Are Services Functions?

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Abstract. This paper proposes an ontological definition of services. Such a definition is one of the fundamentals of service research. The understanding of essentialities of the notion of services as its definition, which differentiates services from the other notions, contributes proper modeling and conceptualization of services in services design and knowledge management of services. The existing definitions and characteristics of services, however, cannot differentiate services from other concepts: especially function of product. In this paper, we propose a new definition of services based on ontological consideration. Our definition can differentiate services from product functions. Firstly, we discuss the problem of the existing definitions and characteristics about the distinction. Secondly, we explain our definition and the essential characteristics of services using an ontological model of services. Lastly, we demonstrate its applicability of our definition using some examples and compare it with the existing definitions.

Keywords: definition of services, services ontology, meta-services, function

1 Introduction

The definition of the notion of services is one of the fundamentals of service research. Especially, in order to establish and develop a new discipline of services such as the Service Science [1], we need to reveal essential characteristics of services that differentiate services from other notions. In fact, in the early period of the research of services marketing, many researchers have compared services with (physical) goods to establish the services marketing as a new independent discipline from the traditional goods marketing [2]. Then, they have revealed some characteristics of services and defined the notion of services in their own way. Yet there is still no widely accepted definition of services [1].

The existing definitions and characterization of services are, however, insufficient for the differentiation between services and other related concepts such as functions. In most studies, the characteristics of services are taken as intangibility, heterogeneity, inseparability, and perishability (IHIP) in terms of the comparison between services and goods [3, 4]. As discussed in Section 2 below, the IHIP is not specific to "service" rather than "process", which are one of the aspects of functions. Although IHIP nicely differentiates services from products, it does not adequately describe differences between services and functions, because functions also have

characteristics of process and satisfy all these four. In fact, some prominent service researchers pointed out the problem with associating IHIP with the essential characteristics of services [4].

In addition, from a practical point of view, it is also important to understand the essential characteristics of services in order to establish appropriate models of services and service ontologies for service design and to manage knowledge of services (knowledge management for services). Use of the concepts defined in a services ontology enables us to describe the models of services for increasing the interoperability and reusability of the models. The notion of services is a fundamental in both the models and the ontologies of services. If the definition of services that the models are based on does not capture the essential characteristics of services, the models of services will miss the crucial conceptual elements of services.

Thus, in this paper, we discuss essential characteristics of services through the comparison between the services and product functions, and then propose a new definition of the notion of services. Through these discussions, we answer the question: "are services functions?" in the title of this paper. By "Functions", we mean not only functions of products but also those performed by humans.

This paper is organized as follows. In Section 2, we analyze definitions of services found in the existing research and describe their fundamental concepts. Based on this, we show that the differentiation between services and product function in the existing definitions is insufficient. In Section 3, we propose our definition of services and characteristics differentiating between services and product functions. In Section 5, we provide a final summary of this research and look at future prospects.

2 Analysis of Definitions of Services

2.1 Similarity between Services and Product Functions

By analyzing the existing definitions of services in the literature, we derive conceptual characteristics, and then reveal some fundamental concepts of services. For example, Shimomura et al. defined services as follow: "*Service is defined as a deed between a service provider and a service receiver to change the state of the receiver*" [5]. We can derive the characteristic of *process* from the phrase "change the state" because *process* involves some state-change.

We analyzed the definitions from 15 papers [5-19] in the various fields of service research and have derived 45 characteristics. Table 1 shows a part of correspondences between those definitions and those derived characteristics. To analyze the fundamental concepts, we grouped the characteristics associated with the same concepts and came up with three groups: *process*, *provision*, and *value*. By *process,* we mean a temporal change of a state and, consequently, which includes the characteristics of *action*, *state-change*, *performance*, *intangibility* and so on. By the *provision*, we mean that an agent provides something to another. This concept implies

