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CONCEPTUAL DESIGN FRAMEWORK FOR ICT SERVICE SYSTEM DEVELOPMENT AND DELIVERY

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Keywords: conceptual design, system modelling, design methodology

1. Introduction

Information and communication technology (ICT) service providers have traditionally implemented ICT services (Figure 1) following their clients' requirements for business platforms by integrating software and hardware products. This systems integration (SI) business starts from the requirements for ICT service given by their clients, and the value of the service is created from accurate implementation and operation of the computer system. This business model is essentially the same as that of selling products as both businesses sell final products or finished items to their clients. However, this B2B business has shrunk while the technology - cloud computing - has grown in the ICT infrastructures. The recent rapid growth of cloud services spurred the system engineers to change their roles: the main tasks now are not to implement and supply software functions but to deliver such functions from a network by effectively combining cloud functions: IaaS (infrastructure as a service), PaaS (platform as a service), and SaaS (software as a service). This trend can be regarded as an advancement of servitization as the value of ICT service has changed from exchange value to value-in-use in the view of the service dominant logic [Vargo and Lusch 2004]. Therefore, to provide high value-in-use to their clients, the ICT service provider should reconsider that in the SI business they have developed an ICT system with product-oriented [Tukker 2004].

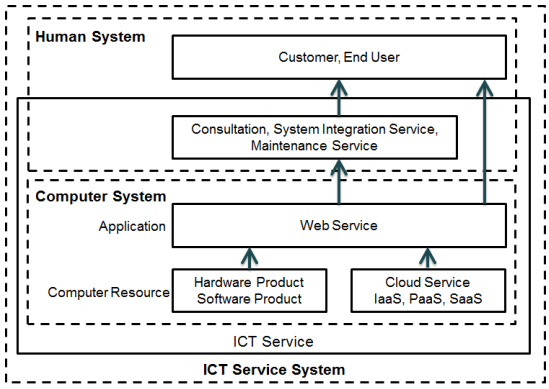

Figure 1. Overview of ICT service system

A business model called product-service system (PSS), which is a combination of products and services, could provide value-in-use to clients rather than a business model that provides only products [Mont 2002], [Tukker 2004]. The PSS is efficient for ICT service providers to provide high value-in-use. In

this paper, the service provider's business models are defined as ICT service systems. This system is composed of computer systems (tools to solve their customers' problems) and human resources (end-user, customers…) (Figure 1). Furthermore, to provide ICT service systems with high value-in-use, ICT service providers need to continuously co-create ICT service systems with clients through all lifecycle phases. At the early development phase of ICT service systems, providers explore clients' business needs and design sustainable ICT service systems. This conceptual design of holistic ICT service systems requires design strategy: what functions are to be delivered by computer system or by manual operations and what functions are to be modularized for effective and efficient operation. This work can be done with business views, and it has been relied on by certain experts and consultants. Hence, inexperienced engineers of ICT service providers need to have such skills, which can only be acquired through collaborative activities with clients and other service practitioners. To assist such skilled work, it is necessary to urgently establish high-level service modelling methods and procedures of conceptual ICT service system design for system engineers.

2. Challenge in conceptual service design in ICT service system

2.1 Emerging roles for systems engineers

Systems engineers have traditionally developed ICT services following requirements given by their clients. This SI business produces value in the correct implementation of their clients' requirements. However, ICT service system businesses produce value in the earlier phase before implementation (Figure 2); they have been designed before the clients' want is acquired completely. Systems engineers have to explore the clients' values, identify comprehensive functional elements in ICT service systems, and modularize the best combinations of functions and resources. The performance of these tasks relies on the skills and experiences of experts, though such knowledge can be structured and understood by inexperienced engineers when they can use common languages or expressions.

