Proposal for a New Framework for a Medical Service System Using Smartphones

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***Abstract*--A service system in service dominant logic (SDL) is considered to be a configuration of operant resources including human beings that effectively increases value-in-context. It is important to integrate these operant resources in this configuration to develop products and services in value co-creation between firms and customers from the viewpoints of value-in- use or value-in-context.**

We propose a new framework for a medical service system using smartphones from the viewpoint of an effective configuration of operant resources for value co-creation. This framework consists of three subordinate service systems. The first is a subordinate service system where operant resources are integrated, the second is a subordinate service system to attain value-in-use and value-in-exchange, and the third is a subordinate service system to accomplish value-in-context. These subordinate service systems are connected with actors who play an important role in the value-in-context of operant resources. This framework was demonstrated to be effective in the management of firms providing products and services through analysis of a case study and it could be expanded to various service systems.

I. INTRODUCTION

The characteristics of innovation have varied in the modern economy. Service innovation has had more impact on markets than technological innovation due to the appearance of information and communication technology (ICT). This has demonstrated that customers may prefer values to functions, and that services are becoming more important for firms that are developing new products. In brief, these products have led to the creation of innovations such as those in services as they have made value-propositions effective for firms developing new products that involve services.

Technological innovations are important for firms that are developing new products. That is to say, technological innovations have many classifications such as discontinuous innovations [13], disruptive innovations [5], and architectural innovations [3], and these classifications of innovations are mainly based on the evolution of technology. Technological discontinuous innovations dramatically advance an industry's price vs. performance, and break incremental technical change [13]. Disruptive innovations are innovations that provide different values from mainstream technologies and are initially inferior to mainstream technologies along the dimensions of performance that are most important to mainstream customers [2]. Architectural innovations are often triggered by a change in a component that creates new interactions and new linkages with other components in the established product [3]. These technological innovations are based on development of technology. While many definitions of service innovations have been proposed [3,7,10,14], these definitions of service innovation have been based on the integration of operant resources (ORs), which is explained by service-dominant logic (SDL) [17], such as knowledge and skills for competence in interaction between firms and customers. Further, services in SDL are based on value-in-use [17].

While service innovations have been discussed from the perspective of values for customers, technological innovations have been discussed from the perspective of functions of products, as was stated above. The definition by Michel et al. [10] is different from those by others, which they compared with technological innovations in examining the terms of SDL.

Michel et al. [10] defined service innovation as discontinuous innovation that changes the role of the customer as user, payer, and buyer.

TABLE. 1 FOUNDATIONAL PREMISE IN S-D LOGIC [9]

Premise number	Foundational premise
FP1	Service is the fundamental basis of exchange.
FP2	Indirect exchange masks the fundamental basis of exchange.
FP3	Goods are a distribution mechanism for service provision.
FP4	Operant resources are the fundamental source of competitive advantage.
FP5	All economies are service economies.
FP6	The customer is always a co-creator of value.
FP7	The enterprise can not deliver value, but only offer value propositions.
FP8	A service-centered view is inherently customer oriented and relational.
FP9	All social and economic actors are resource integrators.
FP10	Value is always uniquely and phenomenologically determined by the beneficiary

They also stated discontinuous innovation changes the firm's value creation, i.e., embedded operant resources, resource integration, and value constellation.

These proposals are very useful for stakeholders (e.g., product developers, marketing managers, and policy makers). Yet, changes in these influence service systems [19], because integrated service systems are connected to other service systems including users and ORs.

This article attempts to explain our demonstration that service innovations reflect service systems. We present our argument by first summarizing the SDL view. Then, we discuss service innovations in some depth from the perspective of using examples to illustrate several cases studied.

We discuss our demonstration on how service innovations reflect service system especially in medical services that utilize smartphones. Medical services are composed of various elements such as doctors, firms, and patients. The service systems are easily influenced by variations in service innovations. Other factors in adopting medical services have

been rapidly evolving including ICT, i.e., in what are called mobile health (m-Health) and medical service systems [11].

II. SERVICE SYSTEM IN SERVICE DOMINANT LOGIC

A. Service dominant logic (SDL)

SDL considers service as central to economic exchange and value creation. This service-centered view suggests that market exchange is the process of parties using their specialized knowledge for each other's benefit [18]. SDL is grounded in ten foundational premises [16], which are presented in Table 1 and are briefly elaborated below as they relate to service science and service systems.

