A Method to Analyze PSS from the Viewpoints of Function, Service Activity, and Product Behavior

T. Hara[1], T. Arai[1], Y. Shimomura[2]

[1] Dept. of Precision Engineering, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo, Japan

[2] Dept. of System Design, Tokyo Metropolitan University, Asahigaoka 6-6, Hino-shi, Tokyo, Japan

hara_tatsu@robot.t.u-tokyo.ac.jp

Abstract

As our economy matures, combination of tangible products and intangible services becomes a key issue toward a harmonious balance with economic growth and environment conscious. This paper aims to present a method for analyzing structures of service processes described in the modeling method the authors have proposed. It includes three indices of service delivery process according to customer satisfaction elements: (1) visibility to receiver, (2) interactivity with receiver, and (3) degree of receiver participation. Through an application case study, it is found that the method can indicates the features of services, and contributes to acquirement of clues for improving services.

Keywords:

Product/Service-System, Service delivery process, Service blueprint, Service modeling

1 INTRODUCTION

Service is attracting increasing attention as manufacturing industries shift from being simple sellers of products to being service providers. To serve this need, the engineering target that needs to be analyzed and designed is shifting from simple products to service offerings. Product/Service-System (PSS) [1] is a specific type of value proposition that a business can offer its clients, comprising a mélange of tangible products and intangible services designed and combined so that they are jointly capable of fulfilling the customer needs [2]. Its viewpoints from business models may create much value onto products. The authors have been researching Service/Product Engineering (SPE) [3] [4] [5] to develop the PSS since 2002. It is characterized as top-down approach of service definition and representation. It has a great advantage in computer aided design system as the theory on service must be implemented in the computer to prove its effectiveness.

In this paper, a modeling method for PSS in SPE research is presented; it describes services from the viewpoints of function, human activity, and product behavior [5]. The method is useful in that it provides us with visual understanding and sharing of services. However, there has been little discussion on the method to analyze and evaluate the modeled services for improving them.

This paper presents another method for analyzing structures of service delivery process described in the modeling method. The rest of this paper is organized as follows: Section 2 first describes the modeling method applied in this paper. Second, it describes the relationship between customer satisfaction elements and service process elements through functions. Section 3 illustrates a method for analyzing service process by introducing three indices: visibility to customer, interactivity with customer, and degree of customer participation. Then, an application case study of the method presented herein is discussed in Section 4. Section 5 concludes the paper.

2 MODELING METHOD FOR SERVICES

2.1 Overview of modeling method

In this paper, service is defined as a deed between a service provider and a service receiver to change the state of the receiver [3]. This definition is broader than typical definitions encountered in traditional management and marketing fields with the obvious difference from products. They emphasize the characteristics of intangibility, heterogeneity, perishability, and simultaneity (e.g., [6] [7]). According to the definition, most business activities are services, including selling physical products. Services to be targeted in this study correspond to PSS (designed to change the state of the receiver), while a pure service (that only comprises human activity) is called a service activity.

Figure 1 shows a schematic illustration of service elements and the modeling method applied in this paper (based on [5]). Elliptical nodes represent customers and service entities such as humanware, hardware, and software. Here, software is any component such as the computational code, policies, norms, rules, procedures, practices and any other formal or informal rules that define the way in which the system components interact [8]. In this paper, software is grouped with hardware or humanware: software is either related to hardware or humanware. Rectangular nodes represent service elements such as customer value, functions, and processes to analyze and design the relationships between customers and actual entities. Service activities are tasks performed by humanware and its related software, and product behaviors are tasks performed by hardware and its related software.

The modeling method for services is detailed below, starting with customer and customer value.