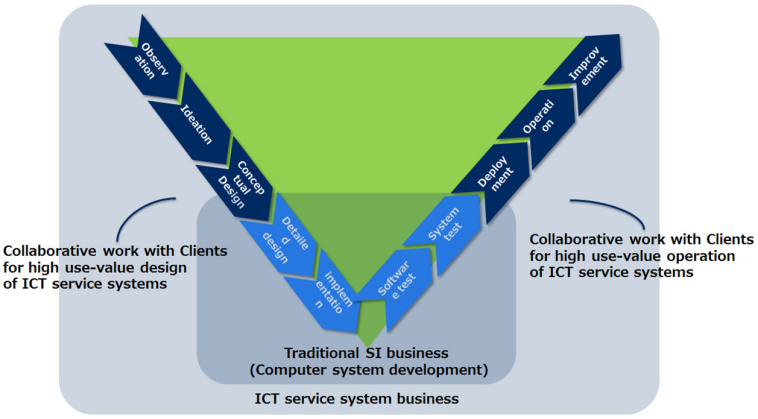

Figure 2. Co-creation activities with clients in ICT service system lifecycle

2.2 Gaps between design for customer values and conceptual system design

ICT service providers have adhered to product-oriented approaches that improve and enhance the functions of the target computer system. They have not been required to put themselves in the users'/customers' position when specifying requirements in service design. They are now required to have market-oriented approaches through plan, design, and implementation phases. ICT service providers need to co-create constantly with their clients not only in the ideate phase but also in the design, implementation and operation phases. This market-oriented paradigm can be established by giving system engineers the right toolset, skillset, and mind-set in human-centered design methods, processes, and governance. The human-centered mind-set can be obtained only by long term practices and experiences. To obtain such a mind-set in a short period, we have designed suitable methodologies and provided them to the engineers in a service design workshop. The workshop program includes learning modelling methods and how to use them in design, aiming at overall improvement of toolsets

and skillsets. In the past, service design workshops were held as an in-house training program to give staff members the ability to design ICT service systems based on HCD, which builds a deep empathy with the people you are designing for [Yasu et al. 2013], [Ide et al. 2013]. The HCD-based service design process did not have a conceptual design phase, where designers bring the users' needs into shape in an ICT service system. Comparing and adjusting functional design with providers' conditions and constraints has not been considered in the HCD approach. Designers tend to focus on designing only 'what to make' in the HCD approach, while 'how to make' should be considered concurrently to complete the conceptual ICT service system design. The results of analysing the trend of servitization in many companies [Timothy 2013] show that one of the enablers of realizing servitization in service development projects is whether providers think carefully about the service providing process. This phase is significant for designers when they take a market-oriented approach in service development projects. When engineers design concepts of ICT services at SI business, they need to select from many kinds of service functions and resources and combim them. Traditionally, these decisions have been relied on enginnners/consultants who are good at exploring cutomers' issues and designign ICT service based on users'/customers' requirements. Design elements which are considered to ICT service systems are more than ICT services. Thus, to advance servitization of ICT service providers, they need systematizing the process and toolsets which inexperienced engineers can evaluate a dependence/independence of service fuctions and a continuity of providing services, and design in a rational manner and an efficient.

2.3 Service Engineering

Service engineering [Sakao and Shimomura 2004], [Shimomura and Tomiyama 2005] has established engineering methods for structuring services at early design phases. It is a promising approach for designing service functions, contents, and service delivery processes based on users' needs. The HCD approach is used for designing 'what to make as a service', while the service engineering approach is used for designing 'how to make a service'. Thus, service engineering can make up for a lack of HCD approach. The design tasks of conceptual service systems are categorized in accordance with four aspects of service modelling based on the definition of service engineering: (1) modelling customers' and users' requirements, (2) modelling service functions derived from the requirements, (3) modelling relationships between actors (stakeholders such as operators, customers, and users) and hardware/software products, and (4) modelling users' behaviours and the service delivery process to finalize service functions and functional relationships among the actors.

3. Conceptual design framework

3.1 Conceptual design framework

The authors propose a conceptual design framework which includes the 'how-to-make' design to help with the performance of conceptual design tasks. This framework has both providers' and receivers' views with 5W1H aspects based on service engineering [Shimomura and Tomiyama 2005] . The service engineering has been engineering methods for services and is a promising approach to designing service functions, resources, and service delivery processes based on users’/customers' needs: this method is based on design principle. Thus, a service engineering approach can make up for the lack of HCD/design-thinking processes. When engineers design conceptual ICT services, their design tasks are categorized with theree aspects of service modeling based on definition of service engineering: (1) modeling service functions and resources derived from user's/customer's requirements: view model [Arai and Shimomura 2004], [Shimomura 2007], (2) modeling relational relationships among the actors: flow model and scope model [Sakao and Shimomura 2007], (3) modeling the service delivery process to finalize service functions and functional relationships: service blueprint [Hara 2009]. For applying service engineering to practice, this framework consists of service modelling and procedures of how to do the design tasks in practice. The models are the requirement function resource (RFR) tree, actors' map, and service blueprint. The RFR tree depicts what functions can realize the users'/customers' requirements and which functions should be selected in terms of ROI. The actors' map can determine the boundary of ICT service systems, depicting who will provide functions to whom. The actors' map

uses the value of 'what', 'which', and 'who' from the RFR tree, and the service blueprint depicts the data of 'when', 'where', and 'how' to structure service delivery process (Figure 3).

