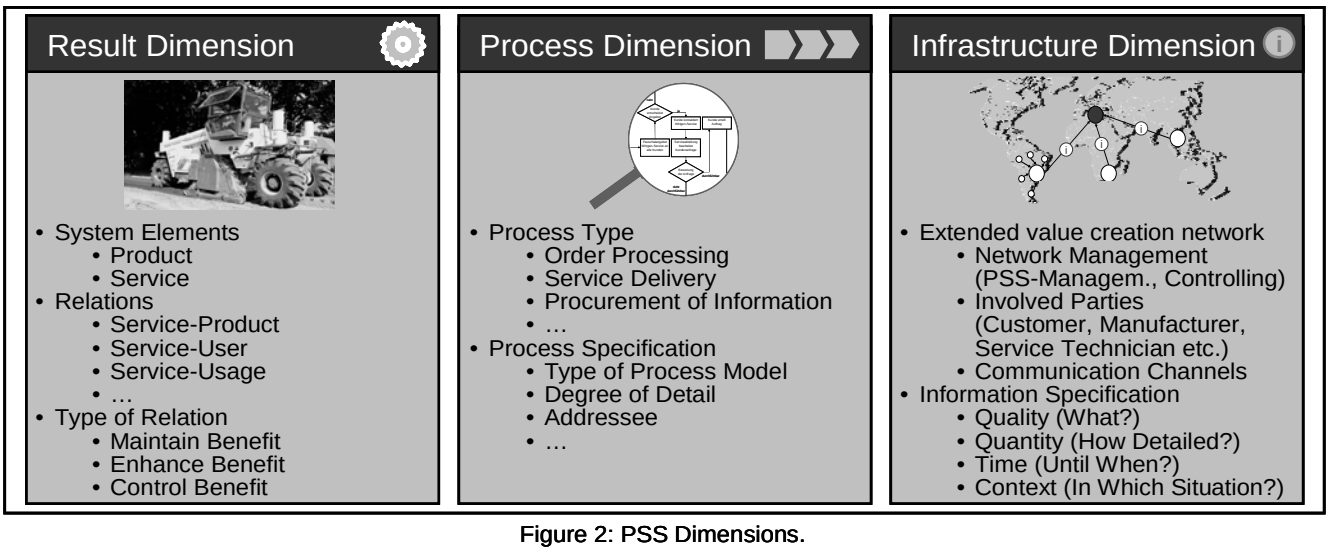

Figure 2: PSS Dimensions.

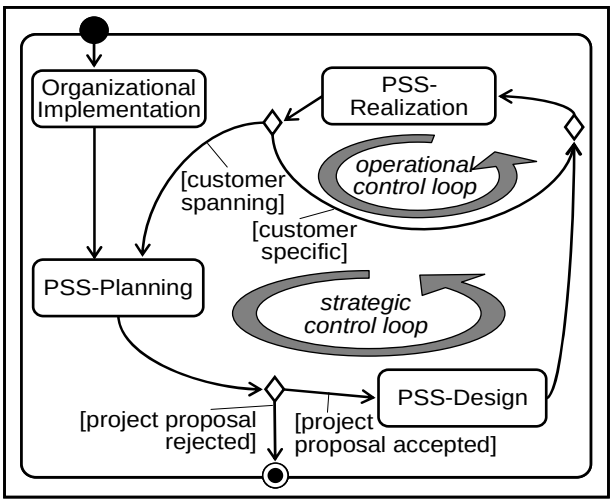

Figure 3: Control Loop Model for PSS LCM.

In the organizational implementation phase, the basis for PSS-LCM is laid in terms of building up the necessary design and realization processes. Besides this, the implementation of the required organizational and operational prerequisites within the extended value creation network of the PSS-provider takes place.

The PSS-planning phase pertains to the identification and definition of physical and non-physical PSS-components contributing to the aims of both manufacturer and customer [8]. For their model based description, the PSS-design phase covers the subsequent planning and execution of a PSS development project. Thereby, focus is on the integration of product and service design [13].

