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Serviceology for Smart Service System

Selected papers of the 3rd International Conference of Serviceology

Springer

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Preface

Services are not merely key economic activities, but also major factors that improve our quality of life, make local communities prosperous, and then provide a foundation for solving emerging issues. In an increasingly globalized market, it is necessary to increase the economic value of products and services, as well as to enrich their value (life value) for every individual citizen using those services. In addition, advanced technologies, including big data, IoT, AI, and others, bring us possibilities to design smart service systems by solving emerging social issues, such as an aging society and social security, and global challenges, such as energy and environmental issues.

Traditionally, service-related research has developed in individual fields typified by management, marketing, information engineering, and design engineering. However, to provide better services to our society, it is critical that social sciences, human sciences, and engineering sciences work together as well as establish a strong partnership between industry and academia. There, we need to create an academic understanding of the activities that relate to social and economic services, which means that it is necessary to establish an understanding of the comprehensive services that include not only the narrowly defined services industry, but also the development of services by manufacturers. Moreover, it is necessary to develop a framework to co-create high customer satisfaction in alliance with customers.

The Society for Serviceology (SfS) was launched in Japan in October 2012 and has been developed globally. SfS aims to contribute to efforts concerning various industrial issues by organizing the vast knowledge of services and to establish "academics for society" relating to services.

The Third International Conference on Serviceology (ICServ2015) was held July 7–9, 2015, in San Jose, CA, USA. The theme of this conference was "Engineering and Management of Smart Service Systems — Cultural Factors in Customer Engagement". It covered service innovation and design, smart service systems, service marketing, human factors and service engineering, and theoretical perspectives on service and social problems in services. The conference was sponsored by Fujitsu, IBM, and The International Society of Service Innovation Professionals (ISSIP). We would like to thank the members of the organizing committee, the program committee, and all conference participants for their contribution to the success of the conference.

Tokyo, Japan — Yuriko Sawatani, Takeshi Takenaka

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Part I

Service Innovation & Design

A New Service Class Scheme for Service Innovation in Japanese Automation Industry

Yoshitaka Yuki, Seiichi Kawata, Hiroyuki Imanari, Takeo Suzuki, Norio Aburatani, Motomi Kohata, Takeru Kawai, Tomio Makino, Yukiyo Akisada, and Motoya Tametani

Abstract

This paper proposes a new service scheme in the industrial automation service classification. It clearly categorizes and orders the seven types of industrial automation service from the view point of customer value. This service class depends on some previous work by GAMBICA and ZVEI, and it is modified and newly created to fit the Japanese automation industry. The proposed service scheme in this paper could bridge the gap of service value understanding between customers and service providers and enable service innovation by smoother and wider outsourcing of traditional plant operation and field maintenance.

Keywords

Industrial automation • Service classes • Service categorization • Product service • System integration service • Plant maintenance • Operation service • Outsourcing

1 Introduction

The Japan Electronics and Information Technology Industries Association (JEITA) is an industry organization that conducts research, promotes the diffusion of innovations, and makes policy proposals on the latest electronics and information technologies. The authors of this report belong to its control and energy management committee, and a working group of the committee has conducted a general study of the service business in the industrial automation systems business. Specifically, it researched a new service scheme to be applied in the industrial automation industry, aiming to define a value-oriented mechanism and standardization.

2 Background

Many industrial plant owners are having difficulties in outsourcing their internal tasks, as they are urged to restructure their maintenance and operations to survive in the fiercely competitive global market. Such tasks include instrument and device maintenance, system design changes

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for production enhancement and upgrade, and process performance and quality optimization to maintain secure and efficient plant operation. As those tasks require a wide range of engineering skills and knowledge, it is inherently difficult to reassign internal work procedures to be executed by temporarily out-sourced service provider staff. To overcome the abovementioned service problems in the plant automation fields, the concept of service science [1, 2] gives us new ideas on how to ensure the value of plant automation services. The service science perspective focuses on how to ensure value is created in a scientific manner [3] and how to build new services by using engineering methodology. Some examples in project management firms [4], machine maintenance [5] and aerospace maintenance, repair and overhaul services [6] are typical of similar fields.

3 Issues with Automation Services

At large-scale industrial plants such as oil refineries and petrochemical plants as shown in Fig. 1, an enormous number of sensors and instruments are installed to enable nonstop, year-round safe and stable operations. This involves the use of many service engineers to maintain the production process and equipment. Their tasks vary from simple routine work to dangerous and complex work which needs deep knowledge and many years of experience. For decades employees in the maintenance department of operating companies have carried out daily checks and routine maintenance in the field. As the number of skilled maintenance engineers is decreasing due to retirement and work rationalization, increasing portions of their work are out-sourced.

However, there are many cases where the plant users and service providers are not mutually satisfied with the service pricing and resulting value because the former is usually determined by man-days and hardware cost related to the work. To understand this better, JEITA's working group conducted a survey in October and November 2012 [10]. The survey comprised of 14 questions regarding service contracting clarity, service quality, service evaluation, and the impact of long product life cycles on service continuity. Each question asks how often a certain problematic situation occurs for the respondent and how it affects prioritization of service issues. The survey was conducted on ten plant users and five automation service providers in face-to-face interviews. The result shows the following five issues are more important among both plant users and service providers:

1. In case of trouble, it is sometimes difficult to determine the specific cause of the problem.
2. Many instruments and devices have been in operation more than 10 years, and it is a burden for both customers and service providers to maintain those that were obsoleted years ago.
3. It is difficult to choose the right service provider with enough capability required for the work.
4. There are miscommunications on the scope of work and the detailed work content.
5. Imported products tend to have more trouble than domestic products because of, for instance, the sales representatives' sudden end-of-support.

These issues not only obstruct the proper outsourcing of the work but also cause mistakes which may even result in serious accidents at the plant. Table 1 shows an excerpt of the survey results.

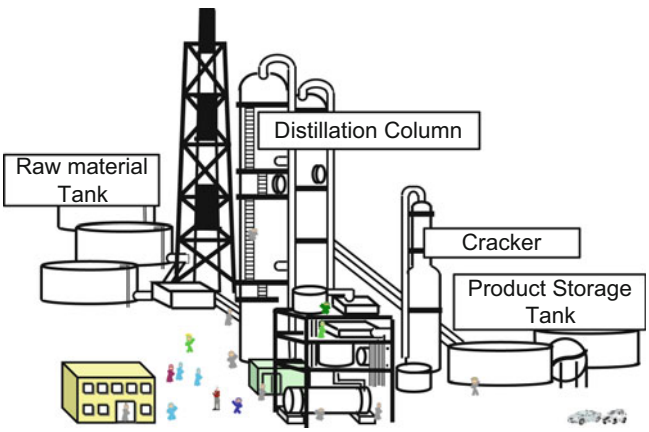


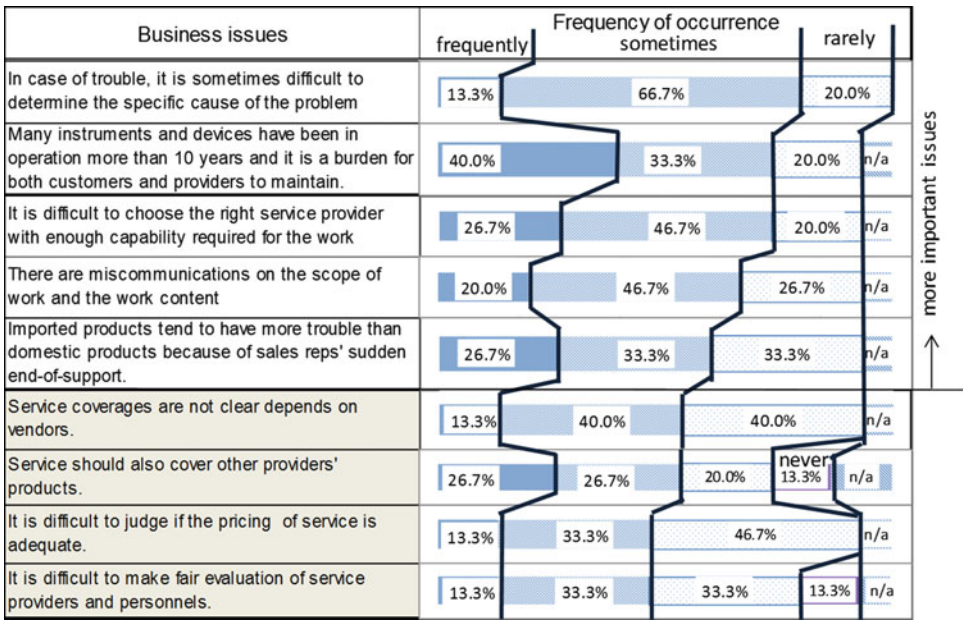
Fig. 1 Petrochemical plant

4 European Automation Service Classes

The issues raised in the previous section are common among large industrial plants worldwide, including those of Japan. Three European automation industry societies, GAMBICA in Great Britain, ZVEI in Germany, and Gimelec in France, are cooperating and acting to establish a unified service scheme called "automation service classes" to classify various types of service work in the automation industry. They defined various criteria with examples to divide automation service work into seven classes [7–9]. They aim to eliminate misunderstandings about the service content, quality, and work level between plant owners as the customer and service providers, so that a greater portion of automation service work can be out-sourced with the correct value and pricing. In their scheme, all automation service work is categorized into seven classes (Classes 0–6) according to the following three criteria:

1. Which party takes the primary responsibility for decision making, either the service provider or the customer?

Table 1 Industry service survey result (excerpt)



2. What is the target, either a product (instrument or device) or an integrated system with several products?
3. Is the work predefined, routine and repetitive, or customized for each activity?

Table 2 shows a survey of European service classes and explains the seven class definitions of the European societies showing service class names, descriptions, party with primary responsibility and the service outcome provided to the customer. The service complexity tends to increase as the class number increases, but it should be noted that the higher classes do not necessarily include lower classes.

Each class definition is basically equivalent in GAMBICA and ZVEI definitions, but there are some differences. It is notable that advising on application aspects is also included in Class 3 definitions of GAMBICA, which might indicate business practice differences between the UK and Germany. It is also notable that holistic asset management (parts management) to enable plant availability is only included in Class 6 of GAMBICA, while that of ZVEI focuses more on enterprise management level services such as management of a multidisciplinary company group relative to the process.

In addition to each service class definition, Table 3 shows the service scope of each class. Within the product-related services from Classes 0 to 3, Classes 0, 1, and 2 cover the delivered product only, whereas Class 3 covers the usage of the product including the adoption to the application environment and the interface to third-party products. In Class 4, multi-vendor products integrated as a system are the target scope of the services but do not include the production process. Therefore, following on, the main target of Class 5 is the production process, and the target of Class 6 is the complete plant operation with the combination of multiple production processes.

5 Japanese Service Classes

As many of the members of the JEITA working group belong to automation service providers, they studied their own business services and categorized them into the seven classes. While keeping the basic concept of the European Automation Service Classes, a new standard and guidelines have been made, suited for Japanese work practices.

The following three points apply to the redefinition of Japanese service classes:

(a) Japanese service classes will replicate European class definitions if those of ZVEI and GAMBICA are equivalent.
(b) Japanese service classes will make new or merged definitions if they currently exist and are different.
(c) Japanese service classes will not define their own if both European service class definitions are insufficient or missing. These will be kept open for each service provider to define.

Table 2 A survey of European automation service classes

Class	Name	Description	ZVEI and GAMBICA comparison	Prime responsibility	*Supplier* provides
0	Basic services – product related	Services directly related to a product, required to comply with statutory requirements which should be expected of any *supplier*	Equivalent	Customer	Product level
1	Standard services – product related	Predefined, standardized services directly related to a product	Software upgrade is included with ZVEI		
2	Customized services – product related	Customer-specific services adapted to the customer's environment. Services for fitting a standard product to the customer's environment	The customer provides direction to the *supplier* and retains overall responsibility with GAMBICA		
3	Application-specific services	The *supplier* provides services for adapting/configuring products to the specific application. The *supplier* assumes responsibility for the proper functioning of the application within the scope of the deliverable	In addition to the common definition, the *supplier* also advises on or verifies aspects of the application with GAMBICA		Solution level
4	System-related services	Services supplied for designing, configuring, implementing or maintaining an automation system	In addition to the common definition, system commissioning is included with GAMBICA	*Supplier*[a]	
5	Plant-related services	Services supplied for integrating an automation system into the process environment and/or the production information system of the customer	Participation in feasibility studies and budgeting is included with ZVEI		
6	Extended plant-related services	Services supplied for achieving a specified process performance for a customer's plant	Holistic asset management (parts management) to enable plant availability is included with GAMBICA		

[a]European service classes use the term "*supplier*" equivalent to "service provider" in Japanese service classes

Table 4 shows the overview of Japanese Service Classes. It elaborates important discussion points for categorizing various service works.

1. *Scope and objective of the service*
   The objective of a service is to help the customer to achieve his/her target. One of the important factors of classification by service classes is whether the delivered product and/or system functions properly or the production system and/or process function properly meets the customer's targets and satisfaction. In other words, the class is differentiated according to whether the service target (i.e., the target product, system or application of a service) is what the service provider delivered or the plant owner operates. In Classes 1, 2, and 4, the service completion is judged by the product or system providers' criteria, whereas in Classes 3, 5, and 6, the service completion is judged by the plant owners operation and work standards or criteria
2. *Primary responsibility of the service*
   Although the customer reserves the right to make the final decision, the service provider undertakes primary judgment of the work in some of their service work. In Classes 1, 2, and 4, the plant owner as the customer defines the precise service requirements. Service execution scheduling constraints depend on the plant operation, so the customer takes the main responsibility for the service and the service provider supports them. On the other hand, in Classes 3, 5, and 6, the service provider undertakes the definition of service requirements and the service execution responsibility by fully understanding the customers operations, work procedures, and constraints.

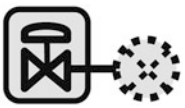
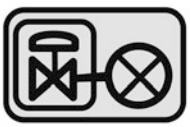
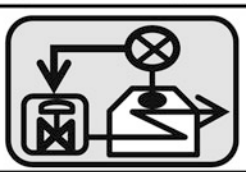
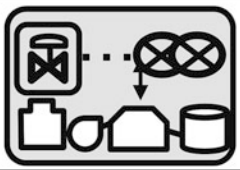
6 Example of Service Class Applications

As a practical use case for the service class scheme, Table 5 shows the comparison between a repair service and an engineering service for each class.

6.1 Repair Services

A repair service is the service to restore malfunctioning instruments and devices to a normal condition. In this case, the plant owner consigns a repair service for a product which cannot be repaired during daily maintenance work. The service contract can take several forms from a spot repair

Table 3 Service scope of each class

Class	Name	Service scope	Service type
0	Basic services – product related	 Delivered product only	Product support (Free of charge)
1	Standard services – product related		Product support
2	Customized services – product related		
3	Application-specific services	 Adaptation to a specific application including the interface to other suppliers product	Project support (Project assistance)
4	System-related services	 An automation system including other suppliers product	Project management
5	Plant-related services	 An automation system including the process environment	
6	Extended plant-related service	 A whole plant, production site	Project contract

order after the trouble to an annual plant-wide maintenance contract. A certain level of field customization could be included as part of Class 1 if it is clearly described in the service menu or contract as a differentiating advantage of the service provider. Occasionally in Class 2 field services, some field engineers customize the service at their discretion. This should theoretically be classified to Class 3.

Some service providers offer a customized package service to cover yearly maintenance including product diagnostics and repair, parts maintenance, and replacement which can be regarded as Class 2 services.

Classes 4–6 are marked as "n/a: not applicable" on this table, because an automation system is a combination of products and in these cases repair services can be regarded as a combination of lower classes.

6.2 Engineering Services

An engineering service includes various work procedures from selecting control instruments and systems to match the process design, specification and piping, and instrument definition to installation and start-up of the selected products. Front-End Engineering Design (FEED) service is the control design work including the piping and instrumentation diagram (P&ID) definition. There are also engineering services to take over the complete construction planning and test run of a plant, as well as consulting services for plant operation.

Engineering services are defined and customized for each plant; therefore, there are no Class 0 and 1 services. The service providers are required to have consulting capabilities

Table 4 Japanese automation service classes

Class	Name	Description	Customer benefit	Engineer skill	Note
0	Basic services – product related	Standard built-in service at the purchase of product including free-training, product update information, return, etc.	Customer can expect the standard warranty from the service provider including the standard return/ exchange service in case of initial problems	Sales document level	Included with product purchase
1	Standard Services – product related	Predefined, standardized services including periodic maintenance, inspection and optional service extension	Customer can easily select from a predefined service menu with clear contents and level	Service manual and product specification level	Select from menu
2	Customized services – product related	Customer-specific services adapted to the customer's environment. Services modified from the standard menu, e.g., special programming or product material selection	Customer can modify the service to fit specific requirements or constraints for using the product	Product internal design level	Scope is the target product
3	Application-specific services	Service provider provides services for adapting/ configuring products to the specific application, e.g., product sizing or anti-environment measures	Customer can expect to adapt/configure the product to the specific operating environment or purpose	Customer application and engineering knowledge	Scope is the target application
4	System-related services	System provider integrates the automation system including 3rd party products such as computers, network devices, and sensors/actuators	Customer can expect the integrated system to start and operate as expected	System integration knowledge including third-party products	Scope is the automation system
5	Plant-related services	Plant unit start-up and operations improvement or tuning performance is included	Customer can expect the specific production unit (e.g., boiler, turbine, distillation column, etc.) to operate as expected	Plant unit operation skill and knowledge	Goal is the expected operation of production unit
6	Extended plant-related services	Extended from 5, plant throughput, cost efficiency, safety index improvements are included in the service scope	Customer can expect the plant production KPI (key performance index) to be improved	Plant operation knowledge including financial and management skill	Goal is to improve the efficiency of production performance

Table 5 Comparison of service contents utilizing service class scheme

Class	Name	Repair service	Engineering service
0	Basic services – product related	Embedded warranty service upon the purchase of a product such as repair and return	n/a
1	Standard services – product related	Standard repair service after the warranty period. Usually customers uninstall and send back the product to the factory and the service provider diagnoses and repairs it. A certain level of field customization could be included as a part of Class 1 if it is clearly described in the service menu or contract	n/a
2	Customized services – product related	Customized services arranged from the above standard repair service. Some customers can have a product replaced before uninstalling the malfunctioning unit to avoid stopping production. Extending the support period after the basic warranty term expires is another example of Class 2. Occasionally, some field engineers customize the service at their discretion. This should theoretically be classified to Class 3	Predefined fixed engineering service related to a delivered product. Product customization to match the customer requirement is included, but the customer defines the customization specification for the service
3	Application-specific services	A special repair service done at the customer plant. Service contents are determined by the customer environment and requests	Services including product selection to meet the requirement of the target production process. The product installation and configuration are included to support a smooth start-up
			For example,
			Field engineer attendance at the customers site
			PLC (programmable logic controller) control application software design and implementation
			Consultation and diagnoses of the product adoption to the process
4	System-related services	n/a	Automation system design and performance evaluation based on explicit requirements made by the customer. System and application design may include some elements of Class 5 services
			For example,
			Automation system integration
			Control application design
			System performance evaluation
			Installation and deployment engineering
5	Plant-related services	n/a	Total automation system integration for a specific production process, in which the system includes computers and instruments provided by multi-vendors. Replicating engineering of an automation system to another production process
			For example,
			Plant integration test, start-up tuning
			Tuning report
			Participation in the feasibility study project, budgeting
			Basic system design work to match the plant requirement
6	Extended plant-related services	n/a	Total contract for process optimization design to improve production performance
			System upgrade planning based on the plant life cycle
			For example,
			Financing and resource allocation planning
			PFI (project finance initiative)
			ESCO (energy saving company)

in the higher classes. Class 4 system and application services may include some elements of Class 5 services when they cannot be clearly separated or the service provider decides to combine as part of their marketing strategy. The consultation service here is to investigate the current plant operation and to make proposals for control design/configuration changes to improve or optimize its production performance, improve productivity or quality index, etc.

7 Discussions

Essentially, the class definitions are consistent among three service classes of ZVEI, GAMBICA, and Japan. However, actual implementation can be differentiated to meet local business practices. In that sense, examples of services in each class are very important to unify the service class scheme in each country.

The benefits of clear definition and adoption of the "automation service classes" are as follows:

1. *Customer benefits*
   - Enable the comparison and selection of the right service products and service providers using objective criteria
   - Enable optimization of service expenditure by evaluating the service contents and completion criteria
2. *Service provider benefits*
   - Promote service value-oriented pricing (not by head count and man-days)
   - Service providers can differentiate their expertise from others by value, not price competition
3. *Customer and Service provider benefits*
   - Avoid misunderstanding and miscommunication between both parties with clear separation of responsibilities.
   - A smooth contract can be realized by sharing a common business platform.

These benefits can contribute to overcoming the issues listed in chapter "A Method for Supporting Customer Model Construction: Using a Topic Model for Public Service Design" of this paper.

The current status of "automation service classes" in Japan is still in draft form. It is being reviewed by the relevant industry experts. According to GAMBICA which published the automation service classes in the UK, the new scheme has been well accepted among some of the automation system providers, and it has been applied to their service menus. However, it is not widely accepted among the plant operators and the new scheme does not seem to be spreading. GAMBICA thinks good understanding by the plant owners is essential for the further diffusion of the new scheme. They are providing online service classification tools for the easier adoption of existing services to JEITA's working group discussed ways to diffuse the scheme with plant owners and other service providers. For the next step, a certification system for the "automation service class" providers, government guidance, and standardization should be considered.

8 Conclusion

This paper has explained a new service scheme named "automation service classes" whose goal is to realize easier and more effective out-sourced contracting of automation services at industrial plants. "Japanese Automation Service Classes" has been redefined with reference to preceding "European Automation Service Classes" cases while supplementing their differences with each other and missing definitions. The industrial plant owners are being urged to transfer expert work which used to be executed by their internal engineers. Classification is not merely subdivision or fragmentation of existing service practice but is rather a logical mapping of tacit knowledge in the field work to explicit knowledge so that the optimal management of out-sourced service is enabled while keeping the unique Japanese advantages of flexible and reasonable mindset for services. The "Automation Service Classes" is expected to contribute to overcoming the issues related to service outsourcing and realize an innovation for the industry.

Acknowledgment We are grateful to Mr. Steve Brambley, Deputy Director Industrial Automation at GAMBICA who kindly gave us the recent status of GAMBICA's "Automation Service Classes."

References

1. Robin G. Qiu: Service Science: The Foundations of Service Engineering and Management, John Wiley & Sons, Inc., July 2014
2. Editors: Paul P. Maglio, Cheryl A. Kieliszewski, James C. Spohrer, Handbook of Service Science, Springer, 2010
3. Paul P. Maglio, Jim Spohrer: A service science perspective on business model innovation, Industrial Marketing Management 42 (2013) 665–670
4. Karlos Artto, Aku Valtakoski, Heikki Kärki: Organizing for solutions: How project-based firms integrate project and service businesses, Industrial Marketing Management 45 (2015) 70–83
5. Mirja Pulkkinen, Anton Naumenko, Kari Luostarinen: Managing information security in a business network of machinery maintenance services business – Enterprise architecture as a coordination tool, The Journal of Systems and Software 80 (2007) 1607–1620
6. Haihua Zhu, James Gao, Dongbo Li, Dunbing Tang: A Web-based Product Service System for aerospace maintenance, repair and overhaul services, Computers in Industry 63 (2012) 338–348
7. ZVEI,"Services in Automation", 2004, <http://cache.automation.siemens.com/dnl/zA/zA0Mjk1NwAA_19852206_TxtObj/BRO_Services_E_31-01-05.pdf>
8. The GAMBICA GUIDE, "ASSESSMENT AND SELECTION OF AUTOMATION AND CONTROL SERVICES", 2006, <http://www.serviceclasses.co.uk/web_images/documents/GAMBICA_Service_Classes_Scheme.pdf>
9. Gimelec, "Classes de Services", 2005 <http://www.slideshare.net/Gimelec/classes-de-serviceschargeursfr120100078101e>
10. Yuki, Y., et al., 2013, Standardization of Service Classes in Industrial Automation, 2nd Serviceology Japan Conference of Society for Serviceology in Hakodate

Design of Service Ecosystem Based on Interactive Design Support in the Case of Job-Hunting Support Services

Yuki Wakisaka, Yuya Yamamoto, Jun Ota, and Tatsunori Hara

Abstract

In past research, we developed a model of service ecosystems involving customers, suppliers, and their communities. The model was constructed using general service loops constituted by the plan-do-check-act (PDCA) cycle and was used to describe service ecosystems. The goal of our research series is to construct a design methodology for service ecosystems. To this end, we need to classify service ecosystems and design a new service ecosystem. Since interactive designs are effective for a loop that indicates adaptive services in a model, we classify service ecosystems from the perspective of interactive design. We devised a new interactive design support system as a job-hunting support service. This system helps users formulate job-hunting plans.

Keywords

Service ecosystem • Open innovation • Interactive design • Job hunting

1 Introduction

1.1 Background

Growing global competition in the provision of services is a major challenge facing several countries. Chesbrough suggested open service innovation as a solution [1]. From the viewpoint of service engineering, the distinctive features of open service innovation are user and supplier participation in service design and openness in interaction among the producer, users, and suppliers. Openness means "having inflows and outflows of knowledge" [2]. Thus, our research has the following general goal: Formulating the design methodology of a service with openness for users as well as suppliers and with the participation of both stakeholders.

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1.2 Past Research

Services of the kind alluded to in Sect. 1.1 can be implemented with the cooperation of a provider, customers, and suppliers. We call such systems "service ecosystems." A framework for such ecosystems (Fig. 1) was proposed [2] and was further developed by Hara et al. [3]. Our model was composed of general service loops (Fig. 2), which we defined based on constructive approach (or synthetic method [4, 5]).

Constructive approach can be explained as, in short, "approach for understanding by construction." It is represented by the plan-do-check-act (PDCA) cycle in production management. Regarding design, "the analytical method must be used as part of the synthetic method" [5]. It means, when constructive approach is introduced, formulating (or improving) a system and analyzing it are repeated for changing specifications (goals). A general service loop involves representation in two axes, actor and action, in order to express cooperation between the stakeholders (or to apply constructive approach with an ecosystem).

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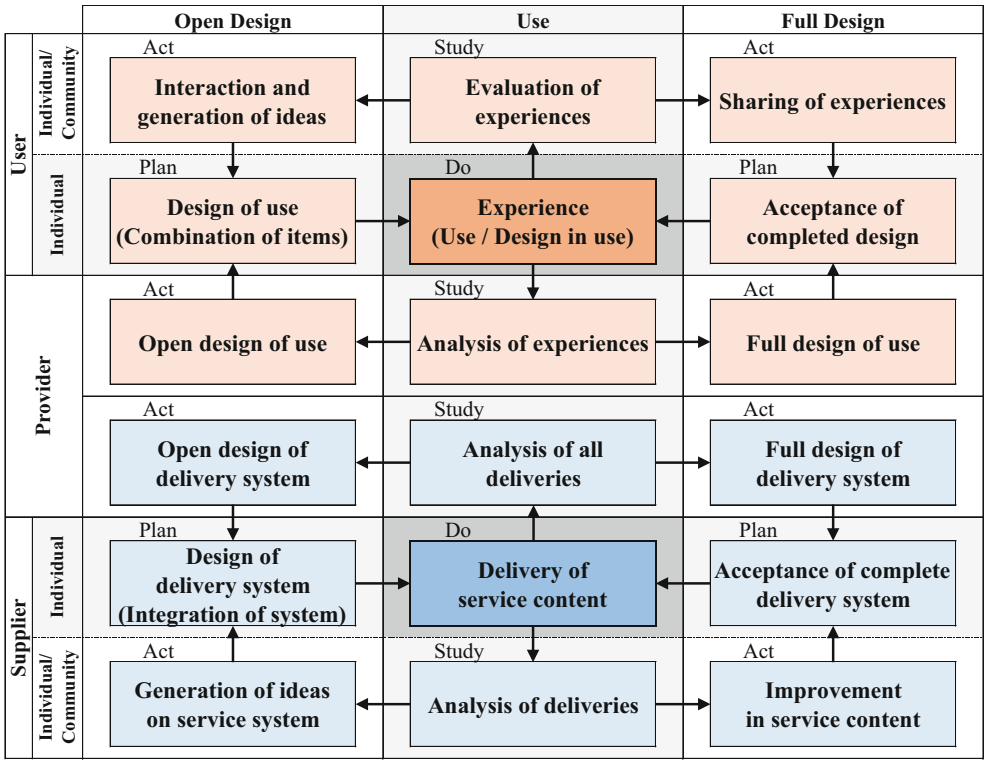

Fig. 1 The framework of service ecosystem

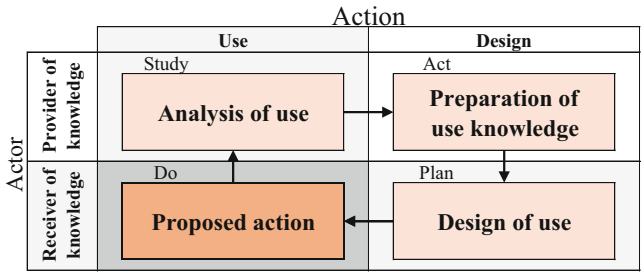

Fig. 2 General service loop

1.3 Objective in This Research

In order to develop a methodology to design service ecosystems based on our model (Fig. 1), we need to observe actual design processes and conduct inductive research.

For the purpose of observation, the center of a service ecosystem is supposed to be automatic and convenient in order to gather data regarding user preferences and behavior. Moreover, since a feature of this model is "design of use," loops in the model can be accelerated with an automatic design support system for users. We then formulate a new design support system.

The process of construction of a design support system in our research is positioned according to the "analysis-by-synthesis" approach explained in [6]. According to Ueda, "The word 'analysis' has the meaning of division methodology as well as the objective of clarification. 'Synthesis' has the meanings of integration methodology and the objective of construction. Therefore, there are four categories: analysis by analysis, analysis by synthesis, synthesis by analysis, and synthesis by synthesis."

Hence, our purpose in this research is implementing a design of service ecosystem to observe and analyze processes of actual design processes on the basis of design support as analysis by synthesis. Note that we just formulated the system, and inspection of the effectiveness and induction for the methodology of designing service ecosystem are going to begin after launching the service with this system.

2 Design Object of This Research

2.1 Operant Resource

One of the foundational premises (FPs) of service-dominant logic is that "service is the fundamental basis of exchange" [7]. This is because the "application of operant resources (knowledge and skills), 'service,' as defined in S-D (service-dominant) logic, is the basis for all exchange." Service is exchanged for service [8]. This means that if users have the requisite knowledge and skills to use a service, they can

receive sufficient value from it. The service field (such as a travel service) has a service that might substitute the user's operant resources. When one travels to another country, one might need to learn to speak a few phrases in the local language. In such a case, a book of common phrases in the relevant language would be an adequate substitute for skill. In such services, it is enough for design support system only to change users' behavior, which makes it easier to achieve users' end than otherwise.

At the same time, in some service, operant resources *cannot* be substituted by any service, depending on users' purpose in using the service in question. In case of cars, the skill to drive cannot be substituted unless automatic cars have been manufactured. In such services, users are supposed to be educated to change in attitude, that is, to getting skills or knowledge. The same claim regarding operant resources can be made in the context of a job-hunting service, which is the subject of this research. Hence, in this study, the skills that users should have are part of our proposed interactive design.

2.2 Past Research

An instance of an interactive design support system is the interactive design support system for eyeglasses frames (IDS-GF) proposed by Yanagisawa [9]. Using this system, each customer can design an eyeglasses frame suitable for him/her by repeatedly comparing six processed images of a face with different eyeglasses frame images (Fig. 3).

Another instance is the CT-Planner (Fig. 4) developed by Kurata [10]. This system can suggest a tour plan with sightseeing spots depending on a tourist's preferences. In the CT-Planner, sightseeing spots are modeled as complete graphs, and a tour plan is a node string. The planner generates the node string with the highest sum of utilities by using a genetic algorithm. A user's tour preferences are modeled using a five-dimensional unit vector. Each sightseeing spot has values corresponding to each vector. The utility of each spot is calculated as an inner product.

The CT-Planner contains a combination of other services, such as sightseeing spots, as an answer. However, not only

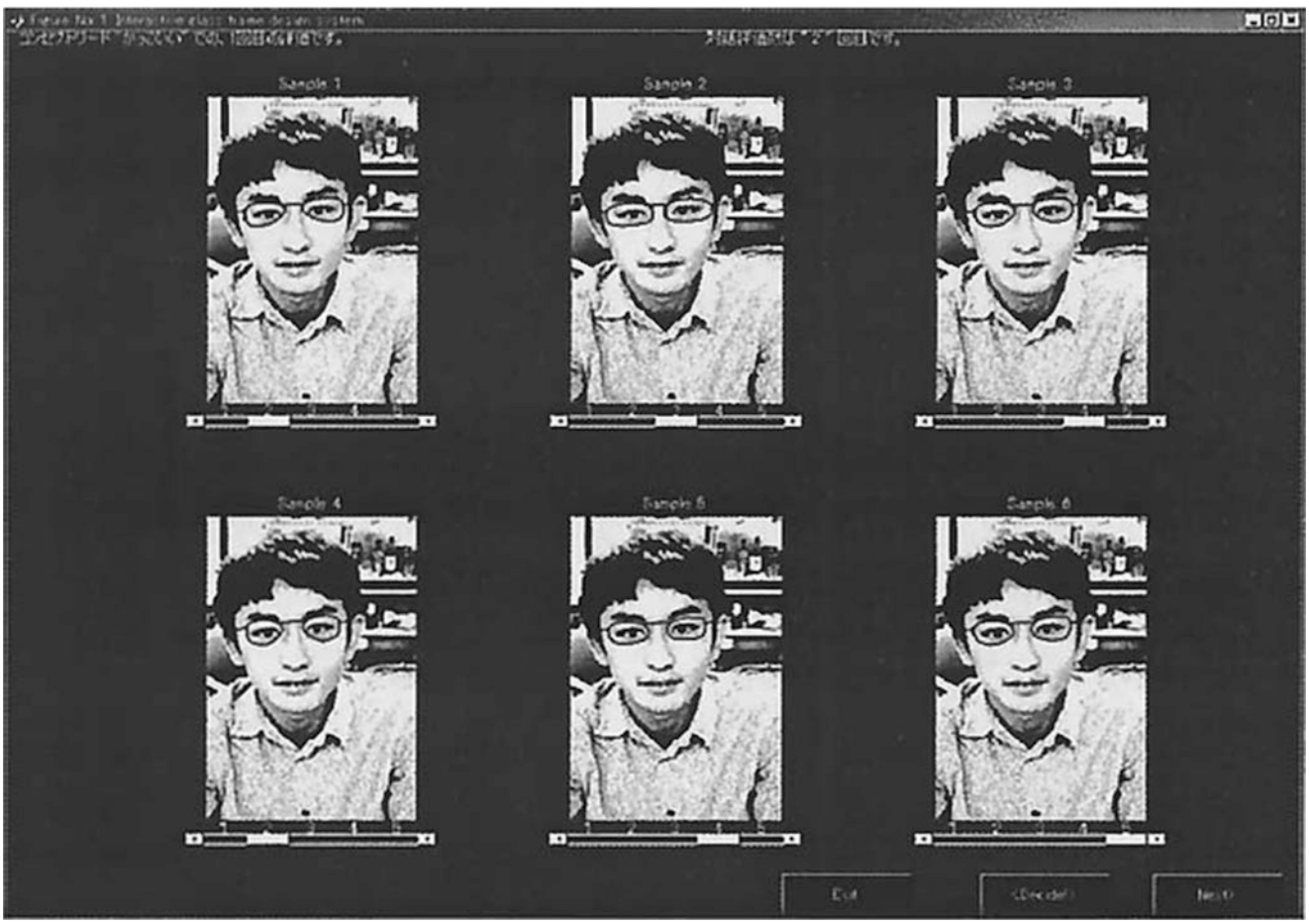

Fig. 3 Design support system for shape of eyeglasses frame [9]

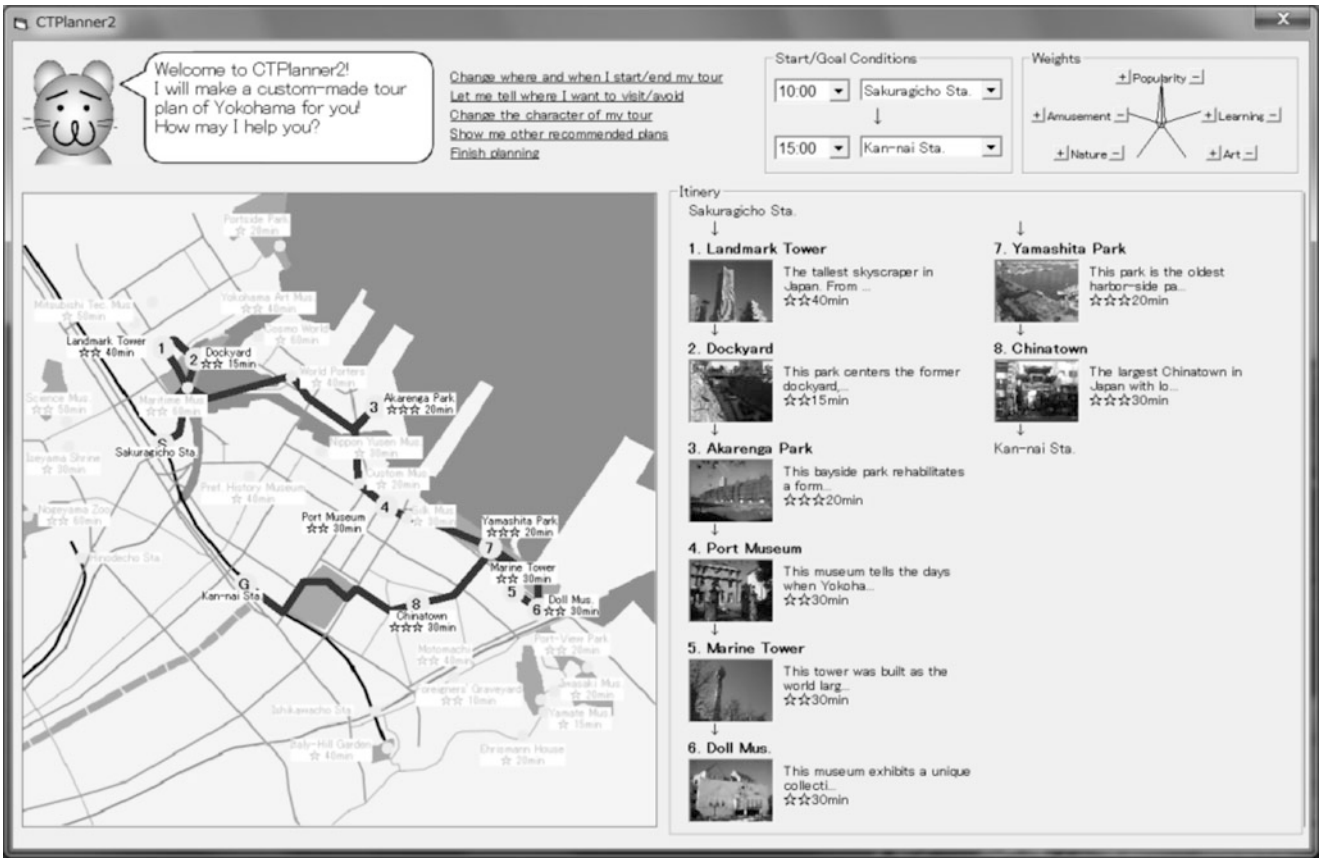

Fig. 4 The main window of CT-Planner 2 [10]

does a sightseeing service contain sightseeing spots, it also contains information regarding transportation, hotels, and so on. This suggests the CT-Planner is not intended solely as a sightseeing service. Moreover, as most operant resources can be substituted by services in the sightseeing service, the skills that users should have are not included in the subject of the CT-Planner.

2.3 Background of Job-Hunting Services in Japan

The design object of our research here is job-hunting support service for university graduates. Job hunting is a new experience for fresh graduates, because of which they might not have the operant resources required for it. In this case, a user's goal in using a job-hunting service as a service field is being offered a job by a company where he/she wants to work, where his/her purpose of using the service is to increase the likelihood of such offers.

In Japan, companies belonging to *Keidanren* (the Japanese Business Federation) start recruiting new graduates at approximately the same time (In the case, for instance, of recruiting students who graduate in March 2016, they begin seeking recruits in March 2015 and make offers in August 2015.) Start-up firms and foreign companies start even earlier. Hence, many prospective graduates begin job hunting or begin using job-hunting services, as early as 2 years before they are set to graduate, be it through internships or signing up for a relevant Web service.

When they start job hunting, few new graduates know how to go about it. Most of them register with a platform service, using which they can search for job openings at many companies and apply for them. Ever more varied types of job-hunting support services are emerging as well. "Agent services" guide new graduates by suggesting prospective employers for them or helping them analyze their own skills as well as the requirements of the companies that interest them. "Scout services" help new graduates apply for jobs. However, these services have not yet become common.

At the same time, the few know where he or she is suitable to work even by him/herself. It depends on their property, such as mind-sets, qualifications, and desire, and companies' specification, such as enterprise, salary, and culture. Agent services help new graduates to know it. As you see, however, they are not commonly known yet, and also their service productivity is still low because advisors meet new graduates face to face and one on one.

2.4 Outline of Proposed Service

Our proposed service provides new graduates, especially those who intend to immediately begin looking for jobs, with two solutions through interactive design:

- A job-hunting schedule (how to go about looking for a job)
- Attributes to improve their chances of employment: e.g., how to interview, English language skills, etc.

From the viewpoint of designing service ecosystems, user data needs to be gathered to track their behavior: information such as how each user executes his/her job-hunting plan and what percentage of these aspirants is offered jobs that they want. Such data can help improve the precision of such a service.

3 Definition and Formalization of the Issue

3.1 Job-Hunting Plan

The duration of object is 2 years, from 2 years before graduation to when students graduate. We chose a month as the unit of length of time ($0 \leq t \leq 24$). Contents (what new graduates could do) are defined by 23 nodes ($0 \leq j \leq 22$), which represent job-hunting support services, such as self-analysis, steps for the Synthetic Personality Inventory (SPI), and actions performed by new graduates on their own, such as studying abroad and gathering news. A job-hunting plan can thus be expressed as a matrix:

$$\mathrm{JP} = \{x_{jt}\} \tag{1}$$

where $x_{jt} = 1$ when the graduate starts j at t; if not, $x_{jt} = 0$.

Each node has an available action term $[a_{j\_\min}, a_{j\_\max}]$, an actual action term range p_j, and consumed energy E_j. The job-hunting plans are executed only when the following three constraints are satisfied. These constraints are referred to as the resource-constrained project scheduling problem and are as follows:

- Term constraint – Actual action terms exist in each available action term:

$$\forall j, x_{jt} = 0\left(\mathrm{t} < a_{j\_\min},\ a_{j\_\max} - p_j + 1 < \mathrm{t}\right) \tag{2}$$

- Energy constraint – At all times, the sum of the energies of ongoing nodes is not greater than the energy limit E_t:

$$\forall t, \Sigma_{j\in J} E_j \Sigma_{(\text{from s}=\max\{t-pj+1,\ aj\_\min\}\text{to }\min\{t,\ aj\_\max-pj+1\})} x_{js} \leq E_t \tag{3}$$

- Repeat constraint – Each node could be chosen fewer than two times:

$$\forall j,\ x_j = \Sigma_{t\in T} x_{jt} < 2 \tag{4}$$

3.2 Indices

Our proposed service aims to provide the same functions as human advisors:

- Proposing and deciding upon a proper job-hunting plan by interacting with new graduates
- Suggesting that new graduates obtain operant resources or alter their aims in order to improve their likelihood of employment with companies of their choice

We also need to assess each job-hunting plan using the following two indices:

- Individuality: To what extent does a job-hunting plan suit the preferences of each new graduate?
- Offer rank: How likely is each new graduate to be offered a job by the company/companies for whom he/she would like to work?

3.2.1 Individuality S_I

New graduates who use our service answer 41 questions (a total of 131 choices). Their answers are expressed as ans_i $\varepsilon\{0, 1\}$ $(0 \leq i \leq 1)$. ans $= \{ans_i\}$ is called the "preference of a new graduate." The questions are classified into three categories:

- Questions regarding knowledge: e.g., "How well do you understand each business field?," "How many times have you sought career counseling?," etc.
- Questions regarding skills or experiences: e.g., "Have you ever interned?," "Have you been positive when faced with difficulty?," etc.
- Questions regarding status: e.g., "When do you graduate?" and "What type of school will you graduate from?"

Each node contains a value corresponding to each choice val_i^j. Individuality S_i is estimated as

$$S_i = \Sigma_{j\in J} \Sigma_{i\in I}\, val_i^j * ans_i * x_j \tag{5}$$

3.2.2 Offer Rank

Offer rank is the result of the evaluation of offer probability S_N using thresholds. Offer rank is tacit of advisors. Thus, the value of S_N is determined to express it in the system. The rules to calculate S_N are defined in (6a) to (6c) and are nonlinear functions. S_N is calculated and translated into offer ranks S, A, B, C, D, and F using (7):

$$b_i = f_{ans \to \mathrm{b}}(ans_i) \tag{6a}$$

$$b_{iu,\ iv} = f_{ans \to \mathrm{b}}(ans_{iu}, ans_{iv}) \tag{6b}$$

$$b_{iu,\ iv,\ iw} = f_{ans \to \mathrm{b}}(ans_{iu}, ans_{iv}, ans_{iw}) \tag{6c}$$

$$S_N = {S_N}^b * \Pi_{i \varepsilon I} b_i * \Pi_{iu,\ iv \varepsilon I} b_{iu,\ iv} * \Pi_{iu,\ iv,\ iw \varepsilon I} b_{iu,\ iv,\ iw} \tag{7}$$

3.3 Prepared Data

The data were provided by an advisor prior to the construction of our system:

- The value of each node to is separately calculated.
- Rules and function values to calculate offer probability.
- There are a total of 24 samples of new graduates to determine the thresholds of offer ranks (pairs of **ans** and offer rank). (Contents of proposed service)

3.4 Outline

The workflow of our proposed service is shown in Fig. 5, and its outline is as follows:

(A) Showing answers for initial user input
(B) Interactive design of preferences to change (yellow)
(C) Decision regarding job-hunting plan (green)
(D) Making to-do list

In (C), by using new preferences defined in (B), the system suggests a job-hunting plan and finalizes it through interactive design.

3.5 Show Answers for Initial Input

A user (a new graduate) answers a few questions when he/she begins using the service. His/her answers (**ans**) are used as input. Using (6) and (7), the offer probability S_N is calculated from **ans**, and the offer rank is shown to the user.

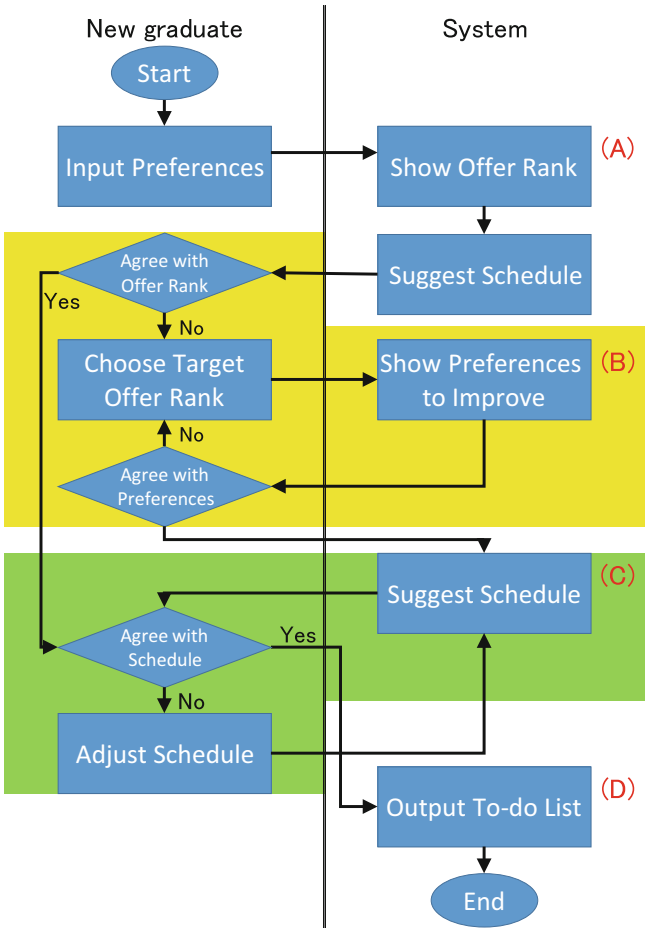

Fig. 5 Workflow of the service

At the same time, a job-hunting plan most likely to suit the user is suggested. Plans are generated using a genetic algorithm, and the one with the best individuality S_I is chosen. The display of the service is shown in Fig. 6.