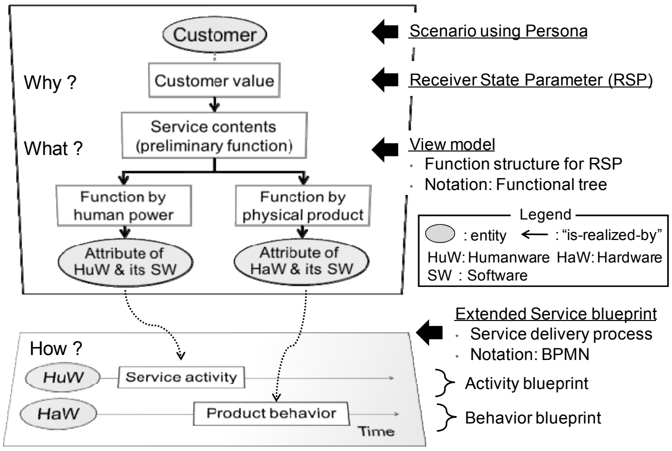

Figure 1: Schematic illustration of the proposed method for modeling services.

2.2 Receiver State Parameter (RSP): customer value

The upper part of Figure 1 shows the customer, customer value, and the corresponding modeling methods: scenario using persona and Receiver State Parameters (RSP) [3] [4]. A set of RSPs represent customer value and they are indices of customer satisfaction in receiving service offerings.

2.3 View model: service contents and their corresponding functions

The middle section of Figure 1 shows the service contents, their functions, and the corresponding "view model" method [3] [4] [5]. After identifying the customer value as RSPs, functions and attributes of entities for each RSP can be described as a view model. A view model works as a bridge between the customer value and actual entities via a tree structure. Yoshikawa's General Design Theory (GDT) [9] provides a basis for our approach. The theory is discussed in terms of two topologies defined by functions and attributes of artifacts. The projection from functions to attributes can be universally recognized as design of products. Assuming that services can also be designed by the same projection, RSPs may consist of parameters in both function and attributes.

A function is defined in this paper as "a description of behavior abstracted by humans through recognition of the behavior in order to utilize the behavior" [10]. Here, the term behavior implies both physical phenomena and human activity. According to this definition, a function can be represented in two ways: (1) as symbols represented in the form of to do something and (2) as a set of behaviors. In order to emphasize the flexibility of the description, let us consider the first representation wherein functions in a view model can be represented as lexical symbols (i.e., (1)). Although the symbols are meaningful only to humans, this information, which is associated with the RSP, is essential for clarifying the roles of the design objects. On the other hand, the behavioral aspects of functions (i.e., (2)) are incorporated in the linkage using the service blueprint that is introduced in Section 2.6.

Some of lowest-level functions are implemented through humanware (such as staff and customers), and some of lowest-level functions are implemented through hardware (in the form of machines and facility). Software involves both these functions. Since the customer value (represented through RSP) is related to an embodiment of a service, whose characteristics are recognized as attributes, designers can perform a static evaluation of customer satisfaction based on these entities and their attributes.

However, the view model includes little information with regard to the service delivery process. Thus, the ways in which entities complete the connected functions are inevident. The details of the relationships between functions and entities are depicted in a service blueprint.

2.4 Traditional service blueprinting method

The service blueprint [11] [12] and the service map [13] are the most famous tools used by marketers to sequentially and visually describe service activities. In the service blueprint, service activities are arranged with respect to two lines: (1) the line of interaction around which the customer and the service provider interact and (2) the line of visibility that separates the "onstage" (visible) activities from the "backstage" (invisible) activities performed by the provider.

The service blueprint is known to be an effective tool for analyzing and designing the delivery of services prior to the actual delivery. The service blueprint, however, has the following problems in terms of PSS development.

Difficulties in association of the described service process to the customer requirements

A number of researches (e.g., [14] [15] [16]) have pointed out that the service blueprint is more an operating manual of the provided service, rather than a depiction of customer requirements. The service blueprint is unable to properly correlate a customer value and service activity. This problem makes it difficult to assess the quality of services from the point of view of the customer.

Need for physical processes in addition to human processes

Academic literature on the service blueprint has placed considerable emphasis on the interpersonal service delivery system. In this study, however, the authors strive to develop a service offering comparable to PSS, which itself is a combination of products and service activities. Since human processes and physical processes have alternative and/or complementary relationships with each other in PSS, understanding product behavior and its relationship with service activities is essential in the design, evaluation, and simulation of a PSS throughout the lifecycle of products. Therefore, the blueprint of a service such as PSS should contain information concerning the product and its service behavior as well as information on the human activity associated with the service.