In SDL, service, which is in the singular because of indicating a process, is the basis of all exchange (FP1). SDL also includes direct and indirect service exchange among service system, which is the process of value creation as intermediary service system (FP2). Through intermediary service system, the process of exchange is facilitated (FP3). In this perspective, intermediaries such as goods, money and organizations play an important role in value creation. In SDL, operant resources (ORs) such as knowledge, information and skill are the underlying source of value (FP4). These operant resources are integrated among service systems (FP9).

B. Service systems with SDL

Service in SDL is defined as the underlying basis of exchange and he application of competencies (knowledge and skills) by one party for the benefit of another party[10]. The purpose of exchange is the creation of values and this definition implies that values are collaboratively created in interactive configurations of mutual exchange. Values are fundamentally derived and determined in use by the integration and application of resources within special contexts. Value-creation configurations are called service ecosystems in this way. Service systems interact through mutual relationships of service exchanges and integrate resources that are mutually beneficial. These resources are called ORs in SDL.

SDL classifies resources as operant resources or operand resources. Operand resources, such as natural resources, goods, and money, are tangible, static and finite and must be acted on to be beneficial. While operant resources, such as knowledge and skills, are intangible, dynamic and infinite and act on other resources to create benefit. That is, operant resources are the underlying source of value. In addition, SDL argues that value-creating resources are not confined to the firm; customers, suppliers, and other stakeholders also constitute operant resources and contribute to value creation [18].

A service system in SDL is an arrangement (including people, technology, and information) connected to other systems by value propositions [19,20]. A service system's function is to make use of its own resources and the resources of others to improve its circumstances and those of others. One way to acquire resources is through those of other service systems [19].

Service systems co-create values, effectively depending on the resources of others to survive. This interdependence drives service-for-service exchanges and resource integration (See Fig. 1) [19].

Integration of other service systems for value-in-use has extensive features in this way and this is illustrated in the foundation premises (FP9) of SDL in Table 1, where "all social and economic actors are resource integrators".

Several service systems [2,6,21] have been proposed.

Wieland et al. advocated service systems as actor-to-actor (A2A) orientation with reference to general system theory, complexity theory, and a viable system approach [21]. They focused on the dynamic and systemic nature of social and economic exchanges on value creating activities. Therefore, they argued that all social and economic actors were essentially creating value for themselves and others through the reciprocal integration of resources. These activities occurred in structured societal groups and systems that connected actors and provided them with the context for their activities, and these activities were positive and harmonious

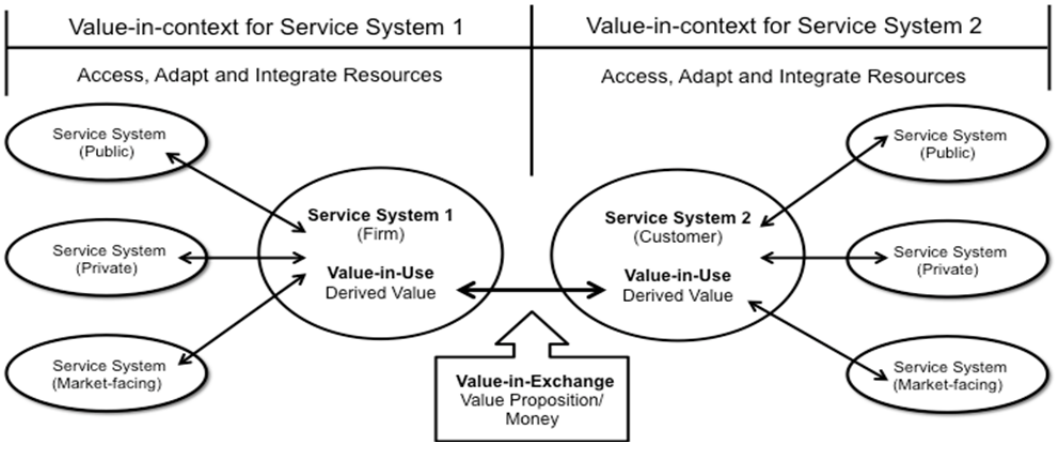

Fig. 1 Service system in S-D logic [14]

interactions with other systems to strengthen the value co-creation process.

Therefore, they recognized service systems as being dynamic and reciprocal between actors. These activities in many-to-many networks are considered actors' networks, and interactions in networks of relationships are important key variables [2]. Also, crucial resources are represented by information, knowledge, and competencies, each of which is considered to be a foundational element in coordinate network systems.

As previously stated, service systems are composed of the integration of resources, which are knowledge and information. Service systems as functions are also affected by this integration.