Table 1. Correspondences between existing services definitions and the derived characteristics (Partial)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		Shimomura et al.[5]	Albani et al.[6]	Ferrario et al.[7]	Fitzsimmons et al.[8]	Grönroos [9]	Hill [10]	IBM [11]	IfM [12]	Kotler [13]	Lovelock et al.[14]	Lusch et al.[15]	Rai et al.[16]	Weigand et al.[17]	Yoshikawa [18]	Zeithaml et al.[19]	counts
1	Process	○		○	○	○	○	○	○	○		○	○	○	○	○	13
2	Activity					○					○				○		3
4	Action	○	○	○		○				○	○	○				○	8
5	Functionality	○													○		2
6	Interactivity				○			○				○			○	○	5
7	Performance				○					○	○	○				○	5
9	Intangibility				○	○				○			○				4
12	Take over														○		1
13	State-change	○					○	○							○		4
15	Providing	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	15
17	Provider (Person)														○		1
19	Provider (Structure)														○		1
25	Receiver (Person)														○		1
26	Receiver (Customer)				○	○		○			○		○				5
28	fulfillment of expectation	○													○		2
31	providing value/profit		○	○				○	○		○	○	○	○	○		10
34	Mutual benefit								○								1
37	Agreement		○	○			○		○								4
38	Explicit implementation guarantee		○	○													2
39	Otherness	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	15
40	Ability		○								○	○					3
41	Value equivalency	○					○				○			○			4
42	Non-ownership										○			○			2
43	Pattern		○														1
44	Resource								○					○			2
45	Commitment		○	○										○			3

the existence of a provider and a receiver, and, consequently, includes characteristics such as *provider (person)*, *receiver (person)*, and others. Finally, the *value* is a concept associated with evaluation of usefulness (value, benefit and request) from the receiver's perspective. Consequently, the *value* includes characteristics such as *providing value/profit*, *fulfillment of expectation* and so on.

Looking at the derived concepts (*process*, *provision*, and *value*), we see considerable similarity between services and product performance functions. For example, the relaxing function of a massage machine is related to a process to relax the muscles of the user and is provided from the massage machine to the user. And, the value of the massage machine lies in this function.

The concepts of services and product functions have the same conceptual structure. We define the product function concept as "a result of teleological interpretation of a behavior (i.e., state-changes) of the operand(s) under an intended goal" [20]. The relation that the product brings about state-changes in the operand corresponds to the *provision* and *process* in the fundamental concepts of services. Moreover, the *value* of product functions and services corresponds to each other because they both are based on some purpose such as a request. From these correspondence relationships, we can say that services and product functions have the same conceptual structure.

Yoshikawa and Shimomura et al. have already pointed out the similarity between services and product functions. In particular, Yoshikawa asserted that "a service is manifested function" [18] and this is an essentiality of services. These suggest the validity of comparing services and product functions.

2.2 Problems with the Characteristics and the Existing Definitions of Services

As mentioned above, existing characteristics and definitions of services are insufficient in terms of the distinction between product and services. Here, we point out the problems through an analysis of some familiar examples.

Intangibility, heterogeneity, inseparability, and perishability (IHIP) focus on the process aspect of services and the physical aspect of products. Intangibility denotes the services are intangible because they are processes as temporal changes of states, thus do not have physical shape. Next, inseparability denotes that the production and consumption processes of services occur at the same time. For perishability, a process only exists during its performance. And heterogeneity denotes the quality of services are uneven because, unlike product, it is impossible to check the quality of services before use due to the inseparability. Thus, IHIP is not the exclusive characteristic of services but the characteristics common to processes.

These characteristics are derived focusing only on the physical aspect of products. Strictly speaking, however, a product is composed of both product as a physical thing and that as product functionality. The product functionality is one of the essential properties in the product concept. For example, a chair as a product has a person-support function. If a chair leg breaks, the chair is not able to perform that function. Then, the chair will no longer be recognized as a product. Thus, the comparison between services as processes and products as physical objects is insufficient in order

to understand the essential characteristics of services. We have to compare services with product functions.

In fact, the existing definitions of services cannot differentiate between services and product functions. For example, Zeithaml et al. define services as "*deeds, processes and performance provided or coproduced by an entity or person for another entity or person*" [19]. This definition cannot differentiate services from product functions, because a product function is a process or performance, and is provided by a product as an entity for another entity or person. In Section 5, we discuss a comparison among our definition and the existing definitions in detail.

As we see thus far, the distinction between services and product functions has not been revealed yet. In the next section, we propose a definition of services that can differentiate services from product functions.

3 Our Definition and Essential Characteristics of Services

3.1 Our Definition of Services

We define services as follow.