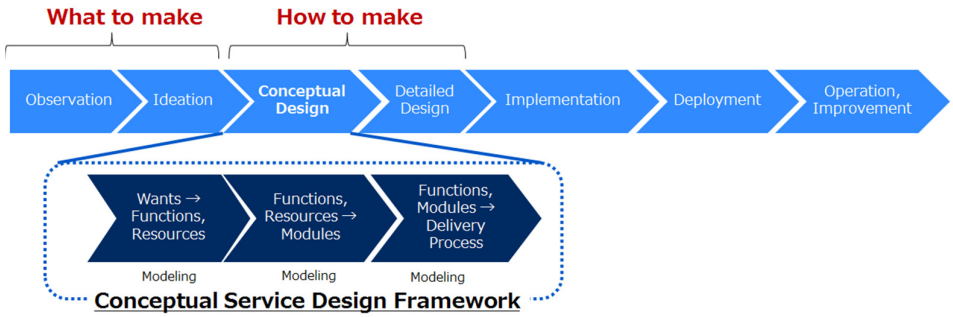

Figure 3. Modelling targets in conceptual design

3.2 Design of selling functions

3.2.1 Requirement function resource tree

The requirement function resource (RFR) tree depicts the users' and customers' wants comprehensively and clarifies what kinds of contents, channels, and resources should be delivered. The RFR tree structures will be implemented to meet the wants with three entities: service 'content', service 'channel', and service 'resource'. The RFR tree visualizes complete transfer of users'/customers' wants to service functions and from the functions to resources.

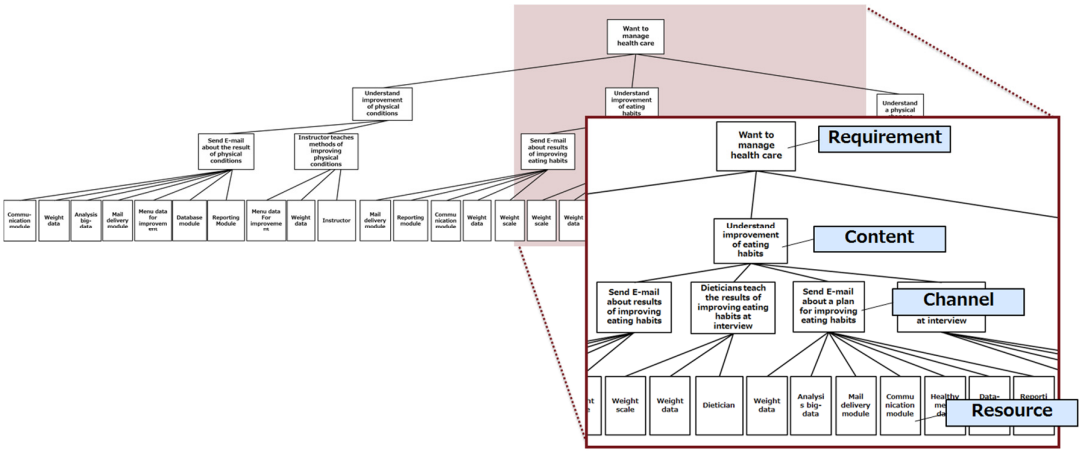

Figure 4. Example of RFR tree

3.2.2 Modelling procedure

The RFR tree is developed in the deployment phase and used in the modular phase. While deployment turns users'/customers' wants into functions, the wants are located at the top nodes, and the wants are trascribed into functions for fulfilling the wants. In the same way, the functions are transcribed into resources. In the modular phase, more than one function can be modularized in terms of their ownership by stakeholders, requirements for quality, and business or technical constraints. Some functions can be excluded as they are not realistic in terms of limited resources.