III. SERVICE INNOVATIONS FROM VIEWPOINT OF SDL

Service innovations are fundamentally different from technological innovations because the latter illustrates the evolution of functions in products in terms of progress in technology. Hauser et al. inferred that much research on organizations and innovation was focused on firms and tangible development of products, and lacked direct links to changing customers in their review [7].

This is in contrast to service innovations that illustrate evolution in the value creation of customers. Therefore, the process of creating value and integrating ORs has characteristics of service innovations.

Tax and Stuart argued that different processes, the skills and knowledge of service providers, and physical facilities are important elements of service innovations for firms to create new services [14]. Berry et al. argued service innovations provided an opportunity to reposition strategic alliances into a value constellation [2].

Yet, it is difficult to classify businesses and markets by using these arguments because the characteristics of service innovations are based on business operations.

However, Michel et al. proposed discontinuous innovations from an SDL perspective, and their proposal was useful for classifying service innovations [10]. Their proposal implied two dimensions where the first was changing the customer's role and the second was changing the way the firm was created.

Customers in SDL are frequently co-creators of values. This co-creation of values requires customers to play three different roles of users, buyers, and payers. The change in user's role indicates the change of the way users co-create value, in buyer's role the customers' buying process changes and in payer's role the customers' buying and paying processes changes. The user's role refers to value-in-use, the payer's to value-in-exchange, and the buyer's role bridges value-in-use and value-in-exchange. Moreover, combinations of these roles are involved in the first dimension of changing the customer's role.

The second dimension of changing the way the firm is created involves embedding ORs into objects, changing the integrators of resources, and reconfiguring value constellations. By embedding ORs into objects such as products, the customers make the products smarter. Changing the integrators of resources implies that a given value creation activity requires a certain amount of integration, such that the customer, as a co-creator of value, can integrate more or fewer resources as necessary. Reconfiguring value constellations implies service innovations often link customers' skills and knowledge together to create a network

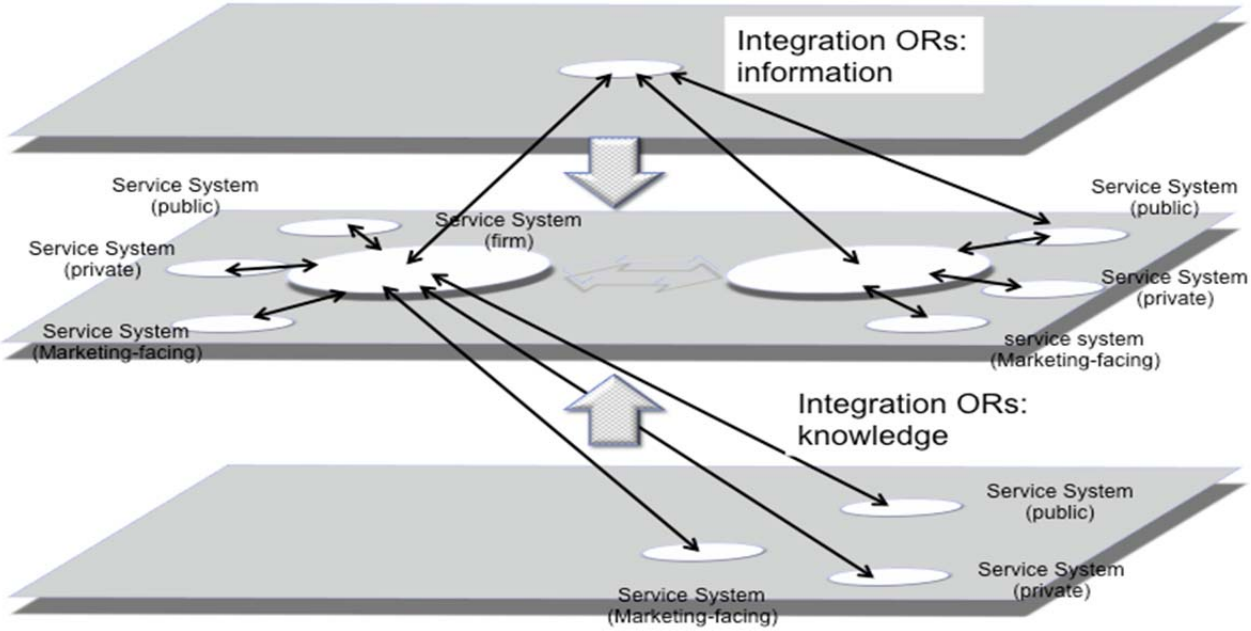

Fig. 2 Service system composed of subordinate service systems

of ORs [9]. The network of ORs becomes extended to more complex value constellations, or what have been referred to as value stars [2].