After the customer individual life cycle oriented configuration of the PSS [14], the phase of PSS-realization aims at providing the customer with a certain benefit. Thereby, the gathering and the analysis of feedback information that supports continuous PSS-improvement is addressed by the manufacturer. Thus, the operational and strategic control loops as shown in Figure 3 can be established in the value creation network.

4 DESIGN OF THE VALUE CREATION NETWORK

4.1 Functions of the Value Creation Network

To fulfil the customer demands and to achieve a high customer satisfaction, the manufacturer (PSS-provider) has a higher degree of responsibility for the product's full life cycle [6], [15]. Taking a look at the PSS life cycle from both points of view, it becomes apparent that an integrated product and service offering results in a long term cooperation between the PSS-provider and the customers. Consequently, this also leads to high requirements for the organizational and operational structure of the belonging value creation network [15]. Compared to networks of manufacturers only providing physical products, the service components of a PSS pose a challenge for structuring of the value creation network. Thereby, these service functions [16] that can be distinguished as follows have to be fulfilled by the network in addition to the functions of a single product:

- The support function refers to ensuring the expected benefit of the product by means of technical services.
- Requirements fulfilment refers to enhancing this use by means of complementary offers, e.g. upgrading, user training or application consulting.
- The procurement of information represents an internal function since it aims at providing the manufacturer with an expected customer, product and market feedback.

These functions only partially can be fulfilled by the manufacturer. Furthermore, all partners of the extended value creation network have to be involved in performing the tasks connected therewith. This leads to different requirements on the expertise of the network partners.

The extended value creation network of a PSS-provider comprises partners necessary for both the production of the physical product core of the PSS as well as for the delivery of the service components (Figure 4).

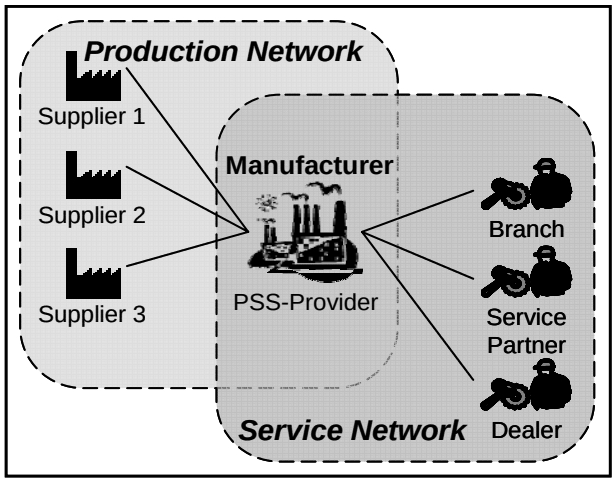

Figure 4: Extended Value Creation Network.

4.2 Production network

The production network includes both the provider of the PSS as well as suppliers of parts, components, modules or systems [17]. It is responsible for the production of the physical product core of the PSS at a limited number of production locations of the manufacturer. Following elements of the production network can be identified:

Manufacturer / PSS-provider

The manufacturer of the physical product core represents the centre of the value creation network. Above all, the manufacturer is responsible for planning and design of the physical products provided all over the world as well as their production realized in closed cooperation with the supplier network.

Suppliers

The suppliers are responsible for the delivery of parts, components, modules or systems. Thus, they support the manufacturer within the production of the physical product core of the PSS.

4.3 Service Network

The service network comprises both branches and service locations of the manufacturer as well as independent distribution and service partners [18]. This service network is responsible for the successively delivery of the services throughout the product life cycle and comprises the following elements:

Manufacturer / PSS-provider

Additionally to the production of the physical PSS-components, the planning and design of the complementary service offerings is realized centrally by the manufacturer. Within these strategic processes, the local branches or service partners being responsible for the service delivery are not directly involved in.