The view model is used to derive service features corresponding to users'/customers' requirements [Arai and Shimomura 2004], [Sakao and Shimomura 2007]. The view model structures the relationships between users'/customers' requirements and service elements: service contents, channels, and resources. When system engineers develop a view model, they start to structure it from users'/customers' requirements. They draw possible contents and channels to satisfy them and draw lines between

requirements and corresponding contents or channels. Then, they decompose contents and channels, i.e. functions and resources, and wire them in the same way. The identified contents, channels, and resources will make up the hierarchical structure of the target service system (Figure 4).

3.3 Design of service system boundary

3.3.1 Actors' map

The actors' map depicts the relationships among persons' roles and software/hardware modules for functional delivery of services. The persons' roles and software/hardware modules are determined in the RFR tree in advance. Each actor can be obtained from a branch of the RFR tree, which shows the relationships between contents, channels, and resources. The functions can be delivered by a person's role or a software/hardware module. However, they can be delivered by another one. These design policies allow designers to determine their best structures; the module of functions is determined in terms of independency between entities, and deployment of modules can be determined by their dependency in terms of ownership.

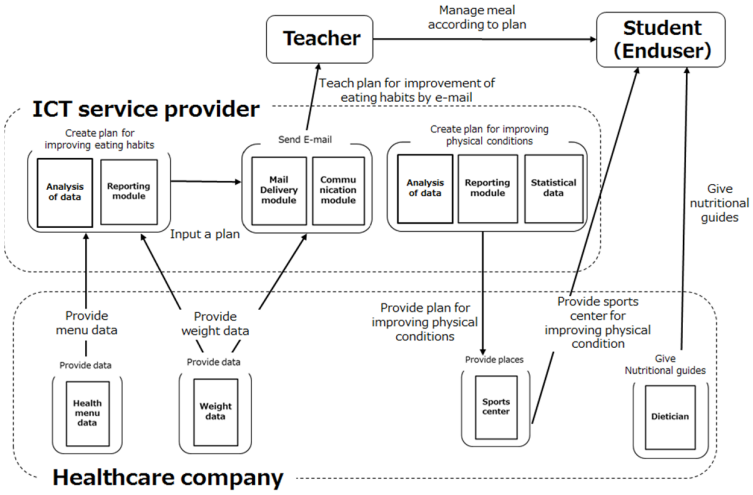

Figure 5. Example of actors' map

3.3.2 Modelling procedure

As shown in Figure 5, the functional delivery between actors is represented as an arrow. They may belong to stakeholders, which means the owners of each actor. For instance, an actor of a software module can be operated by a delivery division. The actors in the same stakeholder are located in the same region, and then the comprehensive relationships between stakeholders and function modules are obtained. When ICT service providers are to operate and maintain a service system, they need to acquire a number of resources to work the system. However, no single actor in the service system can provide all the resources, so they need to have partnerships with each other. The actors' map can depict the ideal relationships between actors and thus show how they can compensate each other's lack of technologies or skills. When the system engineers draw an actors' map, they start by determining which actors deliver which service contents. Then, the channels for the contents are mapped to the actors, and the comprehensive relationships between them are structured.

3.4 Design of service delivery process

3.4.1 Service blueprint

The service blueprint represents users' behaviour and the service delivery process. The service blueprint depicts users' phases of service encounters, (1) access, (2) check-in, (3) diagnosis, (4) service delivery, (5) check-out, (6) follow-up, and the flows of functional deliveries and behaviour in each phase. The

top lane shows the user's behaviour, and each lane depicts each actor's behaviour. Each entity represents human or product activities. This model defines the delivery process (when, where, how) with service contents, channels, and resources (what, which) by some actor (who, whom).