Lack of normative notation

Shostack's blueprint notation in earlier literature was basically a simple flowchart. Consequently, the detailed meanings of graphical elements are often ambiguous and not well defined [17]. Normative notation and explicit control flow are needed for analyzing and evaluating the described service delivery processes.

2.5 Extended service blueprint: interrelated activity blueprint and product blueprint using BPMN

In order to solve these problems, the service blueprint is extended to include product behavior and its relationship with service activities as well as the relationship with customer value as shown in Figure 2. The extended service blueprint consists of an interrelated activity blueprint and behavior blueprint.

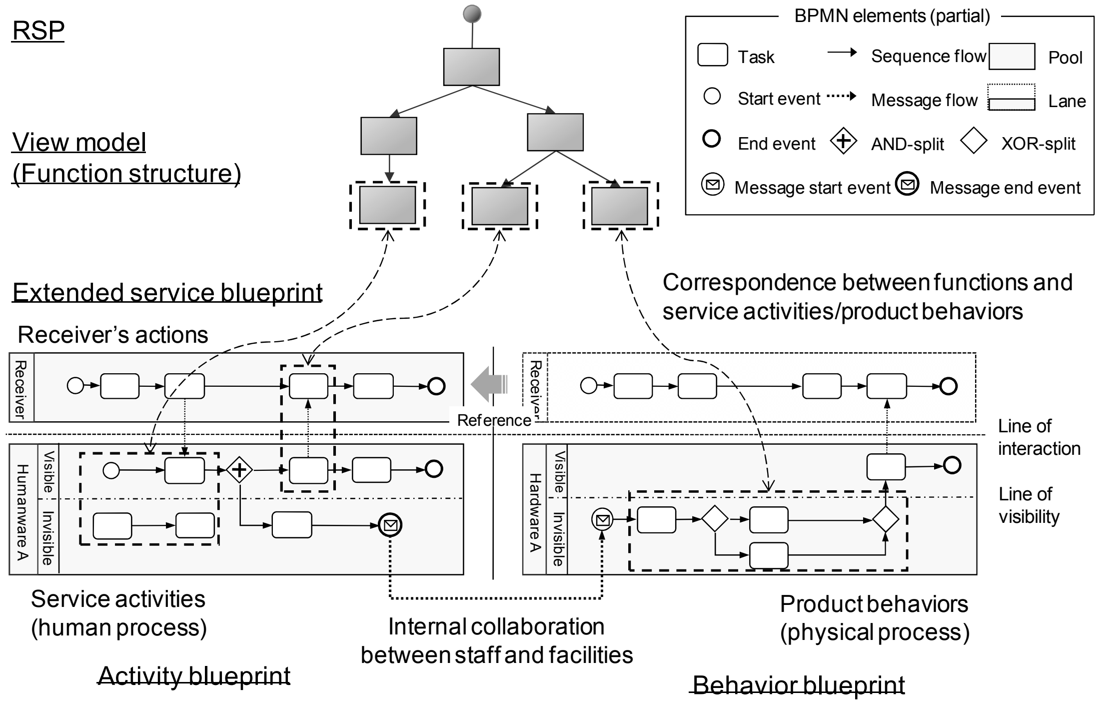

Figure 2: Detailed illustration of the modeling method focusing around service delivery process

The Business Process Modeling Notation (BPMN) [18] [19] [20] is used for describing the service blueprint so as to have consistent semantics (as shown in Figure 2). The modeling in BPMN is made by simple diagrams with a small set of well-defined graphical elements. The adoption of BPMN supports wide variety of control flows and provides a graphical representation that is readily understandable by all business users, from the business analysts, to the technical developers, and to the business people who will manage and monitor those processes [20].