3.6 Interactive Design of Preferences to Change

If the user cannot be satisfied with his/her offer rank, he/she chooses the target offer rank. The system then shows the user a preference list that he/she can update or change. The relevant interface is shown in Fig. 7.

The preference list generated based on rules applied to user responses to questions is expressed as (6a).

For instance, options as answers to the question "How confident are you with regard to interviews?" are "Very confident" ($i = 69$), "Somewhat confident" ($i = 70$), "Not very confident" ($i = 71$), and "Not at all confident" ($i = 72$). The function values b_i are defined as before:

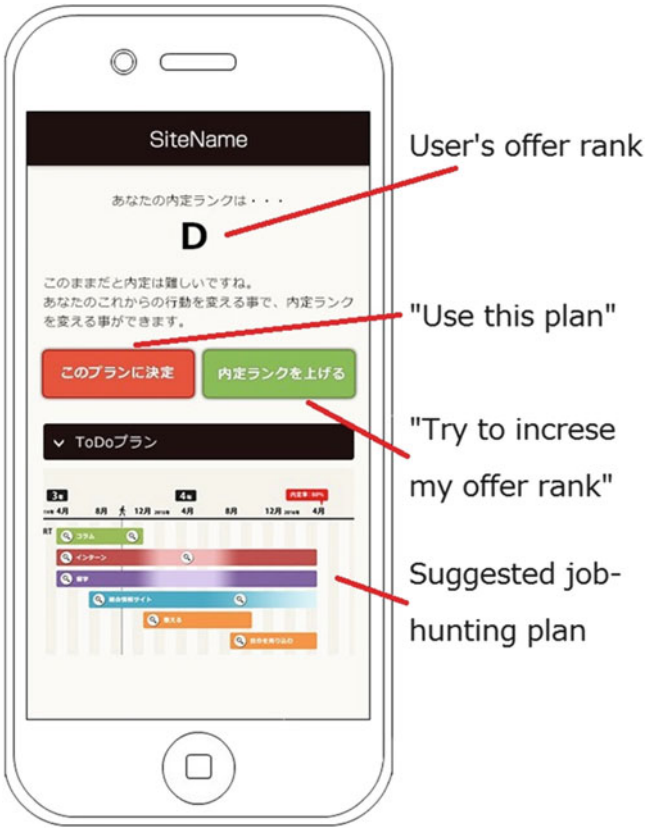

Fig. 6 Display showing answers to input

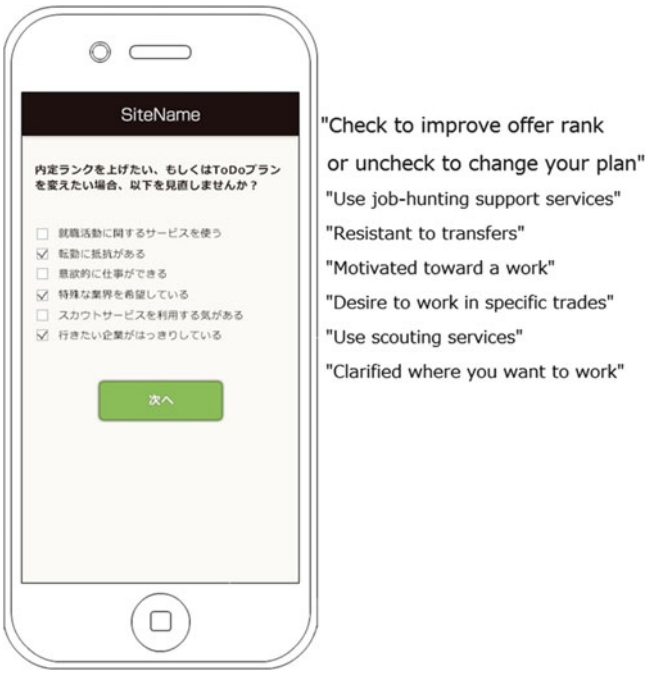

Fig. 7 Display to choose preferences

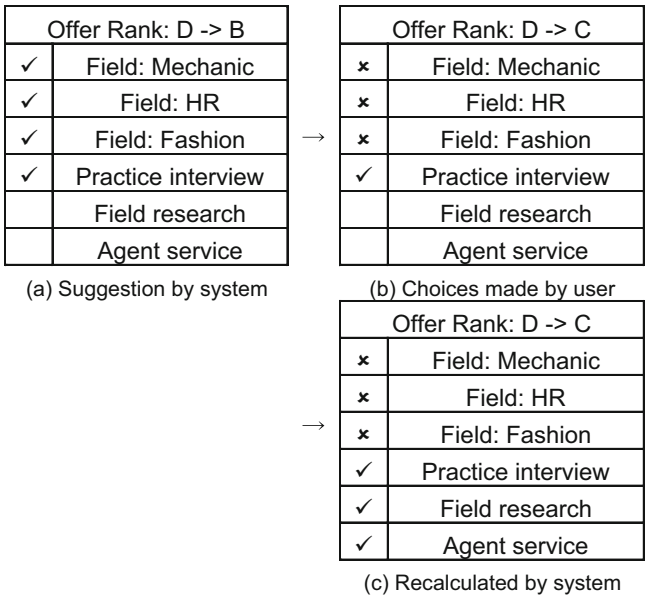

Fig. 8 Preferences that can be changed

$$b_{69} = 1.1$$
$$b_{70} = 1.05$$
$$b_{71} = 0.8$$
$$b_{72} = 0.6$$

When ans_{70}, ans_{71}, or ans_{71} is 1, "practice for interview" is listed in the preference list.

Changes in preference are checked against preferences in the list that would have the most significant effect on improving the probability of the relevant user to be offered a job of his/her interest. As a result, a preference list with some check is generated, which is shown in Fig. 8a.

The user unchecks changes in the preferences that he/she does not change or which he/she thinks are difficult to change (Fig. 8b). Following this process, the offer probability is recalculated. When the offer probability is not enough as the target offer rank, the system proposes other preference changes or suggests changes in preference that would have the next most significant positive effect on the user's likelihood to obtain a job (Fig. 8c).

The new preferences determined thorough these processes are listed in a to-do list. Graduates attempt to meet the goals outlined in their preferences by the time they conclude job hunting and hone their skills to attain their target offer rank. Self-improvement includes obtaining operant resources, skills, and knowledge, such as obtaining information regarding different fields of business. The advantageous feature of this interactive design support system from the perspective of service is not only design of job-hunting plans but also enhancement of users' self-improvement, that is, getting operant resources.

3.7 Decision Regarding Job-Hunting Plan

Following the finalization of the preferences to change as a result of (B), the system suggests a new job-hunting plan based on the new preferences. The final job-hunting plan is defined by the user through the following actions:

- Choosing nodes which he/she does/does not want to use
- Arranging action terms of each node he/she uses according to his/her actual schedule

The plan determined using these interactions is added to the to-do list.

3.8 Creating To-Do List

The changes in preferences decided in (B) and the job-hunting plan decided in (C) are added to a to-do list. New graduates fill this list and proceed to delete the goals that they have accomplished from the list.

Through this process, users' progress can be checked, and notifications can be sent to users who are falling behind the schedule of completion of objectives on the list. The display for the to-do list is shown in Fig. 9.

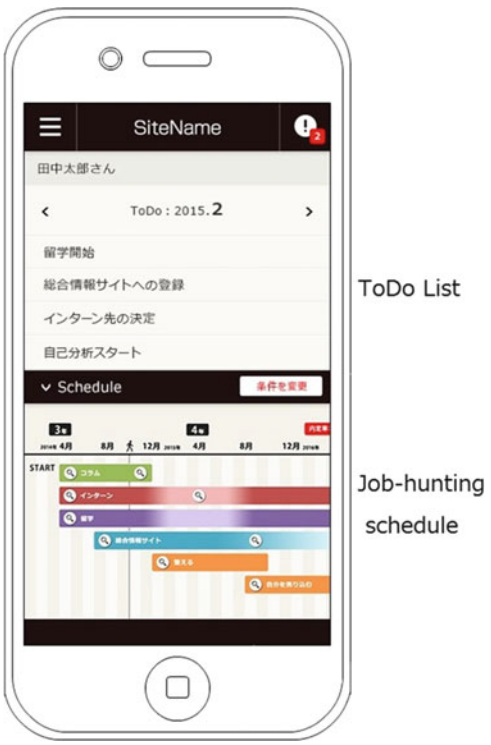

Fig. 9 To-do list and job-hunting schedule

4 Conclusion

In this paper, we proposed an interactive design support system for job hunting in order to implement a methodology for service ecosystem design. At present, the appropriateness of offer rank and the thresholds of offer probabilities can be judged according to the experience of the relevant advisors. The appropriateness of our service, including that of the offer rank, should be determined through its use. Furthermore, the precision of the thresholds, suggestions regarding preferences that can be changed, and the job-hunting plan should be improved based on data gathered during service operation.

References

1. Chesbrough, H., 2011, Open Service Innovation: Rethinking Your Business to Grow and Compete in a New Era, Jossey-Bass, Hoboken.
2. Wakisaka, Y., Okumura, Y., Shimada, S., Ogata, T., Ota, J., Hara, T., 2014, A framework of service grand-design for open services innovation (in Japanese), Domestic Conference of Society for Serviceology, Hakodate, Hokkaido, Japan, 28–29 April: 40–43.
3. Hara, T., Shimada, S., Arai, T., 2013, Design-of-use and design-in-use by customers in differentiating value creation, CIRP Annals–Manufacturing Technology, 62: 103–106.
4. Jovane, F., Yoshikawa, H., Alting, L., Boër, C. R., Westkamper, E., Williams, D., Tseng, M., Seliger, G., Paci, A. M., 2008, The incoming global technological and industrial revolution towards competitive sustainable manufacturing, CIRP Annals-Manufacturing Technology, 57; 641–659.
5. Nakashima, H., 2008, Methodology and a discipline for synthetic research – What is Synthesiology? -, Synthesiology, 1: 305–313.
6. Ueda, K., 2012, Letter from the editor, Synthesiology, 4: 193.
7. Vargo, S. L., Maglio, P. P., Akaka, M. A., 2008, On value and value co-creation: A service systems and service logic perspective, European Management Journal, 26: 145–152.
8. Vargo, S. L., Lusch, R. F., 2008, Service-dominant logic: continuing the evolution, Journal of Academy of Marketing Science, 36: 1–10.
9. Yanagisawa, H., Fukuda, S., 2004, Development of Interactive Industrial Design Support System Considering Customer's Evaluation (Shape Design of Eyeglass Frame), JSME International Journal Series C Mechanical Systems, Machine Elements and Manufacturing, 47: 762–769.
10. Kurata, Y., 2011, CT-Planner2: More Flexible and Interactive Assistance for Day Tour Planning, ENTER 2011, Information and Communication Technologies in Tourism 2011, Innsbruck, Austria, 26–28 January: 25–37

A Method for Supporting Customer Model Construction: Using a Topic Model for Public Service Design

Satoshi Mizoguchi, Takatoshi Ishii, Yutaro Nemoto, Maiko Kaneda, Atsuko Bando, Toshiyuki Nakamura, and Yoshiki Shimomura

Abstract

For the design of public services, it is important to clarify service customers. For this purpose, various methods of customer modeling were proposed. Before constructing customer models, it is required to group customers and to characterize each customer group. However, the customer grouping based on some statistical barometers (e.g. age, sex, and job categories) may not reflect actual customer requirements for the service. This paper aims to propose a method for supporting customer grouping and characterizing without such statistical barometers. Finally, the proposed method is applied to an urban development case to demonstrate the effectiveness.

Keywords

Public service design • User modeling • Natural language processing • Latent Dirichlet allocation

1 Introduction

Recently, services have been attracting much attention from both academic and industrial sides. In general, public service design involves various customers who have different requirements for the service. For example, in a regional environment improvement project, some customers want to enhance the safety of their children, and other customers want to widen the road to solve traffic jam. Thus, in order to realize high value in public service, designers need to accommodate various customer requirements

To analyze requirements for public services, it is important to clarify various customers. For this purpose, there are a lot of customer modeling methods (e.g., persona method [1], Delphi method [2], and conjoint analysis [3]). In particular, persona method [1] is often used for the design of public services. Watanabe et al. construct stakeholder models for the next generation of agriculture by using persona method [4]. By sharing personas of the stakeholders, they designed social services which can solve local problems.

Before creating personas, it is usually required to generate customer clusters and characterize each cluster. For the customer clustering, existing methods generally use statistical barometers which can be easily acquired (e.g., age, sex, and job categories). However, the customer clustering based on such statistical barometers does not necessarily reflect their requirements for the service. Customer clusters should be constructed based on the similarity of customers' requirements. For example, there are two customers who are both 35 years old, female and homemaker. One customer has a baby and wants to remove bicycle parking on a road for pushing her baby carriage. The other customer has a 5-year-old child and wants to park bicycle on a road for going a children's garden by bicycle. If the statistic barometers are only used to cluster these two customers, they may be classified into same cluster even though

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they have the opposite requirements concerning bicycle parking

To solve this problem, this paper proposes a method for supporting customer clustering and characterizing without such statistical barometers. The proposed method aims to cluster customers by using free description concerning customer requirements. In this paper, to demonstrate the usability of the method, we show an application to an urban development case.

2 Literature Review

In order to clarify issues in customer modeling, this chapter summarizes a review on existing methods for customer model construction.

2.1 Persona Method

Cooper proposed persona method in which customers are modeled as "persona" [1]. The "persona" is a fictional character that is described by some barometers such as statistical barometers (e.g., age, sex, and job categories) and scenarios customer are using (e.g., what customer uses, what product the customer uses, when the customer uses it, how the customer uses it). The persona is useful for clarifying and sharing images of customer and is used in both product and service design.

2.2 User Modeling Based on ID-POS

Motomura proposed a user modeling method based on ID-POS data [5]. This method estimates customer categories from purchase behaviors. For example, some people who often buy a high-price beer are characterized as high-end customers, and other people who buy a low-malt beer are characterized as a budget-minded customer. These customer categories indirectly appear on statistical data (ID-POS data). For estimating the customer categories, this method employs a topic model. Topic models estimate "topics" (theme or subject) of documents from the words that frequently appear in the documents. By using a topic model, this method estimates user category from the purchase log: how many times and what items the user purchases. In similar way, this method also estimates product category. From these results, this method estimates customer purchase behaviors by using Bayesian network [6]. The analysis results by using the method reveal "what product category does a customer often buy?" and "what customer category is a product probably bought by?"

2.3 Topic Analysis of Web User Behavior on Proxy Logs

Fujimoto et al. proposed a topic model for web user profiling and clustering [7]. This method estimates the abstract purpose (abstracted user intentions or tasks) of web page access. For example, people who access a site about hotel have an abstract purpose, they want to seek hotel costs, and people who access a site about a local city have an abstract purpose, they want to get information of the local city. These abstract purposes of web access indirectly appear on statistical data (web access log data). This method employs a topic model by regarding a user's web access log as a document and a web address as a word. By using this method, the authors found out 24 abstract purposes of web access from the data obtained from students in Osaka University. A part of the abstract purposes is as follows: "YouTube user," "Wikipedia user," "job hunter," "programming," and "how to make a report."

2.4 Scope of This Study

For the design of public services, it is important to cluster customers for requirement analysis. The cluster should be constructed based on customer requirements (or its similarity). However, customer clustering based on only statistical barometers (e.g., "persona method" [1]) probably does not reflect customer requirements, because it is difficult to find what barometers point out difference of customer requirements.

In addition, there are some methods that estimates the barometer that point out difference of customer requirements (e.g., Motomura [5] and Fujimoto [7]). However, these methods require a large quantity of operating data (e.g., ID-POS or web access log). Thus, it is difficult to apply these methods to the analysis for some cases such as new public service design. Additionally, it is difficult to apply these methods for public service, because of the following two reasons:

1. Owing to a variety of customers, observing data of public service requires huge costs.
2. It is hard to know what data is related to various requirements.

To solve these problems, this paper proposes a method for requirement analysis without using the statistical barometers.

3 Proposed Method

This chapter introduces the proposed method. The proposed method supports service designers to clarify customers by providing the requirement similarity of each customer. The method calculates the requirement similarity from free descriptions about customers' requirements. For calculating the similarity, we employ latent Dirichlet allocation (LDA) that is a method for analyzing natural language.

3.1 Latent Dirichlet Allocation

There are some topic models: latent semantic analysis (LSA) [8], probabilistic LSA (pLSA) [9], latent Dirichlet allocation (LDA) [10], and more. From these topic models, this study employs LDA for estimating customer requirements. LDA assumes and models that the document includes some abstract "topics" that are subject of documents. LDA estimates topic of each word from bias of word frequency in the documents. By aggregating the topics of words in the document, LDA estimates the topic allocation of each document.

For example, there is an example document: "when I went to a local city for a business trip, I want to go to the local tourist attraction and eat a local food." In this example, the result of LDA indicates that the word "tourist attraction" has a topic of "sightseer" and the other word "business" has a topic of "salesman." Thus, this document has two main topics: "sightseer" and "salesman."

LDA assumes that each document has multiple topics. On the other hand, LSA and pLSA assume that the document consist of one abstract topic. Thus, the assumption of LDA is fitter actual document and has better accuracy than LSA and pLSA.

In our study, we assume that free descriptions concerning customer requirements include some topics of requirement. For example, for analyzing city users, a description written by an office worker from other city will include two types of requirement "as a sightseer" and "as a salesman." LDA is able to model such case that various topics are included in a document. Therefore, in this study, LDA is employed for estimating topics of customer requirement.

3.2 A Method for Supporting Customer Model Construction

An overview of the proposed method is shown in Fig. 1.

This method assumes that free descriptions concerning customer requirement have several topics that may be represented as customer's lifestyle (e.g., as a sightseer and/or as a salesman). By using LDA, the proposed method estimates the topics of requirement from the free descriptions. The questionnaire for customers can be used as these descriptions. Then, this method clusters the questionnaires based on estimated topics (and this clustering result is represented as customer clustering). Moreover, this method characterizes customer clusters based on estimated topics. Thus, our method is expected to cluster the customers based on customer requirements.

This method includes four steps;

Step1: *Obtain data about customer requirements*
In Step1, data about customer requirement are obtained. To be more precise, this method requires free descriptions from each customer. One way in getting those data is conducting survey by giving out questionnaires to actual customers. In this case, items in the questionnaire are needed to elicit customer requirements, for example, "what is the important point in the service use?" "why do you emphasize this point?" and so on. In the following steps, a customer is represented by the information obtained in the questionnaire.

Step2: *Estimate topics and a topic allocation of each document*
Step2 estimates topics and a topic rate of each document. In this step, it applies LDA analysis to the free description data obtained in Step1. LDA outputs estimated topic allocation (rate) of each document and representative words of each topic.

Step3: *Cluster customers based on topic rate*
Step3 classifies the free descriptions (i.e., the customers) based on topic rates estimated in Step2. This method regards this classification result as clusters of the customers.

Step4: *Construct customer models based on these results*
In Step4, customer models are constructed based on results of Step2 and Step3. To be more precise, each cluster is characterized based on the representative words for each topic estimated in Step2. For example, if a customer cluster has a topic that includes "business trip," "work," "convenience," and "drink" as representative words, this cluster can be characterized as a "salesman" cluster.

This method is expected to cluster the customer based on customer requirements and to support the analysis of customer requirements. The advantage of our method is able to apply for some cases such as public service design. The advantage of this method is that the free description data is easier to obtain than the operating data.

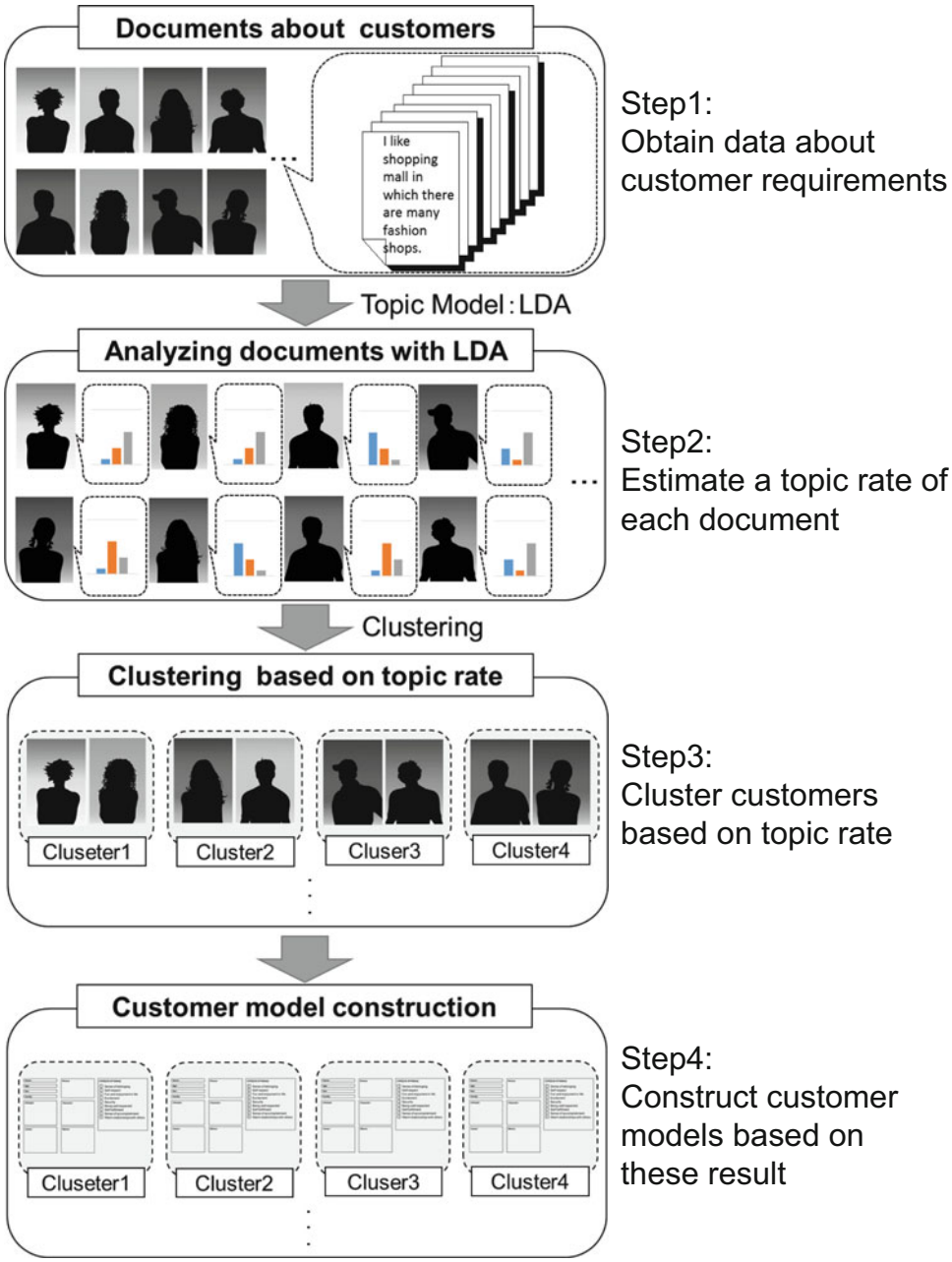

Fig. 1 Overview of the proposed method

4 Application

For checking the advantage of the proposed method, this chapter shows an application result. In this application, the proposed method was applied to an urban development case which can be regarded as a public service design.

4.1 Application to Urban Development

This case is about the development of Tenjin area, a downtown in Fukuoka, Japan. In Tenjin, there are various customers who have different requirements. Therefore, we tried to cluster the customers based on their requirements by using the proposed method.

First, in order to get data about customer requirements for Tenjin, we conducted a survey by giving out questionnaire to actual customers. In the questionnaire, the customers described free descriptions about their requirements. For instance, the customers described their requirements for Tenjin by answering the following questions: "what is an appeal of Tenjin area?" "what should be improved in Tenjin area?" and so on. In addition, we asked customers about their sense of values (e.g.. "what is important for you and why?" "what media you usually use and why you use this?"). We

got those data form web-questionnaire survey. The number of answers was 1122. The total number of words was 360,343, and the average number of words in a document was 321 (a standard deviation was 315).

From the analysis by using the proposed method, 25 topics were found out from the documents obtained in the questionnaire. Table 1 shows a part of result in Step2 that lists the representative five words of five topics (translated to English).

For example, Table 1 shows that the descriptions in Topic2 included the words, e.g., "eat," "restaurant," and "delicious," more frequently than the other topics. From these words, Topic2 could be explained as a topic about "gourmet." The meanings of each topic are used to characterize clusters in this study. Figure 2 shows a part of the result of clustering. In this case, the proposed method classified the documents (i.e., the customers) to 13 clusters by k-means clustering [11]. Figure 2 shows the average topic rate for each cluster.

For example, Cluster11 had approximately 20 % of Topic2 "gourmet," and this rate is larger than other clusters. Thus, this result shows that the customers in cluster11 are interested in "gourmet" and/or have requirements related to "gourmet." In this application, the proposed method could characterize each cluster based on the topic rate of each cluster and the meaning of each topic.

Table 1 The representative seven words of five topics

Topic0	Topic1	Topic2	Topic3	Topic4
Baseball	Parking	Eat	Shop	Bus
Sport	Place	Restaurant	Crowd	Get on
Relay	Car	Delicious	Friend	Traffic
Soccer	Fee	Ramen	Associate	Subway
Spectate	Go	Much	Tenzin	Convenience
Fan	Traffic jam	Cook	Shopping	Hakata
Pro	High	Stall	Go	Station

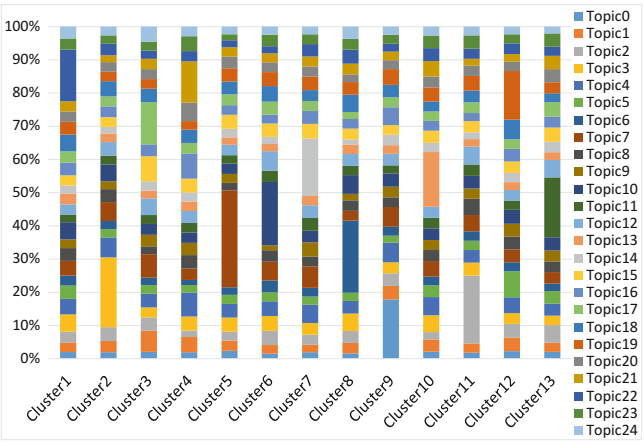

Fig. 2 Topic rates of each cluster

4.2 Cluster Validation

For validating the result of the application, we carried out depth interview to some actual customers who answered the questionnaire. In this result, we focused attention to list of value (LOV) [12] of the customers. LOV represents the importance of interpersonal relations, as well as personal factors, and a personal factor in value fulfillment. We assumed that customers who have similar LOV have similar requirements. Thus, in this validation, LOVs of each customer (#1~#12 in Table 2) were compared.

First, we selected 4 clusters from estimated 13 clusters: Cluster2, Cluster7, Cluster8, and Cluster13. Then, we got interviews for three customers from each four clusters. The selected customers had wide distribution of statistical barometers as shown in Table 2.

Table 2 also shows LOV of each customer, which is selected by each customer in the interview. As shown in Table 2, the customers in the same cluster had similar LOV regardless of the statistical barometers. For example, the customers in Cluster2 (i.e., customers #1, #2, and #3) have similar LOV (i.e., self-respect, fun and enjoyment in life, security, and warm relationships with others). In these results, the proposed method possibly clustered customers who emphasize similar LOV.

However, in Cluster13 shown in Table 2, #11's LOV is different to the LOV of other customers (especially of #12) in Cluster13. Customer #11 has the following LOV: sense of belongingness, fun and enjoyment in life, and security. However, #12 has the following LOV: being well respected, sense of fulfillment, and sense of accomplishment. From the depth interview, it could be understood that the customers in Cluster13 want to develop their ability. The ultimate goal of #11 was different from the ultimate goal of #10 and #12. Customers #10 and #12 want to get the accomplishment by developing their ability. On the other hand, #11 wants to contribute to belonging society by developing their ability. In Cluster13, the customers had common values similar to other clusters. However, there are some cases that the common values cannot be described on LOV [12].

4.3 Discussion

In Sect. 4.1, the proposed method clustered customers from the free descriptions for customer requirement. The free description is more easily to obtain than the operating data. Therefore, this method can be used in the case of such as public service design.

Table 2 LOV of each customer

Characteristics		Cluster2			Cluster7			Cluster8			Cluster13		
		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12
Statistical barometers	Age	35	63	29	46	62	64	36	50	46	23	35	29
	Sex	F	F	M	M	F	F	F	M	F	F	M	M
	Job	Part-time job	Homemakers	Un employed	Office worker	Part-time job	Homemaker	Part-time job	Office worker	Homemaker	Un employed	Office worker	Office worker
LOV													
Sense of belongingness												✓	
Self-respect		✓	✓	✓	✓			✓	✓				
Fun and enjoyment in life			✓	✓	✓		✓					✓	
Excitement						✓							
Security		✓		✓		✓	✓	✓		✓	✓	✓	
Being well respected											✓		✓
Sense of fulfillment									✓	✓			✓
Sense of accomplishment											✓		✓
Warm relationships with others		✓	✓		✓	✓	✓	✓	✓	✓			

In Sect. 4.2, the customers in the same clusters had similar LOV and requirement regardless of the statistical barometers. Therefore, this proposed method is expected to cluster customers based on customer requirements without statistical barometers.

However, this application is insufficient to verify that the proposed method clustered all customers based on their requirements, because of the number of customers who are targeted in the depth interview. Therefore, we need to analyze another data. In addition, in order to cluster customers based on their abstracted requirements, we need to clarify what abstracted level of customer requirements is.

5 Conclusion

To cluster customers based on customer requirements for public service design, this paper proposed a method for clustering and characterizing customers without statistical barometers. To achieve this, the method applies LDA for calculating the requirement similarity. To demonstrate the advantage of the proposed method, an application to an urban development case was conducted. The result of this application showed that the proposed method was expected to support to construct customer models which reflect requirements of each customer. Future works should include clarifying the suitable abstracted level of customer clustering for public service design and developing a method to utilize a classification result for public service design.

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References

1. A. Cooper, 1999, "The Inmates are Running the Asylum", Sams.
2. Norman C. Dalkey and Olaf Helmer, 1963, "An Experimental Application of the Delphi Method, to the Use of Experts, Management Science", Vol. 9, No. 3, April
3. Paul E. Green and V. Srinivasan,1978, "Conjoint Analysis in consumer research: Issues and outlook", journal of Consumer Research, vol 5, September 1978, pp 103–123
4. S. Watanabe, N. Sashida, A. Nakamura, T. Ugai, K. Ishigaki, 2011, "Atrial application study of persona method to the cooperative social design by the people living in a region: in case of Suzaka City of Nagano Prefecture", The Japan of the Regional Science Association International (JSRSAI), CD-ROM, 48th, in Japanese
5. Y. Motomura, 2011, "User modeling in Service Engineering", The Institute of Electronics, Information and Communication Engineers, Vol. 94, No. 9, pp. 783–787, in Japanese
6. J. Pearl, 1985, "Bayesian Networks: A Model of Self-Activated Memory for Evidential Reasoning", the 7th Conference of Cognitive Science Society, 329–334
7. H. Fukimoto, M. Etoh, A. Kinno, Y. Akinaga, 2011, "Topic Analysis of web User Behavior Using LDA Model on Proxy Logs", Advances in Knowledge Discovery and Data Mining Lecture Notes in Computer Science Volume 6634, pp 525–536
8. S. Deerwester, S. Dumais, Y. Landauer, G. Furnas, and R. Harshuman, 1990, "Indexing by latent sematic analysis", Journal of the American Society of Information Science, vol. 41(6), pp. 391-407
9. T. Hofmann, 1999, "Probabilistic latent semantic indexing", SIGIR '99 Proceedings of the 22nd annual international ACM SIGIR conference on Research and development in information retrieval, pp. 50-57
10. D. M. Blei, Andrew Ng, and Michael Jordan, 2003, "Latent Dirichlet Allocation", Journal of Machine Learning Research, 3-993-1022
11. J. MacQueen, 1967, "Some Methods for Classification and Analysis of Multivariate Observations", Proceedings of 5th Berkeley Symposium on Mathematical Statistics and Probability 1, University of California Press, pp. 291–297
12. L. R. Kahle, 1983, "Social Values and Social Change: Adaptation to Life in America", Praeger

A Proposal of the Emotion Hierarchy Diagram for Designing the Service Processes

Nanami Shimazaki, Yasuharu Nishi, and Michiko Tsubaki

Abstract

This paper proposes a method to design emotion-based service processes by decomposing highly abstract emotions into detailed emotions. First, we propose an Emotion Hierarchy Diagram (EHD) to decompose abstract emotions into detailed emotions and organize them for identifying and designing specific service processes. The identification steps for creating EHDs are listed. Further, we propose how to use the EHD for deriving service elements. Further, this study verifies whether the proposed EHD can derive service elements for high-quality emotions. We examine where individual differences appear in the EHD, and we find that these differences appear in the axes. Additionally, using statistical tests, we verify whether the service elements for high quality were listed when the EHDs are drawn in both cases, i.e., when the axes were fixed and when they were not.

Keywords

Service element • Quality of service • Customer's emotion • Hierarchization model • Detailed emotion

1 Introduction

The tertiary industry currently accounts for 70 % of Japan's gross domestic product (GDP). According to Reichheld [1], customers who receive highly valuable services will generate more profits through subsequent visits and positive word of mouth, while customers who receive poor service will do harm with negative word of mouth and by discouraging other potential customers. Therefore, it is necessary to study the process designs for highly valuable services.

Service delivers two types of quality: functional quality and emotional quality. A well-designed service can provide a cup of coffee in just a short time, which represents functional quality, while it can provide the emotions of "relaxation" or "excitement," which represent emotional quality. The research focusing on emotional quality has not advanced much, while the research focusing on improving functional service is quite extensive [2]. For example, although there are some service frameworks such as the service profit chain [3] or the service marketing triangle [4], there is little discussion about how these frameworks can be used for improving emotional quality.

A few prior studies examined emotional quality in the context of services. Parasuraman et al. (1998) proposed a SERVQUAL method to evaluate the quality of service [5] using five criteria: reliability, assurance, tangibles, empathy, and responsiveness. Emotional quality is implicitly included in the survey questions. The SERVQUAL method is not always reliable since the evaluation results of a specific service will be relatively lower because the criteria for the questions are derived from the evaluation of a generic service. Customer journey [6] is a method for visualizing a service process by focusing on the emotion experienced by customers during the service. However, it is difficult to use the customer journey method to improve

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an emotion that is not yet experienced in the context of a particular service.

Next, we discuss the prior research on emotions in the psychology stream. Plutchik [7] proposed a three-dimensional circumplex model in which all emotions can be represented using eight basic emotions and their combinations. Higuchi [8] proposed a psychological model in which an emotion can be constructed with combinations of other emotions using factor analysis.

These models cannot decompose abstract emotions into detailed emotions because the emotions represented in the models are highly abstract and ambiguous. A highly abstract and ambiguous emotion could be associated with several detailed and inconsistent emotions. If a service is designed based on highly abstract emotions, it will deliver several detailed and inconsistent emotional services simultaneously; i.e., it will deliver service with low emotional quality.

For example, consider a café owner who has a service policy that the café will be based on a particular emotion, "excitement." This policy will lead to a confused service process in the café because the emotion "excitement" is too abstract to allow for the design of a specific service process.

Decomposing an abstract emotion into detailed emotions and designing service processes based on the detailed emotions with a focus on emotional quality are significant because there is very little prior research on emotional quality. Moreover, abstract emotions cannot be used to design service processes even if the service provider focuses on emotional quality.

This study proposes an Emotion Hierarchy Diagram (EHD) to decompose abstract emotions into detailed emotions and to choose one or more emotions from among them to determine specific service elements for designing a service process with high emotional quality.

The scope of this study is as follows.

The service classification scheme [9] classifies service products into 2 × 2 categories based on (1) the direct recipient of the service and (2) the nature of the act. The direct recipient of a service is classified into persons and things. The nature of the act is classified into tangible actions and intangible actions. The service classification scheme does not specify whether the service provider is a person or a machine. The scope of this study is limited to the context where the direct recipient of the service is a person, the nature of the act is a tangible action, and the service provider is a person.

2 Proposal of an Emotion Hierarchy Diagram

Ueda and Hoshino [10] show that an increase in the number of loyal customers makes the service more profitable when a store constructs a system to remind customers of "hope" hidden in the customer's unconscious depth psychology. In this study, "hope" is paraphrased as "excitement," and this study proposes a tool called the Emotion Hierarchy Diagram (EHD) for deriving a service element using a sample of applications based on "excitement."

There are two assumptions in the EHD:

Assumption 1: An emotion has a certain level of abstraction.
Assumption 2: The type of abstraction of emotions used is not a "has-a" type (composition or constituent) but an "is-a" type (inheritance or sub-typing), similar to the approach in object-oriented programming.

The components of the EHD are "top emotion," "detailed emotion," "branching line (for combinations)," and "axis." The top emotion is the most abstract emotion. Detailed emotions are decomposed along the axis. Detailed emotions have hierarchical relations. The emotion in the upper layer is a parent emotion, and that in the lower layer is a child emotion. This relation is relative. The branching line decomposes an abstract emotion into detailed emotions. The axis specifies the condition for decomposing the emotions. Figure 1 shows the components and notations of the EHD.

While drawing an EHD, options for the axis are required. This study refers to the "global structure of emotion types" proposed by Ortony et al. [11] for these options. Table 1 presents the options for the axis.

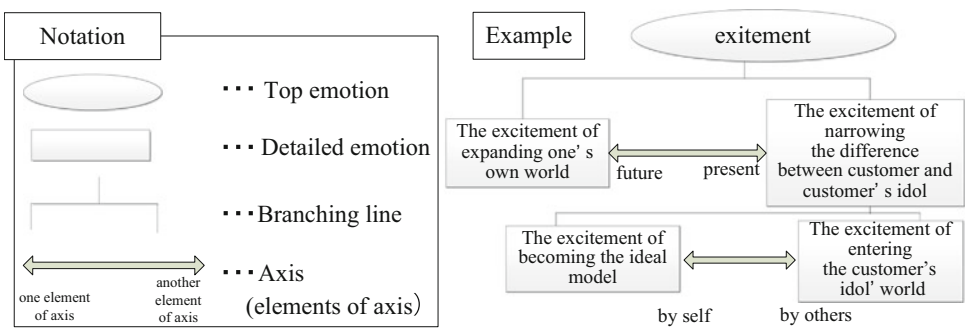

Fig. 1 Components and notations of an emotion hierarchy diagram

Table 1 Options for the axis in an EHD

Name of axis	Elements		
Time	Present	Future	Past
Accomplishment	By self	By others	
Cognition	Unknown	Known	
Gusto	Pleasure	Displeasure	
Who	Self	Others	
Charm	Attractive	Unattractive	

Figure 2 shows an EHD for "excitement." To draw the EHD, this study chose 330 articles at random from the 1,876 articles obtained as search results when the keyword "excitement" was used in the Nikkei BP database [12] on 1 November 2014.

Figure 2 classifies the excitement expressed in the 330 articles along three axes (*time*, *accomplishment*, and *cognition*). First, the *time* axis is used for decomposing "excitement" in Fig. 2. This study refers to the dictionary definition of "excitement" for deciding the axis in the first layer. Sanseido's Daily Concise Dictionary [13] defines "excitement" as "to make someone restless with pleasure or anticipation." We apply this meaning when we examine the axes in Table 1. The axes that can decompose joy and expectation are *time, accomplishment,* and *cognition*. We consider *time* to be the best axis for decomposing "pleasure" and "anticipation" because we consider pleasure to be a current emotion (in the present) and anticipation to be a future emotion. We choose "present" and "future" as elements of the axis because excitements in the past are thought to be recollections of past excitements (in one's mind). Since the real experience of excitement is important, not the recollections of past experiences, this study does not select "past" as an element of the time axis. Next, we choose a suitable axis for the child emotions. In this study, both the axes in the second layer are *accomplishment*. The emotion in the second layer of the present side decomposed by the *time* axis cannot be decomposed to further detailed emotions; the emotion in the future side decomposed by the *time* axis is decomposed to the second layer by *accomplishment* and to the third layer by *accomplishment* and *cognition*.

The EHD can be used to derive service elements via the *following steps:*

1. Decide an emotion that a service wants to build or stimulate.
2. Draw the EHD by examining this emotion using axes.
3. Choose the detailed emotions that a service wants to build or stimulate.
4. Derive the service elements from the detailed emotions.

3 Validation

This study conducts two types of verification.

Validation 1 determines where individual differences appear in the EHD because there may be individual differences in emotions. The verification is based on the assumption that individual differences appear in the axes if the variability of the detailed emotions when the axes are fixed is small and the variability when the axes are not fixed is large.

Procedure

1. The variability of the detailed emotions when the axes are fixed is calculated using cosine similarity in Sect. 3.1.
2. The variability of the detailed emotions when the axes are not fixed is calculated based on the choice of axes: different axes produce different detailed emotions, as discussed in Sect. 3.2.
3. Each characteristic of the verification is compared at the end of Sect. 3.2.

Validation 2 verifies whether the method proposed in this study can derive the service elements required to obtain high-quality emotion.

Procedure

1. The service elements derived from the abstract emotion, and the detailed emotions in the EHD when the axes are fixed are compared using the statistical result in Sect. 4.1.
2. The service elements derived from the abstract emotion and detailed emotions in the EHD when the axes are not fixed are compared using the statistical result in Sect. 4.2.

3.1 Validation of Individual Differences When the Axes Are Fixed

There were nine subjects (seven men, two women) in this validation exercise; they study in the second to third grade of university.

First, the aim of an EHD and the method for drawing an EHD were explained to the subjects. Subsequently, we gave the subjects the articles in the sample and the axes; the subjects drew the EHD using this information. We searched for articles in the Nikkei BP database using the keyword "excitement" on 1 November 2014 and found 1,876 articles. We chose 100 articles randomly from these search results. In this section, the axes and the order of use are fixed; however, the subjects were told that they did not have to decompose an emotion if they could not decompose it into detailed

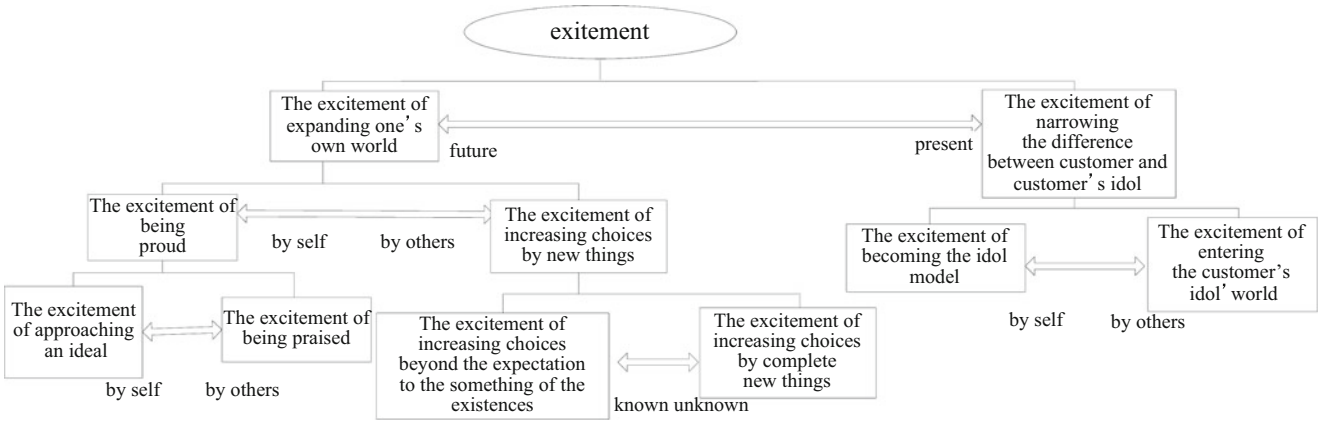

Fig. 2 The EHD for "excitement"

Table 2 Axes used in the EHD for "excitement" in Sect. 3.1

Name of axis	Elements		
Time	Present	Future	Past
Accomplishment	By self	By others	
Cognition	Unknown	Known	

Table 3 Detailed emotions in the EHD of one subject

1. Future side			
The excitement about imagining the future			
The excitement concerning something		The excitement about change around me	
The excitement of consecutive challenges	Unexpected excitement	The excitement about exceeding the last experience	The excitement about gradually increasing knowledge
2. Present side			
The excitement of touching a new thing			
The excitement of touching a new thing on one's own		The excitement of knowing many new things	

Table 4 Number of child emotions corresponding to the elements of the axis

1.	Time (future)
2.	Time (future) accomplishment (by self)
3.	Time (future) accomplishment (by others)
4.	Time (future) accomplishment (by self)
	Cognition (known)
5.	Time (future) accomplishment (by self)
	Cognition (unknown)
6.	Time (future) accomplishment (by others)
	Cognition (known)
7.	Time (future) accomplishment (by others)
	Cognition (unknown)
8.	Time (present)
9.	Time (present) accomplishment (by self)
10.	Time (present) accomplishment (by others)

emotions. Table 2 shows the given axes ordered according to use in this study.

Table 3 presents the detailed emotions in the EHD created by one of the subjects. In fact, there were nine sets of the detailed emotions. Table 4 shows the correspondence between the number of detailed emotions and the elements of the axis, and Table 5 shows the various emotions for each child emotion. The ID numbers in Table 5 represent the subject's number.

This study measured the degree of similarity between two excitements based on the semantic distance, which was calculated according to a word's frequency of appearance. We calculated cosine similarity based on the results of morphological analysis using MeCab [14]. Shiozu and Iwashita [15] used 0.25 as the standard for the degree of similarity. We follow this and assign green color to values with similarity greater than 0.25 and less than 0.5, blue color to values with similarity greater than 0.5 and less than 0.75, and red color to values with similarity greater than 0.75. Table 6 presents the cosine similarity of the first layer <1> and second layer <2>, for example, and Table 7 shows the percentages of each area of cosine similarity per detailed emotion.