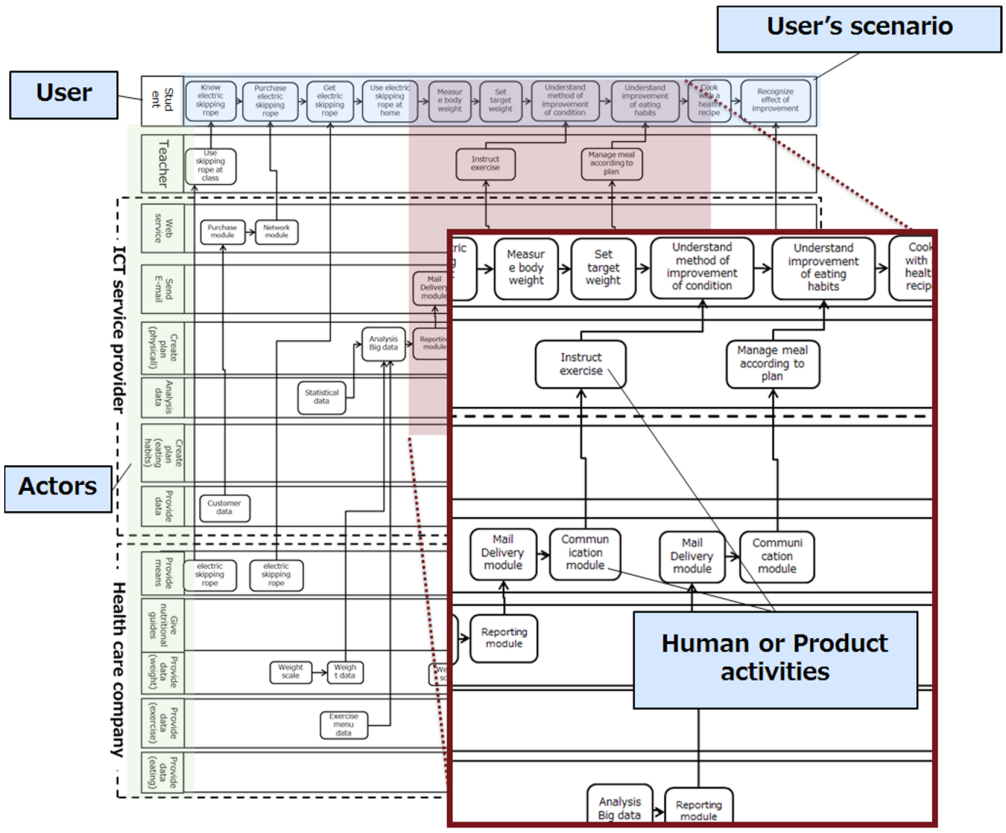

Figure 6. Example of service blueprint

3.4.2 Modelling procedure

The modelling procedures are as follows:

1. The top lane is tagged 'User'.
2. Users' behaviours based on scenarios are depicted chronologically in the top lane.
3. The second-to-last lanes are tagged 'Actors' for the front-end to back-end toward the user, and each actor's behaviour is arranged chronologically.
4. The relationships of functional delivery between the activities in different lanes are depicted as arrows.
5. The relationships of functional delivery between activities in the same lane are depicted as arrows, indicating the work flows of the actors.

The service blueprint depicts a service delivery process [Hara 2009]. It determines collaborations between actors in the delivery phase, visualizing risks for continuous service operation (Figure 6). When system engineers develop a service blueprint, they start by transcribing actors from the actors' map and transcribing service contents and channels using resources from the RFR tree. The actors, contents, channels, and resources are aligned with the users' scenarios from a persona-scenario model.

3.5 Conceptual design process

A group of service planners and systems engineers will have workshops to discuss clients' requirements, functions to deliver, stakeholders to be involved, and delivery plans through developing the RFR tree, actors' map, and service blueprint models collaboratively. The comprehensive steps of conceptual design are streamlined as follows (Figure 7):

1. Observe user's as-is behaviour and difficulties.
2. Depict user's to-be behaviour with laddering.
3. Ideate solutions to realize the to-be behaviour with experience map.
4. Transcribe the requirements into functions and resources to be delivered with the RFR tree. ('what', 'which')
5. Determine the appropriate entities to provide the functions and functional relationship between them with actors' map ('who', 'whom').
6. Depict the delivery process of functions with service blueprint ('when', 'where', 'how').
7. Document requirements, functions to deliver, stakeholders to be involved, and delivery plans from the data in persona scenario, RFR tree, actors' map, and service blueprint.