Definition:

A service is an execution-environmentally situated(A-1) *function detached from the function performer from user (customer)'s point of view*(B-1)*. (By function, we here mean any goal-oriented effect-giving operation performed by any kind of agent)*

Supplements:

(1) A service provider (a) guarantees and advertises the quality of the services (C)*, (b) designs the services contents and trains the service performers, and (c) designs execution-environment to maximize the value of the resulting effects.* (A-2) *Thus, the service provider sells the right to use/access to such a function that is expected to be nicely executed in the predesigned environment (that is, "an execution-environmentally situated function").*(A-3) *Customers are interested primarily in the quality of the function rather than the function performer, and hence the detachment of function from the function performer is realized.* (B-2)

(2) There exists a multiple-layered structure of services where a service at the higher layer enables a service/function at the lower layer. The bottom layer corresponds to daily events in which customers usually participate. It can be a services or a (product) function.

(3) When the service is intended by the service provider, then it is an essential service, otherwise an accidental service.

In our definition, services are regarded as a special type of functions in a broad sense above. This is the answer to the question: "are services functions?" and the conditions described in the definitions shows characteristics specific to service as a special type of function. Our definition is based on a model of service systems and the two main characteristics that differentiate between services and product functions: the *designability of the environment* and the *detachment of the function from the function*

performer. The phrases of underline (A) are based on the former, and the phrases of underline (B) are based on the latter. The supplements and some terms such as "*service provider"* and *"function performer"* and so on are based on our model of service systems. Based on these characteristics, our definition can distinguish services from product functions, which are "functions" in a narrow sense and another special type of the "function" in a broad sense above.

In Section 3.2, we explain our model of service systems. In Sections 3.3, 3.4 and 3.5 we explain those essential characteristics of services.

3.2 A Model for Comparing between Services and Product Functions

In order to compare some concepts correctly, it is important to clarify perspectives to capture them. We clarify our perspective to services and product functions in the way to develop a general model that represents services and product functions. By using this model shown in Fig. 1, we can compare them from a consistent perspective.

This model is composed of *function*[1], *function performer, operand, provider*, *beneficiary*, *and environment*. It is an extension of Kotler's Service Marketing Triangle [21]. The Kotler's model is composed of *firm*, *employee* and *customer*: *firm, employee and customer* correspond to *provider*, *function performer* and *beneficiary*/*operand* in our model, respectively.

The *function* consists of a state-change of the *operand* and a goal, and it is based on our definition of function [20] as mentioned in Section 2.2. The *function performer* is an agent to perform functions. Humans and products can be function performers. The *operand* is a target of the function. The *provider* prepares *function performer* and *environment* where the function is performed. Our model has a multiple-layered structure of functions, which is called *meta-base layer*. The *beneficiary* is an agent who gains some benefit from the performance of function, and the *provider* advertises and guarantees the quality of the function to the *beneficiary*. The underlined phrase(C) in the supplement (1) captures this.

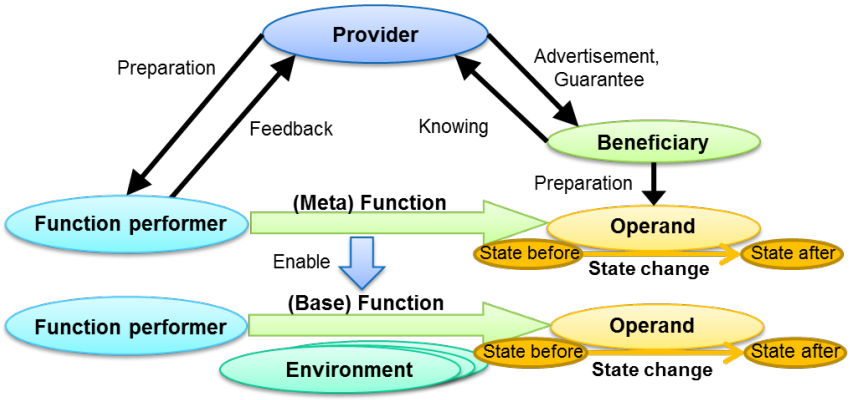

Fig.1. the general model of service systems and product function systems

[1] By "function", we here mean the goal-oriented effect that includes the product function and performance of services by humans and products.