Dealers and branches

At important markets, the PSS-provider relies on own dealers and branches. They depend on the PSS-provider in terms of economical and legal aspects. Additionally to the dealers, branches usually engage product specialists that rely on knowledge of a specific product type.

Service partners

At markets that do not have any branches owned by the PSS-provider, independent partners are responsible for the distribution of the products and services as well as the delivery of the services. Thereby, they act on behalf of the PSS-provider.

Customers

While not directly being a member of the value creation network, the customer itself plays an important role during the delivery of services. Due to the characteristics of services, he is involved in the delivery of services in terms of an external factor.

It becomes apparent that in the extended value creation network the branches, service partners or dealers can be regarded as being in the "middle", linked forward to the customers and backward to the manufacturer [19]. Thereby, the so called account managers usually employed at a specific dealer or branch are responsible for the individual customer contact in terms of a one-face-to-the-customer policy.

4.4 Assignment of Tasks during PSS-LCM

All along the long term cooperation of the network partners, the assignment of tasks and responsibilities often changes because of the different challenges in PSS-LCM (Figure 5). Thus, the following phases need to be distinguished.

Organizational Implementation

Based on the decision to change from a traditional manufacturing company to a producing service provider that focuses on customer solutions, the manufacturer analyses the existing organizational and operational structures in product and service management. Thereby, main focus lays on the analysis of the characteristics of both existing design processes as well as already implemented information exchange processes. Based thereon, processes of PSS-LCM are defined by the manufacturer in order to enable the branches and service partners to support and to participate in planning, design, configuration and realization of PSS.

PSS-Planning

PSS-planning aims at identifying, selecting and specifying of PSS ideas to be developed within the following PSS-design phase. Thereby, the planning of both product and service components of the PSS take place centrally by the manufacturer. In these processes, an essential input is represented by information gathered while realizations of similar PSS that already exist. For this reason, the organizational units that are directly in contact with the customers or that can inform about customer preferences have to be involved in.

PSS-Design

The design of a new type of PSS is realized in two steps. Firstly, the main characteristics of the new PSS type is planned and designed centrally by the manufacturer. Thereafter, the corresponding product and service components of the PSS are adapted according to the specific market requirements. While the responsibility for the detailed design of the physical product still remains with the manufacturer, the service offerings are customized by the partners of the service network that are present at the local markets.

PSS-Configuration

Based on the resulting market specific product and service components, the customer order processes represent the next step in PSS-LCM. Supported by the staff members of the service partners, customers firstly configure the physical product core of the PSS in terms of selecting desired components and functionalities, followed by the definition of the corresponding service components. If necessary, these service components can be customized by the service partners.

PSS-Realization

After the delivery of the product to the customers, the services are delivered by the service partners in close cooperation with the customers. Additionally, the service partners are responsible for the customer benefit oriented continuous improvement of the PSS as well as the gathering of feedback information. The resulting improvements are realized either centrally by the manufacturer or locally by the service partners.

The assignment of tasks has to consider that, within the scope of organizational implementation, the different members of the value creation network have to be qualified in order to fulfil their tasks in a right way. This particularly regards the integrated qualification of the network partners in view of a systematic planning, design configuration and realization of PSS that comprises both product and service components. Hence, it is crucial that all network partners rely on further expertises in designing and adapting processes as well as the corresponding infrastructure.