From Table 7, we understand that the detailed emotions that are high in the hierarchy are inclined to a high level of similarity, by examining the results into two parts separated by the first layer (future parts <1>–<7>; present parts <8>–<10>). The level of similarity decreases if we increase the axes because the emotions decomposed by each axis have a corresponding variability. Moreover, *by self* has a higher level of similarity compared to *by others* in the *accomplishment* axis. When decomposing an emotion into detailed emotions by self or by others, "accomplishment by self" is easy to understand and is determinative. Thus, the level of similarity is high in the "by self" part. Further, the

Table 5 Each layer of excitement

(1) First layer <1>	
1.	The excitement of expecting the future to be better
2.	The excitement about the future
3.	The excitement of enhancing one's own capability
4.	The excitement of imagining the future
5.	The excitement of foreseeing the future
6.	The excitement of expanding one's own world
7.	The excitement of having a view of the future
8.	The excitement concerning the future
9.	The excitement for the future
(2) Second layer <2>	
1.	The excitement of discovering the future by oneself
2.	The excitement born from one's imagination
3.	The excitement about expanding the future
4.	The excitement about relating to the future
5.	The excitement of increasing one's own ability
6.	The excitement of increasing one's own ability
7.	The excitement of being a trigger for changing the future
8.	The excitement concerning the future created by one's behavior
9.	The excitement of behaving on one's own
(3) Second layer <3>	
1.	The excitement of expecting one's future to become better by others' behavior
2.	The excitement beyond one's imagination
3.	The excitement of expanding the future by other's ideas
4.	The excitement of change around oneself
5.	The excitement concerning an improved society
6.	The excitement of expanding the world
7.	The excitement about the thing that has not yet been achieved becoming real
8.	The excitement concerning the future given by others
9.	The excitement of changing circumstances
(4) Third layer <4>	
3.	The excitement of approaching the ideal world
4.	The excitement of consecutive challenges
5.	The excitement of enhancing self by known things
6.	The excitement of enjoying things
7.	The excitement from the accomplishment
8.	The excitement of accomplishing known things by oneself
9.	The excitement of doing something new by using known things
(5) Third layer <5>	
3.	The excitement of facing unknown results
4.	The excitement beyond expectation
5.	The excitement of enhancing self by unknown things
6.	The excitement of doing things not experienced before
7.	The excitement of imagining an unknown future
8.	The excitement of encountering unknown things by self's behavior
9.	The excitement of doing new unknown things
(6) Third layer <6>	
3.	The excitement of ideas that we can imagine
4.	The excitement of exceeding the previous experience
5.	The excitement about improving the entire society by using known things
6.	The excitement of enjoying something new
8.	The excitement of realizing known things given by others
9.	The excitement of hoping to change the environment
(7) Third layer <7>	
3.	The excitement from unexpected ideas
4.	The excitement of gradually increasing knowledge
5.	The excitement about the entire society improving by using unknown things
6.	The excitement of ranking up
7.	The excitement of expecting the appearance of new things that change our life
8.	The excitement about the unknown future given by others
9.	The excitement about unknown things given by others
(8) First layer <8>	
1.	The excitement of enjoying at that time and place
2.	The excitement of achieving desired things now
3.	The excitement in daily life
4.	The excitement of touching new thing
5.	The excitement of enjoying now
6.	The excitement of feeling great shakes now
7.	The excitement of getting close to something new or longing for something
8.	The excitement about the ideal or desired things
9.	The excitement about the present
(9) Second layer <9>	
2.	The excitement of becoming the ideal model
3.	The excitement of daily experience
4.	The excitement of touching something on one's own
5.	The excitement about one's own favorite
6.	The excitement of experiencing the extraordinary
7.	The excitement of gratifying one's desire
9.	The excitement about one's situation
(10) Second layer <10>	
2.	The excitement of simulated experience
3.	The excitement of similar things experienced daily by other persons
4.	The excitement of knowing many new things
5.	The excitement of something that happened
6.	The excitement of experiencing the ordinary
7.	The excitement of novelty and originality
8.	The excitement about the ideal or desired things given by others
9.	The excitement of response by others

elements of an axis that are "far from the meaning of the emotion," "difficult to imagine," and "not determinative" tend to have high variability.

The percentage where the level of similarity is greater than 0.25 is over 85 % for all the detailed emotions. When fixing the axes, the EHD has low variability.

3.2 Validation of Individual Differences When the Axes Are Not Fixed

There were 21 subjects (20 men, 1 woman) in this validation; they study in the second to third grade of university.

Table 6 Degree of similarity of different excitements

(1) First layer <1>

	1	2	3	4	5	6	7	8	9
1	1	0.471	0.408	0.481	0.51	0.589	0.655	0.436	0.516
2	0.471	1	0.577	0.68	0.722	0.667	0.617	0.772	0.73
3	0.408	0.577	1	0.471	0.5	0.722	0.401	0.535	0.474
4	0.481	0.68	0.471	1	0.825	0.544	0.63	0.63	0.596
5	0.51	0.722	0.5	0.825	1	0.577	0.668	0.668	0.633
6	0.589	0.667	0.722	0.544	0.577	1	0.617	0.617	0.73
7	0.655	0.617	0.401	0.63	0.668	0.617	1	0.571	0.676
8	0.436	0.772	0.535	0.63	0.668	0.617	0.571	1	0.676
9	0.516	0.73	0.474	0.596	0.633	0.73	0.676	0.676	1

(2) Second layer <2>

	1	2	3	4	5	6	7	8	9
1	1	0.447	0.559	0.426	0.625	0.577	0.64	0.456	0.668
2	0.447	1	0.5	0.381	0.447	0.516	0.381	0.49	0.478
3	0.559	0.5	1	0.381	0.447	0.516	0.381	0.49	0.598
4	0.426	0.381	0.381	1	0.426	0.739	0.546	0.311	0.456
5	0.625	0.447	0.447	0.426	1	0.577	0.533	0.365	0.535
6	0.577	0.516	0.516	0.739	0.577	1	0.616	0.422	0.617
7	0.64	0.381	0.381	0.546	0.533	0.616	1	0.389	0.456
8	0.456	0.49	0.49	0.311	0.365	0.422	0.389	1	0.488
9	0.668	0.478	0.598	0.456	0.535	0.617	0.456	0.488	1

Table 7 Percentage of each area of cosine similarity per detailed emotion

The layer				1st	2nd	
Number of detailed emotion				<1>	<2>	<3>
$0.75 \leq x$				2	0	0
$0.5 \leq x < 0.75$				27	16	9
$0.25 \leq x < 0.5$				7	20	26
$x < 0.25$				0	0	1
Percentage $0.75 \leq x$				0	0	0
Percentage $0.5 \leq x$				0.806	0.444	0.250
Percentage $0.25 \leq x$				1.000	1.000	0.972
3rd				1st	2nd	
<4>	<5>	<6>	<7>	<8>	<9>	<10>
0	0	0	0	0	0	0
3	6	0	1	10	5	2
18	12	15	18	25	15	22
0	3	0	2	1	1	4
0	0	0	0	0	0	0
0.143	0.286	0	0.048	0.278	0.238	0.071
1.000	0.857	1.000	0.905	0.972	0.952	0.857

First, the aim of the EHD and how to draw the EHD were explained to the subjects. Subsequently, we gave the subjects the articles and the example of the axes; the subjects drew the EHD using these. The articles were the same as those described in Sect. 3.1. Table 8 presents the example of the axes provided to the subjects. The subjects chose three axes each from the examples in Table 8 on their own.

Table 9 shows the detailed emotions in the EHD created by one of the subjects. Table 10 presents the axes used for Table 9.

Table 8 Examples of the axes

Name of axis	Elements		
Time	Present	Future	Past
Accomplishment	By self	By others	
Cognition	Unknown	Known	
Gusto	Pleasure	Displeasure	
Who	Oneself	Others	
Charm	Attractive	Unattractive	
(Unspecified)	Original axes		
(Unspecified)			
(Unspecified)			

Table 9 Detailed emotions in the EHD of one subject

1. Future side			
The excitement about the future			
The excitement about the things that are useful for oneself		The excitement of being useful to people other than oneself by doing new things	
The excitement about receiving praise	The excitement of expecting one's future	The excitement by being helpful to other people	The excitement of expanding the world for everybody
2. Present side			
The excitement of shaking emotions			
The excitement that one's wish comes true		The excitement that one may do it because another person granted an ideal	
The excitement of accomplishing what one wanted to do by oneself	The excitement of accomplishing one's wish by other's behavior	–	–

Table 10 Axes used for Table 9

Time (future, present, past)	
Benefits (to self, to many people)	
Accomplishment (by self, by others)	–

Table 11 presents the axes that were used by the subjects in the EHD. All the axes that were included in Table 1 are colored red in Table 11; the axis that was not included in Table 1 is colored black in Table 11. Table 11 (3) presents some of the axes that were examined in detail for the elements of the axes in Table 8 (shown in blue). Table 12 shows the number of each kind of axes, the total percentage, and the accumulation. The ID numbers in Tables 11 and 12 represent the subject's number.

The *time* axis is used for about 81 % of the classifications in the first layer in Table 12 (1). That is, the variability in the first layer is small. However, in Table 12 (2) the *accomplishment* axis has the highest percentage in the second layer

Table 11 The axes used

(1) First layer

1	Time
2	Time
3	Time
4	Time
5	Time
6	Time
7	Time
8	Time
9	Time
10	Cognition
11	Time
12	Accomplishment
13	Feeling by myself-sharing with others
14	Time
15	Time
16	Time
17	Time
18	Time
19	Time
20	Who
21	Time

(2) Second layer

1	Cognition	-
2	Accomplishment	-
3	The expectation-realization	-
4	Accomplishment	Accomplishment
5	Accomplishment	The material - The spirit
6	Accomplishment	Accomplishment
7	Accomplishment	Accomplishment
8	Who	Who
9	Accomplishment	Accomplishment
10	Accomplishment	Accomplishment
11	Accomplishment	-
12	Time	Time
13	Time	Time
14	Who	Who
15	Cognition	Cognition
16	passive - active	passive - active
17	The benefits to self- to many people	The benefits to self- to many people
18	Cognition	Cognition
19	Cognition	Time
20	Time	Time
21	Cognition	Cognition

(3) Third layer

1	The accomplishment	-	The accomplishment	-
2	The cognition	The cognition	-	-
3	who	-	-	-
4	The gainful something other than emotions - The gainlessness other than emotions	The gainful something other than emotions - The gainlessness other than emotions	The gainful something other than emotions - The gainlessness other than emotions	The gainful something other than emotions - The gainlessness other than emotions
5	The personal ability -The personal emotion	The cognition	-	-
6	The result by self behavior -based on knowledge and experience	The cognition	Extraordinary - famous	Out of imagination-looking down at self
7	The cognition	The cognition	The cognition	The cognition
8	The cognition	The cognition	The cognition	The cognition
9	The accomplishment	The accomplishment	The accomplishment	The accomplishment
10	who (for self)	who (for self)	who (for self)	who (for self)
11	-	The cognition	The recreation -The contest	-
12	The acquisition -The experience	The acquisition -The experience	The acquisition -The experience	The acquisition -The experience
13	-	-	-	-
14	The cognition	The cognition	The cognition	The cognition
15	who (for self)	who (for self)	who (for self)	who (for self)
16	who (others including self)	who (others including self)	who (others including self)	who (others including self)
17	The accomplishment	The accomplishment	The accomplishment	The accomplishment
18	A moment -long term	A moment -long term	A moment -long term	A moment -long term
19	-	Abstract - concrete	-	The gusto
20	The cognition (unknown)	The cognition (unknown)	The cognition (unknown)	The cognition (unknown)
21	who	who	who	who

Table 12 The number of each axis used for classification and the percentage

Axis	Number	Percentage	Accumulation
1. First layer in Table 11 (1)			
Time	17	0.809524	0.809524
Cognition	1	0.047619	0.857143
Accomplishment	1	0.047619	0.904762
Who	1	0.047619	0.952381
Others	1	0.047619	1.000000
2. Second layer in Table 11 (2)			
Accomplishment	13	0.342105	0.342105
Cognition	8	0.210526	0.552632
Time	7	0.184211	0.736842
Who	4	0.105263	0.842105
Others	6	0.157895	1.000000
3. Third layer in Table 11 (3)			
Cognition	17	0.253731	0.253731
Accomplishment	10	0.149254	0.402985
Who	5	0.074627	0.477612
Gusto	1	0.014925	0.492537
Axis composed by elements	16	0.238806	0.731343
Others	18	0.268657	1.000000

(34 %). In the third layer, the *cognition a*xis accounts for 25 % of all the axes. The percentage accounting for all the axes decreases down the hierarchy. That is, diverse axes are chosen in the lower layers. Further, no one chooses the same combination of axes, and no one draws the same combination of detailed emotions. The choice of axis changes according to the layer. Thus, when the axes are not fixed, the EHD has high variability.

To summarize the verification results, the variability of the detailed emotions when the axes are fixed is low; when the axes are not fixed, the variability of the detailed emotions is high. Thus, individual differences appear in the choice of axes. Further, for each axis, the variability tends to be high for the elements of the axis that are "far from the meaning of the emotion," "difficult to imagine," and "not determinative."

4 Validation of the Derivation of Service Elements

Next, we verify whether the EHD can derive service elements with high emotional quality in both cases: when the axes are fixed and when they are not.

4.1 Validation of Derivation of Service Elements When the Axes Are Fixed

There were 12 subjects (11 men, 1 woman) in this validation exercise; they study in the second to third grade of university. The subjects were divided into four groups. Each group

Table 13 Elements of the excitement café discussed in the brainstorming session before the EHD was drawn (Group B)

Dog and cat café
Soldering café
Camera café
Stationery café
Farmer café
Football café
Amusement park café
Entertainment café
Movie café

listed the elements of the excitement café in a brainstorming session before drawing the EHD. Table 13 presents the elements discussed by Group B before the EHDs were drawn.

Subsequently, the aim of the EHD and how to draw the EHD were explained to the subjects. Each subject created an EHD by decomposing excitement into detailed emotions with 100 articles. Further, the subjects identified the elements of the excitement café from the detailed emotions. Table 14 shows the selected detailed emotions and elements of the excitement café per subject in Group B. The ID represents the group-individual number.

The subjects evaluated the elements of the café proposed by the group members in both cases (using EHD and without EHD) with five points (low is one; high is five). Table 15 shows the average score of the elements.

After confirming that the average score is normally distributed by describing the normal plot, we conduct an F-test for the equality of the two variances. Here, we assume that the average score of the elements without EHD is distributed with $N(\mu_0, \sigma_0^2)$, while the average score when using EHD is distributed with $N(\mu_1, \sigma_1^2)$. The result of the F-test is $F = 1.096 < F_{0.05}(11, 10) = 2.943$. There is no significant difference in the two variances. Subsequently, we conduct the student's t-test to test the difference in the averages of $H_0 : \mu_0 = \mu_1$ vs $H_1 : \mu_0 < \mu_1$. The result of the t-test is $|t| = 3.874 > t_{21}(0.05) = 1.721$. Thus, the null hypothesis is rejected.

The population mean of the elements of the excitement café when using EHD is greater than that when not using EHD, as shown by the result of the t-test. Thus, when the axes are fixed, high-quality service elements are listed in the EHD.

4.2 Validation of the Derivation of Service Elements When the Axes Are Not Fixed

There were 21 subjects (20 men, 1 woman) in this validation exercise; they study in the second to third grade of university. The subjects were divided into four groups. Each group

Table 14 Detailed emotions and elements of excitement café selected by each subject in Group B

ID	Detailed emotions	Café elements
B-1	The excitement of experiencing the extraordinary	A café with Indian décor where customers enjoy Indian movies
	The excitement of experiencing the ordinary	A café where customers enjoy the stars in the sky
	The excitement of doing things not experienced before	A house full of tricks café
	The excitement of doing things not experienced before	A café fitted with mirrors all over
	The excitement of experiencing the extraordinary	
B-2	The excitement of imaging the impossible situations	An science fiction-themed café where customers can imagine impossible situations
		A café where customers can fire their imagination with materials like magazines or the Internet
	The excitement of sharing the experience with other persons	A café where customers can talk with 3–5 peoples around a big round table
B-3	The excitement of closing the distance between the idol and the ideal	A café where customers feel familiar with an idol
		A café serving a menu related to an idol
		A café whose owner is an idol
		A café where customers enjoy playing with well-mannered dogs
B-4	The excitement of making new things	A café where customers can use materials and tools from an electronic kit, and the staff help them when required
	The excitement given by others	A café where customers enjoy various movies on the big screen
	The excitement of studying or working	A café where customers can study or work without hesitation
		A café with private rooms to concentrate without distractions
	The excitement of challenging new thing	A café where customers can try out rock-climbing and bungee jumping
B-4	The excitement of challenging new thing	A café where customers can start a fire and serve coffee on their own
		A café with natural interior decoration
	The excitement of using new thing	A café where a machine prepares the food
		A café where robots serve the customers
		A café where customers have a cup of coffee with wearable devices

Table 15 Average score of elements of excitement café

ID	A-1	A-2	B-1	B-2	B-3	B-4
Without EHD	3.00	3.40	2.22	3.11	2.89	3.67
Using EHD	3.71	4.00	–	3.33	4.25	4.10
ID	C-1	C-2	C-3	D-1	D-2	D-3
Without EHD	3.89	3.67	2.50	3.23	3.54	3.62
Using EHD	4.75	4.09	4.67	3.67	4.40	3.33

Table 16 Elements of an excitement café discussed during brainstorming session by Group E before drawing the EHD

A café where we can imitate someone, e.g., samurai, prisoner, time traveler
A café where we can make something, e.g., plastic model, game
A café where the order from the menu is decided by the results of a game, e.g., party game, darts
A café where we can go on imaginary journeys using google maps and head-mounted display (HMD)
A café where a picture we draw is printed by a 3D printer
A café for examinees where past exams are available
A café where we can eat in-flight meals or space food
A café where we can eat food in a two-dimensional world of comics

listed the elements of the excitement café in a brainstorming session before drawing the EHD. Table 16 presents the elements discussed by Group E before the EHDs were drawn.

Table 17 shows the selected detailed emotions and elements of the excitement café per subject in Group E. The ID represents the group-individual number.

The subjects evaluated the elements of the café proposed by the group members in both cases (using EHD and without EHD) with five points. Table 18 shows average scores of these elements.

After confirming that the average score is normally distributed by describing the normal plot, we conduct an F-test for the equality of the two variances. Here, we assume that the average score of the elements without EHD is distributed with $N(\mu_0, \sigma_0^2)$, while the average score while using EHD is distributed with $N(\mu_1, \sigma_1^2)$. The result of the F-test is $F = 12.777 > F_{0.05}(20, 20) = 2.464$. There is a significant difference between the two variances. Subsequently, we conduct Welch's test to test the difference in the averages of $H_0 : \mu_0 = \mu_1$ vs $H_1 : \mu_0 < \mu_1$. The result of Welch's test is $|t| = 2.842 > t_{23}(0.05) = 1.713$. Therefore, the null hypothesis is rejected.

The population mean of the elements of the excitement café when using EHD is greater than that when not using EHD, as shown by the result of Welch's test. Thus, when the axes are not fixed, high-quality service elements are listed in the EHD.

Table 17 Detailed emotions and elements of excitement café selected by each subject in Group E

ID	Detailed emotions	Café elements
E-1	The excitement of encountering unknown things	A café where customers feel like traveling using google maps
	The excitement of urging something by self	A café where customers enjoy party games with strangers
E-2	The excitement that the customers cannot predict what will happen	A café where customers enjoy performances or sports such as magic or soccer
		A café where customers can be surprised by something such as surprising TV programs
	The excitement of experiencing various unknown things	A café where the staff teach the customers some knowledge and techniques that could expand the customers' life
E-3	The excitement of expecting something	A café where customers experience things using HMD
		A café where customers can try out unreleased products
E-4	The excitement from the satisfaction of becoming the ideal	A café where customers are served food eaten by *daimyos* long time ago
	The excitement of entering the ideal world	
	The excitement of growing up humanly	A café where customers communicate in languages other than the native language
	The excitement of stimulating our mind	
	The excitement of growing up humanly	A gym café where customers can order menu according to calorie consumption
	The excitement of stimulating our mind	
	The excitement of getting what it is difficult to get on one's own	Monster Hunter café where the menu is changed according to the result of a game
	The excitement of entering the ideal world	(Monster Hunter is a popular game in Japan)
	The excitement of getting something that is difficult to get on one's own	A café where a certain time period is re-created and the customers are treated as people of that time
	The excitement of getting something that is difficult to get because of our environment	
	The excitement of entering the ideal world	
	The excitement of getting what it is difficult to get by our environment	A café where customers are treated as dwarfs
	The excitement of entering the ideal world	

(continued)

Table 17 (continued)

ID	Detailed emotions	Café elements
E-5	The excitement of satisfying oneself mentally	A café where customers are served food from the comic world
		A café preparing clothes for costume play
E-5	The excitement of enjoying something	A café where there are rooms with various themes
	The excitement of enjoying something	A café where customers receive a status of utilization per month or year
E-6	The excitement of expecting famous or high evaluated things	A café where customers enjoy food prepared by a famous chef
	The excitement of encountering an extraordinary scene	A café where customers are served expensive coffee

Table 18 Average score of elements of excitement cafe

ID	E-1	E-2	E-3	E-4	E-5	E-6
Without EHD	3.63	3.38	3.63	3.75	4.00	3.13
Using EHD	4.50	4.00	5.00	4.33	4.75	1.00
ID	F-1	F-2	F-3	F-4	F-5	
Without EHD	3.67	3.44	3.33	3.56	3.33	
Using EHD	3.00	3.67	4.00	4.33	3.75	
ID	G-1	G-2	G-3	G-4	G-5	G-6
Without EHD	3.30	3.20	3.80	3.80	3.60	3.50
Using EHD	3.00	5.00	4.00	4.67	4.50	4.67
ID	H-1	H-2	H-3	H-4		
Without EHD	3.42	3.85	3.08	3.85		
Using EHD	4.50	5.00	4.33	4.60		

5 Conclusion

This study proposes an Emotion Hierarchy Diagram (EHD) to decompose abstract emotions into detailed emotions and to select them for deriving specific service elements to design a service process with high emotional quality.

This study conducts two types of verification. Validation 1 examines where individual differences appear in the EHD. We find that individual differences appear in the choice of axes.

Validation 2 verifies whether the method proposed in this study can derive the service elements required to obtain high emotional quality. We find that high-quality service elements were listed when the EHD was drawn in both cases: when the axes were fixed and when they were not.

However, the validity of the findings needs further verification.

Internal validity: The service elements were derived from the abstract emotion before the service elements were derived from the detailed emotions. Since the experience could be affected by deriving the service elements with high emotional quality, there were 3-week intervals between the processes. There were one or two women in each experiment. Thus, it is possible that gender difference affected the choice of axes or the service elements derived with high emotional quality. Whether gender has an impact needs to be verified in future research by increasing the number of women subjects.

External validity: Questions could be raised about the external validity since the experiments' subjects were only in the second to third grade of university. However, this method is not designed specifically for the second to third grade of university. The method could be useful for all people who have emotions. We would want to verify the utility of the proposed method for all ages and all levels of education by broadening the research objective.

To conclude, we present further directions for future research. Although the direct recipient of a service was defined as a person, the nature of the act as a tangible action, and the service provider as a person with regard to the scope of this study, the proposed tool and method could be applied in a context where the service provider is a machine. A machine could provide customers a service with high emotional quality if the machine could provide the service elements from the detailed emotions similar to what a person does.

References

1. Reichheld, F., 2003, *The Ultimate Question Driving Good Profits and True Growth*, Harvard Business School Press.
2. Chase, R.B., 2008, *Psychology of Experience: The Missing Link in Service Science,* Service Science, Management and Engineering for the 21st Century,pp. 35–40.
3. Heskett, J.L., Sasser, W.E. and Schlesinger, A.L., 1997, *The Service Profit Chain*, The Free Press
4. Zeithaml, V.A. and Bitner, M.J., 2000, *Services Marketing: Integrating Customer Focus across the Firm*, McGraw-Hill.
5. Parasuraman, A., Zeithaml, O. and Berry, L., 1998SERVQUAL:A Multiple-Item Scale for Measuring Consumer Perception of Service Quality, *Journal of Retailing*, Vol. 64(1), pp. 12–40.
6. Takeyama, M., 2012, Service Design and itsVisualization Techniques, *The Hiyoshi Review of the Social Sciences*, Vol. 23, pp. 15–35
7. Robert, P., 1980, The Nature of Emotions, *American Scientist*, Vol. 89, pp. 344–350.
8. Higuchi, M., 2000, A Study on the Structure of Shame, *Japanese Journal of Social Psychology*, Vol. 16(2), pp. 103–113.

9. Lovelock, C.H., 1996, *Service Marketing*, Prentice-Hall.
10. Ueda, T. and Hoshino, H., 2010, Probability of Life Value Creative Station, *Japan Marketing Journal*, Vol. 29(3) pp. 33–44
11. Ortony, A., Clore, G.L. and Collins, A., 1988, *The Cognitive Structure of Emotions,* Cambridge University Press.
12. Nikkei BP, https://bizboard.nikkeibp.co.jp/daigaku/, (Accessed 1/11/2014).
13. Satake, H., 2000, *Sansedo's Daily Concise Dictionary*, Sanseido.
14. MeCab: Yet Another Part-of-Speech and Morphological Analyzer, http://mecab.googlecode.com/svn/trunk/mecab/doc/index.html (Accessed 19/1/2015).
15. Shiozu, K. and Iwasita, S., 2012, A Method for Automatic Tagging for Classification and Retrieval of News Contents, *The Association for Natural Language Processing*, Vol. 18, pp. 529–530.

A Creed for Service Designers

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Abstract

Some recent discussions in the service science community have been around the need for research on and innovation of human-centered service systems (HCSS) from a multiple discipline perspective. HCSS are complex because of the involvement of people, multiple stakeholders with usually incommensurate value systems spanning networks of resources. Designers of such systems have to draw knowledge and connections from service science, system thinking, design thinking, business, and engineering. In this research, we build an underpinning of the system thinking aspect of service design based on Churchman's *The Design of Inquiring Systems* and Swanson's *Churchman's Theory of Design Integrity* as an important aspect of the education of service designers. This will form the philosophical foundation of a creed or set of beliefs and aims that will guide the service designer's actions. Of particular relevance to service system design is Swanson's interpretation of Churchman's work to propose a Theory of Design Integrity, i.e., designing the wholeness, soundness, and virtue of a system. A system professional can design such a system with precepts based on Churchman's necessary conditions to conceive a system S: it is teleological; it has a measure of performance, a client whose interests (value) are served, teleological components, an environment, a decision maker of resources, and a designer with good intentions to maximize the system's value to the client; and it is stable. Even though Churchman was not specifically referring to service systems, we see that his ideas are as fresh today as then in applying the precepts to value cocreation scenarios. The Theory of Design Integrity also explicitly offers a virtue component that is lacking in the current service design literature. We feel that this should be an essential part of a service designer's creed in today's climate of privacy and security concerns. Swanson also introduced the role of a social witness as an observer who evaluates the system's design integrity by maintaining a critical and responsible stance not separable from the system. We will illustrate the applicability of the Creed for Service Designers with service system scenarios and describe how it could be incorporated into service design education.

Keywords

Service design • System thinking • Design integrity

1 Introduction

Some of the recent discussions in the service science community have been around the need for research on and innovation of human-centered service systems (HCSS)

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from a multiple discipline perspective (Maglio et al. 2015). HCSS are complex and have emergent properties because of the involvement of people, multiple stakeholders with usually incommensurate value systems, and often span networks of resources (Norman 2011). Designers of such systems have to draw knowledge and connections from service thinking, system thinking, design thinking, business thinking, and engineering thinking (Kwan 2013). There are many methods and tools to involve the participation of stakeholders to create empathetic designs (e.g., (Stickdorn and Schneider 2011; Polaine et al. 2013)). There are also researchers seeking answers to: Who is a Service Designer? What should a Service Designer know? What should a Service Designer do? These are all good questions toward the development of the service designer profession.

In this research, we are looking specifically at "What should be the philosophical guidance of a Service Designer?" We take on building an underpinning of the system thinking aspect of service design based on Churchman (1968, 1971) and Swanson (1994) as an important aspect of the education of T-shaped professionals (Kwan 2014) and as a needed companion to service thinking (Lusch and Vargo 2014). We advocate the use of this underpinning to form the philosophical foundation of a creed or set of beliefs and aims that will guide the service designer's actions. Of particular relevance to service system design is Swanson's interpretation of Churchman's *The Design of Inquiring Systems* to propose a Theory of Design Integrity, i.e., designing the wholeness, soundness, and virtue of a system. A system professional can design such a system with precepts based on Churchman's necessary conditions to conceive a system *S*: it is teleological, has a measure of performance, has a client whose interests (value) are served, has teleological components, has an environment, has a decision maker who controls the resources, has a designer with good intentions to maximize the system's value to the client, and is stable. Even though Churchman was not specifically referring to service systems, we see that his ideas are as fresh today as then in applying the precepts to service systems and value cocreation scenarios. The Theory of Design Integrity offers a virtue component that is lacking in the current service design literature. Virtue is in essence human-centric-positive values. We feel that this should be an essential part of a service designer's creed for a professional in today's value-driven market amid a climate of privacy and security concerns. Swanson also introduced the role of a social witness as a critical observer who is exogenous to the system and could well be the evaluator of the virtue of the service system. We will outline *A Creed for Service Designers* and describe how it could be incorporated into a class on service design.

2 Churchman's Theory on Design of Inquiring Systems

Churchman offered a unique theory of system design. The system for him was much broader than other kinds of systems theories have portrayed. It is an inquiring system. He wrote, "Inquiry is an activity which produces knowledge" (p. 8). It is the system that produces knowledge. The system consists of components, which are also systems, and relationships among them. For instance, scientific research is done in a system to produce scientific knowledge. Scientists do not work in isolation. They play a part in the whole system of scientific research in which funding is organized, government policies are created, research results are reported and discussed, new members are trained, etc.

This "knowledge" is quite broad for Churchman. He wrote, "Knowledge carries with it both a tremendous joy and a great despair – a joy of being at one with a whole area of living human activity, and a great despair in recognizing how little this oneness really is compared to what it might be. Nothing touches the true depth of the human spirit so much as the act of knowing" (p. 11).

As a result, design of such a system is quite broad. "It can be seen that design, properly viewed, is an enormous liberation of the intellectual spirit, for it challenges this spirit to an unbounded speculation about possibilities" (p. 13). According to Churchman, design has four characteristics:

1. It [Design] attempts to distinguish in thought between different sets of behavior patterns.
2. It tries to estimate in thought how well each alternative set of behavior patterns will serve a specified set of goals.
3. Its aim is to communicate its thoughts to other minds in such a manner that they can covert the goals in the same manner as the design said they would.
4. It strives to avoid the necessity of repeating the thought process when faced with a similar goal-attainment problem by delineating the steps in the process of producing a design.

So design has not only the creation of alternative behaviors but also the communication of it to others, particularly fellow designers and those who will implement the design choices. He wrote, "It is evident that some 'other mind' is critical for the designer, whether it be his own mind later on or some different person" (p. 6). We also note in this characterization of design that design is "teleological." That is to say, it is a purposeful, goal-seeking behavior. This may sound trivial, but Churchman had quite a subtle notion of teleology, which included its opposite, anti-teleology.

3 From Design of Inquiry Systems to Design of Service Systems

The authors of this paper were both doctoral students of Swanson and, thus in effect, second-generation students of Churchman. The Theory of Design Integrity taught by Swanson had indelibly left deep impressions in our own research thinking. As Swanson reflected on Churchman's work 20 years later, we reflect on Swanson's work another 20 years hence.

In a retrospective of Churchman's *The Design of Inquiring Systems* (1971), Swanson (1994) likened it as a presentation of a Theory of Design Integrity, i.e., the wholeness, soundness, and virtue of a design. Swanson also described how he was successful in using the materials to frame fundamental issues of information systems for students. He found that students could grasp and apply the theory and philosophical rumination expounded by Churchman because of "Churchman's appeal to the professional's integrity (through his or her designs)" (Swanson, p. 55).

In Table 1 we show how we adopted Churchman's necessary conditions that something *S* be conceived as a system (Churchman 1971, p. 43) to *S* being a *service system*.

It is a testament to the veracity and timelessness of Churchman's theory that the nine conditions could be so seamlessly adapted to today's environment (40 years later) as if they were written for the service system literature. Furthermore, Swanson suggested that these nine conditions formed a set of precepts for the system's designer.

It is clear that the inquiring systems are to serve the clients. The designers should work to maximize the value for the clients. Churchman also included decision makers who are not necessarily in line with the clients and have different purposes. In services, these decision makers are always involved, and the design of services is difficult precisely because of this possibly disparate interests. Note that we do not need to assume that there should be three different sets of stakeholders, clients, decision makers, and designers. A stakeholder can undertake multiple roles.

The idea that service systems are teleological and should have virtue may be a new notion to the designer. Virtue is an ultimate end in itself, which has no telos (goals) of its own. Churchman discusses Kant's ethics in which humans should not be treated as means to an end but as ends in their selves (pp. 255–256). Yet, in teleological system, many humans are treated as means. By being teleological, Churchman does not

Table 1 Necessary condition for a service system and its design integrity

Necessary conditions	Design integrity	Comments
(1) A *service system* is teleological	Virtuous	Purposeful, produces human-centric positive value
(2) A *service system* has a measure of performance	Soundness	Performs what it is supposed to do
(3) There exists a client whose interests (values) are served by the *service system* in such a manner that the higher the measure of performance, the better the interests are served, and more generally, the client is the standard of the measure of performance	Virtuous soundness	Client could be viewed as the "customer" in a value cocreation scenario. Cf. one of service-dominant logic's fundamental premises of "Value is always uniquely and phenomenologically determined by the beneficiary"
(4) A *service system* has teleological components, which coproduce the measure of performance of the *service system*	Wholeness soundness virtuous	Subsystems that are aligned in producing value
(5) A *service system* has an environment (defined either teleologically or ateleologically), which also coproduces the measure of performance of the *service system*	Wholeness (soundness?)	The governance mechanism of the service system ecosystem has a stake in the performance of the service system
(6) There exists a decision maker who – via his resources – can produce changes in the measure of performance of the *service system*'s components and hence changes in the measure of performance of the *service system*	Soundness	Some might consider the decision maker as the service provider that controls the resources devoted to the delivery of the service
(7) There exists a designer who conceptualizes the nature of the *service system* in such a manner that the designer's concepts potentially produce actions in the decision maker, and hence changes in the measures of the *service system*'s components, and hence changes in the measure of the performance of the *service system*	Soundness	The designer is the broker between the client and the decision maker. Churchman put the designer "directly on the hook." That is, the designer is responsible
(8) The designer's intention is to change the *service system* so as to maximize the *service system*'s value to the client	Virtuous	A stipulation that the designer's intention is good. Otherwise the client and decision maker will always have to second-guess the intention of the designer
(9) A *service system* is "stable" with respect to the designer, in the sense that there is a built-in guarantee that the designer's intention is ultimately realizable	Soundness virtuous	This reflects on the completeness as well as the soundness of the service system instead of just some unreachable goals

advocate a simple end to which the system moves toward. For instance, in a service, the goal is to satisfy customers, encourage repeat visits, and improves their benefits. Churchman has a much more complex view of teleology. His teleology is dialectically mediated by ateleology (Yamauchi 2015). Teleology is always tied to ateleology.[1] Some people say that they perform a service for the sake of service – the action is important on its own and not for a certain purpose. Acknowledging this, Churchman shows that this is also part of the teleology if we look at the larger system in which this person operates.

Related to teleology is the idea that any system is embedded in a larger system. This later system provides the context for a higher teleology. The purpose of a system is tied to the larger system in which it is embedded. This larger telos is given by an observer who is in the position to observe the whole system and hence situated in the larger system. He wrote, "Teleological observation, on the other hand, is a way of observing the world so that the resulting information is useful to a purposive being. To know that a subject has observed 'objectively' we need to know the total system in which the subject acts" (p. 168).

This is a critical point if we think of service designers. Service designers should look deeper beyond superficial goals such as profits and revenues and idealistic and heroic ends such as betterment of the society. The teleology of a service system should be found in the dialectical movement between teleology and ateleology.

The notion of value is quite important for us service researchers. Churchman was quite subtle on this notion as well. Values are not simply some personal interests that are to be fulfilled. He wrote, "one important implication of the subjectivist doctrine is that it is impossible to compare the values of two or more members of a society other than in terms of their simple preference ordering" (p. 152). We need to treat values at the intersubjective, i.e., system, level where the observer again becomes relevant. Values are constructed within interactions between the subject and the observer. While Churchman's inquiring system is to serve clients' values, these values are much more complex than the subjective interests.

4 Swanson's Design Integrity

Swanson takes on one part of this Churchman's masterpiece, design integrity. He clarified three aspects of integrity: wholeness, soundness, and virtue.

Wholeness suggests that no part can be taken away. The wholeness is important for the system to function. In addition, the wholeness is also important because the system is always embedded in another system and designers should take a holistic view. Any design decisions should be made while broader considerations are entertained. Therefore, the wholeness is related to both the system's components and its environment.

Soundness is "the condition of not being marred or violated" (p. 55). He wrote, "a sound design is necessarily one in which each system component is shaped in relationship to the other components and to the whole system" and "A design is sound only to the extent that its relationships are fully articulated" (p. 57). Soundness is related to the system's measure of performance which, in essence, is a composite of the subsystems' performance measures.

Virtue is the "freedom from moral corruption" (p. 55). The key is that "the designers' intentions with respect to the client are taken to be good ones (no such assumption is made for the decision maker)" (p. 56). Therefore, Swanson says, "Churchman puts the designer directly on the hook. The designer cannot distance him – or herself – from the system conceived" (p. 56). As discussed above, virtue does not mean that designers should try to please clients. Clients' values are a system concept, not individual preferences.

Swanson suggests that this Theory of Design Integrity is useful for professionals. Swanson asked his MBA students to analyze an actual information system. They were asked to be "critical observers" (p. 58). Many used Churchman's nine conditions to do so. Swanson wrote, "Students who used Churchman's conditions in characterizing and critiquing the systems found their diagnostic power especially strong" (p. 58).

Swanson was ambivalent regarding the role of critical observers: he wrote, "If there was a danger in this, it was that the students might choose to distance themselves from the system by standing outside it rather than committing themselves to it more directly. They might see themselves as observers somehow separable from the system. Churchman would have frowned upon that" (p. 58). Yet, we think this is precisely the point that Churchman tried to make. By introducing the notion of "observer," he suggested that the system was embedded in the larger system and thereby that such an observer can help clarify and guide the teleological design. While the designer has moral goodness as a necessary condition, there is no theoretical guarantee that the designer's actions are virtuous from the system's point of view because the designer is part of the system and cannot comprehend the system completely. Therefore, Swanson wrote, "Every designer needs the benefit of good critical observation beyond his or her own" (pp. 58–59).

[1] See Stamoulis et al. (2003) for an interesting discussion of ateleological development of "Design-Decisions-Independent" Information Systems.

5 Service Designers' Creed

We thus recommend the following:

A Creed for Service Designers
Design integrity should be the guiding precepts for service designers to design service systems that are whole, sound, and virtuous.

This creed is a set of beliefs and aims that guide the service designer. Its adoption is a solid constructive step in developing the standard for professionalism for service designers.

6 Service Design Curriculum

Given the *Creed for Service Designers*, how should we educate our next generation of service designers to adopt the *Creed* in their design work?

We propose the following three learning objectives to achieve that:

1. Service designers should be able to take the role of a critical observer and identify a service system and delineate its nine necessary conditions as in Table 1 and evaluate the integrity of its design.
2. Service designers should be able to demonstrate in a realistic service system design project the nine necessary conditions and its design integrity.
3. Service designers should be able to formulate design integrity as an integral part of the value proposition for the service system's stakeholders.

There are, of course, many methods to achieve and assess these learning goals for students undertaking a service design curriculum. Here are some practical recommendations:

Learning objective 1 – The method reported by Swanson is a very practical mean of achieving this objective. Students are assigned the role of critical observers to evaluate common-day service systems (e.g., university, transportation, utilities, hospitality, etc.). This could be incorporated into a common exercise where students are asked to name all the service systems from the time they wake up to arrival in the classroom. They could then be asked to pick one of the observed service systems and perform the exercise.

Learning objective 2 – This could be incorporated into a long-term service system design project, and the demonstration is a required part of the project deliverables.

Learning object 3 – This could be part of the long-term service system design project as in the two above. The incorporation of design integrity into the value proposition could be an enhancement of the formulation of a service system value proposition suggested in Kwan and Müller-Gorchs (2011) and Kwan and Hottum (2014) and in a more general format (Osterwalder et al. 2014).

7 Conclusions

In this paper, we have proposed *A Creed for Service Designers* based on Swanson's design integrity and the extension of Churchman's necessary conditions for a system into the realm of service systems. The *Creed* adds a philosophical foundation to the professionalism of a service designer, which is lacking in the service design literature. We have also proposed learning objectives and methods to incorporate the *Creed* into a curriculum for service design. A useful next step in this research is to link the Creed to more specific service design processes and methods and illustrate them with examples.

References

Churchman, C. W. (1968) The Systems Approach. Delacorte Press, New York.

Churchman, C. W. (1971) The Design of Inquiring Systems. Basic Books, New York.

Kwan, S. K. & Müller-Gorchs, M. (2011). Constructing Effective Value Propositions for Stakeholders in Service System Networks. Proceedings of AIS SIGSVC Workshop.

Kwan, S. K. (2013) "Service Design and Innovation SIG Workshop". Presented at the 1st International Conference on Serviceology (ICServ 2013), October 16–18, 2013, Tokyo, Japan (available at http://slideshare.net/stephenkwan).

Kwan S. K. (2014) "T-shaped Professionals". Presented at Spartan Thinkers Society, April 17th, 2014, San José, California, USA.

Kwan, S. K. & Hottum, P. (2014). Mantaining Consistent Customer Experience in Service System Networks. *Service Science*, 6 (2), 136–147.

Lusch, R. F., Vargo, S. L. (2014) Service-Dominant Logic, Premises, Perspectives, Possibilities. Cambridge University Press.

Maglio, P., Kwan, S. K., & Spohrer, J. (2015) "Commentary: Toward a Research Agenda for Human-Centered Service System Innovation". *Service Science* 7:1; March 2105, pp. 1–10.

Norman, D. A. (2011) Living with Complexity. The MIT Press, Cambridge, Massachusetts.

Osterwalder, A., Pigneur, Y., Bernarda, G. & Smith, A. (2014) Value Proposition Design. John Wiley & Sons, New Jersey.

Polaine, A., Løvlie, L. & Reason, B. (2013) Service Design. Brooklyn: Rosenfeld Media.

Stickdorn, M.; Schneider, J. (ed.) (2011) This is Service Design Thinking: Basics – Tools – Cases (1st ed). BIS Publishers, Amsterdam.

Stamoulis, D., Theotokis, D., Martakos, D., & Gyftodimos, G. (2003) Ateleological development of "Design-Decisions-Independent" Information Systems. In Patel, N. (ed.) Adaptive Evolutionary Information Systems. Idea Group Publishing.

E. Burton Swanson (1994) "Churchman's Theory of Design Integrity". *Interfaces* 24: July–August 1994 (pp. 54–59).

Yamauchi, Y. (2015) "Services as Struggles: Research on Customer Interactions" (in Japanese), Chuokeizaisha.

Design Support System for Sightseeing Tours

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Abstract

The Japanese government has initiatives on promoting tourism. To fulfill various needs of tourists from many countries, sightseeing tours need to have large variations. This demands productivity improvement. Among others, determination of a sequence among tourist attractions is challenging due to its contextual feature. This paper proposes a design support method for service sequences. Network-structured models are employed to visualize the relationships among tourist attractions in three aspects: place, time, and content. Tour designs are evaluated using a simulation that incorporates multiple stakeholders. The usefulness of the proposed method is discussed via a case study with a prototype system.

Keywords

Service design • Service model • Service sequence • Knowledge management • Information visualization

1 Introduction

1.1 Background

In recent years, the service industry has accounted for a large proportion of Japan's economy and future demand for services is likely to increase. Many people are satisfied with the items required for daily existence, such as food, clothing, and housing. The service industry is required to provide people with new functions for leisure and self-realization. Thus, requests become more advanced and complex. It entails a much more demanding situation for the service industry. Furthermore, as individual worth and preferences have been diversified, a broad variety of requirements need to be satisfied.

However, to this day, many services have been designed to depend on individuals' skills. The service industry has been made to rely on the experience and sense of individual service designers, which manifests as product competitiveness of such services. Whether such a specific service design process that depends on individual skills has high productivity is difficult to state. Acquiring the knowledge gained through experience to enable better design takes a long time. In addition, this knowledge is integrated as tacit knowledge possessed by the individual, and sharing knowledge is difficult. The current service design process seems to have limitations.

To manage these problems, a discussion on improving service productivity has commenced. The Service Productivity & Innovation for Growth (SPRING) council [1] at the Japanese Ministry of Economy, Trade and Industry started multiple industry-university cooperation initiatives. As such, improving the productivity of services on the basis of scientific approaches has been researched and service design is actively being researched.

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1.2 Current Status of Sightseeing Tour Design

As part of a program to improve service productivity, in recent years, the tourism service industry as an area has become of particular interest [1]. Further, the Japanese government established a Tourism Nation Promotion Basic Plan [2] to attract foreign tourists through a stronger focus on this industry. In 2013, more than ten million foreign tourists visited Japan [3]. Because the 2020 Olympic Games will be held in Tokyo, the increase in tourists is expected to increase the demand for tourist services in the future. By attracting foreign tourists, travel companies hope to increase sales; however, to realize such a sales increase, they must meet the requirements of various tourists visiting from all over the world.

Travel companies aim to increase sales by designing a sightseeing tour to meet such diversified needs. However, because sightseeing tours are a typical service, which is designed by individual designers, the planning and operating capability of the current design approach is limited. Therefore, service design support systems have been called for to increase this planning capability.

In response to tourist requests, sightseeing tour designers list tourism resource candidates. Then, tourism resources are selected from the list of candidates, which determines the departure and possible order of the visits. The tour planner's experience and intuition are required to provide the appropriate tourism resource candidates and to decide on the sequence in which to visit places by considering the convenience of the tourists, the tourism resources, and the travel company. By incorporating a scientific approach in this effort, efficiency and labor-saving designs could be realized.

1.3 Related Research and Problems

The field of service science and service engineering has been established as a scientific approach to services. Generally, service science takes a reductive approach to the scientific analysis of the service. In contrast, service engineering is primarily a constructive approach [4]. This paper adopts the constructive approach to service engineering because the intention is to incorporate scientific methods into service design. As a prominent approach to incorporating scientific methods into service design, tools developed in product design can be adapted. Although the four unique characteristics of service—intangibility, heterogeneity, inseparability, and perishability (IHIP)—are said to represent the differences between service concepts and manufacturing concepts [5], the tools seem applicable to service design. The differences between products and services are also discussed in the Unified Services Theory [6]. In the service-dominant process, which is defined in [6], feedback from the service receiver can change the process immediately after the feedback while the process is running. However, such onsite adjustments could not be designed before the service is aligned in the marketplace. Thus, the former design or plan could be identical to that of the products.

In the following text, the goal of this paper is stated and the theory and methodology of service design studies conducted in the category of service engineering are reviewed. Yoshikawa [4] and Shimomura [7] provided the following definition: "Service is the activity of the provider that can change the state of the receiver to demanded state." To design a high-quality service, considering the state changes requested by the service receiver is necessary. However, because requests are dynamically changed by the receiver's state, accurately determining the receiver's request is difficult. In particular, if the service is provided by a plurality of service behavior, the receiver's state changes depend heavily on the provided sequence. This contextual aspect of service should be considered when designing services. Therefore, considering the sequence of a service and the resultant state change of the service receiver is necessary.

In addition, studies in tourism research have been conducted on the visiting sequence. CT-Planner, which is proposed by Kurata in [8] and [9], is a system that automatically generates a sightseeing tour plan on the basis of the data entered by travelers describing their tastes. When generating a sightseeing tour plan using CT-Planner, selecting a tourism activity and determining the visiting sequence are solved as traveling salesman problems that maximize the utility value calculated from travelers' tastes and visited features. Therefore, although a tour plan is developed by considering efficient movements, the best visiting order is planned considering a traveler's state changes.

1.4 Purpose of This Research and Approach Taken

This paper aims to propose a support method for service design that considers the order in which services are provided and applied to tourist sightseeing tour designs. Therefore, we attempt to develop a service model that represents the difference in efficiency and value (service providers and receivers) caused by differences in the service sequence.