By connecting the view model aforementioned and the extended service blueprint, it is possible to describe service activities and product behaviors while clarifying their influence on the receiver (i.e., quality of service). In other words, by focusing on customer value and the roles of entities as described in the view model, service activities and product behaviors can be equivalently dealt in the extended service blueprint. The extended blueprint can be especially used as a communication tool for managers, marketers, and engineers in service development.

Activity blueprint

The activity blueprint corresponds to Shostack's blueprint and illustrates the activity-oriented aspects of a service.

The left section of Figure 2 represents an activity blueprint using BPMN. Each humanware of a service is arranged as a BPMN pool, and the line of visibility is denoted as the border between a visible BPMN lane and an invisible BPMN lane in the pool. Some of the steps performed by the receiver in the activity blueprint are selected from the scenario presented in Section 2.2. The activity blueprint specifies the interactions between the receiver and the staff; these interactions are represented as BPMN message flows.

Human processes, which are represented by a set of service activities and BPMN sequence flows among them, are subject to organizational rules, employee manual, and so on.

Behavior blueprint

The product blueprint illustrates the behavior-oriented aspects of a service. Physical processes in the behavior blueprint are described as well as the activity blueprint using BPMN for the sake of achieving a simple user interface. Since BPMN is a general-purpose modeling language for business process, it can be applied to a technology-oriented process in PSS.

The behavior blueprint specifies the interactions between the receiver and the products including self-service machines. These interactions are represented as BPMN message flows. Physical processes, which are represented by a set of product behaviors and BPMN sequence flows among them, are subject to physical lows and/or computational algorithms.

Relationships between two blueprints

By preparing a similar user interface for both activity and behavior blueprints, marketers and engineers can easily understand both blueprints. In addition, as shown in Figure 2, there is an interrelation between the behavior blueprint and the activity blueprint. Some BPMN message events (shown by a letter with a circle) are symbols that show two types of collaborations between the two blueprints. The first type of collaboration involves an interaction between the receiver and the product hardware, while the second involves interactions between the staff and equipment or facilities. Information about such collaborations and service delivery denotes how the products are used, which is useful for product design.

2.6 Relationships between view models and two blueprints

The middle section of Figure 2 presents the relationships between functions in a view model and the service activities/product behaviors in a service blueprint. Each of the lowest-level functions is mapped to a process that produces a service; the process can comprise service activities, product behaviors, and receiver actions. Such relationships represent the behavioral aspects of the lowest-level functions. Therefore, they are subjective and exhibit a many-to-many correspondence, according to the discussions on function and behavior in conventional design studies [21]. In the case where a mapped process includes receiver actions, the corresponding function needs customer participation as a co-producer of the service.

Some of the humanware/hardware entities in view models, such as staff and machines, are correlated with BPMN pools in the corresponding activity/behavior blueprint. The remaining entities (i.e., static objects) in the view models can be correlated with BPMN data objects.

According to the above relationships, the typical steps to describe service blueprints based on view models are as follows:

- Add BPMN pools that correspond to entities in the view models.
- Deploy each of the lowest-level functions in the view models into a series of activities and/or behaviors.
- Add BPMN data objects that correspond to rest of the entities in the view models.
- Organize all processes to ensure the totality of the delivery process.

3 METHOD FOR ANALYZING THE STRUCTURE OF SERVICE DELIVERY PROCESS

3.1 Representation of service delivery process

In this paper, the term “task” is inclusive term for process elements in a service blueprint, namely, receiver action, provider’s activity, and product behavior. A set of all tasks T in a service blueprint is represented as

$$T^p = T^{pa} \cup T^{pb} \quad (1)$$

$$T = T^r \cup T^p \quad (2)$$

where T^r denotes a set of actions by a receiver of a service, T^{pa} denotes a set of human activities by service provider, and T^{pb} denotes a set of product behaviors by facility and product.

In this paper, a service process that comprises elements of T^r is called “service receiving process,” while a service process that comprised elements of T^p is called “service providing process”. Hence, whole service process that comprises both receiving process and providing process is called “service delivery process.”