SDL defines innovations with regard to providing values, which can be directly or indirectly transferred by embedding ORs into objects.

The process of co-creating values involves integrating resources. Firms could integrate more resources to provide products and solutions. However, because customers are always co-producers in SDL, they participate in co-creating value for value-in-use.

IV. CHANGES TO SERVICE SYSTEMS IN SERVICE INNOVATIONS

We contend how changes in the elements in service innovations reflect service systems in this article based on service innovations by Michel et al. We focus on the integration of ORs and value constellations when we argue for these changes because changes in customers' roles also reflect service systems. It is useful to maintain that service systems that consist of various system layers have specialized functions. Vargo and Lusch illustrated that service systems were integrated with other systems, which were connected through the acceptance of propositions and evaluation of values to attain efficient value-in-use; however, they did not argue what functions service systems had [19] (see Fig.1). Also, functions in service systems are not advocated in value constellations and value networks.

We especially contend that functions are needed in service systems in terms of service innovations [10] because in developing new products and services, firms need knowledge and information of function of new products and services and need functions of networks in relation to value-in-use. Integrated ORs are important elements from the perspective of service systems. Integrated ORs, such as skills and knowledge, involve various means of implementation. That is, there are at least two kinds of integration of ORs: (1) integration of knowledge to achieve efficient value-in-use and the (2) integration of information to achieve efficient value-in-context.

Integration of knowledge to achieve efficient value-in-use specifies that for efficient integration, knowledge needs to be obtained together with other knowledge about usage in advance. We need to surmise what knowledge will be utilized in gathering knowledge. Public, private, and market-facing goals are integrated in service systems [19], yet for this integration to occur, we need to deduce what knowledge is required. It is worth gathering knowledge about customers when firms are developing new products because they have many kinds of technologies as core competencies and they need to utilize the core competencies. Value-in-exchange and research on marketing are effective when directly gathering knowledge about customers. This can be applied to service systems [19]. Firms arrange to gather knowledge in advance about customers when indirectly gathering this knowledge, which is important. This integration is different from directly gathering knowledge from such a point of view. Therefore, we propose service systems that are comprised of several layers for integrating ORs (see Fig. 2). That is, these service systems are comprised of subordinate layers in which ORs are directly and indirectly gathered. The middle layer in the figure indicates a service system for value-in-exchange and value-in-use [10], which directly gathers knowledge and information for value-in-use. In this subordinate layer, firms and customers gather knowledge and information which is directly connected with value-in-use.

The subordinate layer below indicates how knowledge is gathered indirectly. In the subordinate layer below, firms should gather knowledge, about products and services, to which is indirect connected in advance and should understand the knowledge to develop new products and services.

This direct and indirect gathering of ORs can be applied to the integration of information to enable efficient value-in-context. Namely, the upper subordinate layer in Figure 2 indicates information being indirectly gathered. Firms should understand the implications in gathering information indirectly to attain efficient value-in-context as in directly gathered knowledge.

The integration of ORs specifies the integration of services-for-services in service systems in SDL [10]. Our proposed service systems are useful to configure integration and value constellations because service systems are designed to make subordinate layers with value constellations more efficient based on the service innovations by Michel et al. Further, this configuration for service systems is more effective, when firms have more efficient value-in-use with customers.

The next section explains how these service systems were adopted in medical services. We especially focus on developing medical devices using smartphones. There are two reason for focusing on these because (1) medical services are complicated with many concerned stakeholders, such as firms, doctors, patients, and governments; consequently, our proposed service systems that consist of several subordinate layers are suited for directly and indirectly integrating ORs [10] The second reason is that (2) smartphones are useful devices for value-in-use because there is a context between stakeholders who use smartphones.

V. METHODOLOGY

We carried out a case study where our proposed service systems were incorporated into medical services including medical devices using smartphones. Many medical devices have recently been introduced on the market and announced in academic journals [4,11,13]. These service systems were adopted in studies that referred to these journals and related documents, which were press releases and articles on the internet. Especially, we search for services using cameras of smartphones. So, we searched academic journals in optics such as Photonics. Moreover, we searched search engine

PUBMED, a database in life sciences and biomedical topics, to get some cases smartphones are used in healthcare systems.

VI. DISCUSSION AND IMPLICATIONS

This article illustrates changes in service systems with variations in customers' role in terms of integrating ORs by using various cases.

A. Integration of knowledge

CellScope (http://cellscope.berkeley.edu) is a piece of equipment that can turn the camera of a standard cell phone into a diagnostic-quality microscope. Moreover, otoscopes have been developed based on this mobile microscope. Service systems that use these devices have subordinate service systems that integrate customers' knowledge and that of information.