The meta-base layer represents the relationship that a function enables to perform another function. A function that enables others to work is called a meta-function. A function that enables no function to work is called a base-function. Base-functions are demanded by beneficiary directly or indirectly, and are performed in daily events in which customers usually participate. For example, the case of the massage salon services, the base-function is the massage-relaxation function performed by the massager and the meta-function is taking a reservation of the massager prior to giving a massage. The supplement (2) in our definition captures this.

We can explain service systems based on this model. Service companies are regarded as providers, and each of them is called a service provider. The service providers prepare the function performers: employees or equipment in the services (e.g. hiring and training employees, installing equipment, and designing service environment). The underlined phrases $^{(A\text{-}1,\ A\text{-}2)}$ in the definition is based on this. They also advertise and guarantee their services to customers, which are the beneficiary in this model. The operand depends on services; in a massage service, customers themselves are regarded as beneficiaries and in a laundry service, their clothes are regarded as operands. The underlined phrase $^{(C)}$ in the definition captures this.

Similarly, we can explain how product functions are represented by this model. The function of a product becomes available to a user once the maker (or sales outlet, regarded here as an integrated function performer) sells the product to the user. Consequently, we can regard a product function as a base-function and sales function as a meta-function. We use the proposed model to capture a product function. Here, because a product performs a product function, the product is regarded as a function performer and the maker that designs and manufactures the product as a provider. The user of the product enjoys the product function. So the user is regarded as a beneficiary. We can then regard the target of a product function as an operand.

Compared with Kotler's model, our model divides the customer concept defined in Kotler's models into two parts: beneficiary and operand. By dividing the customer concept into two objects, the semantics of the model become clearer. For example, in modeling a laundry service based on the Kotler's model, we cannot identify the target of the laundry service whether clothes or customers of the laundry, while based on proposed model, we identify more clearly the clothes as the operands and the customers as the beneficiaries. Furthermore, based on studies about function [20], this model can express delivering services in more detail. The most significant value of this model exists in the introduction of the meta-base layer.

3.3 Non-ownership

To begin with, we consider some differences between services and product functions through some examples: services of massage salon as typical services, sales services of products, use of the products, rent-a-car services and use of the cars.

Table 2 shows their meta-base structures and some significant attributes such as ownership, time, and place. In Section 3.2, we have already mentioned the meta-base layers of massage salons services and sales services. In the case of the car rent-a-car services, the meta-functions are the functions of lending the customer a car, and the base-functions are the car's functions which is performed when the user drive the car.

Table 2. The restrictions caused by ownerships of function performers(FP) on uses functions in services and product functions

		Typical Services (e.g. Massage salon)	Rental Services (e.g. Car rental)	Sales Services (e.g. Massage machine sales)
Meta-layer	Meta-function	Transferring temporary use rights of base-FP (Taking a reservation)	Transferring temporal use rights of base-FP (Lending a car)	Transferring ownership of products as base-FP (Selling a massage machine)
	Owner of FP (FP)	Providers (Receptionists)	Providers (Clerks)	Providers (Salespersons)
	Time	Restricted (In the business hours)	Restricted (In the business hours)	Restricted (In the business hours)
	Place	Providers' side (In the salon)	Providers' side (In the shop)	Providers' side (In the shop)
Base-layer	Base-function	(Massaging)	(Carrying something)	(Massaging)
	Owner of FP (FP)	Providers (Massager)	Providers (Rented car)	Beneficiaries (Massage machine)
	Time	Restricted (Period of a massage service)	Restricted (Lending period)	Unrestricted (Anytime customers like)
	Place	Providers' side (In the salon)	Beneficiaries' side (Anywhere customers like)	Beneficiaries' side (Users' room)

These meta-functions are apparently services. On the other hand, in the base-layers of them, while the base-functions of massage salon are services, the ones of sales services are product functions, and the ones of car rental seem to be intermediate between services and product functions.

There is a difference with respect to ownerships of function performers in these cases. In the cases of product functions, users as beneficiaries can use the functions of the products whenever and wherever they want, because they have ownership of the products. In the case of services, unlike product functions, customers as beneficiaries cannot use the services of service performers freely, because they do not own the service performers. They need some permission to use the services from service providers, who own the service performers. In addition, the service providers usually specify the situations where the services are performed in order to provide the services in the appropriate environments. We call that the beneficiaries do not have ownership of the function performers in services "non-ownership"[2]. The restrictions caused by the non-ownership, which is one of the major differences between services and product functions.