In the proposed method, a service design is divided into a study stage and an evaluation stage. In the study stage, the sequence in which a service is provided is considered, which requires skills for effective planning. To be able to consider

the sequence of services and to determine which are good or bad from the service provider and service recipient perspectives in the design study stage, this paper proposes a method for visualizing an evaluation of the sequence using a network. In addition, in the evaluation stage of the design, the proposed sequence from the perspective of both the provider of the service and the receiver is evaluated. A simulation method proposed by the authors in a previous study [10] is applied as an evaluation method.

2 Modeling of Tourism Resources and a Sightseeing Tour

2.1 Elements of the Tourist Resources Model

In this study, a tourism resources model presented by the authors in the previous studies [11] and [12] is used to represent the components of the tour. This model is expressed in units of each tourist activity of a sightseeing tour to represent the experiences of a single tourism resource. In addition, the movement between tourism resources is built into the tourism activity model. For the sightseeing tour, the following attributes are to be arranged in advance for the tourism service to be operable:

- Place: Location of tourism resources
- Time: Start time, end time, and standard required time of tourism services
- Supplier: Supplier of tourism services
- Content: Contents of the tourism services
- Reservation Element: Elements to be arranged in advance to operate the tourism service
- Capacity: Number of individuals in tourism services that are acceptable at a time
- Cost: Cost of tourism services

Figure 1 shows an example of the tourism resources model. Among the attribute elements, place, time, and content may retain a hierarchical structure to enable a comparison of the attribute elements using a distance calculation. The sum of the similarities of the attribute elements held by individual tourist resources is compared and the similarities between the tourism resources are obtained [12].

2.2 Multiple Stakeholder Viewpoints in the Tourism Resources Model

Each stakeholder's perceptions of the same information on the same tourism resources differ. Therefore, we defined a model (displayed in Table 1) from the point of view of three stakeholders: customer (tourist), provider (travel company),

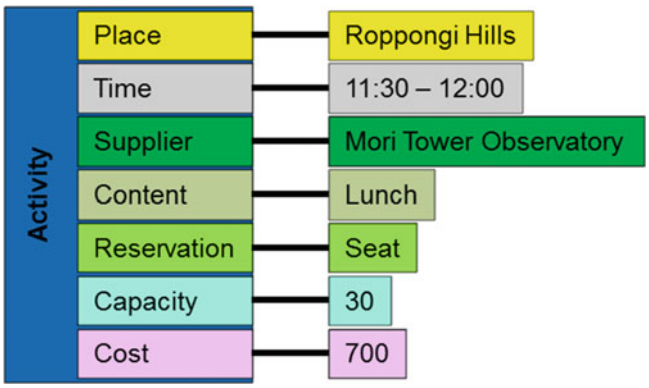

Fig. 1 Tourism resources model

Table 1 Tourism resources model of each stakeholder

Stakeholders	Role	Tourism resource information	Tourism resources model name
Customer (tourist/traveler)	Receiving tourism services	Wish to do	Request
Supplier (tourism resource)	Supplying tourism services	Able to do	Capability
Provider (travel company)	Operating sightseeing tours	Going to do	Activity

and supplier (tourism resources). By using the same model of tourist resources viewed from the perspective of all stakeholders, comparing the information between stakeholders is possible. By comparing requests and capabilities, it is possible to judge whether the capabilities provided by the supplier satisfy the customer requests. In addition, by comparing capabilities and activities, it is possible to judge whether the capabilities provided by the supplier operate the activities planned by its provider. Evaluating the same types of tourism resource models, deliberating alternatives is possible, such as by exploring similar tourism resources through a comparison of capabilities.

2.3 Sightseeing Tours Model

Multiple activities that determine the sequence are defined as a sightseeing tours model. However, simply placing activities together cannot guarantee that sightseeing tours are operable. Therefore, constraints for connecting activities are employed to ensure operability.

To enable the transition between two activities, the constraint is set that time and space assigned to the activity must be continuous—called a spatial-temporal constraint. Then, each activity in a tour must be operable. As previously

mentioned, the operation of an activity is characterized by its attribute element. For example, "where can I" and "when to do" are defined by place and time. Referencing capability enables a check of whether the possible operation is done. Tourism activity, which is declared as an activity, should be guaranteed as capable of providing tourism activities. We call this operation a capability constraint.

3 Planning a Sightseeing Tour

3.1 Consideration of Order in Tourism Activities

We assume that providing a sequence of a service can be done only from the characteristics of a service receiver and the relationship between the target services. For example, for a receiver that hopes to receive significantly similar content, the continuous provision of similar content services is highly appreciated. In contrast, for a receiver who has no particular preference for content, the possibility is that he or she becomes bored with similar content, resulting in a negative evaluation.

In this case, by considering a semantic connection between the two services and the receiver's preferences, the designer must consider the order of the services. Therefore, the visualization model for the relationship between tourism resources using a network was developed for determining the sightseeing trip sequence. This model enables a design study by considering the semantic relationship between tourism resources. Sightseeing tours created using the network model were evaluated through a service simulation that considers the characteristics of the customer as a service receiver [10].

3.2 Use of the Network Model

We consider the nature of the relationship between tourism resources. By comparing the attribute element of the tourism resources, we can judge whether any relationship exists between the start and the end of these resources. We consider the context of the place, time, and content of the attribute element previously mentioned to create a network model of the three attribute elements of place, time, and content, which are considered associations between tourism resources. In the network model, a node represents each tourism resource and a link represents the relationship between two tourism resources. A link represents the relationship attributable to an attribute element of tourism resources at both ends using a thickness and color based on strength and type. Using a network created in this manner enables the completion of a design study by visually considering the relationship of the tourism resources (such as the presence of a type of uneven distribution or clusters of links).

We describe three types of network models that were defined for each attribute element. Table 2 provides a description of the network model. We create three types of network models for activity, capability, and request. Table 3 shows the information on the tourism resources model and the network model for each attribute element.

In the design study stage, we explicitly use this information to support the design study on the visiting sequence of the sightseeing tour activities. The order of sightseeing tours is determined when a bird's-eye view of the relationship between the activities in the network model is designed.

The detail of each network model is discussed below.

3.2.1 Place Network Model

Providing a strong link between geographically close tourism resources and a weak link or eliminating the link between tourism resources that are separated helps with visualizing the geographic distance relationships between tourism resources in the network model. A tourism resource cluster with a solid concentrated link has resources that are suggested as being near each other. Transfer efficiency is increased by continuously visiting nearby tourism resources because merit exists

Table 2 Features of each network model

	Meaning of the link	Features of the cluster
Place	Line width: geographic distance	Nodes (places) connect by links with thick line: places locate at the same area
Contents	Color: type of contents Line width: relevance	Nodes connect by the same colored link: with continuous visits, the element item becomes strong
Time	Direction of the arrow: design procedure Line width: difficulty for adjustment	Hub node: can flexibly respond to the sequence change

Table 3 Types of network model

Network model	Activity	Capability	Request
Place	Passage cost of sightseeing tours	Suggestion of visiting sequence from the viewpoint of passage	Desired area to visit
Time	Robustness of changing the schedule time	Suggestion of availability for tours from the viewpoint of the time constraints	Desired visiting sequence
Contents	Content item that is received in operation sequence	Suggestion of chunk of tourism resources that can be expected to have a synergistic effect	Desired content item to be received

to reducing the movement cost of the tour. However, tourism resources near one another reduce location variety—and may result in lower customer evaluations.

3.2.2 Time Network Model

Feasible succession between tourism resources is represented by a link, which satisfies the time constraints. Because some tourism resources have set end times or both start and end times, the time cannot be determined freely. By utilizing the directed links, the order of determination of the time to visit each tourism resource is recommended. As unnecessary reworks to adjust visiting time are reduced, design time can be shortened.

3.2.3 Content Network Model

In some cases, a synergistic effect occurs depending on the contents of the tourist services continuously received. For example, if a tourist visits a restaurant immediately after visiting another restaurant, the sightseeing tour may receive a low evaluation. Considering such synergistic effects is necessary. Possible synergistic effect is visualized as a color of the link between tourism resources, which is specified by contents the tourism resources have in common. It stands on an assumption that continuous visit to the same kind of tourism resources increases the impression on this content. When continuously visiting a set of tourism resources belonging to a cluster formed by the same type of link, the content common to the tourism resource is emphasized in the tour.

4 Design Approach to Planning Sightseeing Tours

The service designer creates a service policy to meet customer requests and then initiates the service design process. In sightseeing tour design, tourism resources are appropriately selected and aligned in a sequence to satisfy multiple customer requests. A multitude of customer requests are depicted as requests set in a request network. Analyzing request sets reveals the potential customer requirements. While referring to the request network, a designer operates the capability network, a candidate set of possible services. At this stage, the designer explores the possible design solution space. Then, while referring to the capability network, the designer operates the activity network, a set of services to be provided. At this stage, the designer specifies a design solution. If contextual links between elements are successfully conveyed in the transitions from request network to capability network and from capability network to activity network, the resultant activity network satisfies potential customer requirements (Fig. 2).

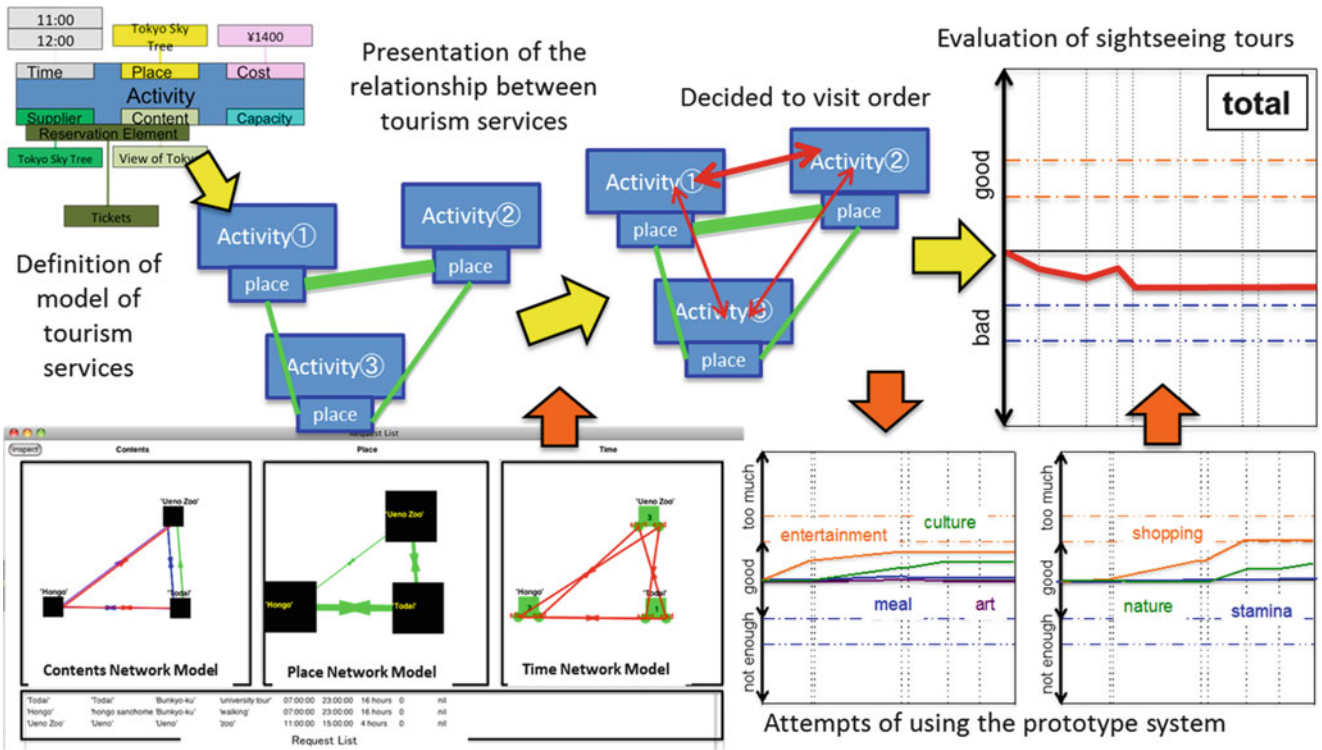

Fig. 2 Overview of sightseeing tour design

4.1 Determination of Capability Set

This section explains the search method for providing possible tourism resources that reflect individual requests. As previously mentioned, the ability to provide tourism resources is expressed as a capability. Several alternatives should be considered in the design study. As a result, a capability set that may be incorporated into a tour is formed. Because the capability set reflects requests, when the requests are later declared as activities adopted from this capability set, the activities reflect the requests. Additionally, input tourism resource information (a travel company holds all information on tourism resources) is presumed to exist in all capability formats. The method for creating and searching a capability set is as follows:

1. Create a single request for each customer request, and then create a set of requests.
2. Calculate a highly similar capability from a similarity calculation for the attribute elements from the request, and add it to the capability set.

When searching for a candidate set of capabilities in regard to the request set, finding a capability to satisfy each request is indispensable. However, a customer may not know each service well enough. Therefore, requests may not represent all customer requirements.

In such cases, the designer should be aware of the potential customer requirements. In the proposed service model, we assume that potential customer requirements can be read from the request set, in the context of a plurality of requests. The corresponding capability set should also convey the same context as the request set. Details of this method are presented by Mizushima et al. in [13].

4.2 Determining Activity Order

The visit sequence of activities is determined by referring to the capability network and request network, which is described as follows:

1. Create a network model of place, time, and contents using a request set.
2. Create a network model of place, time, and contents using a capability set.
3. Determine the combination of tourism resources that are visited successively from the capability network by referring to the request network.
4. Create an activity network from the capability network, which leaves only a link between capabilities for continuous visits.
5. Determine the time of each activity by referring to the activity network model.

When changing the network model, paying attention to the interdependence of the behavior of the network model of place, time, and contents is necessary. For example, changing the place network model of capability may unintentionally change the content network model of capability.

Responses to overt requests can be evaluated by checking whether the activity node exists in the activity network for each request node of the request network. In contrast, the potential requirements are represented as a link in the request network. Therefore, assessing the response to potential requirements is possible by observing the links that correspond to the activity network. In other words, a more similar shape and color of a network model better represents a tour that satisfies customer requirements.

4.3 Evaluation of Sightseeing Tour Plans

In Sects. 4.1 and 4.2, the method for completing a design study for sightseeing tours using a network model was discussed. The network model supports the design study by visualizing the information on place, time, and content that should be considered when engaging in a design. However, the sightseeing tours' effectiveness has not been evaluated. When adopting a final design, comparing and evaluating multiple tour proposals is necessary.

In this paper, the simulation of tourism services proposed in the previous study by the authors [8] is applied. In this proposed method, tourism services are evaluated by considering the satisfaction of services' stakeholders (customer, provider, and supplier). In addition to customer satisfaction, the supplier of each tourism resource and of the service's operation, i.e., the quality of the service when considering the provider's evaluation to operate the sightseeing tour, are evaluated. Service quality was assessed through these three evaluations. The following sections discuss the evaluation criteria for each stakeholder's satisfaction.

4.3.1 Customer Satisfaction

In the definition of service engineering, the customer is the receiver of a service and the change in the customer's state represents the value of the services. This proposed method assumes that the content of the activity influences the recipient's state change. We have developed a simulation model that can change the customer's state after an activity experience.

1. *Effect of customer's state*:
   The customer's characteristics are defined by the request, and the state of the previous experience of the activity is defined by the history of the activities. For customer characteristics, desired content elements are extracted from the content network of requests. The previous state of the activity is quantified by integrating the receiving amount of each element's contents before the activity.

Interchanging the order of the activities changes the integrated value of the receiving volume at the start of each activity. Therefore, the customer's state at the beginning of the activity differs. As a result, the state change in the activity also changes. The integrated value of the property and the receiving customer is the influence of the state of the customer at the time that the activity starts.

2. *Influence value of activity given by content*:
   The receiving amount of the content element of each activity is defined in advance. For each content element item, the amount that was proportional to the time spent on the activity defines the content of the activity.

The content effect of the activity from the amount of the received service obtained from the activity and the current state of the customer are defined by receptor sensitivity. The accumulated amount of each receptor's content element vector of the customer is calculated. From the integrated receptive amount, the overall state of the customer after the visit activity is defined. We evaluate the ability to keep high values and, thus, a high degree of customer satisfaction of sightseeing tours.

4.3.2 Provider Satisfaction

The provider works by performing a prior arrangement through negotiations with the supplier to operate the sightseeing tours. In this paper, such an arrangement is defined as a reservation element. This research introduced an evaluation of the difficulty of this arrangement. We define that fewer reservation elements and those with lower difficulty result in good tours for the provider. The difficulty of the arrangement of the reservation element is considered to be influenced by the visit time zone and the activity. This difficulty is defined as a function of time.

4.3.3 Supplier Satisfaction

Tourism resources have off times with fewer visitors and busy times with many visitors. If a supplier accepts tour visitors during a busy time, they might lose the customers who avoid suppliers because of long lines. Thus, an activity operated in an off time results in higher income than that operated in a busy time. We assume that busy or off times depend on the visiting time zone of the activity, and we defined supplier satisfaction as a variable that changes with time.

5 Prototype System Verification

5.1 Verification Example and its Parameter Settings

The prototype system is created to design and evaluate sightseeing tours using specific proposed methods. This verification example displays a comparative evaluation of the visiting sequence of a sightseeing tour. In addition, the content synopsis, reservation metrics, and supplier metrics are defined in Table 4.

In this paper, the verification example is as follows. The customer has requested a visit to Roppongi, Tokyo Tower, Ueno, and Shibuya. The evaluation process and the results based on the visiting order of these four places are shown below.

5.2 Evaluation of Plan Utilizing the Network Model

The request to visit Roppongi, Tokyo Tower, Ueno, and Shibuya was defined. The network model of the request was then created (Fig. 3). Using the network model of the request as the base, the capability network model was created. As each capability that fulfills all request criteria is found in the search, it is added to the capability network model (Fig. 4). In this verification example, the capability used for Roppongi Hills, Tokyo Tower, Ueno Zoo, and Shibuya is shopping.

Within the capability network, Roppongi Hills, Tokyo Tower, and Shibuya have relatively stronger ties to shopping, as derived from the place network (Fig. 4b), and form a cluster. This derivation indicates the tourism resource proximity between these three places. In addition, within the content network model (Fig. 4a), a shopping-related content link is formed between Roppongi Hills and Shibuya; it implies that this customer has the potential request to go shopping. Regarding the time network model (Fig. 4c), almost no time constraint exists for each of these resources; therefore, no specific features were formed.

Once the capability network is created, it is used as the basis for the activity network model that selects the tourism resources and to plan the order of visitation, thereby creating a sightseeing tour (Fig. 5). In this example, the visiting sequence prioritizes the resources with the closest geographical proximity, followed by prioritization by content continuity.

Table 4 Design study evaluation items in the validation example

	Item name
Items of content element	Hunger, fatigue, acceptability for arts, acceptability for culture, acceptability for entertainment, acceptability for nature, acceptability for shopping
Evaluation items of reservation element	Flexibility for arrangements, difficulty for arrangements, difficulty of reservation by time zone, difficulty of reservation by number of people
Evaluation items of supplier	Difficulty of supplying by time zone

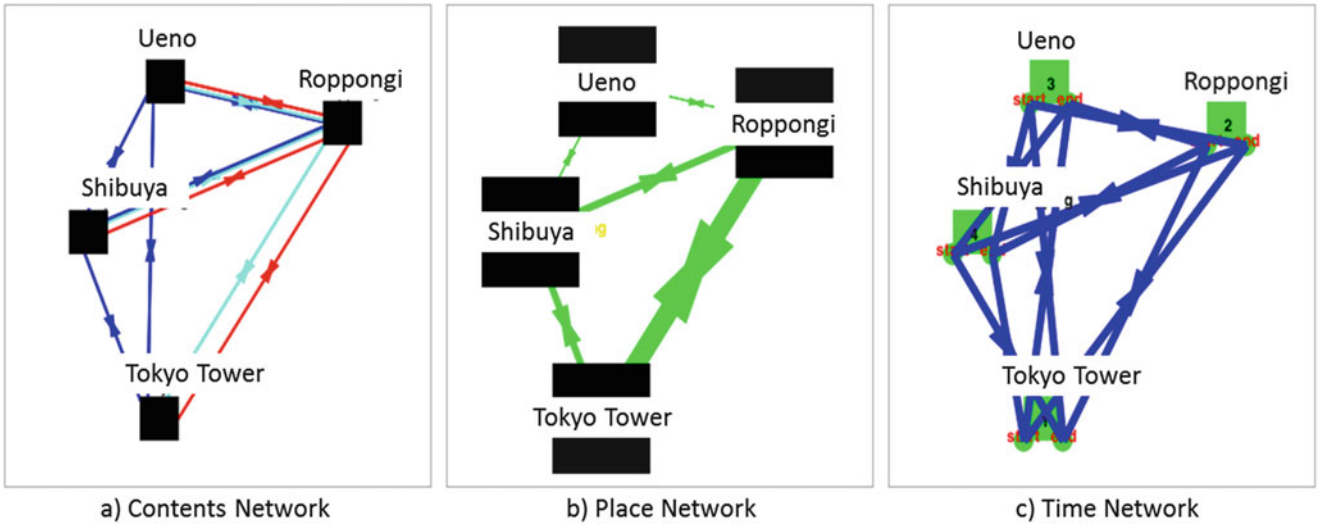

Fig. 3 Request network model

Fig. 4 Capability network model

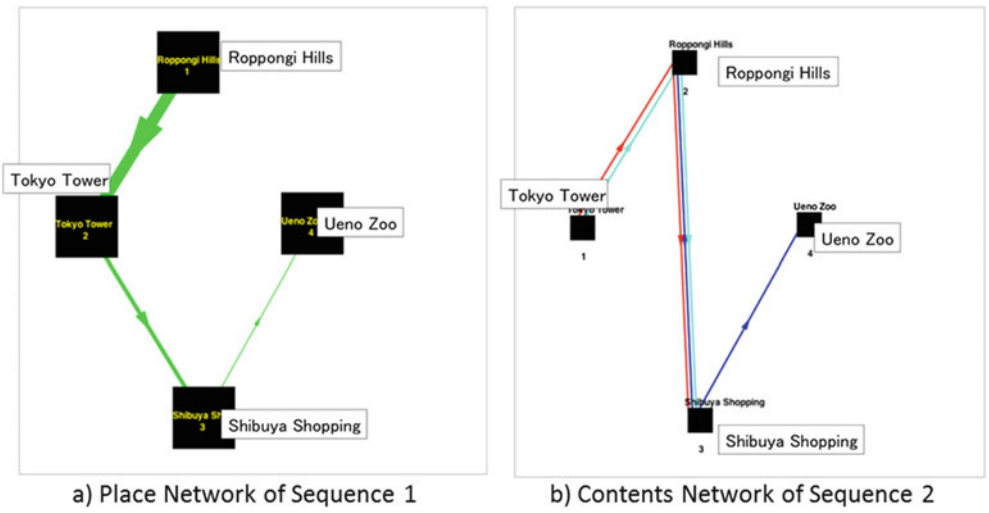

Fig. 5 Decision of visit order on network models considering synergistic effects

The visit sequence predominantly prioritizes geographical proximity, and the main capability used is the place network model (Fig. 4a).

To maximize the thick links between Roppongi Hills, Tokyo Tower, and Shibuya, the sightseeing tour itinerary starts with shopping at these three destinations, followed by a visit to Ueno Zoo.

The planning of the order of the items in the itinerary takes into account the content. Because the request parameter of the content network indicates a potential requirement for shopping, to emphasize this area, the itinerary includes, first, a tourism resource series linked to shopping. The capability of the content network model indicates the common link of shopping for Roppongi Hills and Shibuya. Therefore, to visit these places in succession, the itinerary order is changed to Tokyo Tower, followed by shopping at Roppongi Hills and Shibuya, then Ueno Zoo.

5.3 Design Review Using Service Simulation

This design review evaluates the created sightseeing tour plan. The sightseeing tour previously adopted determines only the itinerary order but does not account for the method of transportation and time used in transport. Therefore, a completed itinerary including additional details is required. Table 5 indicates the sightseeing tour draft planned using the determined visiting order. The evaluation results of this sightseeing tour proposal are subsequently shown. Although comparing multiple tour proposals is desirable, because this paper focuses on the use of a network model, only the itinerary based on visit order is considered.

Figure 6 shows the results of the evaluation from the customer perspective of the sightseeing tours in Table 5. Regarding whether all customer requests have been fulfilled and whether customers' strong request for shopping is reflected in the sightseeing tour, a high satisfaction rate was recorded. Table 5 does not indicate that the provider achieved high satisfaction because the activities did not require significant prior arrangement. In contrast, because shopping in Shibuya was arranged during peak hours, supplier satisfaction was low.

Therefore, the details of the sightseeing tour were arranged to perform the design evaluation. The received results are used again to refine the sightseeing tour.

5.4 Verification Considerations

This paper proposed a design study method using network visualization incorporating consideration of visit order. In the validation example, the order is not decided using purely the efficiency of moving between each place according to the place network model. The content network suggests a

Table 5 Planning verification item of verification example

Activity	Place	Content	Start time	End time
Tokyo tower	Tokyo tower	Tokyo view	10:00–10:15	11:15–11:20
Transportation	↓	Transportation	11:00–12:00	11:05–12:05
Roppongi Hills	Roppongi	City walk	12:00–12:30	14:00–15:00
Transportation	↓	Transportation	14:00–15:00	14:10–15:10
Shibuya shopping	Shibuya	Shopping	14:00–15:00	15:00–16:00
Transportation	↓	Transportation	15:00–16:00	15:50–16:50
Ueno Zoo	Ueno	Zoo	15:00–17:00	16:00–18:00

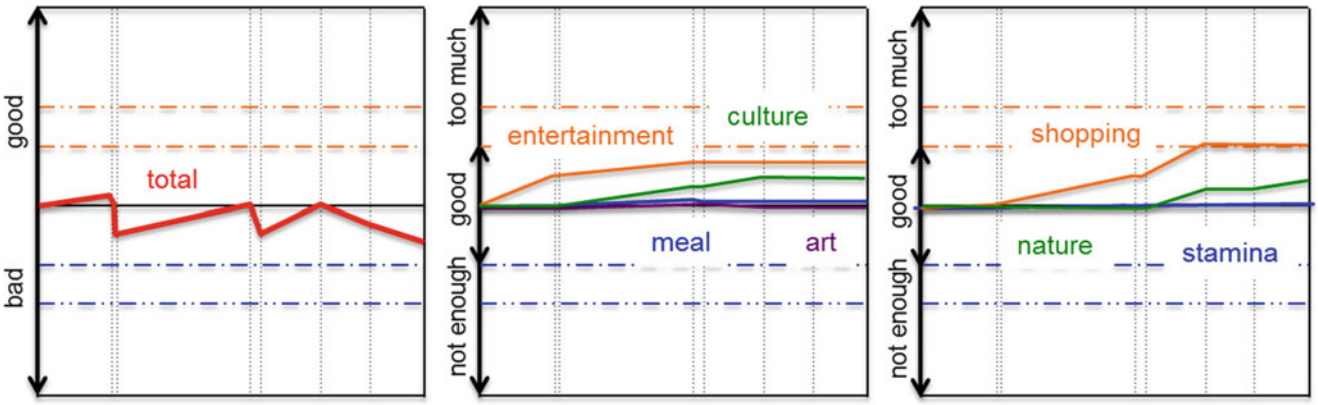

Fig. 6 Evaluation of sightseeing tours by customer state transition

potential request that is further supported by considering common content links between capabilities and arranging them by link order. Although a map may be used to verify the visualization of the place network, the advantage of this system is the ability to visualize the content of services and the links between these services. Furthermore, because the content network and the place network are not independent, reordering based on content can result in deteriorated conditions regarding place. The trade-offs between the different views are considered. In contrast, the design review and their relations remain to be verified. In this design study stage of the utilization of network models, information such as the mean of transportation and the time required between tourism resources have not been defined. However, these details were decided before the design evaluation. Therefore, the effects while transporting between places (e.g., scenery and congestion) and the best timing to visit each tourism resource (e.g., peak hours and view of sunset) are not accounted for in the design study stage. Even though the itinerary is the same, a change in the start time or visit duration of the tourism resources significantly affects the evaluations. A design support method that reflects these areas needs to be considered.

6 Conclusion

Regarding sightseeing tour planning, a support method was proposed to decide on the order of the services offered. For each activity in a sightseeing tour, its temporal factor (time), spatial factor (place), and semantic factor (content) relationship are visualized using a network model (each activity is a node), making it possible to use the model as support when designing and evaluating sightseeing tour itineraries. This method successfully depicts the contextual relationships between the activities in terms of time, place, and content. In particular, the content network indicates a contextual connection between the activities, which is usually managed implicitly.

The previously conducted service simulation research is used to evaluate the order of services, making it possible to evaluate the designed service. This simulation also partially incorporates the contextual aspect of the service, which is the state of the service receiver. Validity of the method is verified through a real prototype system used to plan sightseeing tours.

In this paper, we propose a computer-aided method to support the planning of a sightseeing tour itinerary. Although many forms of services exist, this method can be further developed and adopted for services with difficult order planning, such as tourism. The authors believe that the presented system can support situations for which planning requires consideration of the service attribute relationships that form multiple networks and for which services have multiple linkage points. Thereby, the method can contribute to increasing the productivity of the service industry.

References

1. Website Service Productivity & Innovation for Growth (SPRING), http://www.service-js.jp, (2015/03/01)
2. Japan Tourism Agency, Tourism Nation Promotion Basic Plan, http://www.mlit.go.jp/kankocho/kankorikkoku/kihonkeikaku.html, (2015/03/01)
3. Nihon Keizai Shimbun, http: //www.nikkei.com/article/DGXNZO63439740R01C13A2SHA000/ (2015/03/01)
4. Hiroyuki Yoshikawa, Service Engineering Introduction. Framework for handling service theoretically, Synthesiology, Vol. 1, No. 2 (2008)
5. Savas Balin and Giard Vincent, 2006, A service-oriented approach to the service concepts, Service Systems and Service Management 2006 International Conference, Vol. 1, pp. 785–790
6. Scott E. Sampson and Craig M. Froehle, Foundations and implications of a proposed unified services theory, Productions and Operations Management, Vol. 15, No. 2 (2006), pp. 329–343
7. Yoshiki Shimomura, Hara Tatsunori, Kentaro Watanabe, Tomohiko Sakao, Tamio Arai, Tetsuo Tomiyama, Service engineering proposal: 1st report, modeling techniques (mechanical elements of service for service engineering, lubrication, machine tools, production management, etc.), Japan Mechanics Proceedings Part C, Vol. 71, No. 702 (2005), pp. 669–676
8. Yohei Kurata, Keiichi Okunuki, and Yukio Sadahiro, Development of a tourism course automatic creation system in accordance with the personal taste, Geographic Information Systems Association Conference Paper Collection, (2000), pp. 199–202.
9. Yohei Kurata, More flexible and interactive assistance for day tour planning, ENTER (2011) pp. 25–37
10. Jun Hirota, Ogiwara Yosike, Toshiki Mizushima, Kazuya Oizumi, and Kazuhiro Aoyama, Travelers in tourism, travel company, proposed sightseeing tour design that takes into account the effect relationship of tourism resource provider, Annual Conference of the D&S in JSME (2013)
11. Kazuya Oizumi, Yohei Meguro, CX Wu, and Kazuhiro Aoyama, Supporting system for tour lineup based on tour service modeling, In Proceedings of CIRP IPS Conference 2012, CIRP (2012), pp. 257–262
12. Yosuke Ogiwara, Kazuhiro Aoyama, Kazuya Oizumi, and CX Wu, Tourism design information description model to design support sightseeing tours, Service Society of the 1st National Convention (2013)
13. Toshiki Mizushima, Jun Hirota, Kazuya Oizumi, and Kazuhiro Aoyama, Tourism structure definition of tourism resources information in the design support system of tour, Annual Conference of the D&S in JSME (2014)

Service Data Model in Design Support System for Sightseeing Tours

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Abstract

This paper proposes a data structure definition of the tourism resources that will help tour designers determine tourists' fundamental needs based on their requests and design their tours more efficiently. This study analyzes tour services and divides the information useful in proposing services, based on tourists' requests, into three types: geographical, time, and meaning information. This paper employs those three types of information to define two indexes for use in proposing services that match customer requests.

Keywords

Service design • Service model • Sightseeing tour • Data modeling

1 Introduction

1.1 Background

Services must fulfill customers' needs and satisfy them. This cannot happen unless service providers fully grasp those needs. Service design draws from a great many resources, and designers must select those that match their customers' needs. Designers must often depend on their intuition and experience, thus drawing heavily on their individual skills. As experienced and skilled designers are limited, increasing productivity in the service industry while maintaining quality is difficult.

1.2 Tourism Industry in Japan

The Japanese consider their tourism industry to be important, and the government has made efforts to attract more tourists. In 2013, more than ten million tourists visited Japan [1]. The 2020 Tokyo Olympic Games are expected to increase demand for tourist services. To meet the growing demand, Japanese tourism companies must improve productivity and design attractive tour services more efficiently.

1.3 Tour Design Process

Designing tours requires much time and effort from designers because they must consider so many different factors, and the quality of the results heavily depends on their personal skills and experience. To design a tour, designers first determine the customers' needs; then, they select a set of tourist attractions and establish their sequence. Finally, they verify the tour's feasibility and evaluate the plan. Hirota [2] presents a method to help designers determine the sequence of the selected services and evaluate their tour plans.

When the requested services are insufficient for a tour schedule, the designers must find other services to include in the tour. Experienced designers select a set of available services and assemble them into a feasible form based on their experience, which effectively tells what the tourists' fundamental needs are. However, unskilled designers will likely not grasp those fundamental needs nor assign the

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appropriate services. Design is thus left to experienced designers only, which reduces productivity of tour design.

1.4 Research Objective and Approach

The main objective of this study is to propose a structural service data model and method by which tourism company designers may select the services that match tourists' fundamental needs and thus efficiently select the appropriate tour resources. This will make tour quality less dependent on the designer's skill and allow less skilled designers to design attractive tours more easily.

The relationships among customer requests are meaningful to tourists' fundamental needs. To grasp the needs expressed by these requests, this paper focuses on the similarities present among sets of semantic information.

2 Previous Works

The growing service industry requires a method of industrial service design [3]; options include computer modeling and the creation of design knowledge databases [4].

The differences between products and services are acknowledged in Unified Service Theory [5]. In the service-dominant process, defined in [5], feedback from service receivers can change the process immediately, even as the process is ongoing. However, such onsite adjustments cannot be designed in advance, before the service is offered in the marketplace. Thus, the former design, or plan, could be quite identical to that of products.

The method developed by Uehara [6] vectorizes the features of tourism resources based on Web information and recommends the tour services that match the locations the users select. In this method, however, the selected tour locations do not reflect the reasons why the users selected them, leaving undetermined whether, for example, the users are interested in history, want to feel relaxed, or enjoy quiet places. The recommended services are therefore not likely to reflect users' fundamental needs.

Tarui [7] proposes a system that vectorizes the features of tourism resources (the "tourist site vector") and users' travel histories (the "travel history vector") to produce tour recommendations. These vectors indicate what is important to users when they select their tour services. The system can also recommend tour spots users have never visited by referencing the travel histories of other travelers with similar feature vectors. The reliability of this system is dependent on the amount of travel history data available and the users' provision of their own travel history; obtaining detailed travel histories is difficult.

3 Tour Design System

3.1 Tourism Service Model

This paper proposes a method by which tour designers may recommend service candidates to customers based on their fundamental needs using a service model discussed in previous research [8]. In this model, a tour is described as a sequence of activities representing the experiences of a single tourism resource. The tourism resources model consists of seven elements, as shown in Fig. 1: place

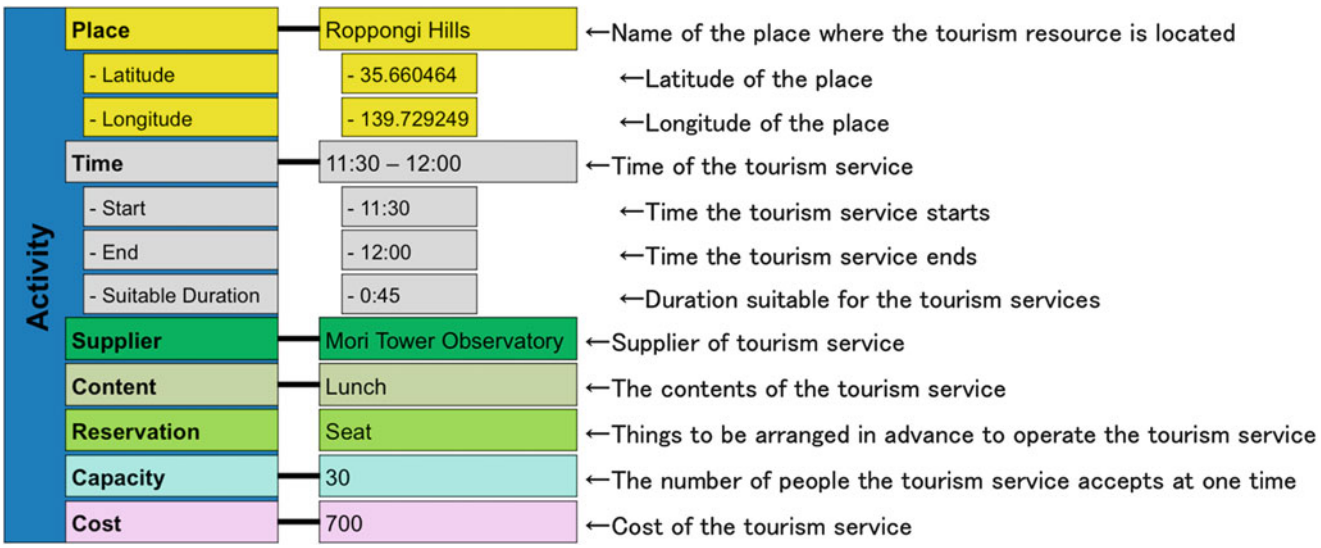

Fig. 1 Tourism resources model

Table 1 Tourism resources model of each stakeholder

Tourism resource model name	Stakeholders	Role	Tourism resource information
Request	Customer (tourist/traveler)	Receiving tourism services	Wish to do
Capability	Supplier (tourism resource)	Supplying tourism services	Able to do
Activity	Provider (travel company)	Operating sightseeing tours	Going to do

(denoting "where"), time (denoting "when"), supplier (denoting "who"), content (denoting "what"), reservation (denoting "how to arrange it"), capacity (denoting "how many"), and cost (denoting "how much"). Combinations among these elements describe tour service composition. Designing a tour service involves designing individual activities and determining their sequence. Place, time, and content operate hierarchically, enabling a comparison among the elements through distance calculation. The sums of the similarities among the elements of the tourist resources are compared, and the similarities among the tourism resources are determined.

Each stakeholder has a different perception of each tourism resource. The literature [8] offers a model (displayed in Table 1) defined from the points of view of three stakeholders: the customer (tourist), provider (travel company), and supplier (tourism resource). The customer receives tourism services, the supplier supplies them, and the provider operates them. Stakeholder information can be compared by examining a model comprising of tourist resources viewed from the perspective of all the stakeholders. Comparing request and capability allows designers to determine whether the capability provided by the supplier meets the customers' requests. Comparing capability and activity allows designers to determine whether the capability provided by the supplier provides the activity desired by the provider. The same types of tourism resource can also be compared in this model; for example, similar capabilities can be compared to identify alternatives.

3.2 Design Process

This paper considers the tour design process outlined by Hirota [2], in which activity is expressed as a node, and the relationships among the activities are visualized by a network model. A tour is designed in the following steps:

Step 1: Learn what the customer wants to do (input request). Here, the designer researches the customer's requests for the tour.

Step 2: Grasp the relationships among the requested services (create request network). Here, the designer determines the geographical relationships among and contents of the requested services and their requested sequence.

Step 3: Select the services that match the customer's requests (search the capability corresponding to each request; see Fig. 2a). The designer compares among the requests and capabilities and selects the capabilities that meet each request.

Step 4: Grasp the relationships among the services selected in Step 3 (create selected capability network). Here, the designer determines the geographical relationships among and contents of the selected services and the timing flexibility they allow.

Step 5: Search for additional services if those selected are insufficient for a tour (add new capability if needed; see Fig. 2b). If the tour allows enough spare time, the designer can search for additional tourism resources to visit.

Step 6: Considering the customers' needs, determine the sequence of the selected services (determine sequence of activity considering the request and capability network; see Fig. 2c). The designer compares the requested and selected services to establish the tour schedule. Afterward, the tour's feasibility is confirmed, and the tour is evaluated.

3.3 Position of This Study in the Design Process

This paper focuses on step 5, in which a new capability is added to the capability network based on combinations of requests. In this step, the designer searches for and assigns new services based on the customers' fundamental needs when the requested services will not last long enough to fill a tour schedule.

Combinations of requests appear within the context of the customers' fundamental needs and display the similarities among them. By evaluating the similarities between the context and the other services, designers can judge whether those services share a context and are thus able to meet the fundamental needs of the customers.

However, current service models do not provide tour designers with the information required to grasp request contexts because their similarities are calculated only via the hierarchical structure of the elements of the model; designers can judge the similarities among services but not those between the contexts and each service. To facilitate the evaluation of contexts and customers' fundamental needs, this paper extends the service information structural model used by previous research [8].

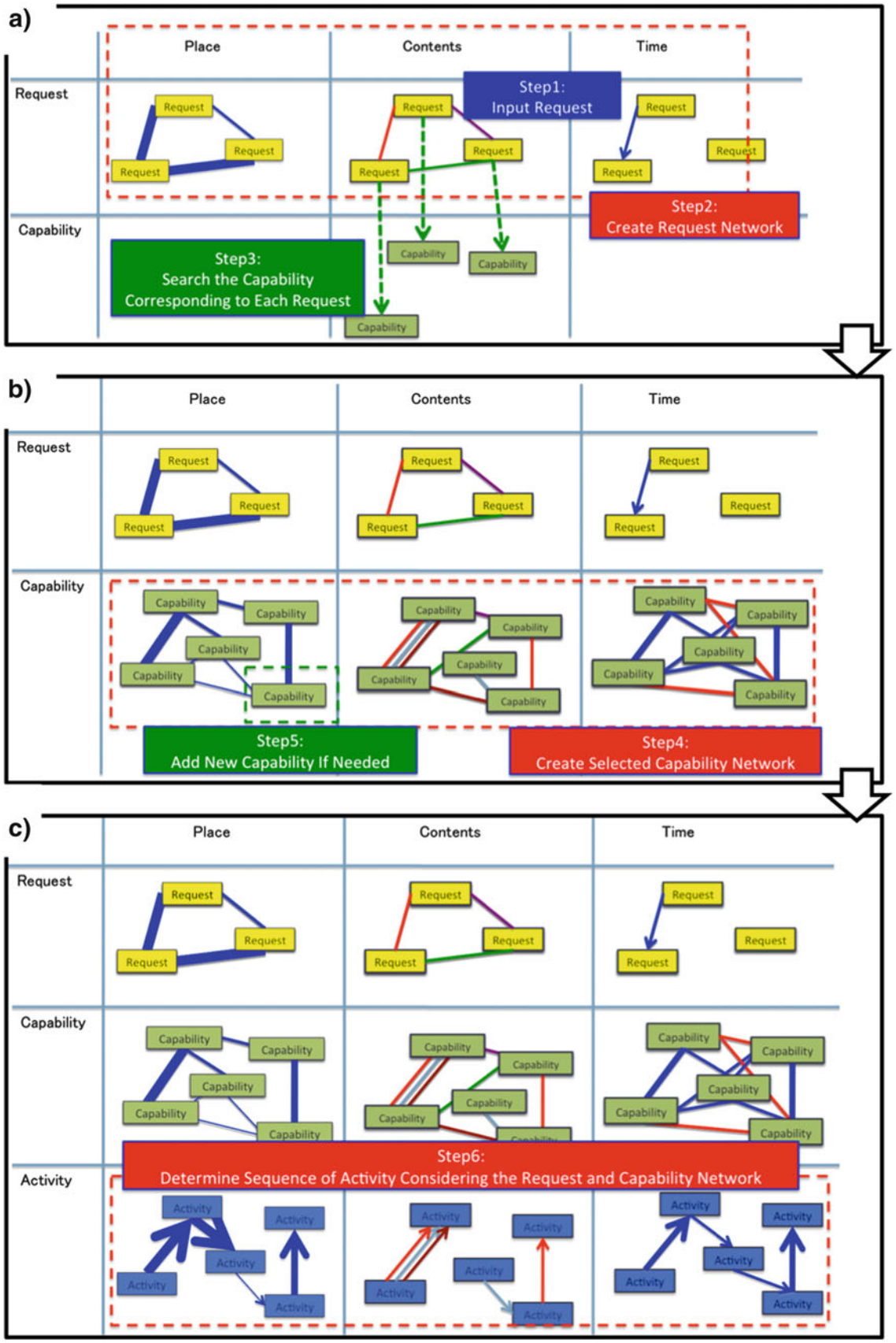

Fig. 2 Tour design process [2]

4 Extension of the Service Model

4.1 Specification of the Model

To find the services that meet customers' needs, designers must judge whether each candidate service shares the context of the requested tourism resource by evaluating their degree of similarity. This is difficult to do using the current model because it evaluates similarity only through the hierarchical structure of model elements and doesn't reflect the customers' perspectives. To ensure that the evaluation does reflect the customers' views, the information listed below should be incorporated into the tourism resource model:

- Action: What customers do during the service
- Character: The direction of the tourism service
- Taste: The atmosphere of the tourism service
- Age: The appropriate age range of the tourism service

The content of each service reflects the customers' actions and their objects. Thus, "lunch" contains the behavior "eat French food," in which "eat" is the action, and the object is "French food." Services that share an action or object are considered similar and may have a common context. This information allows designers to find services that match the contexts of the requests as implied by the customers' actions (defined as both the expressions of the actions themselves and their objects).

Different services affect customers differently. Services that inspire similar feelings in customers are considered to have similar properties. To judge services' similarities, information on the services' properties must be provided.

The number of people who will enjoy a service depends on whether the service matches the visitors' preferences. For example, "artistic" resources will likely not impress people who have no interest in art, and "nature" resources will not impress people uninterested in the natural environment. This paper denotes the totality of a service's properties as its "character." The atmosphere of a service, such as its "calm" or "busyness," affects customers emotionally; the service's main target age, such as "for adults" or "for families," also impacts customers' impressions. The former property is denoted as "taste" and the latter as "age."

Using these considerations, this paper defines the structure of tourism service information as shown in Fig. 3. The resultant information and similarity index are defined as follows.