5 PERFORMANCE MEASUREMENT OF PSS

Focus in the PSS-realization phase lays both on providing the customers with a desired benefit through a specific configuration of products and services as well as on the establishment of the described operational and strategic

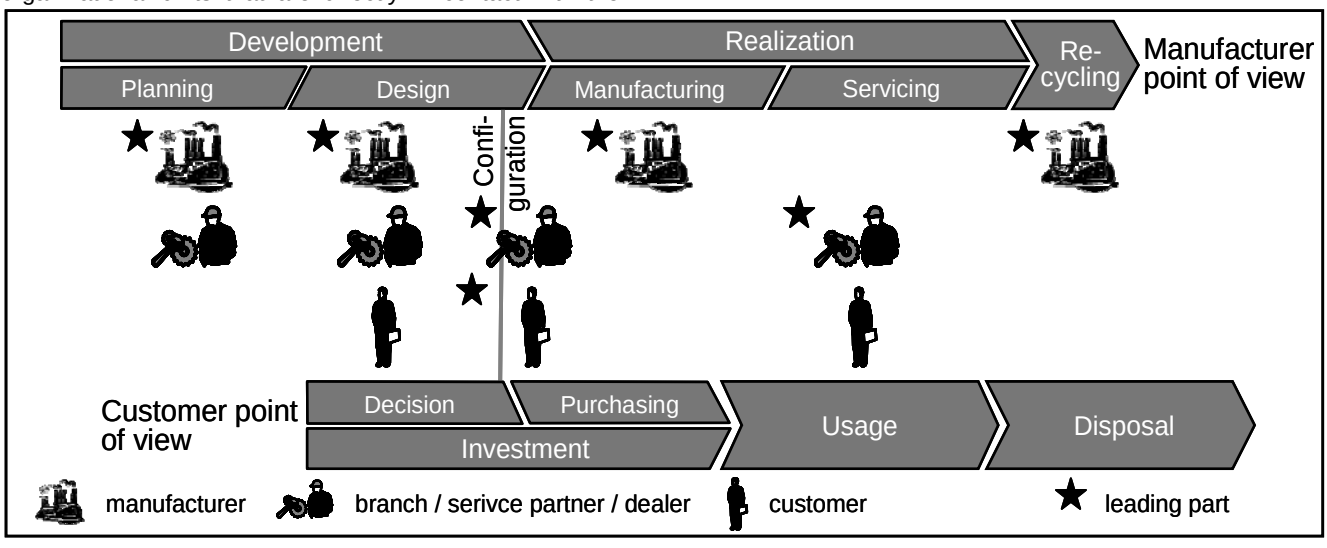

Figure 5: Assignment of Tasks during PSS-Life Cycle.

control loops according to Figure 3. To measure the performance of a PSS systematically, two important prerequisites have to be fulfilled. On the one hand, a continuous information flow between the customer respectively the service technician being in contact with the customer and the branch, service partner or dealer responsible for the support of a customer individual PSS has to be established. On the other hand, key figures to scrutinize the desired benefit need to be defined.

5.1 Key Figures

Predefined reference values underlying the evaluation of the performance of PSS require a standard of comparison that should be quantifiable [20]. For example, a standard of comparison can be requirements that may be derived from customer or manufacturer targets. Thereby, the characteristics of this standard as well as their possible values must be known (e.g. the life cycle costs of a PSS and their range). In general, this standard of comparison is characterized as a key figure. Consequently, key figures are defined as information that allows a qualitative and quantitative description of circumstances and facts in a concentrated way [21]. Thereby, key figures can have both a monetary and a non-monetary character and aim at controlling and analysing environmental conditions as well as business processes. They provide the basis for a systematic planning and evaluation of alternative solutions or are used for controlling processes [22]. Thus, key figures provide a promising device for performance measurement of industrial PSS.

5.2 Key Figures in Context of PSS

The definition of key figures for each customer individual PSS is carried out within the PSS-configuration in order to provide a measurement of the PSS performance. This happens in collaboration between the customer and the respective branch, dealer or service partner and depends both on manufacturer and customer targets to be fulfilled along the PSS life cycle. Thus, at the beginning of the PSS-realization phase key figures are defined that allow a continuous examination of the benefit by gathering and analysing field data. Thereby, the key figures can refer to the different dimensions of a PSS as described above:

- Product or result oriented key figures describe the benefit provided by the PSS for both customers and manufacturer. These key figures are often related to certain functionalities of the PSS that are realized by both product and service components of the PSS (e.g. product oriented quality figures, such as availability).
- Process oriented key figures are related to the processes necessary for providing the expected benefits. This kind of key figure is for example used for an assessment of the efficiency and effectiveness of maintenance and repair processes.
- Infrastructure oriented key figures describe the resources (e.g. energy) necessary for processes that aim at guaranteeing the realization of expected benefits.
- Information oriented key figures allow a description of the information exchange processes between the customer and the PSS-provider during the product usage phase. One of these key figures can e.g. be the availability of a service hotline.

The key figures can thereby be related to both product and service components of a PSS as well as the interrelations of the product and service components.

In connection with the definition of the key figures, processes for gathering and analysing the corresponding information have to be determined. This also includes the definition of the organization units responsible for gathering the information as well as the definition of the target values of each of the key figures. The definition of critical values of the key figures determines, in which situation the PSS-provider respectively his network partner has to think about or to initiate appropriate product or service related improvement measures that can be either customer individual or customer spanning.

5.3 Processes of Information Gathering

To implement a systematic evaluation of the PSS performance, a few network partners has to be involved in performance measurement mechanisms. Primarily, this concerns the network partners communicating with the customer or servicing a customer individual PSS. These network partners have to support the processes of information gathering and analysis with the objective of an immediate forwarding of the information to the appropriate organizational units. Thereby, following sub-processes of information gathering can be distinguished [9]:

- Identification of information: Information gathering processes can be initialized both internally by an organizational unit (e.g. information about a PSS required for the PSS-planning are specified by the manufacturer) as well as externally by a staff member communicating with a customer. In the latter case, a staff member being in closed contact with the customer independently gathers information that maybe is of interest to the manufacturer.
- Gathering information: Gathering information describes the admission of field data. Thereby, service reports are generated by the service technician in form of paper based standard forms or by means of electronic resources. Afterwards, these service reports are transferred to the manufacturer or his network partner responsible for servicing the customer individual PSS.
- Analysis of information: This sub-process comprises the examination of the information for completeness and plausibility and an assessment of their relevancy for the manufacturer. Thereby, it can e.g. be distinguished whether information can be used for further purposes or if information only has statistical characteristics.
- Allocate information: The last step of the information gathering is the appropriation of the information to an organizational unit responsible for the further processing of the information. Simultaneously, the person who gathered the information gets feedback about the relevancy of this information.

6 CONTINUOUS IMPROVEMENT PROCESSES

A Continuous Improvement Process (CIP) demonstrates a mindset adopted by all persons involved in. CIP aims at continuously changing for the better while the developed solutions should have sustainable effect. Thus, it is related to product, process or service quality. Thereby, CIP comprises all activities as well as the whole company network of a product, service or PSS-provider.

6.1 Fundamentals

The idea of establishing Continuous Improvement Processes traces back to the Japanese Kaizen concept that aims at consistently changing things for the better. Thereby, the basic idea of Kaizen is the increase of productivity by a stepwise continuous improvement. CIP as a synonym for Kaizen concentrate on the processes necessary for either the production of a product or the delivery of a service. Thereby, deviations, differences, anomalies or failure in these processes are systematically determined. Based thereon, solutions have to be developed in formalized problem solving processes in order to eliminate the identified weaknesses. These

solutions afterwards are realized by the affected organizational units. Following phases of CIP can be distinguished (Figure 6):

- Understanding existing problems,
- Analysis of causes,
- Development of product or process improvements and planning of remedial action,
- Taking selective measures,
- Testing the measures for target achievement,
- Improvement of the taken measures and definition of the measure as a new standard.