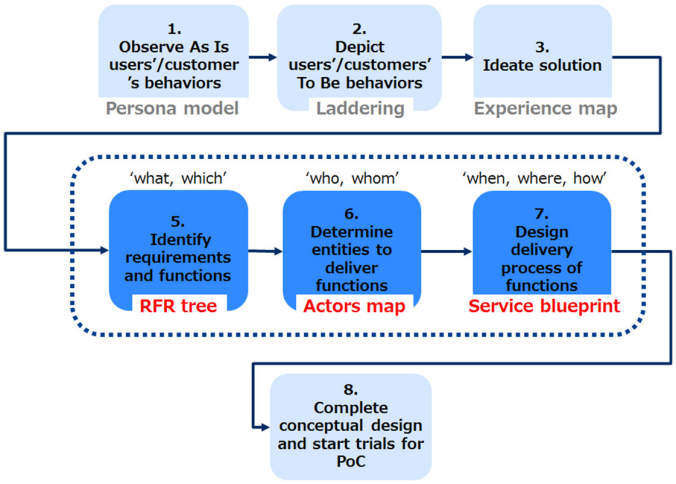

Figure 7. Conceptual service design process

4. Case study

4.1 Workshop overview

The workshop "Planning a new ICT Service with HCD" was designed for learning human-centred design methods and procedures. It consists of six steps (Table 1). The contents includes the HCD approach, which helps participants think about how service ideas are transformed into service functions and tailored to depict their useage scenarios. This workshop was held three times (8/2014, 2/2015, and 9/2015) as an in-house training program, and the participants were in charge of planning, operating, maintenance, and sales for the cloud service, network service, and web service.

Table 1. Tasks of service design in workshop (9/2015)

ICT service system design process (models)		
Creating service ideas	1. Specifying target user	(Persona model)
	2. Identifying value from user's needs	(Laddering)
	3. Designing user's flow: user's behavior, expectations, and needs	(Experience map)
	4. Creating service ideas based on user's needs	(Experience map)
Designing ICT Service system	5. Structuring service contents, channels, and resources based on user's needs	(RFR Tree, Actors Map)
	6. Designing service providing process	(Service Blueprint)

4.2 Practice and evaluation

Three to five people in each group developed an RFR tree, actors' map, and service blueprint (Figure 8, 9). They designed a new service for a healthcare firm, a healthcare service for the elderly, and an exercise management service for an elementary school student. The results of the three workshops revealed significant differences. The results of the first and second workshops indicate that the ICT service provider played the role of an ICT platform provider. The provider developed a software application, integrated it with hardware, and completed their tasks when the integrated platform was delivered to the healthcare firm. This model is equivalent to the conventional SI business. However, the result of the third workshop shows that the ICT service providers delivered analytic services to the healthcare firm continuously as an element of the sustainable service system. The reason for the significant difference is using or not using an actors' map. When not using an actors' map at the workshop, the result of the service model was that an ICT service provider provided an integrated system to the healthcare firm.
The results between the two workshops show significant difference. The result of the first workshop shows that the ICT service provider played the role of a computer system provider. The provider developed a software application, integrated it with hardware, and completed their tasks when the integrated platform was delivered to the healthcare firm. This model is equivalent to the conventional SI business. However, the result of the second workshop shows that the ICT service provider delivered analytic services to the healthcare firm continuously as an element of the sustainable service system. Hence, they could extend their thoughts about selling functions as a change-of-ownership model to continuous delivery while maintaining the ownership in service providers.