A subset of tasks corresponding to an RSP in T is defined through the relationship between functions and service activities/product behaviors explained in Section 2.6. In the following sections, such a subset corresponding to the i-th RSP is represented as T_i.

3.2 Analysis of service delivery process

Table 1 (in Section 4) presents a framework for analyzing the structure of a service delivery process according to customer satisfaction elements. RSPs and their relative importance are listed on the vertical axis. Indices of service delivery process are listed on the horizontal axis: **Visibility to receiver** and **interactivity with receiver** are indices of activity blueprint and behavior blueprint; **the ratio between service activity and product behavior** is an index of the balance between two blueprints; and **degree of receiver participation** is an index of the entire service blueprint. These indices are explained below.

Visibility to receiver

This index represents recognizability of provider’s tasks in a service providing process. Here, the recognizability of a task implies receiver’s perception of the task through not only the visual sense but also the auditory and olfactory sense. Visibility to receiver with regard to the i-th RSP v_i is defined as

$$v_i = \frac{\overline{\overline{VT_i^p}}}{\overline{\overline{T_i^p}}} \quad \left(VT_i = \left\{t \middle| t \in T_i^p, V(t) = 1\right\}\right) \quad (3)$$

where V $(V: T^p \to \{0,1\})$ denotes a map from task to its visibility. In Eq. (3), T^p is replaced with T^{pa} or T^{pb} depending on which blueprint is focused on.

If the index is higher, it is implied that a receiver can obtain more information to evaluate the service from visible provider’s tasks: there is a high possibility that the providing process may influence other unexpected RSPs in addition to the original target RSPs. For instance, in case of a restaurant service wherein process of cooking in a kitchen is visible, other RSPs such as “a feeling of security” and “cleanliness” might be identified and affected by the process in addition to the original target RSPs such as “delicious dish.”

Thus, when analyzing a service process with high visibility, designers should make sure that the receiver state is sufficiently analyzed regardless of the importance of the original target RSPs.

Interactivity with receiver

This index represents the ratio of interaction tasks with a receiver to all of the tasks in a service delivery process. Interactivity with a receiver with regard to the k-th RSP i_k is defined as

$$i_k = \frac{\overline{\overline{IT_k}}}{\overline{\overline{T_k}}} \; \left(IT_k = RT_k^{p \to r} \cup ST_k^{p \to r} \cup RT_k^{r \to p} \cup ST_k^{r \to p}\right) \quad (4)$$

where $RT^{p \to r} \subseteq T^r$ and $ST^{p \to r} \subseteq T^p$ denote a set of sending and receiving tasks of messages from provider to receiver respectively; while $RT^{r \to p} \subseteq T^p$ and $ST^{r \to p} \subseteq T^r$ denote a set of sending and receiving tasks of messages from receiver to provider, respectively. In Eq. (4), T^p is replaced with T^{pa} or T^{pb} depending on which blueprint is considered.

If the index is higher, it is implied that a service providing process and a receiving process are more interdependent; scheduling and timing of each process are strongly emphasized. On the contrary, if the index is lower, these processes can be performed independently.

Degree of receiver participation

This index represents the ratio of receiver actions to all the tasks in a service delivery process.

The degree of receiver participation with regard to the i-th RSP p_i is defined as

$$p_i = \frac{\overline{\overline{T_i^r}}}{\overline{\overline{T_i}}} \quad (5)$$

If the index is higher, it is implied that a receiver contributes more to the realization of a service delivery process. In this case, since the process depends on the attribute and ability of the receiver, it can be difficult for the provider to control the quality of service functions actualized by the process. This leads to uncertainty and variability of such functions due to the receiver. One of countermeasures for solving this issue is to provide a complementary service or product that helps the receiver to easily perform his/her actions.

4 APPLICATION

4.1 Public transportation service: Manyo Line

The aforementioned methods have been applied to the Manyo Line (tram) [22] (Figure 3), which runs between Takaoka City and Imizu City in Toyama Prefecture.

Figure 3: Photograph of Manyo Line.