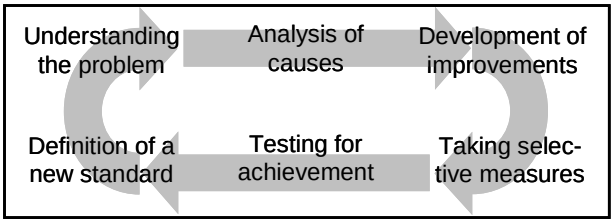

Figure 6 : Continuous Improvement Processes.

6.2 Towards Continuous Improvement of PSS

To implement CIP in context of PSS, different requirements to be fulfilled can be identified as follows:

- The PSS to be improved has to be described sufficiently with regard to all three dimensions (result, processes and infrastructure). In the same way, a border between the PSS and its environment has to be established.
- The model based description of the PSS has to be standardized within the whole value creation network to enable the different network partners to work on the improvements of the PSS together.
- The operation conditions of the PSS resulting from the specific customer life cycle must be describable in order to model them systematically.
- The PSS-improvement processes have to be standardized within the value creation network as well in order to guarantee a high process quality. Furthermore, the resulting requirements on the expertises of the network partners have to be defined clearly in order to succeed the processes.
- All staff members within the extended value creation network have to internalize the interrelations of the business processes within the network to guarantee the success of the network partner spanning improvement processes.
- Since improvement measures predominantly aim at improving a customer individual PSS, an appropriate Performance Measurement System has to allow an assessment of the actual performance of each PSS.
- Information and communication networks not only have to ensure the forwarding of information generated within the improvement process. Furthermore, the networks must enable a judgement of information by all network partners in order to attach importance to information.

These prerequisites have to be taken into account while implementing a PSS-CIP.

7 CONTINUOUS IMPROVEMENT OF PSS

7.1 Overview

Due to the characteristics of PSS described above, a PSS-improvement process can be seen as a process taking place within the whole value creation network, especially the service network. Based on a systematic problem description, a problem analysis and assessment takes place. Thereafter, possible solutions are planned and assessed. Thereby, it has to be determined, whether customer individual or spanning measures will be taken. The implementation of the selected solution closes the PSS-CIP (Figure 7).

7.2 Organizational Prerequisites

As an initial step of improvement processes, the system to be improved has to be defined. In case of PSS, this description comprises both the precise definition of the result, process and infrastructure dimension of a customer individual PSS as well as the establishment of a border between the PSS and its environment. This can be done by means of the model based description of the PSS developed during the PSS-design phase and standardized all over the value creation network. Thus, the system to be improved subsequently becomes clear.

To provide support to the service technicians at problem solving, a solution database has to be introduced. This database contains product and servicing problems appeared in the past and described in connection with appropriate solutions. Since this database is available all over the world, all partners of the extended value creation network can access this database as well as update both problems and solutions described therein.

During configuration, PSS specific key figures are determined by account managers operating within one of