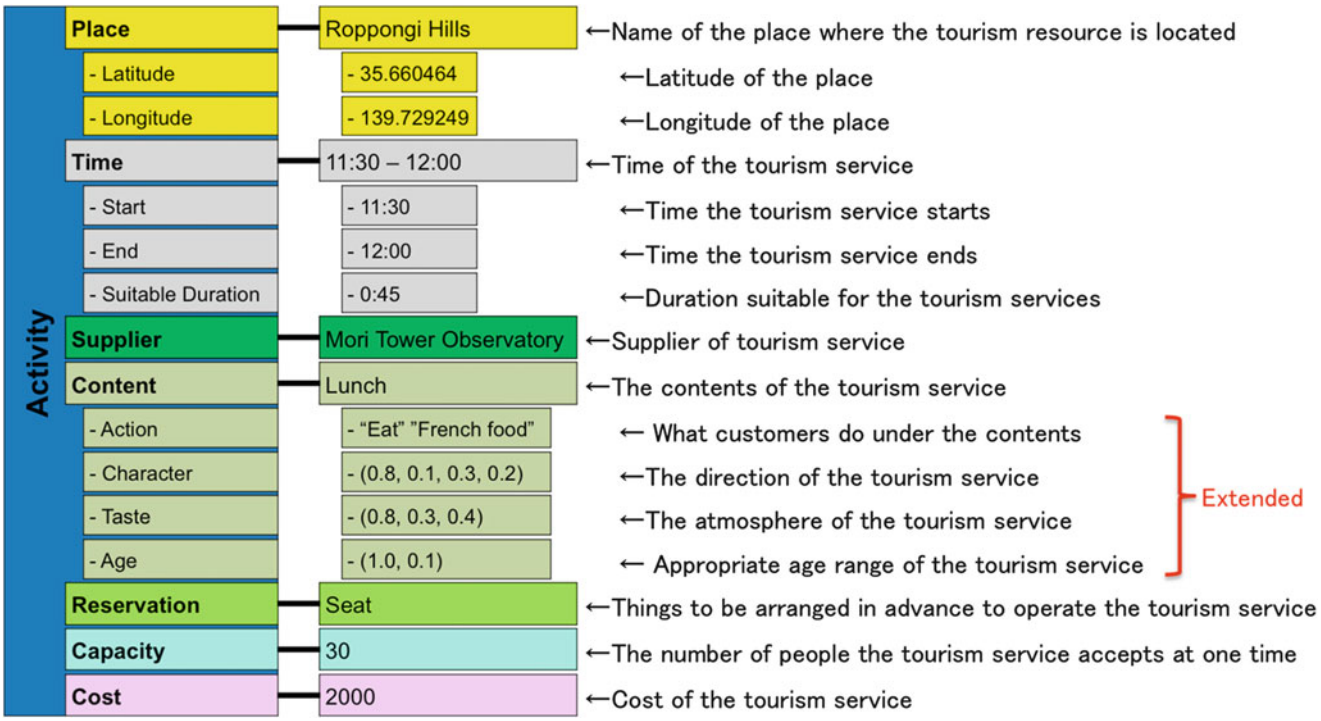

Fig. 3 Extended tourism resources model

4.2 Analysis of Semantic Information

Each tour service necessarily contains a tourist action. For example, going to the museum is the service whereby people visit exhibits, and going up to the observation deck of the Tokyo Sky Tree is the service whereby people see the scenery. The action "see" is the customer action, and "exhibits" and "scenery" are its subjects. Such sets of actions and their subjects constitute tourism services. This paper uses customer action as the index by which similarities among tourism services are evaluated from the point of view of service form.

Information that does not depend on service format can affect the similarities among the services. People can enjoy seeing the scenery from the observation deck of the Tokyo Tower or the Tokyo Sky Tree: both represent the same "see" service. However, the Tokyo Tower and Tokyo Sky Tree offer totally different sceneries and moods. Meanwhile, a museum and a ceramic art show are both cultural events but have different service forms. While both events have a "cultural" property, implying a service similarity, this similarity will be affected by the services' specific elements and the feelings the customers experience during each service.

4.3 Similarity Calculation of Semantic Information

Determining the similarities among actions enables an evaluation of the similarities between candidate tourism services and the contexts of the requested services from the point of view of form. Services that share an action type or subject are considered to be similar. Subjects of actions can be clustered according to their abstraction level (e.g., building ∋ historic buildings ∋ castle). This paper organizes actions using a hierarchical structure according to type and subject. Each action is represented as a combination of structural elements (described as "top" elements and "bottom" elements for convenience). For example, in Fig. 4, Action Z, which has three elements ("castle," "historical building," and "visit"), is described as "visit castle." Using this structure, the evaluation value of the similarities among tourism services is calculated from the point of view of the services' form. This paper defines that value as the "action score." In Fig. 4, Action Y and Action Z share two elements ("visit" and "historical building"), and these two elements reside in the contexts of Action Y and Action Z. Action X has three elements and shares one element ("visit") with this context; thus, Action Score X is calculated as 0.33 (1/3).

The property of a service, such as the impression it gives or its atmosphere, has many factors. Not only the presence of each factor but also its strength must be represented. Therefore, this paper expresses the property of a service using a vector, with elements representing the strength of the factors. Cosine similarity is used to calculate the evaluation value of the similarities among tourism services from the point of view of their properties. This paper evaluates the similarities among tourism service forms by defining three vectors as follows:

- Character vector: The direction of the service
- Taste vector: The atmosphere of the service
- Age vector: The appropriate age range of the service

The elements of these vectors are defined based on Kurata [9], in which, for example, the taste vector has three dimensions: degree of less-known, degree of calm, and degree of local. The value of each element ranges from −1 to 1. In Fig. 5, a customer wants to enjoy service A and service B, denoted as "request A" and "request B." Request A has the taste vector (0.9, 0.3, 0.2), and request B has the taste vector (−0.1, 0.3, 0.7). The vector that directs to the midpoint of these two vectors is determined as the context vector, which represents the fundamental needs of the customers who want to enjoy service A and service B. In Fig. 5, the context vector of requests A and B is (0.4, 0.3, 0.45). In this paper, each tourism service has a three-dimension taste vector. Similarities are calculated between the context vector and each taste vector. The more a service's taste vector is similar to

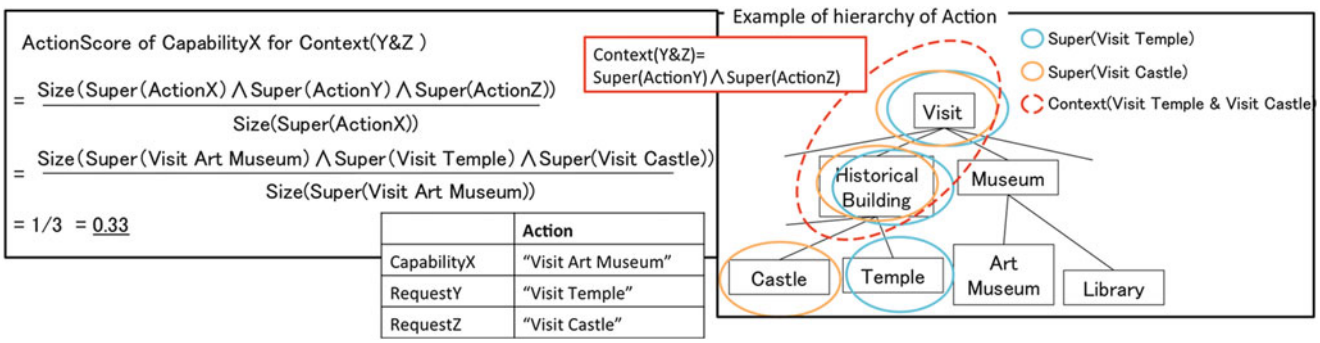

Fig. 4 Calculation of action score

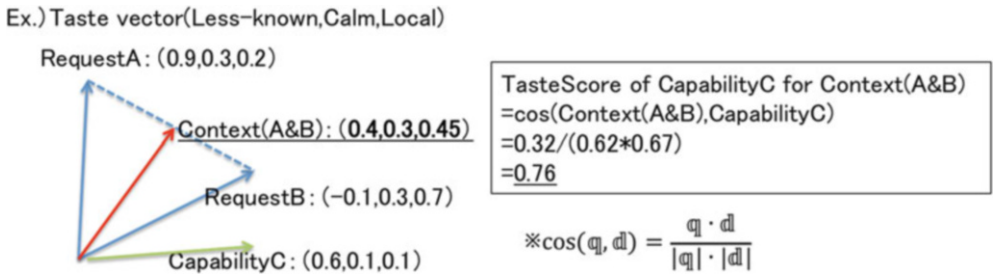

Fig. 5 Calculation of taste score

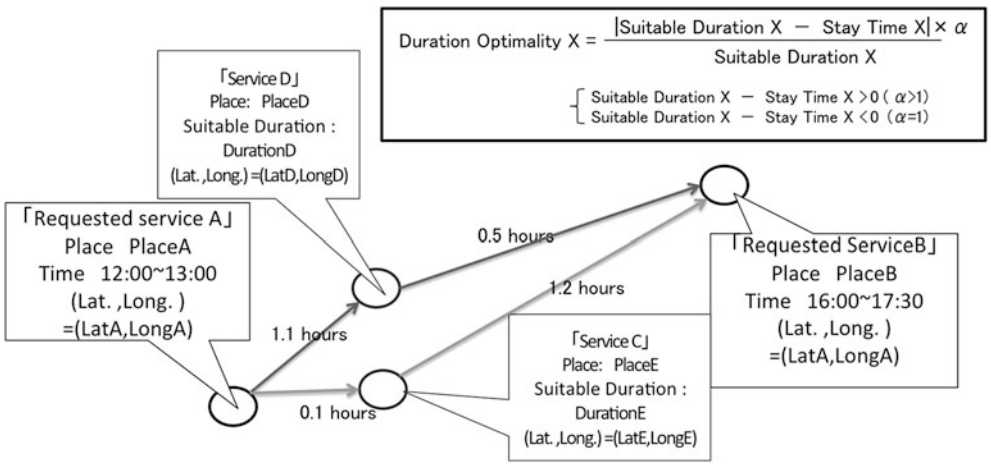

Fig. 6 Calculation of duration optimality

the context vector, the more appropriate the service is for meeting the customers' needs. This evaluation value is the taste score; the character score and the age score are derived the same way. The similarity score is obtained by summing up the action scores; these three scores use fuzzy integration.

4.4 Index of Geographical and Time Information

The location and duration of the requested services restrict the options of additional ones. Tour design would be more efficient if designers could determine which of the available services that meet the geographical contexts of the requested ones can be assigned most easily.

Designers must calculate the time needed to move between service locations in order to judge whether a service is feasible under the requested situation. To this end, this paper uses the latitude and longitude of the location. The time required for a customer to fully enjoy a service is denoted as the "suitable duration," and the time allowable for enjoying the service under the requested situation is the "stay time." Comparing these two times indicates the degree to which the customer will be able to enjoy the tourism service. The gap between the two is denoted "duration optimality." This study scores tourism services based on this index. Services with higher duration optimality are able to satisfy a customer more effectively under the requested geographic and time restrictions (see Fig. 6).

5 Service Recommendation and Efficacy Verification

5.1 Output Example

This study develops a service recommendation system following on from the previous chapter. At least two services must be input into the system as customer requests; the system then calculates the similarity score and duration optimality of the other tourism services. Then, the system outputs the resultant tourism services on Google Maps with color-coded icons corresponding to both scores, allowing designers to determine the similarities visually. Color shadings indicate the scores. A large marker in a deep color represents the location of a tourism service similar to the context of the requested ones.

If the color of the circle is deep, the service's duration optimality is good under the requested situation. The

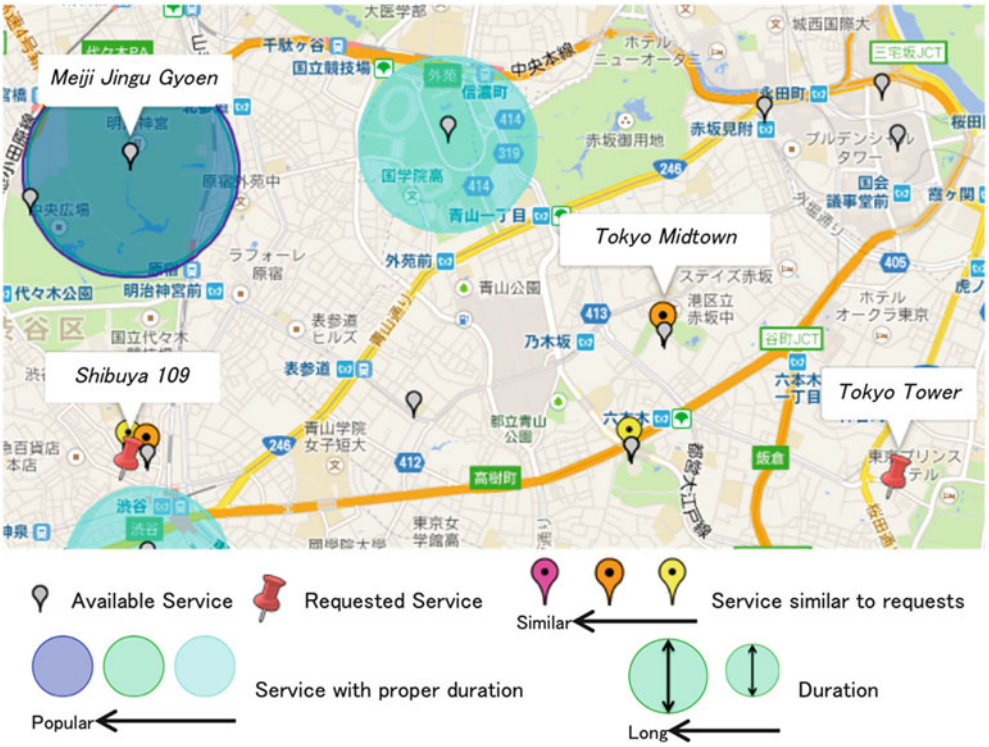

Fig. 7 Output of services on Google Maps

Table 2 Input request

Request	Place	Action	Requested time
"Want to go up to the observation deck of Tokyo Tower"	Tokyo Tower	Landscape (enjoy scenery)	10:00–12:00
"Want to go shopping at SHIBUYA 109"	SHIBUYA 109	Department store (shopping)	13:00–

designer can change the coefficient of each score via fuzzy integration, which changes the similarity score according to the element the designer views as important. In Fig. 7, "Want to go up to the observation deck of Tokyo Tower" and "Want to go shopping at SHIBUYA 109" are input as a combined customer request (see Table 2), and the system evaluates other tourism services. In the output, designers can visually grasp that "Go shopping at Tokyo Midtown" has a high similarity score and that the duration optimality of "Visit Meijijingu Gyoen" is also high under the requested situation. The former service matches the customer's fundamental needs, as expressed in the input requests, and the latter is given sufficient time to be enjoyed between the two requested services within the given time limit.

5.2 Application of the 1-Day Tour Design

An example of the use of the system based on the design flow described in Sect. 3.2 is presented below.

Suppose two requests, "Want to go to Printemps Ginza" and "Want to visit Yasukuni Shrine," are made for a 1-day tour. These would be awkward because they would leave the customer with a great deal of free time. Therefore, the designer must choose additional tourism services based on the customer's fundamental needs, requiring a manual search through a huge number of tourism resources and the expenditure of much time and effort.

First, the designer inputs the two requests and then creates a request network. The designer assigns two capabilities that correspond to those requests, "Go shopping at Printemps Ginza" and "Visit Yasukuni Shrine," and creates a capability network. The designer inputs the two requests into the system, which then evaluates the similarities between other tourism services and the combination of the two requested services. The designer visually determines which services have high Duration Optimality and Similarity Scores and uses this information to select additional capabilities (see Fig. 8). For example, "Go shopping at Shinjuku Takashimaya" and "Visit Yushima Tenmangu" are formally similar to the requested services and are thus marked in a deep color – indicating that they match the customer's fundamental needs. Meanwhile, "Go to Mori Art Museum" is neither a "shopping" service nor a "visit shrine or temple" service; thus,

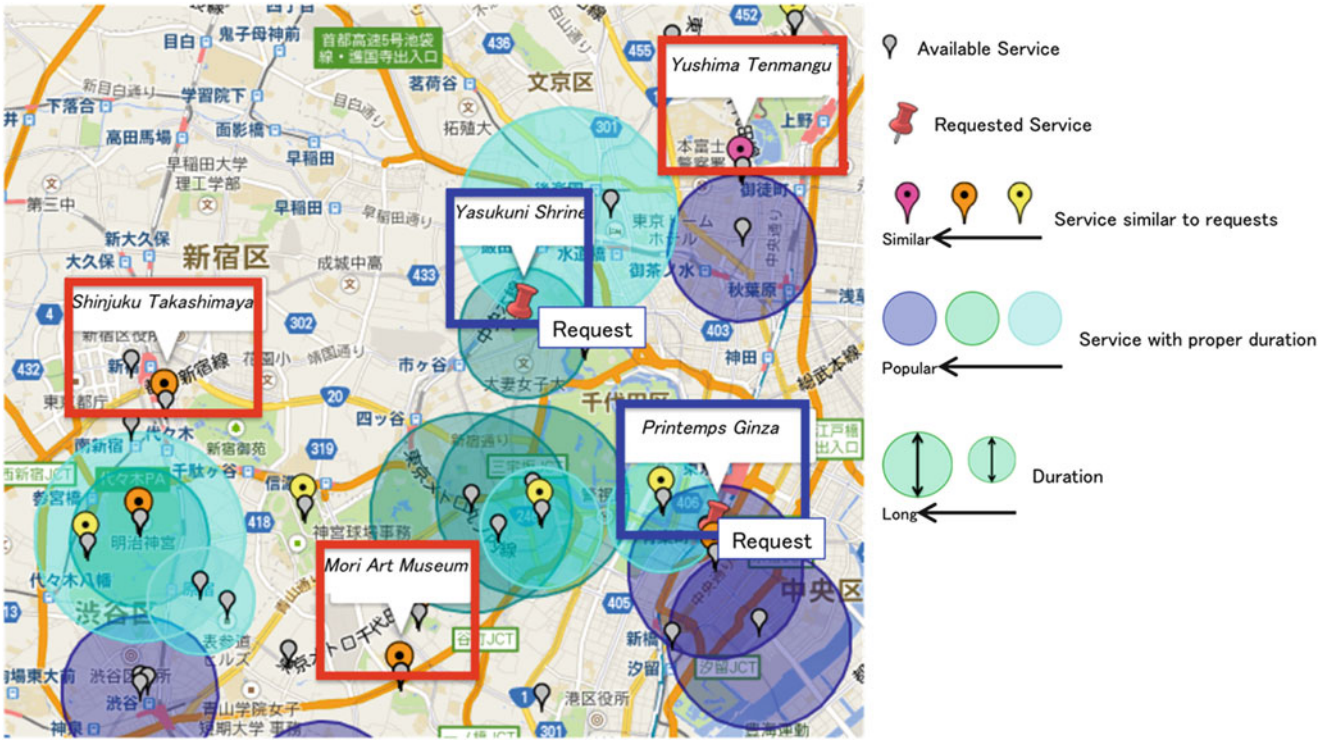

Fig. 8 Evaluation of services based on two requests

its form is different from that of the requested services. However, the system judges that these three spots have some shared properties, such as quietness and an "adult" impression, indicating that the properties of "Go to Mori Art Museum" can meet the customer's fundamental needs; this is why the marker of this service also has a deep color. At this point, the choice of service is up to the designer. Suppose the designer selects "Go to Mori Art Museum" and adds it to the capability network. There would then be three assigned capabilities in the network: the new one and the originally requested ones. Taking the length of the tour and the combination of the assigned services into account, the designer adds other capabilities in the same flow if necessary. Based on the capability network thus created, the designer uses Hirota [2] and determines the sequence of the services in the tour. The tour plan is thereby completed from the customer's requests.

6 Conclusion

This paper proposed a method of enabling tour designers to determine the contexts of requested services and judge whether candidate services share their contexts by incorporating the following information into the current tourism resources model:

- Action: What customers do during the tourism service
- Character: The direction of the tourism service
- Taste: The atmosphere of the tourism service
- Age: The appropriate age range of the tourism service

These data as well as geographical information are used to define two indexes: similarity scores and duration optimality scores for use in selecting candidate services. Designers select the tourism resources that match customer needs; this model helps them grasp the contexts of customer-requested services and find the matching resources, reducing tour quality's dependence on designer skill and experience.

Future research should seek to determine the parameters of tour services' semantic information and value objectively. There are many kinds of services that require designers to select the appropriate resources from among an enormous number of them. Defining a structural data model and a resource selection method can reduce service design's dependence on individual designers' skill and experience, increasing the productivity of the service industry.

References

1. Nihon Keizai Shimbun, http: //www.nikkei.com/article/DGXNZO63439740R01C13A2SHA000/ (2015/03/01)
2. Hirota J., 2014, Design of Sightseeing Tours Considering the Influence of the Stakeholders, University of Tokyo.
3. Shimomura Y., Hara T., Watanabe K., Sakao T., Arai T., Tomiyama T., 2005, Proposal of the Service Engineering: 1st Report, Service Modeling Technique for Service Engineering, Transactions of the Japan Society of Mechanical Engineers,71: 315–322.

4. Kitai Y., Oki, K., Chiba, R., Shimomura Y., 2010, Construction of Design Knowledge Base for Service Design, Design & Systems Conference, 20.
5. Sampson, S., Froehle, C., 2006, Foundations and Implications of a Proposed Unified Services Theory, Productions and Operations Management, 15: 329–343.
6. Uehara H., Shimada, K., Endo, T., 2012, Sightseeing Location Recommendation Using Tourism Information on The Web, IEICE Technical Report, 112:13–18.
7. Tarui Y., 2011, Recommendation System of Tourist Site Using Collaborative Filtering Method and Contents Analysis Method, Bulletin of the Faculty of Management Information Sciences, Jobu University, 36:1–14.
8. Yosuke O., Kazuhiro A., Kazuya O., Wu, CX, 2013, Tourism Design Information Description Model to Design Support Sightseeing Tours, Service Society of the 1st National Convention.
9. Kurata Y., Hara T., 2014, CT-Planner4: Toward a More User-Friendly Interactive Day-Tour Planner, Enter 2014, 73–86.

Design of a Localized Science Education Program for Cultivating an Intergenerational Community

Kinuko Iizawa, Koki Kusano, Eri Inoue, and Naohiko Kohtake

Abstract

This paper describes a novel science education program called "localized science education program" that covers topics of a local area, such as its natural wonders, and involves community residents to cultivate an intergenerational community. The science education program has three features: (1) the ability to learn collaboratively is fostered, (2) the programs and educational materials are prepared in the target local area, and (3) the children and adults of the community experience the programs together. An application example of this was implemented in the target local area for 1 year. It is considered that its efficacy for cultivating an intergenerational community.

Keywords

Local • Science education • Intergenerational community • Social service • Collaborative learning

1 Introduction

In recent years, it has been said in many countries that the relationships in local community have weakened. For example, in the United States in 2001, Robert D. Putnam published *Bowling Alone: The Collapse and Revival of American Community*, and the book drew much attention. In Japan, according to a 2007 white paper on the national lifestyle of Japan, the feelings of connection between community residents have been weakened since the late 1960s [1]. Some local communities find it difficult to function as a community [2]. Functionalities important to communities include achieving peace of mind and a sense of fulfillment and creating values that support community residents and society by encouraging cooperation [1]. Therefore, having strong bonds between members of the local community is extremely important for both individuals and society.

There are multiple kinds of bonds between community members: bonds at school, bonds at a workplace, bonds among the elderly, and bonds between generations. Among them, this paper focuses on "bonds between generations" as one of the key factors to cultivate local community and calls the local community where such bonds successfully grew between generation's "intergenerational community." In this paper, the authors define the word "intergenerational community" as the community in which children closely relate to adults who are not their own parents or grandparents and in which adults closely relate to children who are not their own sons/daughters or grandsons/granddaughters. Here, "children" are defined as those who are under 13 years old – mainly, elementary school children. Self-rated health and social networks are more likely to improve or to be maintained among older people who take part in an intergenerational community [3]. Children's attachment to the community deepens as they interact with other residents, which can facilitate prosocial behavior [4].

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This paper proposes a science education program that involves community residents to cultivate an intergenerational community. In this program, children become quite engaged with adults who are not their parents or grandparents. This program focuses on children in the community and on their activities as a tool to get adult residents in the area involved in the community. The name of the proposed program is *localized science education program* (LSEP). The LSEP comprises three key features: (1) participants experience collaborative learning; (2) the programs and educational materials are prepared locally; and (3) the community children and adults manage the program together. This program fosters natural bonds between community residents by placing children at the center of the community. It also cultivates residents' abilities to ask questions and learn through educational discussions about local topics (e.g., a statue at the park or a forest). Thus, residents are encouraged to appreciate the attractiveness of the local community and to start conversations among generations.

2 Related Works

Activities to cultivate intergenerational communities have been used all over the world. For example, an administrative organization and several other groups implemented a program in which three biodiversity gardens were cultivated by gardeners of various ages within the community [5]. The "Environmental Education on the Farm" program involved elementary school children and community elders who raised food crops together on an urban organic farm [6]. The "Knowing Me, Knowing You" program initiated cultural or modern activities between the younger and older members of various traveler communities; this program is managed by a non-government organization of volunteers [5].

Other activities to revitalize local communities in Japan have been proposed. For example, "Machinaka-demia Sumida" is a local private education program found in the suburban areas of Tokyo, Japan. This program allows community residents to develop good relationships between generations through mutual education [7]. "The project of cultivating close relationships in a local community" in Morinosato Atsugi, Japan, is overseen by a junior high school Parent–Teacher Association. This project is a volunteer activity for junior high school students. The volunteer projects are organized based on community residents' requests. Junior high school students are able to learn about the real state of the local community and communicate with various generations of residents through their volunteer activities on the project [8].

The above projects focus mainly on community residents teaching each other and creating something together in the target area. Hence, the authors hypothesize that projects must include many opportunities to involve residents, and highlight the appeal of community participation, to cultivate intergenerational community more effectively. However, these projects cannot work without special skills or roles. The LSEP ensures that everyone can join the community and participate in managing it.

3 Localized Science Education Program

The LSEP was undertaken by a group of researchers from a communication company and a major university with a group of residents including children by the way of participatory design [9]. It went through three phases. In research phase, authors held three workshops. They were clear the present situation of the local community, the participants' deep thoughts and willingness for the local community, and a typical resident's life in the local community. Based on that, in design phase, the residents and authors created many ideas on what the residents can do. They clarified the idea properties, putting their ideas on two axes. The axes were relevance to existing activity and time to realize. After that, the residents discussed and decided the criteria for option selection. They are "various senses of values which visitors in a group of residents have," "having power to live on," "children and adults can enjoy their own life," "responding social problems," "exchanging other generations," "money goes around," and "having originality." They compared the idea and criteria. The residents and authors thought and selected LSEP is the best for them. The final phase, the trial phase, applies to a pilot study in this paper.

The concept of the LSEP is "centering children and asking questions unite the local community." It is a science-learning program that covers topics such as local wonders, nature, and people. Using local topics encourages community residents to develop regional loyalty and plays an important role in making this program sustainable. Importantly, local residents manage this program themselves. It creates a place where children can learn and interact with adults. In this program, "science" is defined as "knowledge about the world, especially based on examining, testing, and proving facts" [10]. Therefore, topics in the LSEP include chemistry, biography, history, and geography.

The LSEP has three components, as shown in Fig. 1. They are the local community, the residents, and the question. A local community refers to the area in which the program is applied. The residents are classified as questioners, operators, people who search and consider answers, and people who know the answer. The LSEP is composed of three features, as shown in Fig. 2. We designed it to help people increase the degree and power of participation. The details are explained below.

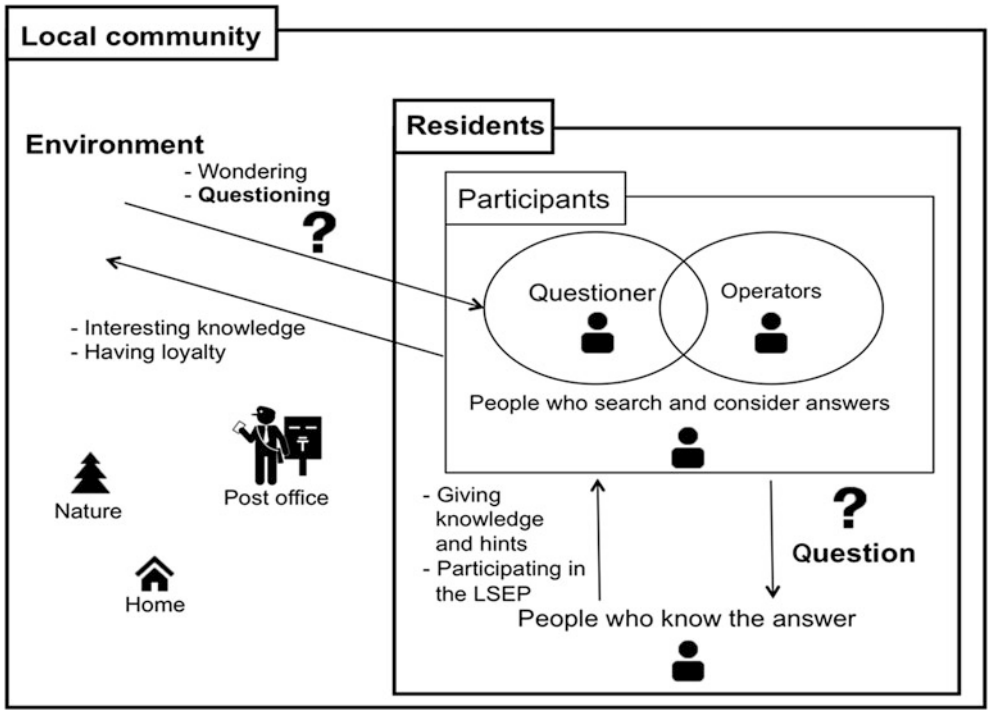

Fig. 1 The structure of the LSEP

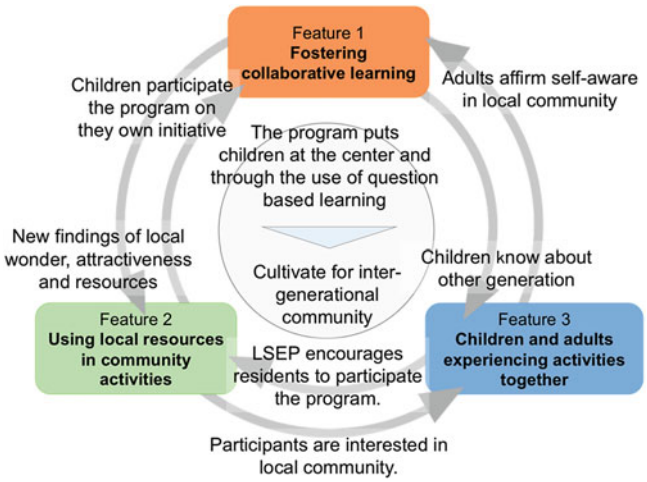

Fig. 2 Three features of localized science education program

3.1 Feature 1: Fostering Collaborative Learning

The LSEP encourages children to learn scientific thinking based on their own questions. Children are not forced by their parents to participate in the program but participate of their own initiative.

Children complete fieldwork to find wonders in their local area and then share their findings. If the children know the answers about a particular wonder, they share the answer with LSEP participants. If children do not know the answer, the LSEP staff help them find the answer scientifically. Ideally, LSEP staff try to find a local community resident who knows the answer and then conduct programs with them as part of the LSEP. The community residents explain and discuss the wonder, and participants are able to learn about the reasons or hypotheses. New hypotheses can be found and shared by anyone. If no participants can find an answer, they discuss and explore the topic further.

Through this process, the LSEP staff and participants have opportunities to build connections with each other organically and to discover local wonders, beauty, and communities.

3.2 Feature 2: Using Local Resources in Community Activities

Local resources include not only physical resources but also human resources. In the LSEP, local resources are used for the theme and setting of an event. For example, if a theme relates to the nature and geography in a specific area, a local forest will be used for fieldwork and associated discussions. By doing this, participants view discovered problems as their own and expend their best efforts to solve them.

Thus, communication among community residents is promoted by the discovery and later discussion of interesting objects and locations. Residents are the main resource in the program; through participation, residents realize that their

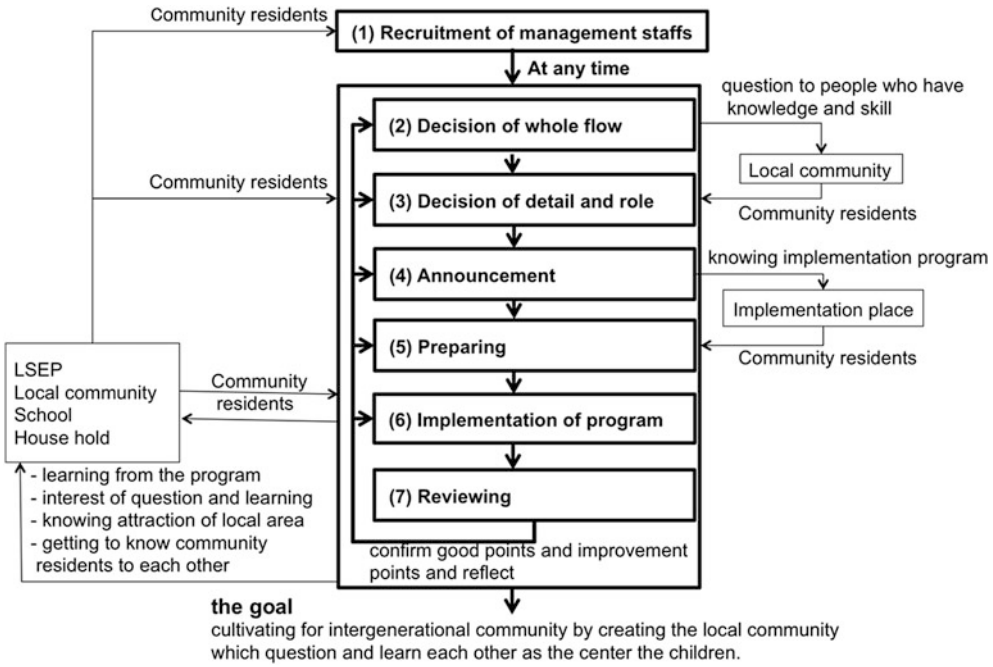

Fig. 3 Process for achieving the LSEP goal and establishing relationships with stakeholders

abilities and knowledge about the local area are useful for younger community members.

3.3 Feature 3: Children and Adults Experiencing Activities Together

Participants organize intergenerational groups to create opportunities for children and adults to learn together, thereby experiencing and cultivating intergenerational relationships within the local community.

Feature 3 seeks to involve community residents using the following processes: (1) LSEP participants share the topics and benefits of the program with nonparticipants; (2) community residents who learn about the program become interested in it; (3) nonparticipants join the LSEP staff, thus expanding the LSEP in the local community.

3.4 Stakeholders and Process

Figure 3 illustrates the plan to achieve the goal of the LSEP and establish relationships between the project's stakeholders. The plan consists of seven steps, starting with the recruitment of management staff from community residents who are interested in the LSEP. Specifically, Step 1 involves gathering management members, a task handled by an LSEP leader. Steps 2 and 3 are the most important steps because they can potentially influence participants' loyalty to the local community. Thereafter, the LSEP staff prepare a program and review it.

The program operates as shown in Fig. 3. The right and left arrows in this diagram denote the movement of people – designed in this manner to facilitate the involvement of other community residents by LSEP staff. It is important to note that, during our study, the LSEP management staff had to allow the research staff to also handle programs, without hindering the performance of the program.

4 A Pilot Study of LSEP

We conducted a pilot study of the LSEP to evaluate it in a local target area. Discussions of its effectiveness continued throughout the study period, and accumulating insights were noted.

4.1 Selection of Target Area

To be conducted properly, an LSEP must involve local children and adults. We first contacted some local communities to find one that could meet two conditions: (1) have many children in the local area and (2) have residents who are aware of their community issues. A suburb of Kanagawa Prefecture was ultimately selected. The area contains a mix of two kinds of residents: those who have lived there for a long time and those who have lived there for a short time. The lack of opportunities for communication between these

groups is a recognized social issue in the community. In our study, we collaborated mainly with a community residents' organization that had been reengaging neighbors by revitalizing old unused houses in their community.

4.2 Management

To make the LSEP feasible for this target area, local stakeholders were involved in its design. Figure 1 shows the structure of the LSEP. We categorized the residents' organization in our target community as one of the most important stakeholders and initially helped them design the LSEP. Subsequently, our university helped them design and conduct programs and also collected data to analyze the effectiveness of the LSEP. Further, student organizations in the local community cooperated with them as a club activity; children and their parents (i.e., community residents) also participated in the programs.

4.3 Program Content

Each of the programs consisted of a workshop, experiment, and fieldwork. The LSEP was implemented six times from January 2014 to January 2015, as indicated in Fig. 4.

In the first program, community children explored local places and discovered interesting facts and wonders about their community. Operators selected the theme of a second activity based on their findings. It was important to maintain high standards in the quality of activities planned; should quality decline, the attractiveness of the next programs would suffer. The most important factor when deciding on a theme was what would appeal to, and suit the abilities of, a variety of people. Hence, we carefully considered the needs of potential participants and arrived at a consensus about the value and vision of the activities – every activity was matched to an appropriate program.

4.4 Results

A few notable results emerged from the pilot study.

A program was held six times as I mentioned in Sect. 4.3. In the first four programs, students of a local university or graduate school played the role of facilitators. In the fifth program, operators and, in the sixth program, local residents played that role. The atmosphere of the last program was quite different from the first four. In the sixth program, the facilitator was a father of the local family. Observing the interactions between local children and the father facilitating this program, it seemed that he enjoyed his "third role" in the local community other than being a "father" nor "working citizen."

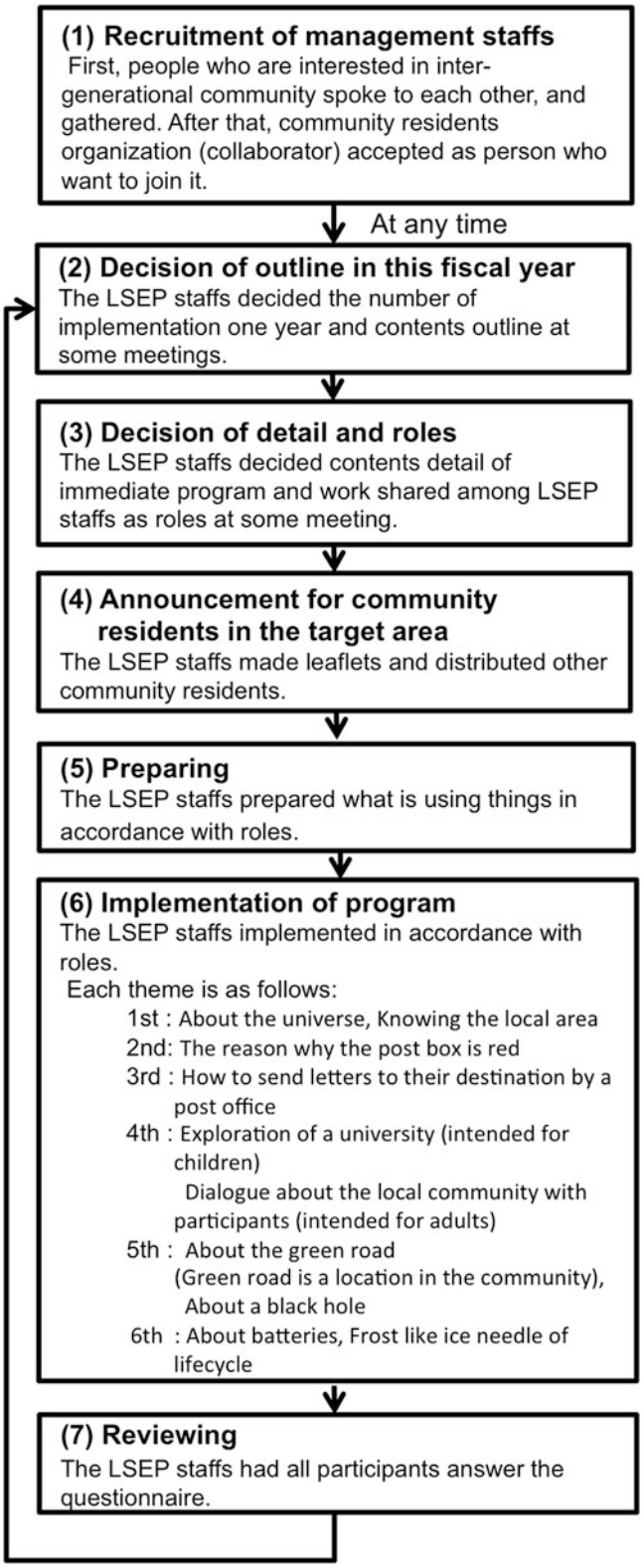

Fig. 4 Application example process

He is considered to have gained closeness to the local children and to the local community. Through this observation, it is considered that by focusing on activities of children, this

program successfully involved adult local residents in the local community.

In the sixth program, adult participants were grouped with local children who are not their own sons or daughters, and each group conducted some kind of experiments using kitchen utensils. After the program, adult participants said that they learned a lot from their very young teammates and they enjoyed the experience of learning things together with the local children. This is the result that we were aiming. The program involves local topics such as natural wonders in the area and local residents as facilitators so that more and more people easily become interested and participate in the program. Prior to the study, we hypothesized that if community residents felt the LSEP was an interesting learning opportunity, they would continue to participate. However, our results revealed that this element of sustainability did not just depend on interesting programs; staff management and the alternating of generational input also contributed to program sustainability. Our study was an extraordinary occurrence for the community; staff and participants will change, and children's range of interests and interactions will change as they grow. In consequence, incentives for the LSEP staff and participants influenced the effectiveness of the programs and the cultivation of relationships.

4.5 Discussion

Our applied study showed promise for growing sustainable social connections. However, to start successfully, LSEP needs people who have local community knowledge. Furthermore, LSEP should be able to adapt to features of a community and learn how to think about local community. Finally, the question of how to develop relevant topics requires careful deliberation. The effect size for a given community depends on whether and how participants' varied interests are considered when dealing with a topic.

4.6 Future Works

To ensure that LSEP promotes the cultivation of an intergenerational community, the efficacy of themes should be carefully researched; how to select themes based on children's input is particularly important. Additionally, potential for sustainability should be verified. If necessary, support during program start-up and schemes for the motivation of participation should be redesigned.

5 Conclusions

The authors proposed a community education program – the LSEP – to promote the cultivation of an intergenerational community and conducted an LSEP pilot study. Results suggested that the LSEP was effective; however, participant incentivization would enhance its efficacy. This would involve programs for quality monitoring, continuous and routine implementation, and properly designed incentives. Thus, people managing such programs should design targeted incentives for community residents. To this end, we have created guidelines for implementing and managing programs more efficiently.

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References

1. Cabinet Office. 2007. White paper on the national lifestyle: A comfortable way of life for the Japanese people, founded on personal relationships (in Japanese).
2. Ministry of Land, Infrastructure, Transport, and Tourism. 2006. White paper on land, infrastructure, transport and tourism (in Japanese). Available from: http://www.mlit.go.jp/hakusyo/mlit/h18/index.html [Accessed: May 15, 2015].
3. Murayama, Y. 2009. The effect of exchanges with aged persons on children (in Japanese). The Japanese Society of Social Psychology. 25(1): 1–10.
4. Ozeki, M. Yoshizawa, H. & M, Nakajima. 2009. The Affect of Social Interaction with Community Residents on Prosocial Behavior by Children: The Meditation Model by Benefit of the Community and the Attachment to the Community (in Japanese). Bulletin of Graduate School of Education and Human Development, Nagoya University (Psychology and Human Development Sciences) 56: 1–9.
5. Finn, C., & Scharf, T. 2012. Intergenerational programs in Ireland: An initial overview. Available from:https://www.ageaction.ie/sites/default/files/pdf/Mapping%20Report%20November%202012_web.pdf [Accessed: May 15, 2015].
6. Smith, J., Bartosh, O., & Peterat, L. 2009. Cultivating and reflecting on intergenerational environmental education on the farm. Canadian Journal of Environmental Education, 14: 107–121.
7. Machinakademia Sumida. 2015. Available from: http://machinacademia.com (in Japanese). [Accessed: March 15, 2015].
8. Onozato, M. 2014. Creating a regional community in the Morinosato ward in Atsugi City (in Japanese). The Japan Association of Regional Development and Vitalization, 5: 415–421.
9. Kusano, K. Ohno, T. & Kohtake, N. 2014. Participatory Design Process to Solve Social Issues in Local Community: A Use Case. PDC'14 Proceedings of the 13th Participatory Design Conference: Shortpapers, and Keynote abstracts, 2: 123–126.
10. Bullon, S. 2006. Longman Dictionary of Contemporary English. Pearson: Japan.

How to Generate Sustainable Services?

Adi Wolfson and Dorith Tavor

Abstract

Sustainability is a service that should be produced and delivered in any process that generates tangible or intangible values and that should be incorporated into each phase of the value chain. Moreover, sustainability should also be an essential part of value co-creation, the process of which eventually recruits the customer as a provider of sustainability to current and future generations. In so doing, the value co-creation process and subsequent propagation of sustainability can mimic the cyclic and evolutionary aspects of nature.

Keywords

Sustainability • Life cycle • CleanServ • Service science

1 Introduction

Any action or process creates value, and its undertaking simultaneously affects global sustainability, for better or for worse. In general, a value or a product can be tangible, i.e., a good, or intangible, i.e., a service, and it is transferred from a provider to a customer. The sustainability of the product, therefore, depends not only on the production process but also on both the provider and the customer individually and on the interactions of the two (Wolfson et al. 2015).

One of the most important challenges humanity faces today is in the development of methodologies for the design of more sustainable processes (in terms of the production of goods and the design of services) that satisfy the needs of today's customers without sacrificing the ability of future generations to satisfy their own needs (Dresner 2008; Dryzek 1997; Edwards 2005). However, the implementation of the general concept of sustainability requires a novel cognitive and behavioral approach that integrates environmental, social, and economic elements, but that is difficult to break down into its fundamental parts. The successful implementation of more sustainable processes, therefore, dictates a modus operandi based equally on a rational use of physical resources that yields efficient processes and prevents and/or reduces the discharge of harmful effluents to the environment and on the responsible design and operation of the process, integral to which is cooperation between people, i.e., nonphysical resources (Prakash 2000; Druckrey 1998).

The economy can be described generally as based on the three sectors of manufacturing and agriculture, both of which produce tangible values, i.e., goods and services, which deliver intangible values (Wolfson et al. 2015). Besides their difference in terms of tangibility, services and goods differ in several other respects:

1. Inseparability – services are simultaneously delivered and consumed, while the purchase of goods can be (and is typically) completely separate from their production.
2. Perishability – unlike goods, services cannot be stored or returned, i.e., they are not reversible.
3. Inconsistency – while the same good can be produced at the same quality in different places and at different times, the production and delivery of a service can never be

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repeated in exactly the same way, as the supplier, the customer, and the place and time change from one delivery of service to the next.
4. Co-creation – service production and delivery requires client participation in the process, but the customer can purchase goods without meeting the producers of those goods. Therefore, in the production of goods, the producer is actually a supplier and the client is a consumer. In service delivery, on the other hand, the producer becomes a provider and the client is a customer.

In 2004 Vargo and Lusch suggested a new paradigm for thinking about commerce, marketing, and exchange. Known as "service-dominant logic," it overcomes the limitations of the "goods-dominant logic" mindset (Vargo and Lusch 2004; Lusch and Vargo 2006). In their paper, Vargo and Lusch proposed that the traditional market's focus on the exchange of products or goods should be shifted to that of services. Moreover, they claimed that all exchanges between producers and consumers are actually based on service. At about the same time, Spohrer and Maglio from the IBM Almaden Research Center foresaw a need for a new discipline, appropriately named "service science," that would be a platform for systematic service innovation (Maglio and Spohrer 2007a, b; Maglio et al. 2010). Later these two novel concepts, both of which highlighted the importance of the value co-creation process, were synchronized (Vargo and Akaka 2009; Lusch et al. 2008).

Value co-creation entails processes in which the value is designed, delivered, and used jointly and reciprocally by the provider and the customer via the exploitation of a constellation of integrated resources and capabilities that are shared, combined, and renewed by provider and customer (Vargo et al. 2008). In general, four types of co-creation can be generated (Wolfson et al. 2015, Kuusisto and Päällysaho 2008):

1. Consume – the customer exploits a service and passively co-creates by their perception of the value.
2. Co-perform – the customer performs some of the tasks of a service.
3. Co-produce – the customer uses resources, such as information from a service, in the process creating the service's value.
4. Co-design – a dialog between customers and providers provides the framework for the types and forms of service desired. In addition, the combination of new technologies and the co-creation of innovation also spawned the development of new service modes, such as "super-service," a service that is mainly performed by the supplier, and "self-service," wherein the customer assumes an active part – and invests knowledge, skills, and facilities – in execution of the service (Campbell et al. 2011).