Table 1 presents the result of the application case study. As shown in Table 1, the following parameters were identified as RSPs: transportation to destination, tram availability, tram punctuality, ride comfort, and ease of paying fare. The RSP weights for the passengers were computed numerically according to the AHP method [23], using bilateral comparisons between parameters.

An overview of the result focusing on the visibility column and the interactivity column indicates that the recognizability of a motorman's activities is much lower than that of the tram's behaviors. This is because passengers only feel the t ram's behaviors controlled by the motorman at the forefront of the tram while riding in it. However, considering the information about the ratio between service activities and product behaviors (the middle part of Table 1), the result indicates that such activities of motorman surely contribute to the realization of the service.

Regarding the result of RSP "tram availability," the degree of receiver participation in the RSP is zero. This implies that the quality of service functions affecting such RSP can be mostly designed prior to the actual tram operations: (i.e., embedded in planned operation hours).

Let us now focus on the RSP "punctuality," which has the highest importance among the identified RSPs. The ratio of service activity and the degree of receiver participation in the RSP are both high. This results from the high ratio of dialogues between the passengers and the motorman to the process affecting the function of controlling standing time for the RSP (e.g., dialogues pertaining to lost numbered tickets and exchange of money). Figure 4 shows interactions between the passengers and the motorman when getting off the tram in the described activity blueprint. Therefore, it is found that reconsidering the method of paying fares can contribute to not only satisfaction regarding the RSP "ease of paying fare" but also satisfaction regarding the RSP "punctuality."

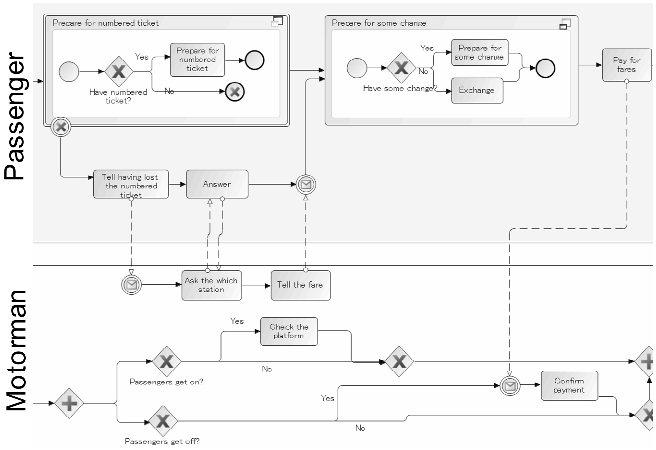

Figure 4: Interactions between passengers and motorman when getting off the tram in the described activity blueprint.

5 CONCLUSION

The aim of SPE research is to develop methodologies to evaluate and design PSS. This paper presented an analytical framework for analyzing the structures of service delivery process according to customer satisfaction elements as a next step of service modeling. The framework presented in this paper includes the following indices of service delivery process: (1) visibility to receiver, (2) interactivity with receiver, and (3) degree of receiver participation.

Through an application case study, it is found that the method can indicates the features of services from the viewpoint of service function, human activity, and product behavior. Such implications contribute to evaluation of services and acquirement of clues for improving them.

Future research will include the feasibility assessment on more complex product–service combinations and the enrichment of modeling criteria for ease of applying the analytical method presented in this paper.

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Table 1: Result of analyzing service delivery process regarding public transportation service: Manyo Line.

		Service delivery process					
		Service activity			Product behavior		Receiver
Receiver State Parameter (RSP)	Importance weight	Visibility to receiver	Interactivity with receiver	Ratio between service activity and product behavior	Visibility to receiver	Interactivity with receiver	Degree of receiver participation
Transportation to destination	0.24	0	0	0.50	0.50	0.70	0.29	0.17
Tram availability	0.26	0	0	1.00	0	0	0	0
Tram punctuality	0.29	0.33	0.21	0.67	0.33	0.56	0.20	0.29
Ride comfort	0.11	0	0	0.47	0.53	0.88	0.15	0.25
Ease of paying fares	0.04	0	0	0.20	0.80	0.63	0.56	0.50

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