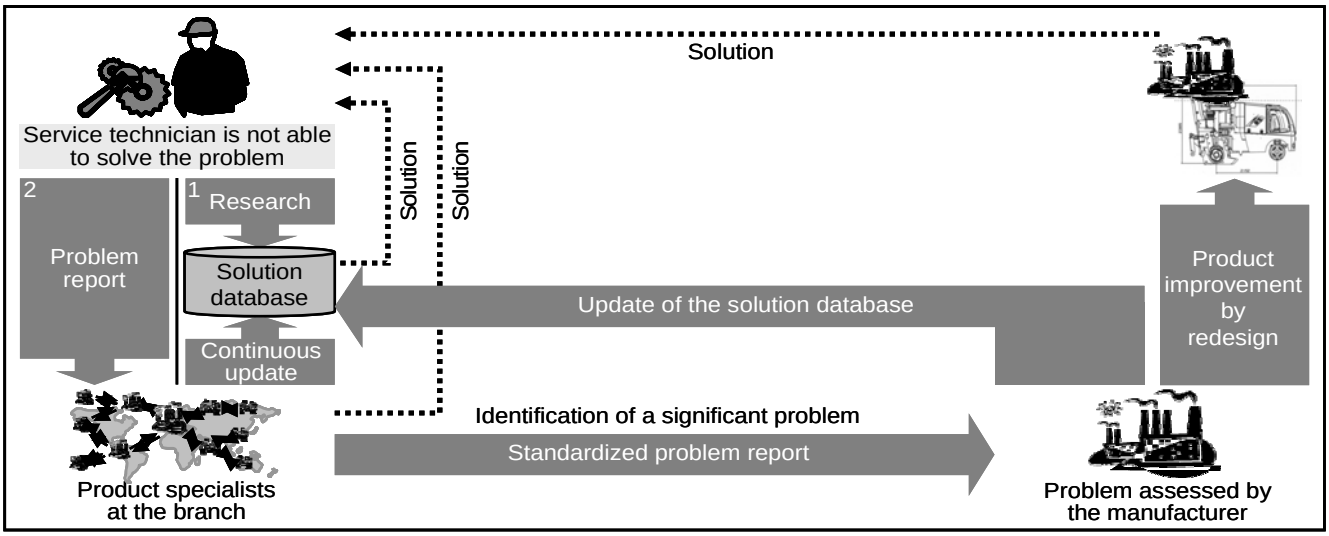

Figure 7: Continuous Improvement Processes for PSS.

the service network partners. These key figures allow for the measurement of the actual performance of each customer individual PSS.

7.3 Problem Description and Analysis

The description of problems and the analysis of its causes represent the first step of a PSS-improvement process.

The measurement of the actual PSS performance can be seen as an initial step. The measurement on the one hand can be initialized as a reaction of customer complaints. In this case, service technicians are sent to the customer in order to solve an existing problem detected and reported by the customer. Thereby, the individual key figures of the PSS can be determined. On the other hand, these key figures can be determined pre-emptively. This means e.g. that measurements can be taken in planned intervals or in the context of planned on-site inspections. By means of the measurement results, the actual performance of the PSS can be described. Thereafter, the information is analyzed by account managers in order to compare this state with a target state individually defined for each PSS.

In case of deviations from the target state, the actual condition of the PSS as well as the problems addressed have to be described in a detailed way by a service technician. Furthermore, the problems are assessed with regard to the requirements resulting form customer production processes to be fulfilled by means of the PSS. This allows conclusions to malfunctioning processes that indeed cause the problem but that cannot be solved by improving the product or service components of a PSS.

A further specification of the problem follows the problem description described above. Thus, possible causes for the problem, interfaces to operation conditions as well as side effects can be described. This description usually is done by a service technician who is in face of the customer. Based thereon, the targets underlying the improvement process can be specified by either the service technician or the account manager. This includes the limitation of the field of activity. Thus, it becomes clear, if the measures to be developed address the result, process or infrastructure dimension of the PSS.

While improvement measures predominantly address customized PSS, some specified measures can not only be significant for a unique PSS, but also concern a whole PSS-type. Therefore, the problem occurred has to be assessed by product specialists within the responsible branch. This comprises on the one hand the case that the problem can directly be solved by the service technician because of knowing the solution or finding a similar problem yet described in the solution database. If so, the problem is only documented in form of a service report that enables the product specialists at the branch to analyse and to assess the specific case. On the other hand, if the service technician is not able to solve a problem occurred, he can directly apply to the branch. After a description of the problem, the product specialists can support the service technician and help him to select an appropriate immediate measure. Concurrently, the solution database has to be updated by the product specialists. In both cases, the assessment of the problem done by the product specialists allows them for drawing conclusions on the character of the problem. Thus, problems that require customer spanning improvements of product and service components of PSS can be identified and distinguished from individual problems.