The devices were evaluated in a middle-school science classroom and museums in terms of the integration of knowledge[11]. The services and devices were developed to make users' value-in-use efficient based on knowledge of the evaluation. Therefore, knowledge was embedded into these devices. The service system adopted the below subordinate service system in Fig. 2. Integrated customer knowledge was embedded in the devices to create the service system composed of subordinate service systems. Then, the devices were tested in clinics, homes, and schools for diagnosis in terms of the integration of information. This information about users created efficient value-in-use.

The devices that had embedded ORs in this service system changed users' roles because they were composed of subordinate service systems.

B. Integration of information

Peek Vision (http://www.peekvision.org) is a service composed of a portable kit for eye examinations that has an ophthalmic scope device for use with smartphones. The service focuses on providing eye examinations mainly to patients in developing countries. It features services where general health workers visit patients living in remote areas without ophthalmologists and obtain information from eye examinations by using medical devices based on attachments to smartphones. Moreover, the information is shared with ophthalmologists who instruct the general health workers. This service system includes subordinate service systems, which is above subordinate service system in fig.2, to integrate information in the customers' service systems. Moreover, this service system integrates ORs, which clinicians acquire in examining patients, for firms.

C. Service systems for relations between customers

The medical device, iExaminer, which received U.S. Food and Drug Administration (FDA) clearance is a panoptic ophthalmoscope that utilizes smartphones. The device is a combined system that connects an attachment on the ophthalmoscope to smartphones for clinicians to make diagnoses. Therefore, users' roles do not change as the way the device is used is the same as that with ordinary ophthalmoscopes. It is also important to create value-in-use for clinicians who confirm the validity of devices by making accurate diagnoses with them. Consequently, services with devices developed with ordinary methods are adopted in SDL [9]. Moreover, the service system is essentially a telemedicine product that can bring ophthalmologists to remote clinics that would otherwise not have one on staff, and it spreads the network of clinicians. This effect is adopted in many-to-many networks [2].

TABLE. 2 FUNCTION OF SUBORDINATE SERVICE SYSTEM

Subordinate service system	Functions of service system	Cases
integration of knowledge	• The knowledge about customers, who aren't true customers, is directly gathered for value-in-use. • Integrated customer knowledge is embedded in products. • Firms having relation to some service systems changes user's role .	• Cellphone
service systems including value-in-exchange	• Service system is composed of many-to-many network. • Service system is adopted to improve the functionality of new product. • Whether integration of ORs is direct or indirect depends on the purpose of service system.	• iExaminer • iTube
integration of information	• Integration of information in customers' service creates value-in-context. • Integration of ORs connect service system in firms with service system in customers.	• Peek vision

Even though firms and customers share information in this service system and directly make value-in-use efficient, shared information between firms and users is indirect in the service system of iTube. iTube utilizes the phone's camera in combination with an application, which measures the content of ingredients in food that create allergies. The iTube platform could test for a variety of trigger foods, including peanuts, almonds, eggs, gluten, and hazelnuts when the device was developed. Therefore, it was not necessary for customers to transform information on the criteria for the content of ingredients that created allergies, i.e., the indirect integration of operant resources.

The development of new products for improving functionality is estimated to be adopted by service system, which is middle subordinate service system in fig.2, in SDL [15], as was previously stated, and ORs are expected to be integrated directly or indirectly.

This service system includes value-in-exchange and value-in-use.

VII. CONCLUSION

This article discussed the change in subordinate elements in service systems in terms of integrating ORs in SDL.

Our proposal service systems for integrating ORs are composed of two kinds of subordinate service systems; knowledge and information is directly and indirectly gathered. And in this service system model, the knowledge and information about products and services classify the functions of subordinate service systems for value-in-use and value-in-context. The subordinate service system as " integration of knowledge value-in-use" and as " integration of knowledge value-in-context" are connected to subordinate service system for value-in-exchange, which is based on the service system in SDL [15]. We illustrated several cases, where medical services using smartphones were adopted, and the characteristics of service systems depended on the integration of ORs to create value for customers or users.

The above mentioned our proposal service systems are summarized in table.2

This proposal model is useful to firms in developing new products and services, because they select subordinate service systems based on the function of product and services. In research of SDL, our proposal service systems are characterized by the functions of subordinate service systems, which are connected to knowledge, information and stakeholders.

The main limitation of this research was in specific cases because more medical devices using smartphones in medical services need to be adopted. It is necessary for more cases to be investigated so that our proposed model of service systems can be generalized.

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