The need to develop more sustainable production systems and services is a universal concern that can be accomplished via the rational use of resources, the exploitation of cleaner technologies (Cleantech), and the creation of more sustainable services. Two related routes to achieve the goal of sustainability that differ in focus comprise the production and delivery of "environmental services" and of "green" or "environmentally friendly services." The core of the former is in the creation of complementary and novel environmentally related values that are added to existing processes aimed at benefiting the environment. One example of an environmental service entails the measurement of environmental damage (to air, water, and soil as well as that related to waste, noise, biodiversity, and landscapes) with the goals of eventual control, through treatment and restoration, and ultimately the prevention or minimization of additional environmental damage. An environmentally friendly service, on the other hand, is concentrated on delivering the same value using a more environmentally sound method by organizing and managing the resources used in its creation differently, i.e., making existing processes, both service delivery and goods production, greener. Yet in general, the focus of environmentally friendly services is mainly on the physical resources of the process.

As every product usually entails an element of service and every service is likewise typically based on the use of products, another way to increase the sustainability of a process is to approach its value generation process from a product-service system perspective (Sakao and Lindahl 2009; Beuren et al. 2013; Tukker 2015). By fulfilling customer demand more efficiently with respect to the use of physical resources, a product-service system can generate the same solution more sustainably. However, servicizing, which refers to the intensification of the service component of a product-service system, also changes the nonphysical resources of the process, as the provider now offers functionality rather than a product and the consumer, who does not necessarily assume ownership of the product, co-creates the value with the provider. Thus, product-service systems are also referred to as eco-efficient services.

In the same context, we recently offered a new framework, termed CleanServs (i.e., clean services), for thinking about and generating sustainability innovation in the service sector (Druckrey 1998; Wolfson et al. 2013a, 2014). The overarching aim of a CleanServ is in the delivery of solutions that are based exclusively or mainly on services. It can be accomplished by providing a service that is competitive with, if not superior to, its conventional, tangible counterparts and one that reduces, for example, the energy consumption of its related production processes and cuts or eliminates emissions and wastes. CleanServs can be described according to the five categories of prevention, reduction, replacement, efficiency, and offset.

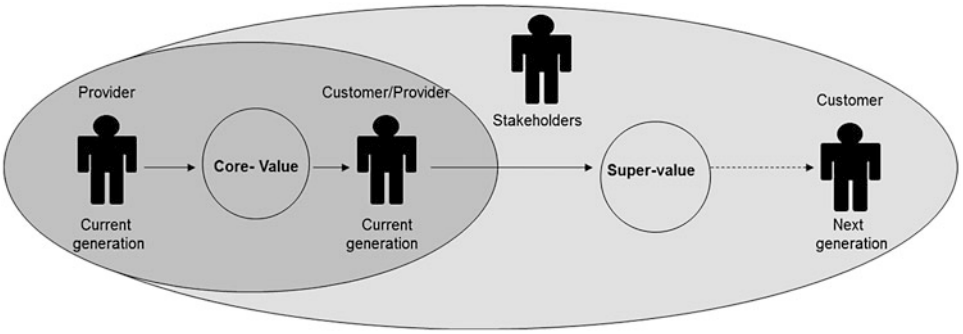

Fig. 1 Sustainable service

We recently offered a new model of "sustainable services" that perceives of sustainability as a basic value and as an essential part of each process. Moreover, it is based on the integration of tangible and intangible resources to create a new value that provides the customer with a solution that meets the customer's demands more sustainably (Wolfson et al. 2010, 2013b, 2015). In addition, a sustainable service is one that improves the operational performance and efficiency of the value production and delivery process. As such, it not only reduces the consumption of materials and energy and the discharge of waste and pollution to the environment, it also fundamentally changes how the provider and the customer engage in co-creating the service "core value," i.e., the essence of the service. We also suggested that a sustainable service should be designed not only with the value of the whole service chain as well as that of the service's customers in mind, but also with the understanding that as a sustainable service it obliges all stakeholders to provide sustainability as a "super-service" (Fig. 1). In addition, we proposed that performing the service in an alternative mode, such as "self-service," can also affect the service's sustainability (Wolfson et al. 2012). Lastly, in addition to the prerequisite that it be based on environmental and social awareness, the rational use of natural resources, and efficient operation and co-creation processes, a sustainable service must also extend the provision of immediate and personal customer demands to the extent that it can continue to fulfill those demands for extended periods of time without negatively affecting either the natural or social environment.

2 Discussion

2.1 Natural Mimicry Approach

Nature supplies many services that promote and sustain ecosystems and that benefit humans, i.e., "ecosystem services" (Costanza et al. 1997). Ecosystem services can be roughly divided between those that provide goods, like food, fibers, and fuels, and those that perform services, such as cleansing of the water and the air and temperature control. Inherently efficient, all natural processes are also characterized by (1) a future-oriented perspective that ensures the continuity of every ecosystem and, therefore, of life; (2) efficient use of the material and energy resources available on Earth; (3) process cyclicity, which accounts for the renewability of resources; and (4) a dynamism that ensures that processes can evolve to adapt to changes. Nature can therefore be used as a blueprint according to which unnatural processes can be imbued with sustainability (Wolfson et al. 2011).

2.2 Sustainability as Service

The generation of any value can be set in motion by a customer with needs that can be supplied by the value provider, by a provider that offers a particular solution to the customer, or through a combination of the two. Yet to provide the value, the provider relies on a variety of supplies, such as natural resources, knowledge, and technologies, while the customer might or must add its own skills and resources. In addition, while generating the main or the core value of the process, other values are usually also produced as part of a super-value of the process and of the interactions with other processes. Furthermore, every process also has indirect stakeholders, from employees to shareholders, and its effect on the social and natural environments should also be considered.

As sustainability should be an integral and essential part of the core- and super-value of each process – and therefore, it should be incorporated into each stage of the process value chain – it is in fact a value in and of itself. Moreover, because sustainability is intangible, inseparable, nonperishable, and non-heterogeneous and it should be produced and delivered via a co-creation process, it can (and should) actually be defined as a service. Defining sustainability as a service is in line with service-dominant logic, in which the emphasis on sustainability extends the relation between sustainability and service beyond the incorporation of sustainability into the production of goods and services to the production of goods and services that is guided by the philosophy of

sustainability. This approach ensures that sustainability will be incorporated into any process by all of the process' direct and indirect providers and customers, who do so via the exploitation of both physical and nonphysical resources.

As previously mentioned, a process can be described as a set of activities that are organized in a value chain and whose performance should deliver a value from a provider to a customer. In general, the value chain of a process comprises the innovation stage (i.e., the design and development of the value), the operation stage (the production, marketing, and delivery of the value), and the final stage, the use of the value (Fig. 2a). Each phase of the value chain of a process involves materials and energy as well as nonphysical resources (e.g., knowledge and effort), and the activities of each phase may

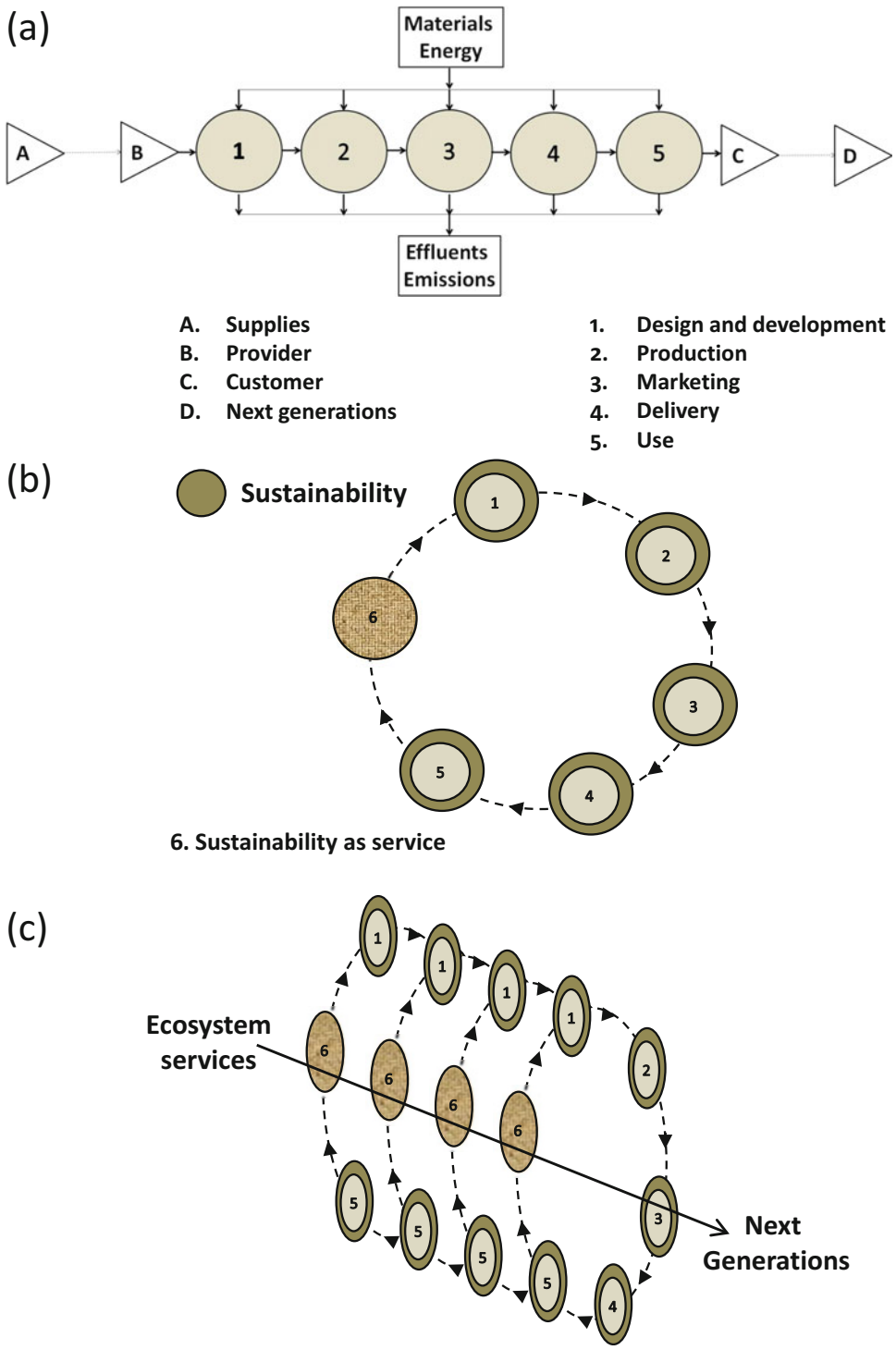

Fig. 2 Illustrations of the (**a**) value chain, (**b**) sustainable value life cycle, and (**c**) evolutionary sustainable value perspective of a process

generate effluents and/or other types of discharge to the environment.

The goal of increasing the sustainability of a process' value chain should consider each of the stages in that chain and can be achieved via different routes. One way is through a reliance on a more efficient use of natural resources, e.g., materials and energy, and less discharge from the production process to the environment while emphasizing more efficient use of the product itself. Alternatively, the sustainability of the value chain can be improved by designing a product that will be more efficient or redesigning and delivering the product using different methods. In addition, it can be accomplished by dividing the responsibilities for the resources and the capabilities differently between the provider and the customer and shifting the service boundary either to that which is operated mainly by the supplier, i.e., a super-service, or to a service that is fully operated by the customer, i.e., a self-service (Campbell et al. 2011). Finally, the value chain can also be imbued with sustainability by adding to it new supporting and complementary values.

To ensure that the process will be sustainable, however, the value chain should be designed as a closed, cyclic system in which both physical and nonphysical resources are renewed; in short, it should adopt a natural mimicry approach. As such, closure of the cycle is done by adding sustainable values that assure the reuse and regeneration of physical resources but also that facilitate changes in habits, ways of thinking, and behavior that will, over time, engender an increase in global sustainability, i.e., the super-value (Fig. 2b). Moreover, the implementation of this approach ultimately recruits the customer as a provider of sustainability to the next generation.

Finally, because the process should also match and adapt to changes in the market and in the social and natural environments while preserving the rights of the next generation, it should also be evolutionary (Fig. 2c). Thus, a new value should be generated to guarantee that when a certain product or service reaches the end of its life, its effect on the next generation will endure.

2.3 Examples

Recall that a value chain comprises a series of activities that are performed to produce and deliver a core-value – which can be either tangible or intangible, but more often, it is a combination of the two – from a provider to a customer (Fig. 2); fulfillment of the core-value of a value chain is also associated with the generation of other values, i.e., super-value, and it involves additional suppliers and customers. In addition, any value chain involves the sharing and exchange of physical and nonphysical resources, e.g., materials, energy, knowledge, and capabilities.

To demonstrate how sustainability can be produced and delivered as an integral part of any process, three examples are given below: (1) the production and delivery of an electric device, such as a domestic cooking oven, which emphasizes the more sustainable use of a physical resource; (2) the production and delivery of education as a service, with a focus on the nonphysical elements of sustainability; and (3) the entire value chain of a good, a half-liter PET bottle of Coca-Cola.

The sustainability of any electric device can be increased during both its production and use steps via the rational use of natural resources and the reduction of discharge to the environment, e.g., implementation of an energy-saving program at the factory and a change in the behavior of the customer, who cooks only when the oven is full. In addition, sustainability can be further increased by exploiting recycled materials in the production of the device and by recycling the appliance itself at the end of its life, which creates a closed material life cycle. However, sustainability can also be added to the product by addition of new supporting and complementary services – such as repair services or redesign and replacement of the original oven door so that it will suit a new kitchen design – that can prevent prematurely exchanging the device for a new model.

In contrast to the manufacture and use of an electrical appliance, school education is a service that holds as it core values the knowledge, methods, and tools that are used to teach the pupils productive ways of thinking and behaving. From this perspective, school education is an intangible value, and therefore, it does not involve the use of any direct physical resources. The sustainability of the service can be increased, for example, by its customers, i.e., the children, who, in learning about sustainability, can effect change in their habits at school and/or at home accordingly. To create a closed service life cycle that improves sustainability, however, the children should also function as "agents of change" in their families and in society, ultimately helping to perpetuate the service's sustainability in the long term. Taken another step further, the children receiving educations today will be the citizens, teachers, engineers, and elected officials of tomorrow, and therefore, they will be equipped with the tools and know-how to shape the social environment and manage the natural environment more sustainably.

The last example will trace the entire value chain of a good, a half-liter PET bottle of Coca-Cola. For some people, the purchase of beverages is almost a daily activity that they do without really considering the value chain and its consequences and that can become embedded in their behavior as a habit. However, what is the core value of this process? Is it the bottle of Coca-Cola, i.e., the good, or is it a service that delivers values like fun, pleasure, and feelings of belongingness vis-à-vis groups like family or friends? Alternatively, perhaps is it a product-service system? Its

super-value, on the other hand, accounts for environmental values such as water and energy use, greenhouse gas emissions, and effluents, social values such as fair employment policies and promotion of the local economy, and economic values like the price of the beverage.

A value-chain assessment of the entire process used by Coca-Cola in the production of a half-liter bottle of its product examines several phases and steps (Coca-Cola Europe 2010b), from production (the production and delivery of ingredients, like sugar and water, and the manufacture of the drink) through delivery (production and filling of bottles or cans and distribution of the product, including its transportation) to the eventual use of the product (storage and refrigeration by the retailer, operation of refrigerated vending machines, and consumer use and disposal).

The value chain can also undergo a physical resources assessment that accounts for energy and water utilization, from the growth of the ingredients and production of the raw materials, through the production of the beverage and its packaging to the delivery, use, and recycling of the package. These were considered by the Coca-Cola company, which they expressed as the carbon footprint (CFP) and the water footprint (WFP, Table 1).

As previously mentioned, the sustainability of the value chain can be increased by adding complementary services and values to each step and by changing the value co-creation process. From the perspective of physical resources, the issue of sustainability is rather straightforward. In addition, the awareness of many companies (providers) today of sustainability is much higher, and many have adapted their performance accordingly. Indeed, the strict regulations in place today and the need to remain competitive in the market, on the one hand, vs. the simple fact that the rational use of resources also leads to a reduction in production costs, on the other hand, has led many companies to make their processes more efficient and treat their emissions and effluents, thereby increasing their sustainability.

With regard to the customers, they can promote and propagate sustainability by reducing physical resources during their use of the product and by recycling unused resources at the end of the product's life. However, in this respect, despite the increased awareness of people over the world of the numerous environmental crises with which humanity is contending today, there is still room for improvement. The provider, too, is obligated to actively influence both its suppliers and customers to behave more sustainably. Thus, the value co-creation process dictates that to achieve the goal of sustainability in the service-dominant framework, both the customer and the provider must assume new, collaborative roles.

Table 1 Breakdown of the carbon footprint (CFP) and water footprint (WFP) of a half-liter bottle of Coca-Cola

Phase	Step	CFP (gCO_2eq)[a]	WFP (Liter)[b]
Production	Ingredients	33.6	28
	Manufacturing	26.4	0.4
Delivery	Packaging	103.4	7
	Distribution	16.1	–
	Refrigeration	58.8	–
Use	Drinking and disposal	1.7	–
Total		240	35.4

[a](Coca-Cola 2009), [b](Coca-Cola 2010a)

In the case of Coca-Cola, the dissection of the CFP and WFP of its value chain for the production of a half-liter bottle shows that all the resources involved – i.e., from the supplies used for the production and delivery of the raw materials to the production, packaging, and delivery of the beverage – are ascribed to the provider. Thus, from the provider's perspective, the sustainability of its product, i.e., a full bottle of Coca-Cola, can first of all be dramatically changed by instituting innovative design concepts. These could include, for example, replacing the conventional, petroleum-based plastic used in its bottle with a sugar-based biodegradable plastic or changing the shape of its plastic bottle to streamline packaging and make the bottle more compatible with recycling. The Coca-Cola Company can also increase its efficiency with respect to resource use. The production process could thus be redesigned to use less energy or renewable energy sources in at least some of the production steps. Likewise, its production plants could recycle the water used in the manufacturing process and offset its fresh water needs by using gray water (kitchen sink, shower, and laundry water) in the agricultural production of its raw materials. These are just some of the viable opportunities open to a company to reduce both its CFP and its WFP. The corresponding reductions in wastewater volumes and greenhouse gas emissions to the surroundings will increase the environmental value of the entire process.

Resources can also be cut by the provider by using a service that manages the distribution of the product, which would manage the distribution by only sending trucks that are full to reduce the fuel used. However, resource reduction should also be the responsibility of the customer who, by disposing of empty bottles at a recycling center or in dedicated recycling bins, will help close the value chain cycle with respect to the plastic. Even though the bottle recycling step is performed by the customer, the provider still bears the responsibility of ensuring that its customers use the recycling service by informing and even educating them about how that is done and why it is important and by ensuring not only that the dedicated recycling bins will be accessible and visible but also that their contents will be collected when the bins are full. Likewise, the provider is also obligated to insure that the bottles collected will be recycled and used again in the market.

Finally, although the ultimate consumers of the bottles of Coca-Cola are not directly accountable for the majority of the resources that were consumed throughout the product's value chain cycle, those consumers can effectively reduce the amounts of resources used by changing their behavior. For example, the customers can change their preferences and buy only larger bottles of Coca-Cola that are composed of less plastic per liter of beverage and that, therefore, require less energy per liter to produce. On the other hand, consumers can switch to another brand of beverage whose CFP is lower. In fact, the CFP and WFP measures can also be used to increase beverage market competitiveness, thereby generating extra value. In this scenario, companies like Coca-Cola can add a carbon and water labeling service (Wolfson et al. 2015) to their products. Labeling the bottle with the product's footprints would allow customer to choose their preferred beverages based not only on taste and price or on the number of calories but also on the CFP and WFP values of the product.

In summary, the sustainabilities of both the core-value and the super-value of the process can be increased by reducing the use of physical resources throughout the value chain – from the supplies, through the provider, and on to the customer. However, sustainable services must also consider non-physical resources, and in this respect, new intangible values should be generated. As previously mentioned, although Coca-Cola is fundamentally a beverage company involved in production and delivery, it is also selling a brand that is associated with nonphysical values like joy and happiness as well as togetherness. Thus, any attempt to improve the sustainability of its value chain must be connected with these values. This starts through the company's adoption of "corporate social responsibility" (McWilliams and Siegel 2001) or "responsible care" (Givel 2007) policies and practices that incorporate ethics and international morals and laws and that promote improvements in health, safety, and environmental performance while upholding open and transparent communication with the stakeholders. Finally, sustainability can and should be combined with the core-value itself. For example, joy and pleasure are also associated with health, which is affected by the state of the environment, e.g., air quality, while values that are connected to being part of a group can be translated in the long term into greater values that promote social and environment justice.

3 Summary

The sustainability of any good or service value chain can be increased by adding new values to the core- or super-value, by considering the numerous stakeholders and by redesigning the co-creation process. It begins by defining sustainability itself as an intangible value, i.e., a service, and by implementing a rational use of resources. But it can only be achieved by designing the value chain as a closed cycle that operates in an evolutionary fashion and by recruiting the customer to become a provider of sustainability to the current and the next generation.

References

Beuren, FH, Ferreira MGG, Miguel PAC (2013) Product-service systems: A literature review on integrated products and services, Journal of Cleaner Production 47:222–231.

Campbell CS, Maglio PP, Davis M (2011) From self-service to super-service: How to shift the boundary between customer and provider, Information Systems and E-Business Management, 9:173–191.

Coca-Cola carbon footprint in the UK (2009): http://visiblebusiness.blogspot.co.il/2009/11/co2-coca-cola-coca-cola-20082009.html

Coca-Cola-Product water footprint assessments (2010a): http://assets.coca-colacompany.com/6f/61/43df76c8466d97c073675d1c5f65/TCCC_TNC_WaterFootprintAssessments.pdf

Coca-Cola Europe-Environment review (2010b): http://nachhaltigkeitsbericht.coca-cola.de/download/coca-cola_environment_review.pdf

Costanza R, d'Arge R, de Groot R, Farberk S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Suttonkk P, van den Belt M (1997) The value of the world's ecosystem services and natural capital, Ecological Economics 1(25):3–15.

Dresner S (2008) The Principles of Sustainability. 2th Ed., EarthScan, London.

Druckrey F (1998) How to make business rthics operational: Responsible care – an example of successful self-regulation? Journal of Business Ethics 17(9–10):979–985.

Dryzek J (1997) The politics of the earth: Environmental discourses. Oxford University Press, Oxford.

Edwards AR (2005) The sustainability revolution: Portrait of a paradigm shift. New Society Publishers, Gabriola Island.

Givel Mi (2007) Motivation of chemical industry social responsibility through responsible care, Health Policy 81(1):85–92.

Kuusisto A, Päällysaho S (2008) Customer role in service production and innovation -Looking for directions for future research. Report 195, Lappeenranta University of Technology, Lappeenranta.

Lusch RF, Vargo SL (2006) The service-dominant logic of marketing: Dialog, debate, and directions. ME Sharpe Inc, Armonk, New-York.

Lusch RF, Vargo SL, Wessels G (2008) Toward a conceptual foundation for service science: Contributions from service dominant logic. IBM Systems Journal 47(1):5–14.

Maglio PP, Spohrer JC (2007a) Service science, management and engineering (SSME): an Interdisciplinary approach to service innovation. IBM Almaden Research Center, San Jose.

Maglio PP, Spohrer JC (2007b) Fundamentals of service science. IBM Almaden Research Center, San-Jose.

Maglio PP, Kieliszewski CA, Spohrer JC (2010) Handbook of service science. Springer, New-York.

McWilliams A, Siegel D (2001) Corporate social responsibility: A theory of the firm perspective, Academy of Management Review, 26(1):117–127.

Prakash A (2000) Responsible care: an assessment, Business Society, 39(2):183–209.

Sakao T, Lindahl L (2009) Introduction to product/service-system design. Springer, New-York.

Tukker A (2015) Product services for a resource-efficient and circular economy-a review, Journal of Cleaner Production, 97:76–91.
Vargo SL, Lusch, RF (2004) Evolving to a new dominant logic for marketing, Journal of Marketing 68(1):1–17.
Vargo SL, Maglio PP, Akaka MA (2008) On value and value co-creation: A service systems and service logic perspective, European Management Journal 26(3):145–152.
Vargo SL, Akaka A (2009) Service-dominant logic as a foundation for service science: Clarifications. Service Science 1(1):32–41.
Wolfson A, Tavor D. Mark S, Schermann, M, Krcmar H (2010) S3-Sustainability and services science: novel perspective and challenge, Services Science 2(4):216–224.
Wolfson A, Tavor D, Mark S (2011) Sustainable service: The natural mimicry approach, J. Serv. Sci. Manag. 4(2):125–131.
Wolfson A, Tavor D, Mark S (2012) S. Sustainability and shifting from a 'person to person' to a super- or self-service. J. of u- and e- Ser. Sci. and Tech. 5(1):25–34.
Wolfson A, Tavor D, Mark S (2013a) From CleanTech to CleanServ. Service Science 5(1):193–196.
Wolfson A, Tavor D, Mark S (2013b) Sustainability as service. Sustainability, Accounting, Management and Policy Journal 4(1): 103–114.
Wolfson A, Tavor D, Mark S (2014) CleanServs-clean services for a more sustainable world, Sustainability, Accounting, Management and Policy Journal 5(4):405–424.
Wolfson A, Mark S, Martin PM, Tavor D (2015) Sustainability through service: Perspectives, concepts and examples. Springer, Heidelberg.

Service Innovation for Reducing Food Adulteration Problem in Bangladesh

Iffat Tasnim Haque and Youji Kohda

Abstract

A dynamic and well-structured service system is needed for solving the food safety and food security problems in Bangladesh. Moreover, food adulteration has maximized the severity of these problems. Agricultural products are mostly adulterated, and there is a significant scarcity of these products in urban markets. Women farmers in the agricultural sector can deliver better services to consumers if opportunities can be created for them within the specialized service system. This paper proposes an innovative service model based on urban schools. The major focus of this service system is not only creation of opportunities for women farmers to become empowered but also to reduce food safety and adulteration issues and provide nutritional benefit to children in urban areas of Bangladesh.

Keywords

Service innovation • Food adulteration • Women in agriculture

1 Introduction

Food safety and food security are major problems in Bangladesh, which also faces numerous other poverty and health problems. In Bangladesh, people with lower incomes, like rural farmers, do not have the financial ability to provide nutritious food for their children. Stakeholders, such as the government and non-governmental organizations (NGOs), have introduced various strategies to reduce poverty for these rural farmers. One of the strategies is engaging rural women farmers in the agricultural sector so they can be major income generators in the family as well as men farmers.

On the other hand, due to the malfunctioning of the product delivery and overall service system, even economically stable populations in urban areas of Bangladesh suffer from unsafe food and health problems. One of the recent social problems is adulteration by unacceptable or more than permissible levels of hazardous chemicals, such as formalin, carbides and textile dyes, in fruits, vegetables, fish, spice, etc. These chemicals are added to food for making it more attractive and hence more profitable. The long-term health consequences of consuming adulterated food are cancer, liver and kidney damage, skin diseases, abdominal discomfort and much more. Besides the poor service system, the unethical practices of food traders, lack of knowledge among producers and poor awareness among consumers are the major causes of the problem. Moreover, ineffective and poorly implemented government policies and regulations together with the lack of strict punishments have made the situation worse. The food adulteration problem has become a burning social and health issue in urban areas in the country.

The main barriers within the service system are a lack of proper transportation facilities, lack of marketing knowledge and improper training and communication of the actual market price and that producers and farmers have less access to the local market especially in urban areas. These constraints have made opportunities for middlemen and retailer groups to indulge in the unethical practices of adding hazardous chemicals to foodstuffs before selling them to consumers. This urban food market now faces a serious

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scarcity of non-adulterated food. Moreover, despite the increasing demand for food in urban areas, farmers in Bangladesh lack the ability to fulfil the demand. Here, technological limitations still remain in Bangladesh that make it hard for the supply to meet the demand. Moreover, major agricultural products like fruits and vegetables are very perishable; it is very difficult for poor farmers to store these products for a long enough time due to a lack of proper refrigeration and storage. This limitation also poses the risk of harmful chemicals being added to extend product shelf life. The ultimate result is that the food supply is insecure in urban areas and children are the major sufferers as they have less immune function to fight against hazardous chemicals and become victims of life-threatening diseases.

Therefore, one idea is to encourage women farmers as well as men farmers to produce chemical-free, non-adulterated agricultural products and provide them the opportunity to become entrepreneurs in this sector.

Many stakeholders like the government and NGOs work individually to reduce the problem. Though the economic condition has been improved for some producer families by engaging women as agricultural income generators, the malfunctioning service system, poor access to the market and lack of knowledge make it so that producers still get low prices for their agricultural products. On the other hand, consumers are suffering from the interference of middlemen and retailers in the total service system of the food delivery chain. Both the food safety problem and food security problem can be reduced by creating a better service system and creating trading opportunities for them.

The main objective of this study is to create a service system model which coordinates values among different significant stakeholders. Moreover, the service system model is one where women farmers can empower themselves through trading of agricultural products and at the same time consumers can benefit by getting non-adulterated food from women entrepreneurs. In this system, both producers and consumers benefit by trading products at fair and reasonable prices.

We focused on women farmers for several reasons. In Bangladesh, women are empowering themselves in the agricultural sector for purposes of reducing poverty for their families, reducing gender violence and providing better nutrition and education for their children. Importantly as well, men are switching to the non-agricultural sector, because as farmers, they are not getting fair payment for their agricultural products to lessen the economic burden on their family. Therefore, creating opportunities to deliver products through an effective service system can promote women farmers in the agricultural sector and reduce the scarcity of food products in the market.

The remainder of this paper describes the problems that women farmers are facing and the strategies and trade opportunities being promoted by the government and NGOs. Two different service models have been designed to ensure women farmers have efficient and effective means to deliver products and services to consumers. The first example, focusing on the growth centre market in rural areas in Bangladesh, has created opportunities for women farmers to gain access to large-scale rural markets. Our model targets schoolchildren in urban areas by focusing on meeting their nutritional requirements through delivery of non-adulterated food products. This not only enhances the business opportunities for women farmers but also improves the availability of non-adulterated food products for consumers.

2 Role of Women Farmers in Food Security

2.1 The Extent of Food Adulteration and Food Insecurity in Bangladesh

Bangladesh is one of the most densely populated countries in the world and has been suffering from food deficiency. A lot of factors are associated with food insecurity (or crisis), including cyclones, floods, salinity intrusion, high food prices, middlemen and retailer interference in the market system, illegal trading of foodstuffs across the Indian border and insufficient food supply. Retailers and middlemen dominate the product delivery in the total food service chain and are making an unethical profit through food adulteration. Food adulteration has been happening on a massive scale for the past half a decade due to increased investment, an expanding market and high consumer demand. Basic food items like rice, fish, fruit, vegetables and sweetmeats are adulterated with hazardous chemicals in an indiscriminate manner. There is a lack of statistical data on food adulteration, which could be used to chart the actual extent of the problem in the country. But in 2004, a random survey conducted by the Public Health Laboratory of Dhaka City Corporation found that more than 76 % of food items on the market were adulterated [1].

One of the major reasons for health problems and malnutrition in children is food adulteration. As well, consumers, by spending much more on adulterated food, are making it so that non-adulterated food like fruits and vegetables can't be found in the market. As a whole, food adulteration has been playing a significant role in creating food insecurity in urban areas.

2.2 Women in Agriculture in Bangladesh

The participation of women in the overall economy, particularly in the agricultural sector, is high throughout Asia.

Bangladesh, Bhutan, Cambodia, China, India, Myanmar, Nepal, Pakistan and Vietnam have particularly high percentages of women employed in the agricultural sector, with estimates ranging between 60 and 98 % [2]. By comparison, Bangladesh lags behind, with 59 % (compare this figure with those of its neighbours India, 74 %; Pakistan, 64 %; and Nepal, 85 %). Bangladesh is a traditional Muslim society, where women hardly participate in agricultural activities outside the home [3, 4]. Moreover, nowadays, there is scarcity of labour in rural agriculture and yet farm technologies have not sufficiently developed to cope with this scarcity. This has meant that the population of women as entrepreneurs in the agricultural and farming sector is increasing in Bangladesh [5, 6]. Poverty and the migration of male family members away from agriculture to nonfarm occupations have led to a growing empowerment of women in the agricultural sector in recent years. In the absence of male family members, women's roles have changed from unpaid family workers to farm managers. This phenomenon is called the "feminization of agriculture" [7].

2.3 Role of Women in Food Safety and Nutrition

Women are not only being empowered in the agricultural sector as income-generating persons; they are also playing a significant role in achieving food safety and meeting the nutritional requirements for their children and overall household. Women are crucial in the translation of products of a vibrant agricultural sector into food and nutritional safety and security. They are often farmers who, alongside the men in their households, cultivate and produce commercial crops as a source of income. Substantial evidence shows that women's income is usually spent on food and children's needs. Women also have responsibility to provide safe food for their children. Therefore, women farmers also can take on the responsibility of producing safe agricultural products [8].

Women also can play a significant role in producing and delivering agricultural products for commercial use, and they help to ensure the safety of food for other children through trading safe food. On a whole, women are key to food safety and security [8].

2.4 Empowering Women by NGOs to Become Farmer Entrepreneurs

Many NGOs are working on empowering women farmers through capacity building. NGOs provide small loans to farmers and technical training for better agricultural output. The International Fund for Agricultural Development (IFAD) is collaborating with the Bangladesh Agriculture Research Institute (BARI), Bangladesh Rice Research Institute (BRRI) and Bangladesh Livestock Research Institute (BLRI) [9]. One of the programmes initiated by the government is the Northwest Crop Diversification Project (NCDP); this project is run through popular NGOs in Bangladesh like BRAC, RDRS and PROSHIKA. The main objectives of this programme are to encourage women to undertake farming activities outside the boundary of their households like their counterpart male farmers [5].

The Food and Agriculture Organization (FAO) works to provide education on nutrition and food production. Ensuring women's participation in tackling food insecurity and malnutrition is a major priority. Improvement of women's access to resources has been shown to be particularly effective in increasing agricultural production and reducing poverty for both families and the nation. Advocacy, knowledge exchange, demonstrations and capacity development can make women's participation in agricultural activities more effective by securing them better access to productive resources (including training, knowledge and assets) [10].

As mentioned above, there are lots of programmes and projects being carried out by different NGOs for the purpose of empowering women in the agricultural sector. Not only that, women are also getting trained in a diverse range of topics, including food safety; farming techniques; effective use of soil, fertilizer and land; and food storage, which also helps them to produce more agricultural products from small investments.

2.5 Social Constraints of Accessing the Local Market

Although some NGOs are helping women farmers through small loans, the number receiving them is still very small. Moreover, there are lots of barriers to getting opportunities in the market:

1. Women farmers have less access to credit, which is also constrained by high interest rates.
2. They have less fertile land than men.
3. They have less access to seed and farming inputs.
4. They do not have secure access to irrigation and drinking water.
5. They have less access to training services about new inputs and methods on how to farm productively.
6. They have less access to local markets to sell their produce because of time constraints and poor access to market information, transport and facilities to add value to their produce [11].

Moreover, farmers or primary producers in Bangladesh get lower than fair prices for their products because of

communication and knowledge gaps regarding the market. Lack of transportation facilities is one of the major barriers, and middlemen, called Bapari/Faria (small buyers) and Mohajon (large buyers), have been accused of unethical practices like cheating farmers and adulterating food products. Due to these barriers, farmers have less access to the local market to sell their products directly. The restricted mobility of women in Bangladesh and their dependency on others for selling their products mean that they do not receive fair payment for their products [12].

3 NGO Support for Women in Agriculture

3.1 Nature and Extent of Women and Men in Agriculture in Bangladesh

The Labour Force Surveys (LFS) of 1999–2000, 2002–2003 and 2005–2006 showed that the percentage of adult male participation has decreased over time while that of women has increased. According to these sources, the percentage of adult male participation in agriculture decreased from 51.9 to 41.4 % and 31.9 % in 1999–2000, 2002–2003 and 2005–2006, respectively. On the other hand, the percentage of women in agriculture increased from 48.1 to 68.1 % during the same period (Fig. 1) [7].

Women's participation in postharvest activities, raising livestock and poultry and homestead gardening has also increased over time because the majority of farmers are now doing nonfarm activities in industry, transportation, construction, business/trade, and service-related activities. Findings showed that in 2008, 18 % of adult women household members took part in homestead gardening. In rural Bangladesh, credit support from NGOs (sometimes supported by training) has largely facilitated the involvement of women in livestock and poultry rearing as well as homestead gardening. The participation of women in fisheries is still negligible [7].

3.2 Charting the Progress in the Perception of Women Farmers Through a Review of Some Success Stories

Case 1: After completing training on new technologies for growing wheat in one project in Barisal, Anindita Mollik, a wheat farmer in Khulna, Bangladesh, said, "We never thought wheat production would be possible on our saline land; but we observed how it is done and eventually I grew it myself. We are very happy" [13].

Case 2: In 2011, Aroti, from the Khulna district, attended a training course on how to cultivate rice, add fertilizer, etc. Her husband learned from her about the content of the training course and expressed his feelings about his wife's undertaking: "She reminded me of the importance of the right dosage and timing of applying chemical fertilizer and weed management" [13].

Case 3: This case shows that husbands can view their wives as capable and knowledgeable farmers who can generate income for the family. Radha, from Khulna, attended a

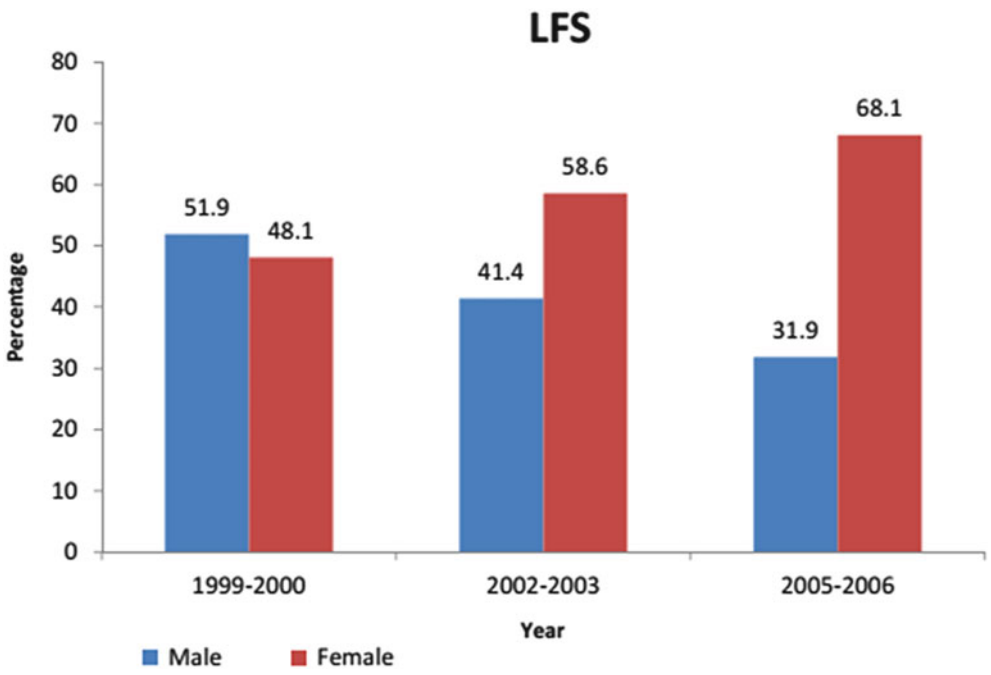

Fig. 1 Changes in adult male and female participation in agriculture over time: Bangladesh

training course about how to cultivate different crops on the same land, and she explained what she learned to her husband. In this way, they cultivated vegetables and sold those products for BDT 10,400 (USD$134) against a cost of BDT 6400 (USD$83). Her husband said, "She (Radha) is my Laxmi (Hindu Goddess of Wealth) who helped enhance my knowledge of productivity, which I had never imagined possible" [13].

Case 4: Selina Akter, who is a successful farmer and is leading other farmers to a better future, describes how she is making extra income for her family and how to reduce food insecurity [13].

Rural women in Bangladesh are responsible for most of the hard work in and around the homestead, yet their work is seldom recognized as part of agriculture. The case study reviews prove that women from a small village in Bangladesh can contribute to household food security through improved farming practices.

3.3 Microfinance Support for Building Capacity

Since the late 1970s, Grameen Bank has supported poor farmers in Bangladesh through small credits, and its growth has been remarkable. Indeed, the microcredit sector has developed a number of microfinance institutions (MFIs). Influenced by the Grameen Bank model, several NGOs and MFIs are supporting small and marginal farmers and follow a service delivery model based on a group approach with the goals of reducing poverty and agricultural development.

One project, called MFMSFP (Microfinance for Marginal and Small Farmers Project) was a US$29.7 million project over a 6-year period (2005–2011) with the goal of improving livelihoods to 210,000 poor small and marginal farming households. The major objectives of the project were to (1) enable marginal and small farmers and agro entrepreneurs (both men and women) to access and utilize viable microfinance services in order to invest in existing activities and in new farm and off-farm enterprises and (2) increase agricultural production through access to information, adoption of new technologies and fostering of linkages to markets [14].

A lot of NGOs are working on capacity building and supporting market linkages, but there are still not a sufficient number to fulfil the demand for food.

3.4 Implementation of Training Programmes

The Cereal Systems Initiative for South Asia in Bangladesh (CSISA-BD) project led by USAID aims to test and disseminate new cereal-based technologies that can raise family income by at least US$350 for 60,000 families [13].

It provides women farmers with support through the following activities:

1. Participatory farmer trials and adaptive trials: In 3 years of the CSISA-BD project, there have been 3092 women farmers who have participated in project-sponsored adaptive trials or technology demonstrations.
2. Short-term agricultural sector productivity or food security training: CSISA-BD has provided short-term training directly and indirectly to 22,582 women farmers. A total of 8,977 women farmers have received direct training support and 13,583 women farmers have had exposure to new varieties and technologies through farmers' field days and cross-farm visits [13].

4 Potential Opportunities for Women Farmers

4.1 Developing Market Linkages

PROSHIKA, one of the largest NGOs in Bangladesh, supports over a million families. After several years of intervention, it reported that poor farmers improved their access to and control of local markets by bypassing "middlemen" and selling their products directly to the consumers and wholesalers. The main objective of their study was to understand (1) to whom and in which markets group members sell their products, (2) which markets or sales outlets have the best prices for products, (3) what problems groups face in marketing their products and (4) what steps group members of farmers felt would be appropriate to improve their marketing of products to ensure the highest profit [12].

After an investigation and analysis from the perspective of the farmers, it is clear that, due to a lack of infrastructure and transportation facilities and other reasons, poor farmers cannot get fair prices for their products. The situation is even worse for women farmers who have much direct less access to the local market. Small farmers can participate in collective marketing as follows:

- Group members can come together and market their products collectively in distant markets by hiring trucks.
- Members can plan their harvest so that the final product can be marketed together and at the same time.
- External support (e.g. from NGOs) can help in developing new markets.
- Collective marketing generates employment for unemployed village youths. They work for the producers in

marketing their products and are paid from the extra profit earned in the process.
– Collaborative action among producers enables them to eliminate the middlemen (Bapari) and increase their profit by reaching the business (Mohajon) directly [12]

Particularly in the agricultural sector, NGOs are promoting market opportunities as a way of bridging the gap between producers and consumers. When they cannot sell their products, small farmers are compelled to pay interest on their credit for longer, or they are forced to sell their products only in existing markets in local areas. This situation creates opportunities for middlemen to engage in unethical practices with producers and consumers.

4.2 Growth Centre Market Concept for Women Farmers

The market for agricultural commodities is changing rapidly especially for high-value and unadulterated products. These changes may create opportunities for women as well as men to participate in the market. However, access to these markets is still limited for women. Moreover, poor and small producers may be excluded from the lucrative high-value markets because they may not be able to compete in terms of cost and prices with the other larger producers. As attempts to reduce these barriers, some NGOs in Bangladesh have created services called growth centre markets with a special focus on women farmers.

Growth centre markets (GCMs) are special services offered at local focal points for selling rural produce and distributing agricultural and consumer goods. This type of market is an innovation because it is unlike rural markets, which are usually very muddy, congested, dusty and unhygienic. The Third Rural Infrastructure Development Project has constructed or improved common public facilities at 196 growth centre markets to provide a safe, efficient and hygienic trading environment [15].

GCM sites are selected through consultation with women traders, women's union members, the market management committee and other officials. The most important aspect of GCMs is that they provide women vendors an exclusive area of the market, which has an open space and shaded shops. Only women can trade there, and the presence of men working in a shop will lead the cancellation of the allotment. Sixty percent of the women receive training before obtaining the opportunity to do business through this project. The monthly income of these traders ranges from 800 to 10,000 BDT. Because these shops are located in growth centre markets which are well connected with other nodal points, traders can collect their tradable commodities very easily. Credit remains a major constraint; about 25 % of the traders receive loans from different NGOs, but in small amounts. This experience highlights the need to provide complementary support, particularly financing, infrastructure improvements and shop allotments [15].

5 Conceptual Framework

There are several stakeholders working on creating opportunities for women farmers to trade and become entrepreneurs in the agricultural sector. But there are potential limitations in trading agricultural commodities, and these limitations in the total service system worsen the situation of food security and food safety in Bangladesh. As the market value of these agricultural products is very high especially in urban areas and women have been showing strong interest in business, we have concentrated on developing innovative service system focusing on empowering women in agriculture and fighting against the food adulteration problem.

The growth centre market creates opportunities for women farmers to sell their products directly. Based on this concept, we have innovated a school-based service and product delivery model that explains the simple cocreation activities among the different stakeholders. This model is potentially useful for reducing food adulteration and its effect on schoolchildren.

We have created a conceptual framework on how women farmers get marketing opportunities through growth centre markets in different settings near urban areas in Bangladesh.

5.1 Growth Centre Market-Based Service Model

Women farmers are provided small loans or financial support through NGOs for developing small agricultural business. In addition, they also get training for efficient farming techniques and other agriculture-related knowledge. But they have fewer marketing skills and less awareness of food safety, which are two keys to success.

The gaps between farmers and consumers can be reduced through a number of initiatives or coordinations:

1. NGOs can train women farmers to give them market accessibility skills.
2. NGOs can provide training regarding food safety and the long-term negative health impact of adding poisonous pesticides, chemical fertilizers and chemicals that make food products lucrative and provide longer shelf life. Such content can be presented during the training programmes.
3. NGOs can offer low-interest microcredit options to groups of women farmers in a community or specific

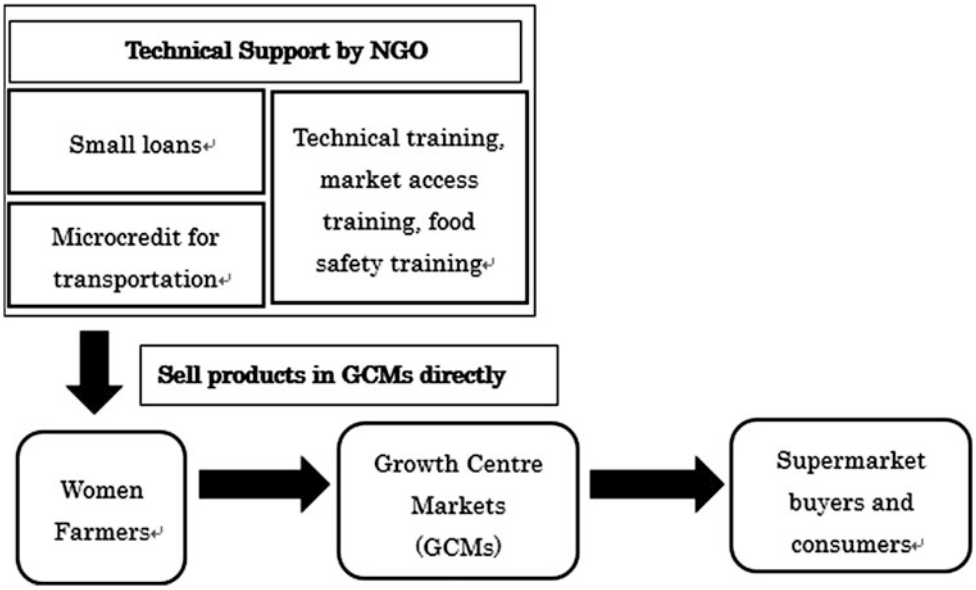

Fig. 2 Growth centre market-based service model

area for supporting transportation, to hire or buy a vehicle with a storage facility. In this way, a group of women can minimize transportation costs when travelling with their products to the GCM. Access to transportation would also help them to attend the market regularly and sell fresher products, which also reduces storage costs.