Thereafter, the product specialists assess, whether a customer individual PSS-improvement is sufficient in the further course of the problem solution process or if customer spanning improvement measures have to be taken. Customer specific improvement measures are related to a customer individual PSS and hence are implemented on-site by either a branch or a local service partner. Thereby, it is primarily about the adjustment of product, user or process oriented services, e.g. minor modifications of a machine or machine specific user trainings. In contrast, customer spanning improvement measures are relevant for a multitude of PSS of the same type. For example, these measures are related to often occurring machine faults or often occurring customer requirements that are not yet fulfilled.

In case of a thinkable development of customer spanning improvement measure, information about the problem as well as rooms for improvements identified by the product specialists are forwarded to the product manager of the manufacturer responsible for the concerned PSS-type. This can e.g. be done by means of standardized problem reports. Based on these problem reports, the product managers of the manufacturer can define customer spanning improvement measures and take them in the worldwide value creation network.

7.4 Planning of Solutions and Measures

The development, assessment and selection of solutions to be suggested represent the next step of the PSS-CIP. Based thereon, a definition of the improvement measures as well as a planning of their implementation takes place.

Gathering of ideas for the solutions of the specified deficits can take place on different levels. At local level, the solution can be generated by the service technician either autonomously by means of the solution database or in cooperation with the customer. If the problem case is forwarded to the branch by the service technician the solution has to be created by the branch (in case of customer specific solutions) or by the product managers of the manufacturer (customer spanning solutions).

If there is more than one solution for one specific problem, the solution ideas have to be assessed by the responsible organizational unit. Based thereon, a selection of the most promising solution that builds the basis for the derivation of corresponding improvement measures takes place. Thereby, revenue and expense of the special improvement measure have to be considered. After the specification of the improvement measures, the responsibilities for taking the measures as well as the required resources are defined. This can either be done by the branch in case of customer specific improvement measures or be done by the manufacturer in case of customer spanning improvements.

7.5 Implementation of the Improvement Measures

In the next step, the implementation of selected and pre-planed improvement measures follows.

PSS-improvement measures are mostly implemented by the local branch. Above all, this concerns customer specific adaptations of the service components of a PSS (e.g. additional user trainings or upgrading). Therefore, it is important that the branches are able both to develop and implement such product and service related measures as well as documenting their implementation autonomously. Customer spanning measures mostly are extensive since they usually are connected with a modification of the physical product. Therefore, these measures are coordinated by the manufacturer himself and realized in close cooperation of all network partners.

After the implementation of the solution, the success of the taken measures has to be measured by means of the established Performance Measurement mechanisms.

Thereby, in case of extensive PSS-improvements it could be necessary to adjust the key figures existing for each customer individual PSS. This can also be connected with an adjustment of the corresponding performance measurement and information gathering processes.

The documentation of the taken measures concludes the improvement process. Thereby, the standardized model-based PSS-description enables each of the network partners to document the improvements comprehensibly.

8 CONCLUSIONS

Processes that aim at continuously improving PSS need to match the requirements resulting from the PSS-characteristics, e.g. the realization of PSS in a worldwide value creation network. Special focus in this paper has therefore been laid on the establishment of organizational and operational network structures as well as appropriate performance measurement mechanisms. Based thereon, an approach to customer individual and customer spanning PSS-improvement has been introduced.

Thereby, it became apparent that, in contrast to physical products, the PSS to be improved has to be considered as a system that can be described with regard to result, process and infrastructure dimensions. Consequentially, these dimensions have to born in mind while both establishing performance measurement mechanisms within the whole value creation network as well as selecting appropriate measures for PSS-improvement. Due to the fact that PSS are realized within the whole value creation network, the comprehensive definition of information exchange processes represents a crucial factor of success on implementation of a continuous improvement process for PSS.

Further research has to be done to refine the information exchange processes within the value creation network, especially the service network. This also includes the detailed specification of information with regard to the specific characteristics of PSS. Additionally, the system characteristics of PSS have to be analyzed in order to enable the organizational units responsible for the PSS-improvement to take improvement measures concerning both product and service components of a PSS while considering their interactions.

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