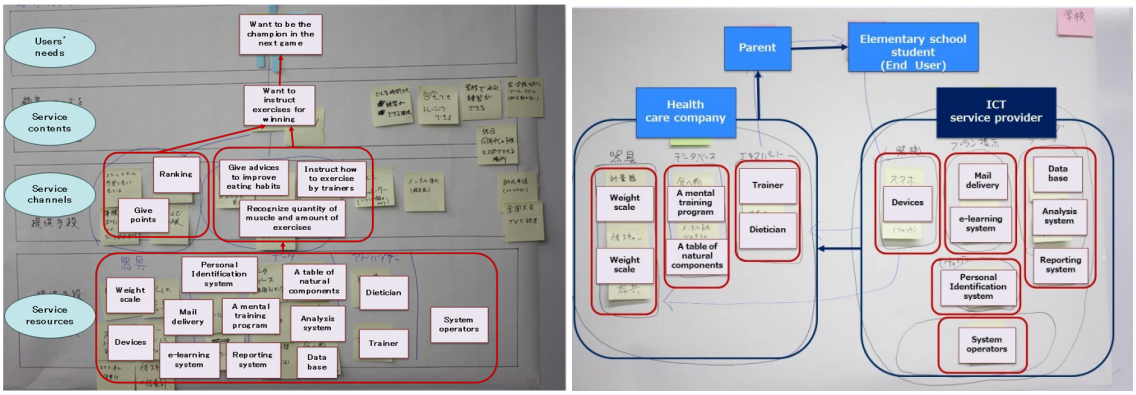

Figure 8. Results of RFR tree and actors' mapDESGIN

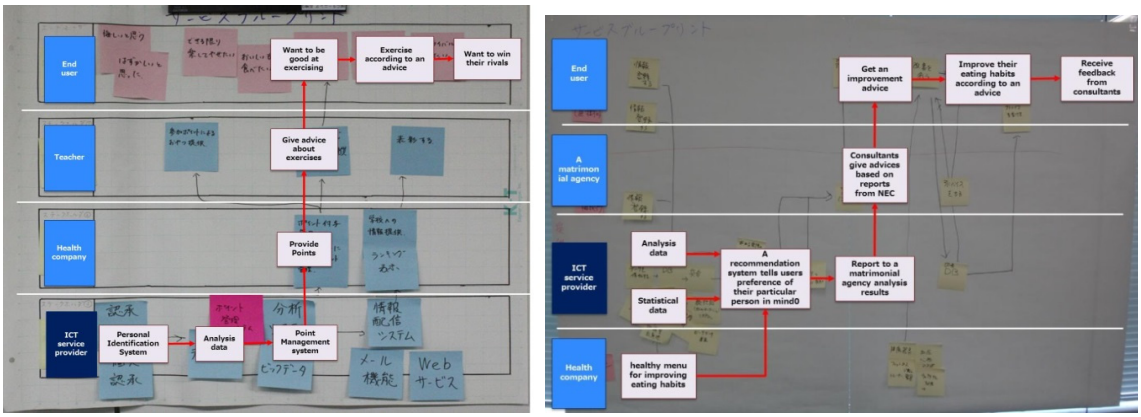

Figure 9. Results of service blueprint (before and after)

5. Discussion

5.1 Mind-set of selling functions instead of products

This framework has both providers' and receivers' views with 5W1H aspects and reduces the chance of overlooking functions and resources to be delivered, and a minimum set for designing conceptual ICT service system. At workshops, participants who are unfamiliar with designing conceptual ICT service system, could complete the counceptual designing tasks within two hours using this framework. The results of the workshops show that this framework is efficient enough for inexperienced engineers to design in a short time. Futhermore, the evaluation rate was improved significantly from the first and second workshops (8/2014, 2/2015) to the third one (9/2015). The participants evaluated this framework with higher rates. Compared with the evaluation rate, the qualitative values of the framework have been verified through workshops (Table 2). The value of satisfaction and understanding level for a workshop continuously grew with repetition. The contents of workshops were improved between the second workshops and the third one. The difference between workshops was caused by introducing an actors' map. Depicting an actors' map made the participants understand where the service functions are deployed for effective service delivery and how the functions are modulated for the actors of the service system. The participants naturally modulated the functions into actors and set relationships between them, i.e. the boundary of service systems by using an actors' map.

Table 2. Change value of satisfaction and understanding level for workshops

Not Satisfied ⟷ Satisfied						
Satisfaction Level	1	2	3	4	5	Average
2014/8/24	0	0	5	2	4	3.9
2015/2/24	0	0	0	5	1	4.2
2015/9/1	0	0	0	2	4	4.7

Cannot ⟷ can						
Understanding Level	1	2	3	4	5	Average
2014/8/24	0	0	4	6	1	3.7
2015/2/24	0	0	0	6	0	4.0
2015/9/1	0	0	0	2	4	4.7

5.2 Future work

Our framework is aimed at introducing systematic design methods to development divisions of service providers for designing sustainable service systems. An actors' map can depict comprehensive relationships of service delivery and can determine the boundary of a service system. Hence, depicting an actors' map brings new thoughts to systems engineers while this system design is still out of the scope of traditional SI business schemes. However, it is difficult for the engineers to speculate on possible changes in the relationships between actors in the long term as the map can depict the static relationships between actors at a certain point of service delivery. In addition, as the relationships are designed by experienced engineers, business and technical constraints known only by them are included tacitly. Therefore, the representation of the model still has subjective aspects. These ambiguities will not be represented by quantitative data, though qualitative formula can be a solution. Our future work will be to extend the actors' map to comprehend qualitative changes in the relationships in continuous service delivery.

6. Conclusion

This paper presents a way of modelling and the procedures of conceptual ICT service system design for helping system engineers. This conceptual design framework is a minimum set for designing a conceptual ICT service system. The results of the workshops show that the mind-set of selling functions instead of products appeared among the practitioners of ICT service providers. Therefore, our framework will help rationally design sustainable services.

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