4. GCMs can organize shops for women and women traders to sell their products directly to wholesale buyers of urban supermarkets as well as to consumers. In this way, they can get fair payment for their products, which was not possible by trading through middlemen.
5. Consumers receive safe agricultural products because the chances of food adulteration are very low at supermarkets that have good storage facilities in urban areas. Figure 2 shows the conceptual model of a GCM-based service system.

5.2 Advantages of GCM-Based Service System

GCMs can be business platforms for women farmers because they are intentionally located in towns and cities that have strong linkages with schools, hospitals, colleges, banking services, large markets (often wholesale function), shopping malls, etc. Such high-level services can be obtained because agricultural products are in demand in urban areas.

In addition, a proper infrastructure for GCMs, in particular, transportation facilities supported by NGOs, can reduce the time and delivery costs born by rural women farmers. Moreover, it would help women farmers get opportunities to access the market and develop a reliable platform to trade their agricultural products safely.

On the other hand, supermarket buyers can get agricultural products free of chemical contamination. The markets are near towns and cities, usually within walking distance.

5.3 Possible Modifications for Gaining Benefits from the GCM-Based Model

As already mentioned, some growth centre markets (GCMs) have already been established and are being supported by some projects. The key to getting safe agricultural food through this model is that NGOs create opportunities for women farmers through transportation facilities. NGOs already have schemes for supporting women farmers with small loans to develop smallholder agricultural businesses; they need to find means to help them benefit from improved transportation.

Although NGOs have training programmes for acquiring agricultural skills, they need to add topics to their training programmes for gaining marketing skills, trading skills and food safety and adulteration knowledge, especially as regards health and nutrition of children.

To promote GCMs, NGOs can publicize the availability of non-adulterated food to consumers through newspapers, advertisements, leaflets, etc.

5.4 Limitations of Growth Centre Market Model

The food adulteration problem is very severe in urban areas, and children are the victims. Consumers, especially those in urban areas, are familiar with food safety and adulteration issues, through advertisements, newspaper and television reports, etc. Despite this knowledge, they remain helpless, because significant interference from unethical middlemen and retailers makes it difficult to get non-adulterated fresh fruits and vegetables in their local markets and supermarkets.

The above circumstances have made it very difficult for schoolchildren in urban areas to get non-adulterated fruits and vegetables. Moreover, there are two problems with the growth centre market model:

1. It is not for urban areas; consumers from urban areas face difficulties getting non-adulterated products because of communication issues.
2. The competitive atmosphere and political situation mean that growth centre markets cannot be easily established in cities.

On the other hand, the concept of our school-based model can benefit both women producers and schoolchildren consumers, and it is feasible to implement it on school premises.

5.5 Urban School-Based Service Model

The urban school-based service model is a way of developing trading and service opportunities in urban areas. It is a new approach to providing services to schoolchildren. The urban school-based service and agricultural product delivery model directly benefit schoolchildren by meeting their nutritional needs in the recent crisis of adulterated foodstuffs.

Schoolchildren require daily intakes of fresh fruits and vegetables in their diet. But due to unavailability, parents are either bound to buy unsafe food or stop buying fruits and vegetables. This failure may lead to significant malnutrition even in very young children. The problem occurs more in urban areas because rural children can consume fresh fruits and vegetables from their own farms if they are economically stable. The severity of the problem in urban areas is exacerbated by unethical middlemen adulterating food products. Nowadays, the majority of food products in urban markets and even supermarkets are adulterated.

Parents can buy agricultural products at GCMs established in the vicinity of the school. Moreover, in the school-based model, NGOs and schools can work together at delivering non-adulterated agricultural products from women farmers. NGOs can collaborate with school authorities to create weekly trading opportunities, and parents can buy fruits and vegetables at scheduled times and dates:

1. NGOs can organize training sessions to increase parents' awareness of consuming adulterated foods (some parents as some parents don't know about the adverse health impact of food adulteration). Such awareness will create more opportunities for women farmers to sell their products.
2. Farmers can get fair prices from direct trading and parents also can buy products at reasonable prices. Parents are also assured safe food when they buy it directly from farmers.
3. Farmers can make business contracts with the schools, and these will give them information on the demand for their products. Such market projections will help farmers to maximize production to meet the demand.

Figure 3 shows the urban school-based service model of delivering agricultural products.

5.6 Advantages of School-Based Service Model

1. Producers' aspect: In this service system, women farmers can be paid fairly for their products. In addition, they can produce seasonal agricultural products according to the demand of the schoolchildren. This will help them to extend the scope of their business and earn more money. In Bangladesh, women are restricted in their movements for religious reasons, and their partners usually do not like to give them permission to go to the market. But in the school-based service model, women can easily do business because the school environment is deemed suitable for their dealing with children's parents. As a whole, women can get a reliable source of income without losses to their products.
2. Consumer aspects: As mentioned earlier, consumers are basically parents living in urban areas who have less opportunity to get non-adulterated agricultural products to fulfil their schoolchildren's nutritional needs. In this service model, parents have a reliable source where they can regularly buy products at more reasonable prices than at the local market or supermarket. They can also develop a friendly relationship with women farmers, and both parties can become aware about food safety and health impact of food adulteration. Parents can also motivate farmers to produce different varieties of seasonal agricultural products and support their initiatives.

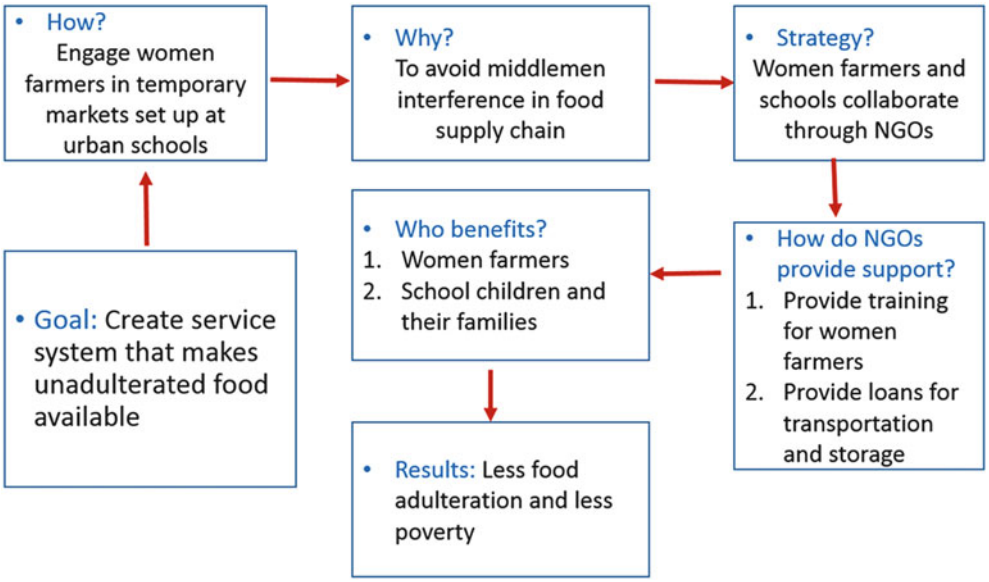

Fig. 3 Urban school-based service model

3. NGO aspects: Non-governmental organizations are actually the key to cocreating value and collaborating with schools and women farmers to create the services. In other words, NGOs are stakeholders that provide services through effective collaboration with schools. Once this service system has become successful, implementation of this idea can be extended in a wider range for reducing food adulteration problem. In this way NGOs can empower women in the agricultural sector and provide them with small loans. Women farmers, once empowered by NGOs, can invest their profit in expanding their business.
4. School aspects: Schools in Bangladesh concentrate on teaching academic courses like physics, chemistry and biology. They take less time to improve children's awareness about food safety and food adulteration. Through collaborating with NGOs, children get training on food safety, hygiene and sanitation, health problems and food adulteration and develop related social and health awareness. This learning would help to empower future generations.

5.7 Possible Initiatives to Benefit from the Urban School-Based Model

NGOs in Bangladesh are very active in health and social issues. It is feasible for them to collaborate with urban schools and with women farmers. Moreover, they can arrange training programmes to make parents aware of the benefits of this service system and negative impacts of food adulteration which ruin the futures of their children. Collaboration among stakeholders is the most important initiative of this service innovation regarding benefit.

5.8 Conclusion

The problem of food adulteration is a burning issue in Bangladesh, and consumers are at risk of long-term health problems. The service system of the food chain is not only complex but also poor in terms of honesty and ethical issues. Here, the strategies of NGOs cannot work well because many middlemen have few ethical concerns and focus on making a profit rather than on thinking about the impact of their activities on people's health. It is also difficult for the government to check each and every food product and punish every middleman. So it is the responsibility of producers and consumers to take initiatives regarding the safety and security of agricultural products.

In the school-based service delivery approach we have proposed in this paper, NGOs have a lot of scope to cocreate value among the other stakeholders and can provide better service opportunities by setting up urban school-based business markets. The feasibility of the proposed service model is very high because NGOs already provide small loans, microcredit options, technical training programmes, awareness programmes on food safety, etc. Only coordination or value cocreation through different activities is needed. The school-based service model explains potential linkages to be implemented for achieving the goal of reducing food adulteration.

The growth centre market approach provides market-level opportunities where women can get easy and prior access for the purpose of trading. In Bangladesh, women's contributions to the agricultural sector have been neglected and have been invisible for a very long time because they have traditionally supported the agricultural work of their partners without receiving any payment. But if they could get financial opportunities, they would be capable and successful entrepreneurs.

On the other hand, in the school-based service model, coordination between NGOs, schools and parents can very easily reduce the impact of the recent food adulteration problem. This service model can be an example for other potential organizations.

The overall success depends on the understanding of the design of the service model by all stakeholders. The implementation of the model not only generates income for rural women and provides safe food and nutrition for consumers but also gradually reduces the food adulteration problem. It will also be helpful for the government when it considers how to reduce the burden of monitoring each sector. If producers and consumers work together, middlemen interference can be reduced.

The collaborative service model that we have proposed in this paper can deal with other social, health and environmental issues in Bangladesh; it is a sustainable solution for a country that lacks a proper service system in major areas.

5.9 Recommendations

It is very important for NGOs to train women farmers, provide technical facilities and provide positive motivation regarding the proposed service system to make it a success. Women farmers need to focus on producing non-adulterated food, and it is the responsibility of NGOs and other consumers to make them understand the high demand for non-adulterated food in the market. Here, women farmers need to be informed that consumers, especially those in urban areas, are ready to pay more for healthy food. The knowledge of the importance of food safety in relation to health, poverty and nutrition must be shared.

In addition, the proposed service model is not specific to women farmers; a similar model is applicable to men farmers, where the main purpose is to avoid the middlemen or retailers who add chemicals to food.

5.10 Limitations of the Proposal

This paper describes a conceptual framework for an urban school-based service that is not yet implemented in real settings. The proposed school-based service system is new and dynamic. Further research is needed to validate the model.

References

1. Muniruzzaman, ANM. 2013, Food Security in Bangladesh: A Comprehensive Analysis, Peace and Security Review, 5: 46–73.
2. FAO (2003): Rural Women: Key to Food Security, Gender and Population Division. FAO, Rome.
3. Hossain, M. and Bayes, A., 2009, Rural Economy and Livelihoods: Insights from Bangladesh. A. H. Developing Publishing House, Dhaka, Bangladesh.
4. Abdullah, T. A. and Zeidenstein, S. 1982, Village Women in Bangladesh: Prospects for Change. A study prepared for the International Labor Office within the framework of the World Employment Program. Oxford Press.
5. Hossain, Mahabub and Jaim, W. M. H., 2011, Empowering Women to Become Farmer Entrepreneur: Case Study of a NGO Supported Program in Bangladesh. Paper presented in Conference on New Directions for Smallholder Agriculture, IFAD Head Quarter, Rome, 24–25 January
6. Birner, R., A. Quisumbing, and N. Ahmed., 2010, Governance and gender: Cross-cutting issues. Paper prepared for the Bangladesh Food Security Investment Forum, May 26–27, 2010.
7. Jaim, W.M.H., Hossain, M., 2011, Women's Participation in Agriculture in Bangladesh, Paper presented in the pre-conference event on "Dynamics of Rural Livelihoods and Poverty in South Asia", 7th Asian Society of Agricultural Economists (ASAE) International Conference Hanoi, Vietnam, 12 October.
8. Quisumbing, A.R., Brown, L.R., Feldstein, H.S., Haddad, L., Pena, C., 1995, Women : The key to Food Security, Food Policy Report, The International Food Policy Research Institute, Washington D.C.
9. IFAD, 2009, Bangladesh: Providing better Opportunities for Women' in Making a Difference in Asia and the Pacific. Special issue: November 2009.
10. FAO, 2014, Towards Sustainable Agriculture and Improved Food Security and Nutrition, Bangladesh Country Programming Framework, CPF 2014–2018.
11. ActionAid, 2011, Investing in Women Smallholder Farmers, An ActionAid International Briefing, June 2011.
12. Kar, K. and Datta, D. 1998. Understanding market mobility: perceptions of smallholder farmers in Bangladesh. PLA Notes 33: 54–58. International Institute for Environment and Development, London.
13. Khan, F., 2013, Life-Changing Stories of Successful Women Farmers, Cereal Systems Initiative for South Asia in Bangladesh (CSISA-BD), USAID.
14. IFAD, 2014, Microfinance for Marginal and Small Farmers Project, Project Performance Assessment, Document of the International Fund for Agricultural Development, Report No. 3307-BD
15. World Bank, 2009, Gender in Agriculture Sourcebook, Agriculture and Rural Development.

Challenges to Deploy Service Design in Organizations: Analysis Through "Scaling Up" Workshops

Fumiya Akasaka, Takehiko Ohno, and Mika Yasuoka

Abstract

More and more companies are applying service design approaches to develop services and products. Not every project, however, has achieved its goals. In many cases, difficulties arise from organizational issues such as organization structure and evaluation system. In this research, we held workshops where success and failure factors of service design projects in organization are presented. By analyzing the results, we construct a model that explains the "difficulties of deploying the service design approach in organization." On the basis of the model, this paper discusses the challenges to the deployment of the service design approach in organizations.

Keywords

Service design • Organization • Workshop

1 Introduction

Our society has changed. In the 1970s and 1980s, the core value of products and services was functionality (e.g., refrigerating foods, washing clothes, and establishing telecommunication). Companies in the 1970–1980s mainly focused on what functions they could realize. As society matured, however, people became surrounded by a lot of products and services that provide a variety of functions. This means that society has become very competitive for companies. In this competitive environment, companies have to consider "what experience they can provide to users" or "how to realize products or services that are chosen and used by people for long term" rather than mere functions.

In this context, service design (SD) (e.g., [1–3]) is attracting much attention in many industries. SD is an approach to develop new services that are useful and desirable from the user perspective and efficient, effective, and different from the provider perspective [4]. The important point of SD is its strong emphasis on improving the user experience, the internal state of the users' mind during service use. In the SD approach, users' values are clarified in the early stage of the overall design process, and service is designed in order to fulfill the users' values.

More and more companies and organizations in Japan are starting to use the SD approach to develop innovation strategies, services, and products. Not every case (i.e., SD project), however, has achieved its goals or purpose. In many cases, it is difficult for companies to implement their ideas as commercial services. As a result, SD is not deployed to their organizations, namely, SD is not used as an approach for developing new services.

Our research answers two research questions:

- *Why is SD not deployed in organizations as an approach for developing new services? What are the difficulties encountered when implementing SD in organizations?*

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- *What challenges must be resolved to deploy SD in organizations? What actions resolve these challenges?*

2 Service Design

2.1 Service Design Research

Looking back over the academic history of SD, the origin of SD is found in the service marketing field [5–7]. At this initial stage of SD research, SD was thought as an approach for improving the quality of service delivery process.

The rapid growth of the service economy in developed countries strengthened research into "services." For example, service-dominant logic, which argues all markets are centered on the exchange of services, has been proposed as a new paradigm for marketing (e.g., [8]). Meanwhile, researches on service science (e.g., [9]) and service engineering (e.g., [10, 11]) have emerged as a scientific and engineering approach that can analyze, design, and evaluate services.

Following this trend, service is now recognized as the center of business in companies, and the scope of SD has become broader. SD is not limited to the design of the service delivery process but includes the design of people, infrastructure, communication, and material components used at the intersections of provider and users in service [12]. Also, SD is considered as a way to obtain competitiveness and realize service innovation [2].

2.2 Service Design Process

The SD process is iterative with the key phases being (1) exploration, (2) creation, (3) reflection, and (4) implementation (Fig. 1).

The exploration phase includes understanding the users and identifying the real problem from the users' viewpoint. Interviews and ethnographic approaches are often used in this phase. In the creation phase, service ideation is the main task. Brainstorming and multi-stakeholder involvement are useful here. During the reflection phase, the service design team makes visualized prototypes and tests them. Service ideas are improved or changed based on the reflection obtained in this phase. The implementation phase is about building an executable service and the change management that is necessary for people to effectively introduce the new service.

The SD process is similar to design thinking process, which includes phases to define problems, generate ideas, make prototypes, and test them in an iterative way [13]. Tools and methods used in design process (e.g., interviews, ethnographic approach, brainstorming, etc.) are also similar.

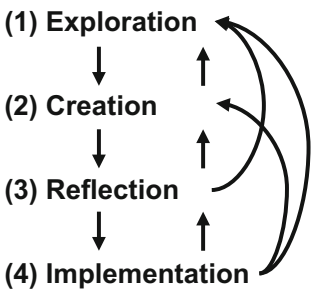

Fig. 1 A service design process (Proposed by Ref. [2])

2.3 Service Design and New Service Development

SD is sometimes misunderstood as being a process to create new service ideas. However, the goal of SD is to develop new services, not to create ideas.

Some designers and researchers have recently been critiqued for SD's weakness in terms of service implementation; their ideas stay on the drawing board [14]. Also, the service design research project in the UK [15] has suggested the need to conduct research into how SD projects can be better implemented, embedded, measured, or scaled up in real business field [16].

On the basis of our experience, it can be said that a lot of Japanese companies that have started to use the SD approach for service development feel the same problem. It is difficult for them to convert ideas into commercial services.

3 Methodology

3.1 Overview

Figure 2 illustrates the methodology used in this paper to clarify the research questions mentioned in Sect. 1.

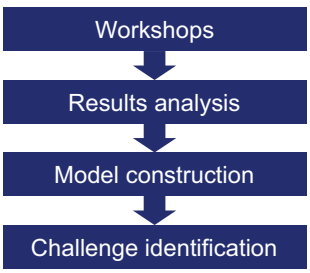

Fig. 2 Methodology used in this paper

Table 1 The scaling up workshops

Place		Copenhagen	Tokyo
Data		September 2014	October 2014
Purpose		To share success and failure experiences of SD projects among participants	
Style		Presentation session style	
Number of Participants	Com.	4	11
	Des.	2	2
	Res.	4	1
Industries		Telecom, electronics, IT, medical equipment, system integrator, global communication, consulting	Telecom, system integrator, software, public service

Com Companies that are trying to introduce SD approach, *Des* Design consulting firm, *Res* Researcher (in universities)

First, we plan and organize workshops, which are called scaling up workshops, where participants present and share reports detailing the success or failure of SD projects in their organizations. After the workshops, we analyzed the workshop results. More concretely, we extracted the success and failure factors of SD projects from the participants' presentations and statements and categorized them. From the results, we developed a model that explains the "difficulties of deploying the SD approach in organizations." Finally, we discuss the challenges that must be resolved in order to deploy SD approach in organizations.

3.2 Scaling Up Workshop

Table 1 shows the basic information on the workshops. Their goal was to share success and failure experiences of SD projects among participants. We planned two workshops in two countries: the first workshop in Copenhagen, Denmark, and the second in Tokyo, Japan. Experiences were given as presentations; each presentation detailed their experiences and was followed by some discussion time. The participants consisted of three types: (1) companies trying to use SD approach in service development, (2) design consulting firm, and (3) researcher (in universities). Eighteen companies from various industries (such as telecom, electronics, system integrator, public service, medical equipment, etc.) participated in total.

4 Results

4.1 Workshop Results

Table 2 lists the number of success and failure factors presented in the workshops. In Copenhagen, eight success factors and nine failure factors were reported. The workshop in Tokyo yielded 30 success factors and 32 failure factors.

After the workshops, similar success factors were grouped yielding 18 categories; we found 23 categories in failure factors. Table 3 shows the labels of each category; column "n" in the table means the number of factors into each category (e.g., two factors were categorized as f1). "Subcategories" were also formed. (Here, the category is called "subcategory," since we made more abstract categories after this process. See Sect. 4.2..) As shown in Table 3, a broad range of topics were presented for both success and failure factors.

Table 2 Numbers of factors presented in the workshops

	Copenhagen	Tokyo	Total
Success factors	8	30	38
Failure factors	9	32	41
Total	17	62	79

4.2 Mapping and Categorizing the Factors

The first purpose of this paper is to clarify the difficulties in implementing SD in organizations. We therefore focused on the failure factors. The 23 subcategories of failure factors were categorized again using the KJ Method.

Next, in order to understand the relevance of these categories, we mapped them to a plane having two axes: (1) the source of the factors and (2) the phase of the factors. It appears that there are two sources of failure factors: the SD team (core staffs responsible for SD process) and the organization. We also identified two phases: idea generation and execution.

Figure 3 shows the results of failure factor categorization and mapping. The 23 subcategories of failure factors were categorized to 13 abstract categories: (F1) to (F13). These categories were mapped on the two axes mentioned before. It is noteworthy that (F12) *Lack of understanding the importance of design activities* and (F13) *Lack of understanding the importance of design activities* actually lie outside of the map. These two categories could not be mapped to either the idea generation or execution phase, since they are related to the overall company system, and so not are limited to a specific phase.

The quadrants of this map have features that are explained below:

Table 3 Subcategories of success/failure factors presented in the workshops

Subcategories of success factors		*n*	Subcategories of failure factors		*n*
s1	Frequent checking on the progress of execution process	1	f1	Little knowledge on how to proceed the execution process effectively	2
s2	Clarification of the commitment of each member in execution process	1	f2	Difficulty on keeping motivation of service design team across the execution process	1
s3	Making a roadmap for execution	1	f3	Lack of skill to optimize resource allocation in the execution process	1
s4	Conducting trend researches in a broader context for idea generation	1	f4	Difficulty to dispel concerns about "new approach" to develop service (SD process is different from traditional process)	2
s5	Planning SD project with a motto of "small start, small success"	1	f5	Little knowledge on how to use personas in designing services	5
s6	Capturing the essential problem based on user researches	1	f6	Lack of skills on creating innovative service ideas from user perspective	1
s7	Collaboration with people outside the company in idea generation stage	2	f7	Difficulty to involve and utilize users effectively in idea generation stage	2
s8	Setting and sharing a common vision among team members	3	f8	Designers' lack of consideration for management/business viewpoints	1
s9	Building a team where each member is treated equally	1	f9	Lack of skills to consider marketing strategy and integrate it to ideas in idea generation stage	2
s10	Investigating and understanding the will of important internal stakeholders (e.g., managers, executives, etc.)	2	f10	Lack of skills to consider revenues in idea generation stage	1
s11	Accumulation of practical accomplishments to reveal the effectiveness of SD approach	3	f11	Difficulty on creating ideas that meet managers' will	4
s12	Involvement of executive officers in design process	3	f12	Difficulty to unearth and utilize technologies buried in company	1
s13	Conducting internal PR activities that promote cooperation of concerned employees in the company	4	f13	Difficulty to utilize diverse human resources to idea generation	1
s14	Building a service design team comprised of diverse employees who have a variety of skill and knowledge	4	f14	Lack of people who has execution skills in service design team	2
s15	Consolidating an in-company system to acquire diverse human resources	1	f15	Difficulty to involve employees who are responsible for execution (e.g., service development or operation division)	4
s16	Consolidating an in-company system for accelerating internal collaboration among different divisions	1	f16	Difficulty on communicating and cooperating with service development division	2
s17	Involvement of members who can be a key to proceed SD project including both idea generation and execution stages	7	f17	Difficulty on transition of organization structure and operation process when introducing new services	2
s18	Use of words and notations that are easy to understand for people in other divisions (most of the people in company does not know words and notations used in SD)	1	f18	Difficulty to proceed new development process in traditional organizational system	1
			f19	Difficulty to convince managers, especially to represent the value of ideas (ideas includes values that cannot be measured in numerical terms)	3
			f20	Effects of organizational problem such as personnel relocation	3
			f21	Limited role and responsibility of designers in company system	3
			f22	Managers' lack of understanding for the importance of design activities	1
			f23	Employees' lack of understanding for the importance of design activities	2

The first quadrant: Organization – Idea Execution

In this area, the factor source is "organization" and the phase is "idea execution." Therefore, categories mapped to this area mention "difficulties in managing or utilizing organizational powers or effects in idea execution."

The second quadrant: Design Team – Idea Execution

The factor source is "design team" and the phase is "idea execution." Categories mapped here mention "lack of skill, knowledge, or experience to conduct idea execution effectively."

The third quadrant: Design Team – Idea Generation

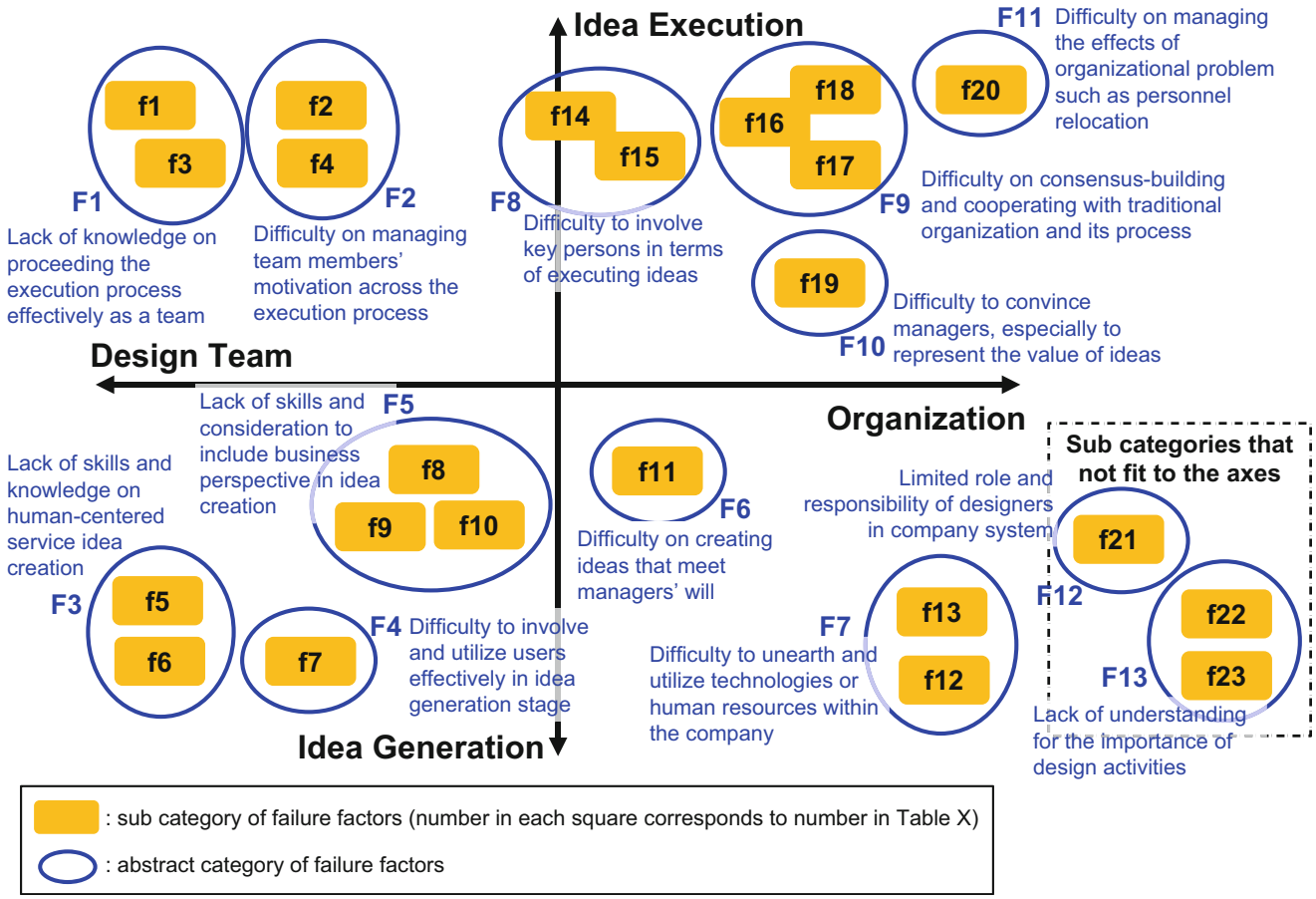

Fig. 3 Result of categorizing and mapping the failure factors of SD projects

The factor source is "design team" and the phase is "idea generation." Categories mapped here mention "lack of skill, knowledge, or experience to generate high-quality ideas."

The forth quadrant: Organization – Idea Generations

The factor source is "organization" and the phase is "idea generation." Categories mapped to this area mention "difficulties to manage or utilize the organizational effects or resources in idea generation stage."

5 Difficulties to Deploy Service Design in Organizations

5.1 Three Types of Difficulties in Implementing SD Approach in Organizations

On the basis of the quadrants in the map in Fig. 3, there seem to be three types of difficulties in implementing SD approach in organizations:

1. *Difficulties in idea generation*
   The first difficulty is about idea generation in SD. This corresponds to the lower area of the map illustrated in Fig. 3. As shown in the figure, F3, F4, F5, F6, and F7 are the types of difficulties.
   Further, as explained in the previous section, this type can be divided into two subtypes from the viewpoint of the source of difficulties: difficulties caused by design team (F3, F4, and F5, the third quadrant in the map) and difficulties caused by organization (F6 and F7, the fourth quadrant in the map).
2. *Difficulties in idea execution*
   The second is about idea execution in SD. This corresponds to the upper area of the map in Fig. 3. Categories F1, F2, F8, F9, F10, and F11 are the types of difficulty.
   This type can also be divided into two subtypes in the same manner as difficulties in idea generation: difficulties caused by design team (F1 and F2, the second quadrant) and difficulties caused by organization (F8, F9, F10, and F11, the first quadrant in the map).

3. *Difficulties created by scant understanding of SD activities in company*
   The third is the company's limited understanding of SD activities. This type of difficulty is depicted as "outsider" in the map, namely, categories F12 and F13.

5.2 Difficulty of Deploying SD Approach in Organization

We use the three difficulties mentioned in Sect. 5.1 to construct a model that explains why SD is not deployed in organizations (the first research question of this research); Fig. 4 shows the model. This model clearly depicts the three difficulties (circles colored black) and the causal relationships among them (black arrows). Around the three main difficulties, we arranged the categories of failure factors, which correspond to (F1)–(F13) in Fig. 3.

This model argues that SD projects in companies are less than successful because of the difficulties mentioned in Sect. 5.1. The second important point of this model is the causal relationships among the three categories of difficulties. Focusing on the causal relationships, we can find significant negative spirals. For example, if an SD team cannot create high-quality ideas due to difficulties in idea generation, then such ideas will not be executed. Further, if few ideas are executed (i.e., realized as commercial services), then company staff (including managers) do not recognize the importance of SD activities, and internal collaboration or employee involvement in SD tasks will not be expanded. If there is limited understanding or cooperation with SD activities in the company, then the activities related to idea generation will be limited in the company. This makes it difficult to create high-quality ideas. Another negative spiral is as follows. If ideas are not realized, then managers in the company will not recognize the importance or effectiveness of SD activities. This may cause a situation where managers tend to reject the design ideas for illogical reasons such as the idea generation process is not traditional. Such an organizational environment makes it extremely difficult to conduct SD projects successfully. These negative spirals make it more difficult to deploy the SD approach in organizations.

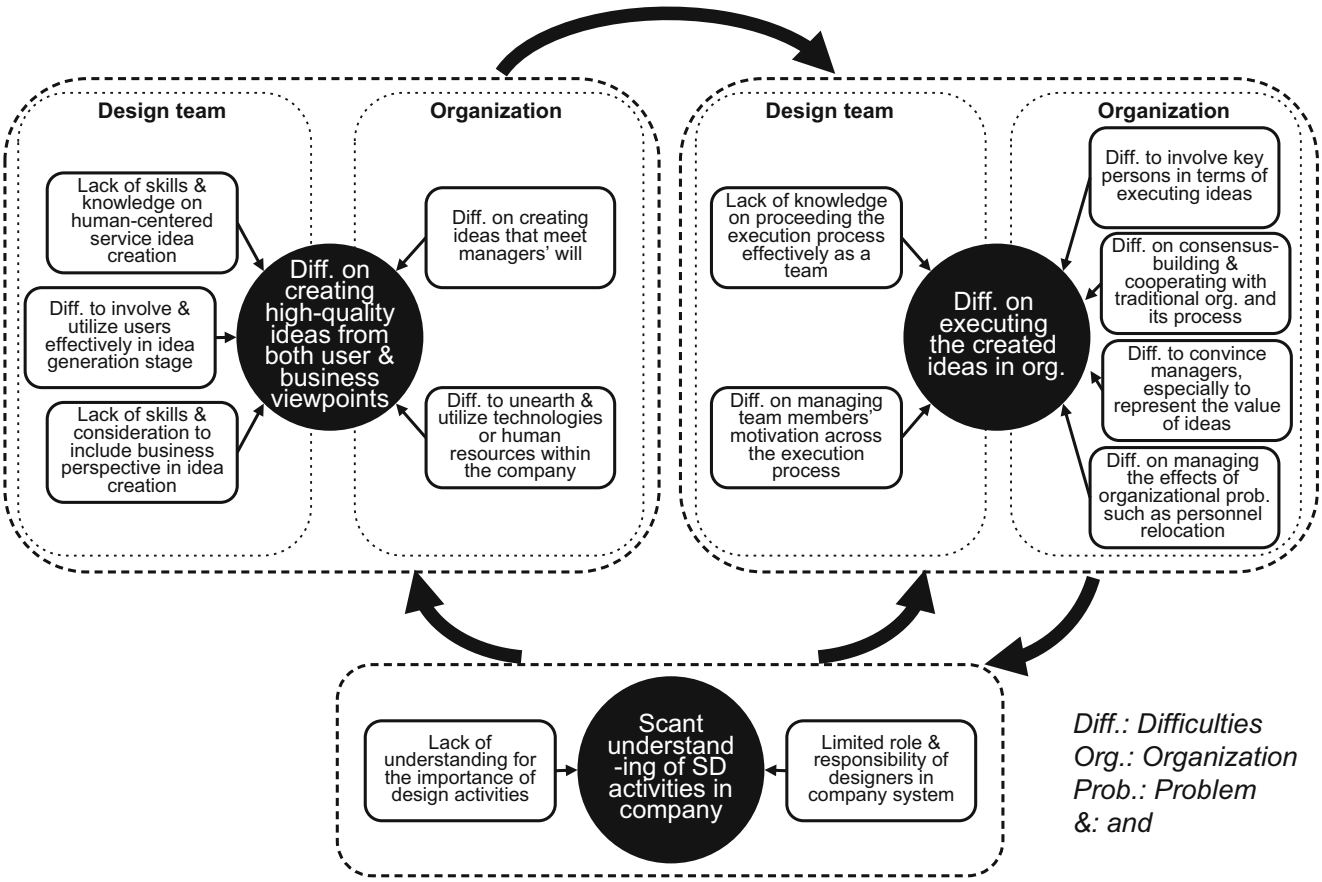

Fig. 4 Difficulty of deploying SD approach in organizations

6 Challenges to Deploy Service Design in Organizations

The model in Fig. 4 reveals three main difficulties in deploying SD approach in organizations. To introduce the SD approach, they should be resolved gradually.

In the scaling up workshop, the participants also shared the success factors of SD projects, which are shown in the left side of Table 3. On the basis of the success factors presented in the workshops, we identified 11 challenges that an SD team should tackle to deploy SD successfully in organizations. Table 4 shows the challenges (the sentence underlined in each cell) for each difficulty and more concrete actions that SD team can take (see the bullet points in each cell). This table also shows what success factors are related to each challenge (see "related category" in each cell; numbers here correspond to the numbers in Table 3).

While there are a lot of challenges (11 in total), SD teams can begin to tackle some specific challenges considering their team's strength/weakness and the project features. The priorities of challenges might change depending on companies or projects.

7 Discussion

7.1 Relation with Existing Researches

In the area of SD research, discussion has mainly been focused on the idea generation phase. More concretely, research targeted "how to create innovative (i.e., something new and interesting) ideas" (e.g., [2]). In contrast, a finding of this research is that companies starting to introduce the SD approach will encounter difficulties not only in the idea generation phase but also in the idea execution phase, i.e., implementing a new service as a commercial product. Few studies have, however, focused on the idea execution phase. Therefore, researches that contribute to solving problems in the idea execution phase are needed in order to implement the SD approach in companies (i.e., the real field of business).

7.2 Comparison Between Danish and Japanese Companies

Figure 5 compares the results of the two workshops (Tokyo and Copenhagen). Figure 5a visualizes the number of failure factors presented by Danish companies; Fig. 5b visualizes that by Japanese companies. F1–F13 in the charts correspond to the number of categories shown in Fig. 3.

By comparing these two charts, two facts can be found. First, Japanese companies tend to face more difficulties in the idea execution phase than Danish companies. Second, participants from Japanese companies think that most of the difficulties with SD projects are caused by organizational factors, unlike Danish companies.

These facts indicate that the organizational system of Japanese company (such as organizational structure, rules, or evaluation system) sometimes becomes a barrier to idea execution of new or innovative services. It must be noted that we are NOT claiming that the Japanese organizational system is unsuitable for innovative service design. We can say conclusions such as the following: (1) most SD teams in Japanese companies have not found an effective way to manage the idea execution process in their organization, and (2) the current SD methods, which were originally developed in Western countries, do not fit to the culture of Japanese companies. Japanese companies should establish methods or processes for new service development that suit their structures.

7.3 Future Research Topics

As discussed above, a perspective such as "how to foster the idea execution phase in organizations" is a key for Japanese companies. With this perspective, the following research topics are suggested.

Integration of Business Perspectives in Idea Generation
To realize ideas in organization, the first hurdle is to pass approval meetings. Here, the most important thing is to convince managers or executive officers. For this purpose, it is essential that the SD team build robust business plans regarding the ideas created. However, in many cases in Japan, SD teams tend to focus only on the novelty or freshness of ideas without considering business logic. Further, creating high-quality business plans normally takes a lot of experience and skill in actual business fields. To solve these problems, methods or tools to support business model planning in the idea generation phase are needed.

Management of Uncertainties in Idea Execution Process
Ideas created in the SD process often include a lot of uncertainties. Actually, no one can accurately judge if an idea will become successful or not as a business before it is launched. These uncertainties have negative effects on motivating members and carrying the SD process smoothly forward in organizations. It is therefore essential to reduce uncertainties as much as possible in the idea execution process. Govindarajan investigated companies that realize innovations in the USA and found that utilization of hypothetical thinking (i.e., hypothesis verification) is critical to reduce uncertainties in new service/product development [17]. Therefore, we should discuss the development of

Table 4 Challenges to deploy SD in organizations

For the difficulties in idea generation	For the difficulties in idea execution	For the difficulties created by scant understanding of SD in company
Improving the quality of human-centered design activities [Related categories: s4, s6, s7]	**Conducting more precise project management in idea execution [Related categories: s1, s2, s3]**	**Enhancement of internal PR activities to promote SD activities [Related categories: s11, s13]**
Conducting trend researches in a broader context for idea generation	Making a roadmap for execution	Conducting internal PR activities that promote cooperation of concerned employees in the company
Capturing the essential problem based on user researches	Clarification of the commitment of each member in execution process	Accumulation of practical accomplishments to reveal the effectiveness of SD approach
Collaboration with people outside the company in idea generation stage	Frequent checking on the progress of execution process	
Making consideration of marketing strategy and business model in the early stage of idea generation	Managing uncertainties in idea execution	
Building a design team comprised of diverse members [Related categories: s8, s9, s14]	**Reinforcement of the consensus building with other decision and its process [Related category: s18]**	**Involvement of managers and executive offices in design process [Related category: s12]**
Building a service design team comprised of diverse members who have a variety of skill and knowledge	Use of words that are easy to understand for employee in other division	Involvement of executive officers in design process
Building a team where each member is treated equally	Use of format of document that are easy to understand employee in other division	Reporting progress or situation of SD project frequently to managers or executive officers
Setting and sharing a common vision among team members		
Deeper understanding of internal stakeholders [Related category: s10]	**Building a design team considering idea execution phase [Related categories: s8, s17]**	**Consolidating an in-company system for internal collaboration [Related categories: s15, s16]**
Investigating and understanding the will of important internal stakeholders (e.g., managers, executives, etc.)	Involvement of members who can be a key to proceed SD project in execution stages	Consolidating an in-company system to acquire diverse human resources
Understanding the constraints in service design	Setting and sharing a common vision among team members	Consolidating an in-company system for accelerating internal collaboration among different divisions
		Consolidating an in-company system to evaluate and educate service designers
	Building a plan that attach importance of putting ideas out into the market [Related category: s5]	
	Planning a small but effective project	
	Planning SD project with a motto of “small start, small success”	
	Conducting activities to have managers understand the value of design [Related category: s13]	
	Reporting the results of user research to managers (who do not know the real users)	
	Representing the value of design in quantified manner as much as possible	

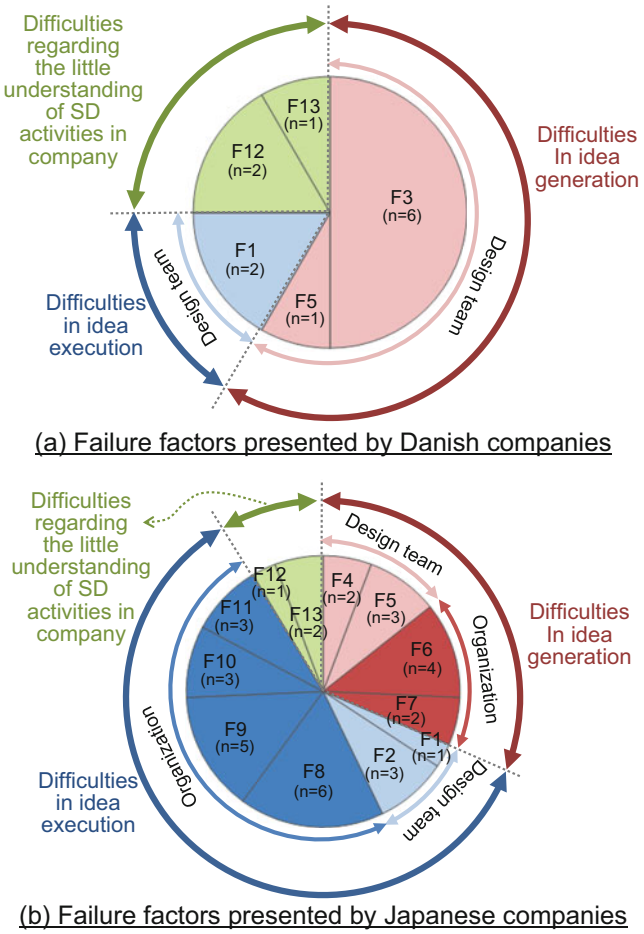

Fig. 5 Comparison of the workshop results

methods or tools that support hypothetical thinking in the idea execution process.

7.4 Limitation of This Research

Although this model was based on the actual experiences of SD projects in Danish and Japanese companies, rigorous model verification has not been fully completed. Future works will include the verification by conducting further interviews of companies.

8 Conclusion

SD appears to be an attractive approach for new service development and service innovation. However, it is a fact that companies encounter many difficulties to implement SD in the *real* business fields. In this study, we therefore tried to clarify two research questions:

- *Why is SD not deployed in organizations as an approach for developing new services? What are the difficulties encountered when implementing SD in organizations?*
- *What challenges must be resolved to deploy SD in organizations? What actions resolve these challenges?*

For this purpose, we held workshops where participants presented and shared their success and failure experiences of SD projects. On the basis of the results, a model that explains the difficulties of deploying SD approach in organizations was constructed. This model is an answer of this research to the first research question. The model argues that we should overcome three difficulties to deploy SD approach in organizations. The three difficulties are (1) difficulties in idea generation, (2) difficulties in idea execution, and (3) difficulties created by scant understanding of SD activities in company. This paper also noted some of the challenges that the SD team should tackle to successfully deploy SD in organizations. Eleven challenges and more concrete actions were elucidated, see Table 4. This proposal is our answer to the second research question.

Furthermore, we compared companies who participated in the workshops, Japanese versus Danish companies. The results of this comparison showed that Japanese companies face relatively more difficulties in managing organizational factors in the idea execution phase. On the basis of this analysis, the paper discussed research topics such as (1) integration of business perspectives in idea generation and (2) management of uncertainties in idea execution process as important for Japanese companies.

In order to accelerate SD activities and realize innovation in Japan, we are planning to push forward research on the topics mentioned above. Ultimately, we would like to establish SD methods or tools better suited for Japanese companies.

References

1. Mager, B., 2004, Service design: A review, Köln International School of Design.
2. Stickdorn, M., Schneider, J., 2011, This is service design thinking: Basics, tools, cases, Wiley.
3. Zomerdijk, L.G., Voss, C.A., 2010, Service design for experience-centric services, Journal of Service Research, 13(1): 67–82.
4. Mager, B., Sung, T.J., 2011, Special issue editorial: Designing for services. International Journal of Design, 5(2): 1–3.
5. Shostack, G.L., 1982, How to design a service, European Journal of Marketing, 16(1): 49–63.
6. Shostack G.L., 1984, Designing services that deliver, Harvard Business Review, January-February 1984: 133–139.
7. Scheuing, E.E., Johnson, E.M., 1989, A proposed model for new service development, Journal of Services marketing, 3(2): 25–34.

8. Vargo, S.L., Lusch, R.F., 2004, Evolving to a new dominant logic for marketing, Journal of marketing, 68(1): 1–17.
9. Maglio, P.P., Spohrer, J., 2008, Fundamentals of service science, Journal of the Academy of Marketing Science, 36(1): 18–20.
10. Bullinger, H.J., Fähnrich, K.P., Meiren, T., 2003, Service engineering—methodical development of new service products, International Journal of Production Economics, 85(3): 275–287.
11. Arai, T., Shimomura, Y., 2004, Proposal of service CAD system-a tool for service engineering, CIRP Annals-Manufacturing Technology, 53(1): 397–400.
12. Erlhoff, M., Marshall, T., 2008, Design dictionary, Perspectives on Design Terminology.
13. Brown, T., 2008, Design thinking, Harvard business review, 86(6): 1–9.
14. Mulgan, G., 2014, Design in public and social innovation, London: NESTA.
15. Service Design Research UK Network. <www.servicedesignresearch.com/uk>
16. Yu, E., Sangiorgi, D., 2014, Service Design as an approach to New Service Development: reflections and future studies, In Proceedings of the Service Design and Innovation Conference 2014 (ServDes 2014): 194–204.
17. Govindarajan, V., Trimble, C., 2010, The other side of innovation: Solving the execution challenge, Harvard Business Press.