We can explain the difference among the three cases in terms of non-ownership. In their meta-layers, whose functions seem to be services, the beneficiaries do not own the function performers. Thus, the time when the functions are performed is restricted within the business hours, and the place where the functions are performed is restricted to the providers' side. For example, in the case of massage salons, the customers do not have the ownership of the receptionists. Moreover, the customer can make a reservation only in the business hours and at the reception desk in the massage

[2] By "ownership" here, we do not mean legal proprietary rights. For example, if a person obtains a loan to purchase a product, he may not have legal proprietary rights of the product until he pays off the loan. Even before paying off the loan, when he actually uses the product, he can do so as if he owned it. Consequently, "ownership" here means he can use the product freely like an owner anytime and anywhere—regardless of legal propriety rights—as if it was his own possession.

salons. Next, in the base-layer of the massage salons, whose functions seem to be services, the customer also do not have the ownership of the massagers, thus the time is restricted to the period of a massage, and the place is restricted to the massage salons. On the other hand, in the case of the shop that sells products such as massage machine, the base-functions are the uses of the massage machine at home and are regarded as product functions. The users own the massage machine, thus can use it anytime and anywhere as they want. Hence, the time and place are not restricted. In the base-layer of the car rental shops, while the time when the customers can use the car is restricted to the lending period, the place is not restricted but anywhere they want. That is the reason why these base-functions seem to be intermediate between services and product functions. Consequently, we regard the non-ownership as one of the essential differences between services and product functions, because it derives some essential characteristics of services as discussed below.

3.4 Detachment of the Function from the Function Performer

We explain differences related to the beneficiaries' recognition of function and function performer.

In the case of services, customers are interested mainly in the quality of function as services rather than the function performer. If the quality of a function fulfills the conditions of guaranteed quality of the services, the function can be a service regardless of who performs it. Let us take a fast-food restaurant as an example. If the employees can work according to the stipulated guidelines in the manual, the function performed by them is accepted as the guaranteed services regardless of who are in charge. Due to the anonymousness of function performers in services, the customers have a stronger awareness of the function than that of the function performers. Thus, they recognize that the function has become detached from the function performer[3]. In the case of product function, the users as beneficiaries own the products as function performers in which functions are embedded. So, to user, the function performer is not anonymous contrary to the services. Consequently, the users tend to be strongly aware of the function performers. This awareness of the relation between function performers and function is called the *detachment of the function from the function performer*. The underlined phrase $^{(B\text{-}1)}$ in our definition captures this. As can be seen from the above, this characteristic is derived from non-ownership.

Section 2 describes how the IHIP characteristics do not contribute to identifying the differences between services and product functions. That is because those characteristics are common to both. We need to identify the difference between services and product functions. The idea of the detachment of function from its performer nicely explains how they are different and why service providers can sell services like conventional products. Such a detachment is realized, in the case of services, by customers' strong awareness to function (especially, the aspect of process of function) rather than the function performer because of the anonymousness of function performers. In the case of product function, on the other hand, the user owns

[3] Of course, in services, the function performer is an important element to the customer, because the quality of services often depends on it. That is, however, a different issue.

the product as function performer. So, he/she is strongly aware of the function performer. Due to this, there are an emphasis on and awareness of the physical characteristic of function performers. They are clearly derived from the non-ownership as fundamental natures of services.

Thus, we conclude that the (execution-environmentally situated) functions detached from the function performer are regarded as services, because, based on this characteristic, we can explain the occurrence of IHIP, which many researchers regard as characteristics of services. In addition, we should characterize services based on not IHIP but this characteristic, because this is more essential than IHIP for distinction between services and product functions.

3.5 Designability of Environment

Within services design, in order to enhance the result of the services, service providers design the environment where the services are performed. For example, in restaurants, the designers might design such a nice environment that the customers can enjoy the meals. In the case of product design, on the other hand, the designers of products can consider the environments where the users use the products, but cannot design them. We call this *designability of environment*. The underlined phrases (A-1, A-2, A-3) in our definition capture this characteristic.

3.6 Essential Services and Accidental Services

In the supplement (3) in our definition, the *essential services* and the *accidental services* represent the difference between providers' perspective for the services and beneficiaries' one. The essential services are intended by the service providers and the accidental services are intended not by the provider but by the beneficiaries. For example, in the case of coffee shops, a provider intends to provide the services which customers can drink coffee. However, if some customer uses the space for his/her meeting, the coffee shop unintentionally provides the services of the meeting space in the perspective on the customer. The distinction between the essential and the accidental is based on our studies about function [22].

4 Some Examples

In this section, we demonstrate that our definition can distinguish services from product function, and that our definition fits successfully some examples of services.

4.1 Services and Product Functions of Massage

To begin with, we look at massage services as a typical example to exemplify our definition and look at a product function of a massage machine to show the distinction between services and product functions.

The massage functions (or services) are to eliminate the fatigues of the customers with massages. The massage services have the designability of environment, because massage salons as service providers usually design the environment of the massage salon in where the massage services are performed. The massage services satisfy the underlined phrases $^{(A\text{-}1,\ 2,\ 3)}$ in our definition, which are based on this characteristic. The massage services also have the detachment of the function from the function performer. If the masseurs can perform the services of which the quality fulfills the guarantee of massage services, the customers tend not to pay much attention to the masseurs as function performers, and the anonymousness causes the detachment of the function from the function performer. This detachment is also caused in the case that automatic massage machines, which are products, perform the massage services. Because, the customers recognize the similar anonymousness, since the qualities of services that the massage machines perform are very even. Thus, the massage services satisfy the underlined phrases $^{(B\text{-}1,\ 2)}$ based on this. The massage salons as service providers usually guarantee and advertise the quality of services. Thus, the underlined phrase $^{(C)}$ is satisfied. Here, we can explain the massage services satisfy our definition and supplement (1). We have already explained about the supplement (2) in Section 3.2. The last is the supplement (3). The essential service in the massage salons is the massage service because the intention of massage service provider is to massage customers. The accidental services is depends on each a customer. If a customer uses the massage salon in order to have a nap, then the accidental services is the services to give a space where he can have a nap. As stated above, the massage services satisfy our definition.

Next, in order to show that our definition can differentiate services from product functions, we consider the two characteristics: the designability of environment and detachment of the function from the function performer, through an example of the use of a massage machine at the user's home. This case does not satisfy the designability of environment because the designers of massage machines cannot design the environment where the users use the massage machine. And this case does not satisfy the detachment of the function from the function performer. The user owns the massage machine, hence the massage machine as function performer is specific not anonymous for user as with services. Consequently, the user is strongly aware of the massage machine. If the same massage machine is, however, used in a massage salon, those characteristics are satisfied as discussed above and thus the massage machine provides services.

Here, we showed that massage services, typical services, satisfy our definition, as well as that our definition can differentiate services from product functions.

4.2 Automobile Sales and Use

The next examples are the services of selling automobiles and using automobiles as product functions. The sales services of automobile enables that the users of the automobiles can use them. This relation is regarded as a meta-base relation as discussed in Sections 3.1 and 3.2.

The function of the sales services is to provide the ownership of the product with the customers in exchange for money. The environments of sales shops including

automobile sellers are usually designed for convenience of the customers. Sales services have the designability of environment and satisfy the underlined phrases (A-1, 2, 3). And, sales services have the detachment of the function from the function performer, because the main purpose of the customers is the possession of the products, whose quality does not depend on the salespersons as function performers. The customers are not strongly aware of who is salesperson and then the salespersons are anonymous for the customers. Thus, the sales services satisfy the underlined phrases (B-1, 2) based on this. And, the underlined phrase (C) is satisfied because the sales shops usually guarantee and advertise the quality of service sales services satisfy the supplement (2). The meta-base layer is mentioned in Section 3.2. On the supplement (3), if a customer uses the test-driving services of an automobile seller to play driving a newest model car, the automobile seller provides the accidental services lending the customer the newest model car. As stated above, sales services of automobile satisfy our definition.

In the same way as Section 4.1, in the case of using an automobile as example of product function, we consider the designability of environment and detachment of the function from the function performer. This case does not satisfy the designability of environment because the designers of automobiles cannot design the environment surrounding the automobiles. Likewise, this case does not satisfy the detachment of the function from the function performer because the automobile as function performer is not anonymous but specific for user due to the user's possession of the automobile.

As discussed above, in the examples of automobile sales and using automobiles, our definition of services can correctly differentiate services and product functions

.4.3 Web Services

Our definition of services can explain the web services, such as an Internet search engines. Web services satisfy the detachment of the function from the function performer and satisfy the underlined phrases (B-1, 2). The server computers, which host such web services as function performer, are anonymous for the users, especially in the cloud-computing environment. The users are not aware of which server provides the services. The underlined phrase (C) is satisfied because the web services providers usually guarantee and advertise the quality of the web services. Next, web services satisfy the supplement (2). The base-layer is the web services itself and the meta-layer is the services that the providers enable users to access the web services. On the supplement (3), if a customer uses the web services to confirm the connection to the Internet, the web services provide the accidental services enabling the users to confirm the connection. As stated above, web services satisfy our definition.

5 Discussion

In this section, we discuss the novelty of our definition shown in Section 3.1 with the comparison to some other existing definitions.

Shimomura et al. define the services as follow: "*Service is defined as a deed between a service provider and a service receiver to change the state of the receiver.*"[5] This definition is essentially the same as the definition of function [20] as described in Section 2.2. The *provider* is regarded as the function performer, and the receiver is regarded as the operand of function. The change of state of the receiver is regarded as the behavior (i.e. state-change). Thus, this definition is not the definition of the notion of "services" but the definition of the notion of "function" that is the general notion including "services" and "product function". Our definition can make the distinction between services and product functions. In addition, our definition contains the new concepts that the existing definitions do not have, such as the meta-base structure of services and the essential/accidental services.

IBM defines the services as follow: "*A service is a provider/client interaction that creates and captures value.*"[11] We suspect it mainly focuses on consulting services. It, however, also cannot differentiate the services from product functions in the same way as the definition of IBM. For example, the using a laundry machine fits this definition. When the user is using the laundry machine, there are some interactions between the laundry machine and the user, such as the user's operation of the laundry machine. And the interaction brings in the value of the cleaned clothes. By comparison with our definition, the definition of IBM also fails to differentiate between services and function

Ferrario and Guarino define the services from a viewpoint of ontology engineering as follow: "*A service is present at a time t and location l iff, at time t, an agent is explicitly committed to guarantee the execution of some type of action at location l, on the occurrence of a certain triggering event, in the interest of another agent and upon prior agreement, in a certain way.*" [7] This definition also has the same problem about the distinction between services and product functions. Obviously, product functions are in the interest of user. Most of product functions embedded in products are sold along with the quality guarantee. In the product guarantee, the location where the product performs its function normally and a certain triggering event of performing functions such as pressing a run-button are described. In addition, we conceptualize the guarantee and the triggering events as the meta-services, which has the higher generality than the concepts of Ferrario et al. Moreover, Ferrario et al. take into account only the providers' perspective, on the other hand, we take into account the both perspectives of the providers and the customers.

Consequently, our definition is advanced over the existing ones with respect to the distinction between services and product functions and the new concepts that represent various services and perspectives, such as the meta-base structure of services and the essential/accidental services.

6 Conclusion

The purpose of our research is to clarify the essential natures of services that are important in the both academic and practical viewpoints. From the academic viewpoint, essentialities of services are one of the fundamentals of uniqueness of the service research. From the practical viewpoint, they are also the core elements of

models and ontologies of services, which are important in the design and knowledge management of services. However, all the existing definitions of the notion of services have a problem in is the distinction between services and other related concepts: especially product functions. For example, the IHIP is not the exclusive characteristics of services but common to processes, which are aspects of functions. Thus, existing definition of services cannot answer the question: "are services functions?"

In this paper, we proposed a definition of services through the comparison of services and product functions using a general model. In our definition, services are the special type of functions. The functions are general concepts that include not only product functions but also those performed by humans. Then, we clarified the two main differences: the designablity of environment and the detachment of the function from the function performer, which are regarded as essential natures of services. Based on them, we defined the notion of services and showed its advantages.

Based on the conceptual elements of services grasped through this research, we are currently building a services ontology and clarifying formal definitions and relationships between concepts. Then, we will describe service models that represent specific service structures and characteristics based on that ontology. We believe this can be achieved by expanding a functional modeling tool named OntoloGear [23].

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