Generalized Service Process Expressed by Context-Free Grammar

Fumihiro Maruyama

Abstract

This paper generalizes processes for various services and defines a generalized service process (GSP). The first half presents GSP in two processes: one on the customer side and the other on the provider side, expressed by context-free grammar with generic terms. The second half proposes a GSP-based system and its applications. A procedure is outlined for specializing GSP by reducing the production rules of GSP. Examples of specialization representing individual service processes are also illustrated. Finally, the effectiveness of the methodology is discussed in terms of how it helps us better understand individual services and share and reuse best practices and knowledge.

Keywords

Service modeling • Service process • Context-free grammar • Generalization • Specialization

1 Introduction

Due to their diversity, it is difficult to compare and analyze services across the boundaries of industries and/or business categories. One approach to this problem is to position individual services in a spectrum. The goods-service spectrum [1] is a spectrum of tangible and intangible parts. Individual services can be compared and analyzed by their position between one extreme, 100 % tangible, and the other, 100 % intangible. As servitization advances in terms of (1) from goods-centric to customer outcome-centric services or (2) from basic to advanced services, the intangible part accounts for a higher proportion. The mind-mechanism spectrum [2], on the other hand, is a spectrum of human service-oriented mind and mechanisms supporting the service through devices, instruction manuals, IT systems, and organizational structures. Mind-dominant hospitality is positioned near one extreme and mechanism-dominant self-service near the other. Qualitative comparison and analysis is possible through the approach of using a spectrum.

However, it is also difficult to share and reuse best practices and knowledge such as policies, metrics, insights, know-how, and ideas when industries or business categories are different. Another approach is to focus on a common feature of services. The objective of this research is to develop a methodology for comparing and analyzing various services and sharing and reusing best practices and knowledge by focusing on a common feature of services.

Since service can be defined as "any activity that one economic entity (called a *service provider*) does for another (called a *customer*) where value is cocreated by the two," the process of services can be regarded as an important common feature of services.

This paper generalizes processes for various services and defines a generalized service process (GSP) with the following four characteristics:

(a) It consists of two processes: one on the customer side and the other on the provider side.

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(b) Both processes are expressed by context-free grammar (CFG). CFG allows us to express hierarchical and repetitive processes succinctly.
(c) There are points of contact between the two processes where interaction between the customer and the provider takes place. It is this interaction that leads to co-creation of value.
(d) The processes on the customer and provider sides for an individual service are expressed by a specialization of the GSP grammar.

After related work is reviewed and CFG is introduced, GSP is presented in two processes: one on the customer side and the other on the provider side, expressed by CFG with generic terms. Next, a GSP-based system and its applications are proposed. A procedure is outlined for specializing GSP by reducing the original set of production rules of GSP. Examples of specialization representing individual service processes are also illustrated. Finally, the effectiveness of the methodology is discussed in terms of how it helps us better understand individual services and share and reuse best practices and knowledge.

2 Related Work

The objective of the MIT Process Handbook Project [3] is to create a systematic and powerful method of organizing and sharing business knowledge. There is a publicly available online knowledge base developed by the project, which includes a set of representative templates and specific case examples [4]. As its name suggests, the project focuses on process activities. All process activities are considered to be specialized types of "act." The first level of specialization below "act" contains eight "generic verbs," that is, "create," "destroy," "modify," "preserve," "combine," "separate," "decide," and "manage." Process activities "sell by mail order" and "sell in retail store" are specializations of the generic sales process activity of "sell product." Specialization continues until process activities become specific enough, such as "sell using customized sales channel," where Dell Computer's case is attached. In addition to "generalization" and "specialization," there are two more attributes: "parts" and "uses." This is how the MIT Process Handbook organizes business cases and knowledge. Although process activities have their sub-activities as their "parts," there is no explicit representation of process flow. There is neither alternative order of activities nor repetitive activities. In other words, the MIT Process Handbook does not deal with processes as a time series of actions or operations.

Even though object-oriented analysis and design methodologies take full advantage of the object specialization hierarchy, the process specialization hierarchy is not supported in major process representations such as the state diagram. From this perspective, an approach to process specialization is proposed in the form of a set of transformations which, when applied to a process description, always results in specialization [5]. It concerns the specialization relationship between individual processes. This paper, on the other hand, assumes the most general service process, GSP, in such a way that individual service processes can be obtained as its specializations.

A study exists on the sequential structure of work processes using rule-based grammatical models [6]. It deals with routine work in an organization and takes technical assistance work provided by a software vendor as an example. Although its approach is bottom-up and it seems difficult to generalize it to services in general, the following four points that [6] points out also apply to this paper:

1. A grammar does not specify a fixed outcome; it defines a set of possibilities.
2. Grammatical models can capture the layered quality of action.
3. Grammatical models are well suited to representing dependencies between events that may be widely separated in an observed sequence.
4. Grammatical models have potential practical value because they provide a clear way to distinguish normatively correct instances of a routine from other instances.

There is an attempt to define a general process flow for services in order to take an accurate measurement of productivity and customer satisfaction of services [7]. The top-level process flow for service providers consists of "proposal," "preparation," "serving customers," "offer," and "after-sales service." There is another process flow for service recipients (customers) to use services, and there are points of contact between the two process flows.

This paper shares the objective of [3], expands the attempt of [7] on the basis of CFG grammar in the same way that [6] uses rule-based grammatical models, and proposes a GSP. While [5] applies a set of transformations to a process description such as a state diagram, restrictions are placed on the GSP grammar to obtain a specialization for an individual service process.

3 Context-Free Grammar (CFG)

CFG [8] is a formal grammar in which every production rule is of the form

$$V \rightarrow w$$

where V is a nonterminal symbol, or a variable, and w is a string of terminal symbols and/or nonterminal symbols (w can be empty denoted by ε). It is called "context-free" because its production rules can be applied regardless of the context of a nonterminal symbol. No matter which symbols surround it, the single nonterminal symbol on the left-hand side can always be replaced by the right-hand side.

CFG is used in linguistics to describe the structure of sentences and words in natural language. It is also used in computer science to define a programming language or a document type.

There is a special nonterminal symbol called the start variable, which is used to represent the whole sentence or program. Rule application to the start variable and repetitive rule application to the resulting strings eventually give us a string of terminal symbols, which is a valid sentence or program. The set of all the possible strings (all the valid sentences or programs) generated by a grammar is called the language of the grammar.

When CFG is used for service processes, a string of symbols represents a time series of processes from left to right in chronological order. A production rule breaks down a process into a time series of subprocesses. A production rule of the form

$$P \rightarrow w' P$$

where P is a nonterminal symbol and w' is a string of terminal symbols and/or nonterminal symbols, is called recursive. The above recursive rule means that the process denoted by P (process P) can carry out a time series of subprocesses denoted by w' first and then carry out process P. Recursive rules enable us to express repetitive processes.

This paper deals with specialization of CFG. A CFG is said to be a specialization of another CFG if the language generated by the former is a subset of the language generated by the latter. For example, if some of the production rules of a CFG are removed with the other elements (start variable, nonterminal, and terminal symbols) remaining intact, then the language generated by the resulting CFG is a subset of the language generated by the original CFG, which means the resulting CFG is a specialization of the original CFG.

The following design policies were set for expressing GSP by CFG:

- Use a generic vocabulary independent of industries and business categories. Detailed processes dependent on a specific industry or business category are out of scope.
- Introduce proper hierarchies.
- Express repetitive processes explicitly.
- Production rules can be redundant. Clear meaning of production rules is more important than avoiding redundancies.

4 Generalized Service Process (GSP)

In GSP expressed by CFG, symbols starting with a capital letter represent variables, and symbols in lowercase letters represent terminal symbols. A vertical bar represents logical disjunction and allows us to express multiple rules sharing a variable on the left-hand side in a single rule by connecting their right-hand sides like $X \rightarrow v \mid w\,X \mid \varepsilon$. "$\varepsilon$" stands for the empty string.

In the following GSP, S_c and S_p are the start variables and represent the whole processes on the customer side and the provider side, respectively. When a symbol, which represents a process, is used by both sides, it is distinguished by a subscript "$_c$" for the customer side and "$_p$" for the provider side.

4.1 Customer-Side GSP

The following is the customer-side GSP expressed by CFG:

$S_c \rightarrow$ recognize Explore_provider Explore_item Consume Settle$_c$ Attitude
| recognize Explore_item Explore_provider Consume Settle$_c$ Attitude
Explore_provider → select_provider
| select_provider visit_provider | abandon_provider
| browse_provider Explore_provider
| search_provider Explore_provider
| get_estimate Explore_provider | ε
Explore_item → select_item | abandon_item
| browse_item Explore_item | search_item Explore_item
| get_estimate Explore_item | sample$_c$ Explore_item | ε
Consume → Procure Appreciate
| Procure Appreciate Explore_item Consume
| Procure Appreciate Explore_provider Consume
| Procure Appreciate Explore_provider Explore_item Consume
| Procure Appreciate Explore_item Explore_provider Consume | ε
Procure → reserve | pay | place_order | contract$_c$
| request | informed | reserve Procure | pay Procure
| place_order Procure | contract$_c$ Procure
| request Procure | informed Procure
Appreciate → receive_item Evaluate
| prepare$_c$ receive_item Evaluate
| receive_item Evaluate Appreciate
| prepare$_c$ receive_item Evaluate Appreciate | Evaluate
Evaluate → satisfied | fair | dissatisfied | unsuitable
| reject | check Evaluate | inquire Evaluate
| request Evaluate | dispute$_c$ Evaluate | informed Evaluate

$\texttt{Settle}_\texttt{c} \rightarrow \texttt{pay} \mid \texttt{dispose}_\texttt{c} \mid \texttt{return}_\texttt{c} \mid \texttt{obtain\_refund}$
$\mid \texttt{feedback} \mid \texttt{Evaluate} \mid \texttt{pay Settle}_\texttt{c} \mid \texttt{dispose}_\texttt{c}\ \texttt{Settle}_\texttt{c}$
$\mid \texttt{return}_\texttt{c}\ \texttt{Settle}_\texttt{c} \mid \texttt{obtain\_refund Settle}_\texttt{c} \mid \texttt{feedback}$
$\texttt{Settle}_\texttt{c} \mid \varepsilon$
$\texttt{Attitude} \rightarrow \texttt{loyal} \mid \texttt{disloyal} \mid \texttt{neutral} \mid \texttt{support Attitude}$
$\mid \texttt{dissuade Attitude} \mid \varepsilon$

The meanings of the processes appearing on the right-hand side of the two rules for S_c are as follows:

- The customer recognizes his/her own needs in `recognize`.
- He/she explores service providers and selects one in `Explore_provider`.
- He/she explores service items and selects one or a set of service items in `Explore_item`.
- He/she consumes the service item(s) provided by the provider in `Consume`.
- He/she settles with the provider in $\texttt{Settle}_\texttt{c}$.
- `Attitude` represents what attitude he/she takes after consuming the service item(s).

The customer basically controls the customer-side process, but the process is influenced by the provider in some cases.

4.2 Provider-Side GSP

The following is the provider-side GSP expressed by CFG:

$S_\text{p} \rightarrow \texttt{Arouse Engage Greet Propose Provide Settle}_\texttt{p}$
$\texttt{Behavioral\_review}$
$\mid \texttt{Arouse Propose Engage Greet Provide Settle}_\texttt{p}$
$\texttt{Behavioral\_review}$
$\texttt{Arouse} \rightarrow \texttt{merchandise} \mid \texttt{promote} \mid \texttt{merchandise Arouse}$
$\mid \texttt{promote Arouse} \mid \varepsilon$
$\texttt{Engage} \rightarrow \texttt{publicize} \mid \texttt{advertise} \mid \texttt{contact} \mid$
$\texttt{give\_estimate}$
$\mid \texttt{guide} \mid \texttt{publicize Engage} \mid \texttt{advertise Engage} \mid$
$\texttt{contact Engage}$
$\mid \texttt{give\_estimate Engage} \mid \texttt{guide Engage} \mid \varepsilon$
$\texttt{Greet} \rightarrow \texttt{welcome} \mid \varepsilon$
$\texttt{Propose} \rightarrow \texttt{advertise} \mid \texttt{recommend} \mid \texttt{give\_estimate}$
$\mid \texttt{sample}_\texttt{p} \mid \texttt{advertise Propose} \mid \texttt{recommend Propose}$
$\mid \texttt{give\_estimate Propose} \mid \texttt{sample}_\texttt{p}\ \texttt{Propose} \mid \varepsilon$
$\texttt{Provide} \rightarrow \texttt{Close-deal Deliver}$
$\mid \texttt{Close-deal Deliver Propose Provide}$
$\mid \texttt{Close-deal Deliver Engage Greet Provide}$
$\mid \texttt{Close-deal Deliver Engage Greet Propose Provide}$
$\mid \texttt{Close-deal Deliver Propose Engage Greet Provide} \mid \varepsilon$
$\texttt{Close-deal} \rightarrow \texttt{accept\_reservation} \mid \texttt{receive\_payment}$
$\mid \texttt{accept\_order} \mid \texttt{contract}_\texttt{p} \mid \texttt{respond} \mid \texttt{decline}$
$\mid \texttt{accept\_reservation Close-deal} \mid \texttt{receive\_payment}$
$\texttt{Close-deal}$
$\mid \texttt{accept\_order Close-deal} \mid \texttt{contract}_\texttt{p}\ \texttt{Close-deal}$
$\mid \texttt{respond Close-deal} \mid \varepsilon$
$\texttt{Deliver} \rightarrow \texttt{Arrange fulfill Assist}$
$\mid \texttt{Arrange fulfill Assist Deliver} \mid \varepsilon$
$\texttt{Arrange} \rightarrow \texttt{prepare}_\texttt{p}\ \texttt{Assist} \mid \texttt{prepare}_\texttt{p}\ \texttt{Assist Arrange} \mid \varepsilon$
$\texttt{Assist} \rightarrow \texttt{redo} \mid \texttt{respond} \mid \texttt{instruct} \mid \texttt{offer} \mid \texttt{observe} \mid$
$\texttt{dispute}_\texttt{p}$
$\mid \texttt{report} \mid \texttt{respond Assist} \mid \texttt{instruct Assist} \mid \texttt{offer}$
$\texttt{Assist}$
$\mid \texttt{observe Assist} \mid \texttt{dispute}_\texttt{p}\ \texttt{Assist} \mid \texttt{report Assist} \mid \varepsilon$
$\texttt{Settle}_\texttt{p} \rightarrow \texttt{receive\_payment} \mid \texttt{dispose}_\texttt{p} \mid \texttt{return}_\texttt{p} \mid$
$\texttt{refund} \mid \texttt{survey}$
$\mid \texttt{observe} \mid \texttt{farewell} \mid \texttt{bill Settle}_\texttt{p} \mid \texttt{receive\_payment}$
$\texttt{Settle}_\texttt{p}$
$\mid \texttt{dispose}_\texttt{p}\ \texttt{Settle}_\texttt{p} \mid \texttt{return}_\texttt{p}\ \texttt{Settle}_\texttt{p} \mid \texttt{refund Settle}_\texttt{p}$
$\mid \texttt{survey Settle}_\texttt{p} \mid \texttt{observe Settle}_\texttt{p} \mid \texttt{farewell Settle}_\texttt{p} \mid \varepsilon$
$\texttt{Behavioral\_review} \rightarrow \texttt{research} \mid \texttt{analyze}$
$\mid \texttt{research Behavioral\_review} \mid \texttt{analyze Behavioral\_}$
$\texttt{review} \mid \varepsilon$

The meanings of the processes appearing on the right-hand side of the two rules for S_p are as follows:

- The provider arouses the customer's needs in `Arouse`.
- He/she tries to establish relationships with the customer in `Engage`.
- He/she greets the customer in `Greet`.
- He/she proposes service items to the customer in `Propose`.
- He/she provides the service item(s) that the customer selects in `Provide`.
- He/she settles with the customer in $\texttt{Settle}_\texttt{p}$.
- He/she reviews the customer's attitude in `Behavioral_review`.

4.3 Points of Contact

The following is the list of points of contact between the customer-side and provider-side processes where interaction between the customer and the provider takes place.

"$\Rightarrow$" indicates that the process on the left-hand side works on the process on the right. In other words, when either the customer or the provider starts the process on the left, the process on the right is requested or induced. Strictly speaking, while the process on the right is required to start

in some cases, it is expected to start but not mandatory in other cases. "⇔" indicates that the process on either side can start first and work on the other process. A process is distinguished by its superior process shown in the succeeding parentheses if it is used in multiple processes.

```
Arouse⇒recognize
browse_provider⇒Engage
get_estimate(Explore_provider)⇒give_estimate
(Engage)
Engage⇒select_provider
guide⇒visit_provider
visit_provider⇒welcome
browse_item⇒Propose
search_item⇒Propose
get_estimate(Explore_item)⇒give_estimate(Pro-
pose)
sample_c⇒sample_p
Propose⇒select_item
reserve⇒accept_reservation
pay⇒receive_payment
place_order⇒accept_order
contract_c⇔contract_p
request(Procure)⇒respond(Close-deal)
report(Assist)⇒informed(Procure)
fulfill⇒receive_item
inquire⇒Assist
request(Evaluate)⇒respond(Assist)
report(Assist)⇒informed(Evaluate)
Evaluate(Appreciate)⇒observe(Assist)
reject⇒redo
dispute_c⇒dispute_p
bill⇒pay(Settle_c)
pay(Settle_c)⇒receive_payment
return_c⇒return_p
refund⇒obtain_refund
feedback⇔survey
Evaluate(Settle_c)⇒observe(Settle_p)
Attitude⇒Behavioral_review
```

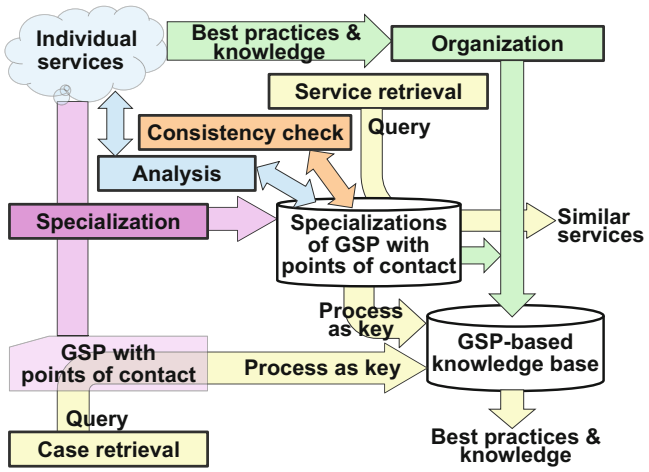

Fig. 1 Configuration of GSP-based system

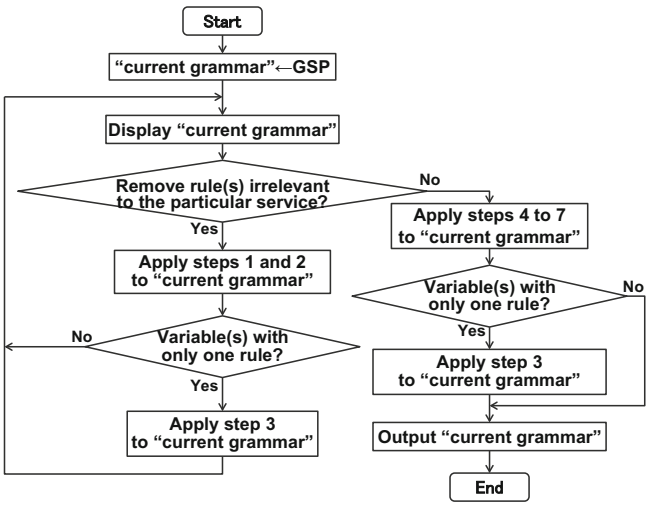

Fig. 2 Flowchart for specialization

5 GSP-Based System

Figure 1 shows the configuration of the proposed GSP-based system.

The system centers around two databases: one for specializations of GSP and the other for the GSP-based knowledge base. The rectangles in the figure represent procedures to perform on the databases.

The specialization procedure is the basis for all the other procedures. Given an individual service, it helps the user specialize GSP with respect to the service in question; there are two instances of specialization, one from the customer-side GSP and the other from the provider-side GSP. It stores the resulting specialization in the database along with relevant points of contact between the customer-side and provider-side processes. Figure 2 shows the flowchart for the specialization procedure. The "steps" mentioned in the figure are described in Sect. 5.1.

Although it is difficult to specify the grammar for an individual service from scratch, it would be easier to follow the steps in the figure to obtain the specialization of GSP for the service in question.

5.1 Specialization of GSP

The seven steps mentioned in the flowchart in Fig. 2 are as follows:

1. Remove production rules irrelevant to the service in question such as those including a process that is not carried out in the service in question.
2. Suppose the production rules for variable X include $X \rightarrow v$ and $X \rightarrow v\ X$. If it is asserted that process v is carried out only at the end of process X in the service in question, then remove $X \rightarrow v\ X$. If it is asserted that process X does not end with process v, on the other hand, then remove $X \rightarrow v$.
3. If there is only one rule for a variable, then replace its occurrences by the right-hand side of the single rule.
4. Suppose there are just two rules for variable X, $X \rightarrow$ v and $X \rightarrow$ w X. If it is asserted that processes v and w are exclusive, then remove $X \rightarrow w\ X$, apply Step 3 to the single rule of $X \rightarrow v$, and end up with the occurrences of X replaced by v. Otherwise, that is, processes v and w are compatible, then replace X by $w^*\ v$, where the asterisk indicates there is zero or more of the preceding element. In a special case of $X \rightarrow w\ X \mid \varepsilon$, replace X by w^*. In another special case of $X \rightarrow w \mid w\ X$, replace X by $w+$, where the plus sign indicates there is one or more of the preceding element. If there are just three rules for variable X, $X \rightarrow w$, $X \rightarrow w\ X$, and $X \rightarrow \varepsilon$, replace X by w^*.
5. If the right-hand side of every rule for variable X is a terminal symbol, $X \rightarrow v_i$ where v_i is a terminal symbol ($i = 1, 2, \ldots, n$), then replace X by $(v_1 \mid v_2 \mid \ldots \mid v_n)$.
6. If all the rules for variable X can be expressed as $X \rightarrow v_1 \mid v_2 \mid \ldots \mid \mathrm{v_n} \mid w\ X$ where $\mathrm{v_i}$ is a terminal symbol ($i = 1, 2, \ldots, n$), then replace X by $w^*\ (v_1 \mid v_2 \mid \ldots \mid v_n)$. If all the rules for variable X can be expressed as $X \rightarrow v_1 \mid v_2 \mid \ldots \mid v_n \mid w_1\ X \mid w_2\ X \mid \ldots \mid w_m\ X$ where w_i is a terminal symbol ($i = 1, 2, \ldots, m$), replace X by $(w_1 \mid w_2 \mid \ldots \mid \mathrm{w_m})^*\ (v_1 \mid v_2 \mid \ldots \mid v_n)$.
7. $(w_1 \mid w_2 \mid \ldots \mid \mathrm{w_m})^*$ can be further simplified by using knowledge of the service in question. If it is asserted that processes $w_1, w_2, \ldots w_m$ are carried out only once in this order, $(w_1 \mid w_2 \mid \ldots \mid w_m)^*$ can be reduced to $w_1\ w_2 \ldots w_m$ (string). $v_1^*\ (v_1 \mid v_2)$ can be reduced to $v_1 \mid (v_1\ v_2)$ if it is asserted that process v_1 is carried out only once. $v_1 \mid (v_1\ v_2)$ can be written as $v_1\ v_2?$, where the question mark indicates there is zero or one of the preceding element, v_2 in this case. The preceding element, v_2 in this case, is optional in other words.

5.2 Individual Service Processes

This section shows examples of specialization of the GSP grammar representing three individual service processes.

5.2.1 Google

The first example is Google's free service using its search engine [9]. Applying Step 1 of Sect. 5.1 to the customer-side GSP with respect to Google's search engine service leaves the following rules:

```
Sc → recognize Explore_provider Explore_item
  Consume Settlec Attitude
Explore_provider → select_provider visit_provider
Explore_item → select_item
Consume → Procure Appreciate
  | Procure Appreciate Explore_item Consume
Procure → place_order
Appreciate → receive_item Evaluate
Evaluate → satisfied | fair | dissatisfied | check
  Evaluate
Settlec → ε
Attitude → loyal | disloyal | neutral
```

Applying other steps of Sect. 5.1 to the above rules leaves the following rules for `Sc`, `Evaluate` and `Attitude`:

```
Sc → recognize select_provider visit_provider
  select_item (place_order receive_item Evaluate
  select_item)* place_order receive_item Evaluate
  Attitude
Evaluate → check* (satisfied | fair | dissatisfied)
Attitude → loyal | disloyal | neutral
```

The following is the specialization of the customer-side GSP grammar with all the above rules combined:

```
Sc → recognize select_provider visit_provider
select_item {place_order receive_item check*
(satisfied | fair | dissatisfied) select_item}*
place_order receive_item check* (satisfied |
fair | dissatisfied)(loyal | disloyal | neutral)
```

(1)

What the processes appearing in (1) mean in this context are as follows:

`recognize`: The customer wants to look up something.
`select_provider`: Selects the Google search engine.
`visit_provider`: Visits the Google site.
`select_item`: Selects a set of keywords.
`place_order`: Inputs the keywords.
`receive_item`: Receives search results.
`check`: Checks them by clicking links.
`satisfied`: Feels satisfied.
`fair`: Feels the results are fair.
`dissatisfied`: Feels dissatisfied.
`loyal`: Becomes a loyal customer.

disloyal: Becomes a disloyal customer.
neutral: Remains neutral.

Applying Step 1 of Sect. 5.1 to the provider-side GSP with respect to Google's search engine service leaves the following rules:

$S_p \rightarrow$ Arouse Engage Greet Propose Provide $Settle_p$ Behavioral_review
Arouse $\rightarrow \varepsilon$
Engage $\rightarrow \varepsilon$
Greet $\rightarrow$ welcome
Propose $\rightarrow$ recommend
Provide $\rightarrow$ Close-deal Deliver
| Close-deal Deliver Propose Provide
Close-deal $\rightarrow$ accept_order
Deliver $\rightarrow$ $prepare_p$ fulfill Assist
Assist $\rightarrow$ observe
$Settle_p \rightarrow \varepsilon$
Behavioral_review $\rightarrow$ analyze

Applying other steps of Sect. 5.1 to the above rules leaves the following specialization of the provider-side GSP grammar:

$S_p \rightarrow$ welcome recommend (accept_order $prepare_p$ fulfill observe recommend)* accept_order $prepare_p$ fulfill observe analyze (2)

What the processes appearing in (2) mean in this context are as follows:

welcome: The provider welcomes the customer.
recommend: Recommends keywords.
accept_order: Accepts keywords as input.
$prepare_p$: Executes the search engine.
fulfill: Displays search results.
observe: Accumulates customer's behavior.
analyze: Analyzes customer's search history.

The points of contact between the customer-side and provider-side processes for Google's search engine service are shown in Fig. 3.

5.2.2 QB House

QB House provides a no-frills rapid haircutting service at a reasonable price [10]. Applying Step 1 of Sect. 5.1 to the customer-side GSP with respect to QB House's haircutting service leaves the following rules:

$S_c \rightarrow$ recognize Explore_provider Explore_item Consume $Settle_c$ Attitude
Explore_provider $\rightarrow$ select_provider visit_provider
Explore_item $\rightarrow \varepsilon$
Consume $\rightarrow$ Procure Appreciate
Procure $\rightarrow$ request | pay Procure
Appreciate $\rightarrow$ receive_item Evaluate
| receive_item Evaluate Appreciate
Evaluate $\rightarrow$ satisfied | fair | dissatisfied | request Evaluate
$Settle_c \rightarrow \varepsilon$
Attitude $\rightarrow$ loyal | disloyal | neutral

Applying other steps of Sect. 5.1 to the above rules leaves the following specialization of the customer-side GSP grammar:

$S_c \rightarrow$ recognize select_provider visit_provider pay* request {receive_item request* (satisfied | fair | dissatisfied)}+ (loyal | disloyal | neutral)

If it is asserted that process pay is carried out only once, then pay* can be reduced to pay as follows:

$S_c \rightarrow$ recognize select_provider visit_provider pay request {receive_item request* (satisfied | fair | dissatisfied)}+ (loyal | disloyal | neutral) (3)

The customer-side process (3) illustrates the following scenario:

(i) The customer wants to have his/her hair cut.
(ii) The customer selects QB House.
(iii) The customer visits a QB House outlet.
(iv) The customer purchases a ticket from a vending machine.

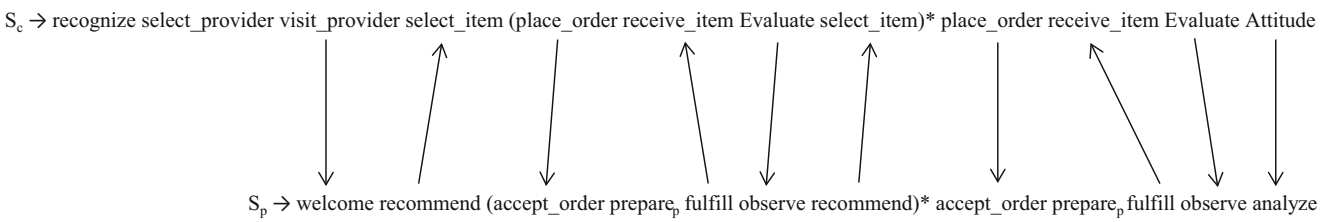

Fig. 3 Points of contact for Google's search engine service

(v) The customer makes a request for the hairstyle he/she wants.
(vi) The customer has his/her hair cut, makes an additional request, if any, and evaluates (satisfied/fair/dissatisfied). Step vi can be repeated.
(vii) The customer leaves the outlet and finds himself/herself a loyal/disloyal/neutral customer.

Applying Step 1 of Sect. 5.1 to the provider-side GSP with respect to QB House's haircutting service leaves the following rules:

```
S_p → Arouse Engage Greet Propose Provide Settle_p
  Behavioral_review
Arouse → ε
Engage → publicize | advertise | publicize Engage
  | advertise Engage
Greet → welcome
Propose → ε
Provide → Close-deal Deliver
Close-deal → receive_payment | respond
  | receive_payment Close-deal
Deliver → prepare_p fulfill Assist
  | prepare_p fulfill Assist Deliver
Assist → respond | respond Assist | ε
Settle_p → dispose_p
Behavioral_review → analyze
```

Applying other steps of Sect. 5.1 to the above rules leaves the following specialization of the provider-side GSP grammar:

```
S_p → (publicize | advertise)+ welcome
  receive_payment* (receive_payment | respond)
  (prepare_p fulfill respond*)+ dispose_p analyze
```

If it is asserted that process `receive_payment` and the first process of `respond` are carried out only once, then the rule can be reduced to the following:

```
S_p → (publicize | advertise)+ welcome
  receive_payment respond (prepare_p fulfill
  respond*)+ dispose_p analyze                (4)
```

The provider-side process (4) illustrates the following scenario:

(i) The provider invites a customer by publicizing and/or advertising including indicating the expected waiting time with a signal.
(ii) The provider welcomes the customer at the outlet.
(iii) The provider sells a ticket with a vending machine.
(iv) The provider accommodates the request from the customer.
(v) The provider prepares, cuts the customer's hair, and meets an additional request, if any. Step v can be repeated.
(vi) The provider cleans up and finishes.
(vii) The provider analyzes customers' responses.

5.2.3 Typical Restaurant

The last example is about the service provided by a typical restaurant serving dinner. Applying Step 1 of Sect. 5.1 to the customer-side GSP with respect to dining at a typical restaurant leaves the following rules:

```
S_c → recognize Explore_provider Explore_item
Consume Settle_c Attitude
Explore_provider → select_provider visit_provider
  | browse_provider Explore_provider
  | search_provider Explore_provider
Explore_item → select_item | browse_item Explore_item
Consume → Procure Appreciate
  | Procure Appreciate Explore_item Consume
Procure → place_order | request | place_order Procure
Appreciate → receive_item Evaluate
  | receive_item Evaluate Appreciate
Evaluate → satisfied | fair | dissatisfied
Settle_c → pay
Attitude → loyal | disloyal | neutral | support
  Attitude | dissuade Attitude
```

The following is the specialization of the customer-side GSP grammar with all the remaining rules combined:

```
S_c → recognize (browse_provider | search_provider)*
  select_provider visit_provider browse_item*
  select_item [place_order* (place_order |
  request) {receive_item (satisfied | fair |
  dissatisfied)}+ browse_item* select_item]*
  place_order* (place_order | request)
  {receive_item (satisfied | fair | dissatisfied)}
  + pay (support | dissuade)* (loyal | disloyal |
  neutral)
```

If it is asserted that process `place_order` is carried out only once, then the rule can be reduced to the following:

```
S_c → recognize (browse_provider | search_
provider)* select_provider visit_provider
browse_item* select_item [place_order request?
{receive_item (satisfied | fair | dissatisfied)}+
browse_item* select_item]* place_order request?
{receive_item (satisfied | fair | dissatisfied)}
```

+ pay (support | dissuade)* (loyal | disloyal | neutral) (5)

The customer-side process (5) covers the following scenario:

(i) The customer wants to dine at a restaurant.
(ii) The customer may browse and/or search restaurants.
(iii) The customer selects a restaurant.
(iv) The customer visits the restaurant.
(v) The customer may browse a menu.
(vi) The customer selects dishes and/or a drink.
(vii) The customer orders them and makes an additional request, if any.
(viii) The customer receives them and evaluates (satisfied/fair/dissatisfied). Step viii can be repeated.
(ix) The customer may browse a menu again; select additional dishes and drink; order them; make an additional request, if any; receive them; and evaluate. This step is optional and can be repeated.
(x) The customer pays the bill and leaves the restaurant.
(xi) The customer may support the restaurant or speak ill of it.
(xii) The customer finds himself/herself a loyal/disloyal/neutral customer.

Applying Step 1 of Sect. 5.1 to the provider-side GSP with respect to the typical restaurant service leaves the following rules:

$S_p \rightarrow$ Arouse Engage Greet Propose Provide $Settle_p$ Behavioral_review
Arouse $\rightarrow \varepsilon$
Engage $\rightarrow$ publicize | advertise | publicize Engage | advertise Engage
Greet $\rightarrow$ welcome
Propose $\rightarrow$ recommend
Provide $\rightarrow$ Close-deal Deliver | Close-deal Deliver Propose Provide
Close-deal $\rightarrow$ accept_order | respond | accept_order Close-deal
Deliver $\rightarrow$ $prepare_p$ fulfill Assist | $prepare_p$ fulfill Assist Deliver
Assist $\rightarrow$ observe
$Settle_p \rightarrow dispose_p$ | bill $Settle_p$ | receive_payment $Settle_p$ | farewell $Settle_p$
Behavioral_review $\rightarrow$ analyze

The following is the specialization of the provider-side GSP grammar with all the remaining rules combined:

$S_p \rightarrow$ (publicize | advertise)+ welcome recommend {accept_order* (accept_order | respond) ($prepare_p$ fulfill observe)+ recommend}* accept_order* (accept_order | respond) ($prepare_p$ fulfill observe)+ (bill | receive_payment | farewell)* $dispose_p$ analyze

If it is asserted that process accept_order is carried out only once, then accept_order* (accept_order | respond) can be reduced to accept_order respond?. If it is asserted that processes bill, receive_payment, and farewell are carried out only once in this order, then (bill | receive_payment | farewell)* can be reduced to bill receive_payment farewell.

$S_p \rightarrow$ (publicize | advertise)+ welcome recommend {accept_order respond? ($prepare_p$ fulfill observe)+ recommend}* accept_order respond? ($prepare_p$ fulfill observe)+ bill receive_payment farewell$dispose_p$ analyze (6)

The provider-side process (6) covers the following scenario:

(i) The provider invites the customer by publicizing and/or advertising.
(ii) The provider welcomes the customer at the entrance and seats him/her at the table.
(iii) The provider recommends some dishes including today's special.
(iv) The provider accepts an order and responds to an additional request, if any.
(v) The provider prepares dishes, takes them to the table, and observes his/her reactions. Step v can be repeated.
(vi) The provider may accept an additional order; respond to an additional request, if any; prepare dishes; take them to the table; and observe. This step is optional and can be repeated.
(vii) The provider bills the customer, receives the payment, and says goodbye.
(viii) The provider cleans up the table.
(ix) The provider analyzes customers' responses.

6 GSP-Based Applications

6.1 GSP-Based Analysis

The three procedures of analysis, consistency check, and service retrieval in Fig. 1 can be used for analysis.

The analysis procedure is directly responsible for analysis. It takes data from an individual service and analyzes it based on the specialization of GSP for the service in question. Important indicators include time, such as the time required and the waiting time, and the number of repetitions of processes.

The following notation is useful for time. |←P Q→| denotes the time required from the start of process P to the end of process Q. On the other hand, P|←→|Q denotes the time required from the end of process P to the start of process Q, and |←P→|Q denotes the time required from the start of process P to the start of process Q. There may be other processes between P and Q. In the example of Google's search engine service, |←`place_order`→|`receive_item` denotes the waiting time for search results. In the example of dining at a typical restaurant, |←`place_order`→|`receive_item` denotes the waiting time for dishes. In the example of QB House's haircutting service, |←`pay`→|`receive_item` denotes the waiting time for the haircut. The waiting time is generalized to |←`Procure`→|`Appreciate` using the hierarchy of GSP. It covers the waiting time for the three examples and allows us to compare the waiting time among various services. This is an example of generalizing indicators based on the hierarchy of GSP for comparing a wider range of services.

The number of repetitions of processes is associated with the parts attached "*" or "+" in the specialization of GSP. In the example of Google, the number of repetitions of

```
{place_order receive_item check*
(satisfied | fair | dissatisfied)
select_item}*                    (7)
```

indicates the number of additional searches. In the example of dining at a typical restaurant, the number of repetitions of

```
[place_order request? {receive_item
(satisfied|fair|dissatisfied)}+browse_item*
select_item]*                    (8)
```

indicates the number of additional orders. The number of repetitions of

```
{receive_item (satisfied | fair |
dissatisfied)}+                  (9)
```

within (8) indicates the number of times dishes are brought to the table.

Since GSP includes processes such as "`abandon_provider`," "`abandon_item`," and "`reject`," abnormal processes can be expressed. It is possible to compare abnormal processes with normal ones for an individual service. It is also possible to compare abnormal processes with those of other services in terms of the "dropout" rate and so on. It is advisable to share and reuse best practices in other services with a lower "dropout" rate.

The consistency check procedure checks if there is any inconsistency in the specialization of GSP for an individual service. Inconsistency occurs when either process of a pair of points of contact in Sect. 4.3 is missing, which means that an action on one side is not adequately supported or responded to by the other side. Resolving inconsistency can improve the service in question. For example, if there is no process under the provider's "`Propose`," it would be worthwhile coming up with a process to work on the customer's "`select_item`" process by retrieving best practices in other services as described in Sect. 6.2. Inconsistency also occurs when the orders of processes on both sides are not corresponding.

The service retrieval procedure can calculate similarity between processes by matching specializations of the GSP grammar. Given an individual service, it returns services whose processes are similar to those of the service in question. Similar services may have priority over other services as to where to look for best practices and knowledge as described in Sect. 6.2.

6.2 GSP-Based Sharing and Reuse

The two procedures, organization and case retrieval, in Fig. 1 are responsible for sharing and reuse of best practices and knowledge such as policies, metrics, insights, know-how, and ideas.

The organization procedure takes best practices and knowledge in an individual service and stores them in the GSP-based knowledge base with the corresponding process attached.

The case retrieval procedure retrieves best practices and knowledge stored in the GSP-based knowledge base by using a process as a key. The user can be either in a special context with an individual service in mind or in a general context. In the latter case, he/she can use any process in GSP as a key. In the former case, he/she is expected to specify either a process appearing in the specialization of GSP for the service in question or a process that is currently missing but necessary for improving the service as illustrated in the example of "`Propose`" in Sect. 6.1.

There are two ways to extend a key in order to extend the scope of retrieval when the number of appropriate results is too few. One way is to use points of contact. "`select_item`" as a key can be extended by adding "`Propose`," which works on "`select_item`." Recommendation of keywords by Google and recommendation of products by Amazon through collaborative filtering may be found in the best practices with "`Propose`" attached. Another way to extend a key is to use the hierarchy of GSP. "`advertise`" as a key can be extended by adding its superior process "`Engage`," which includes processes

such as "publicize" and "guide." In order to narrow down a search, on the other hand, similar services returned by the service retrieval procedure described in Sect. 6.1 are given priority; best practices and knowledge associated with similar services are retrieved first.

What is expected to be shared and reused includes metrics in information retrieval and policies involving IT. Metrics in information retrieval such as precision, i.e., the fraction of retrieved instances that are relevant, and recall, i.e., the fraction of relevant instances that are retrieved, can be used outside of information services. IT becomes indispensable in some aspects of services and helps improve the quality of services when it is properly introduced. The GSP-based methodology allows us to share and reuse policies and metrics related to IT by retrieving best practices and knowledge from seemingly quite different services.

Among the points of contact between the customer-side and provider-side processes shown in Sect. 4.3 is Evaluate (Appreciate)⇒observe(Assist). The process of "observe" is important because it can find out how the customer evaluated the service item. In the example of Google, how the customer clicked the links in the search results can be observed. In an investigation of a cafeteria service, the amount of leftovers was observed. It is valuable to share and reuse best practices on how to observe the customer's behavior and how to assess the customer's evaluation. The GSP-based methodology allows us to share and reuse policies and metrics for the process of "observe."

A survey of the cafeteria service showed that the time required for the settlement process, which is clearing away the dishes, affects customer satisfaction. Since the customer has already consumed the service before the settlement process, taking a long time for settlement makes him/her feel worse. It is also the case with the settlement process at a hotel, that is, checkout. This is why some hotels introduce express checkout or advance payment, which is also good for reducing the staff or allowing them more time to meet customers' various needs around the busiest time of checkout. In general, best practices for $\mathtt{Settle}_c$ or $\mathtt{Settle}_p$ are very helpful. The proposed methodology helps share and reuse best practices for those processes among services in different industries or business categories.

6.3 GSP-Based Service Design

As a new application, there is a possibility of using GSP along with points of contact for designing a new service. An expected process on the customer side is first defined by specializing the customer-side GSP in Sect. 4.1. The overall design is to generate a process on the provider side that is consistent with the above specialization for the customer side. The consistency check procedure described in Sect. 6.1 can be used as a subroutine. More detailed design may use the case retrieval procedure described in Sect. 6.2 for referring to best practices in other services.

Assuming a customer-side process is important to the service provider in the first place. It is a key to providing a good service. It is also important for the service provider to update the customer-side process when he/she collects data about the customers' behavior. He/she might want to define multiple customer-side processes according to customer segmentation.

6.4 Discussion

As mentioned in the Introduction, the intangible part in the goods-service spectrum accounts for a higher proportion as servitization advances. The higher proportion the intangible part accounts for, the more important role GSP will play, because the intangible part is basically realized by processes.

GSP is thought to be able to capture the sequential structure of service processes. But capturing only the sequential structure due to the use of grammar is its limitation. Some work is done in parallel in services, especially in the back office; however, the main focus of the methodology is the sequential structure of service processes like [6]. While work done in parallel has been studied extensively in manufacturing, service is characterized by its interaction between the customer and the provider, and this interaction can be basically serialized.

Although the more detailed processes become, the harder it is to share them among services, it is possible to go deeper than the level of GSPs defined in Sects. 4.1 and 4.2. If it is useful to define additional more detailed processes, it is possible to do so without sharing them with other services.

7 Conclusion and Future Work

GSP is presented in two processes, one on the customer side and the other on the provider side, expressed by CFG with generic terms. Then a GSP-based system and its applications are proposed. A procedure is outlined for specializing GSP by reducing the original set of production rules of GSP. Examples of specialization representing individual service processes are also illustrated. Finally, the effectiveness of the methodology is discussed in terms of how it helps us better understand individual services and share and reuse best practices and knowledge.

GSP can be regarded as a kind of ontology [11], an explicit specification of a conceptualization which aims to support the sharing and reuse of formally represented knowledge. In the context of this paper, what is formally represented is not knowledge to be shared and reused but the structure of processes. GSP can be regarded as an ontology with definitions of process structure such as chronological order and repetition of processes in addition to hierarchical structure.

As part of our future work, the plan is to validate the practicality of the methodology and to implement its useful applications.

References

1. Berry, L. L., Parasuraman, A., 1991, Marketing Services: Competing through Quality, The Free Press, New York, NY.
2. Maruyama, F., Kohda, Y., Katsuyama, T., 2007, Issues of Service Innovation and Its Model, IEEE Joint Conference on E-Commerce Technology and Enterprise Computing, E-Commerce and E-Services, Tokyo, Japan, 23–26 July, 489–490.
3. Malone, T. W. et al., 2003, Tools for Inventing Organizations: Toward a Handbook of Organizational Processes, Organizing Business Knowledge: The MIT Process Handbook, 13–38.
4. MIT Process Handbook's website http://process.mit.edu/
5. Wyner, G. M., Lee, J., 2002, Process Specialization: Defining Specialization for State Diagrams, Computational & Mathematical Organization Theory, Volume 8, Issue 2, 133–155.
6. Pentland, B. T., Rueter, H. H., 1994, Organizational Routines as Grammars of Action, Administrative Science Quarterly, Vol. 39, No. 3, 484–510.
7. Yoshimoto, K., Saito, A., Mihara, K., Tango, S., Okubo, H., Suzuki, H., Yamaguchi, M., 2013, A Technique for Service Visualization, Journal of the Institute of Electronics, Information and Communication Engineers, Vol. 96, No. 3, pp. 610-615. (in Japanese)
8. Hopcroft, J. E., Ullman, J. D., 1979, Introduction to Automata Theory, Languages, and Computation, Addison-Wesley, Reading, MA.
9. Google's search engine https://www.google.com/
10. QB House's website http://www.qbhouse.com/
11. Gruber, T. R., 1993, A Translation Approach to Portable Ontology Specifications, Knowledge Acquisition, Vol.5, No.2, 199–220

Realization of Mobility as a Service in View of Ambient Intelligence

Hideyuki Nakashima, Keiji Hirata, and Junichi Ochiai

Abstract

The concept of a new public transportation system, Smart Access Vehicle System (SAVS), for *mobility as a service* (MaaS) is introduced.

SAVS project is a typical example of the practice in serviceology in the sense that new service emerges in a design-service-analysis loop. Mobility itself is not the goal – mobility is a service, or service platform, on which other services are provided. Mobility enhances activities of people and thus increases the value of other services.

We conducted the field tests of SAVS three times in Hakodate and achieved the world's first full automatic management of real-time multiple demand-responsive transportation. The next step is to enhance its usability and utility. We hope it is possible with the help of ambient intelligence (AmI).

Since SAVS works in outdoor environment citywide, we believe many new and interesting research issues arise from AmI point of view. It will be a city version of intelligent rooms. At the same time, SAVs themselves act as probe cars to collect information about traffic situation.

In the paper, we first briefly describe SAVS and its implementation done so far. We then address the design concept of MaaS in the light of AmI. Combining information and mobility significantly increases the quality of urban life. We present the concept of citywide realization of AmI.

Keywords

Smart Access Vehicle System (SAVS) • Mobility as a service • Ambient intelligence • Demand-responsive transportation (DRT)

1 Introduction

We are developing a new public transportation system, Smart Access Vehicle System (SAVS) [1], under the concept *mobility as a service* [2]. The Internet significantly improved our life in terms of information access and utilization. The next target is enhancement of the mobility of people.

SAVS project is a typical example of the practice in serviceology in the sense that new service emerges in a loop of design, practice/production, and analysis/modeling [3]. Mobility itself is not the goal – mobility is a service on which other services are provided. Mobility enhances

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activities of people and thus increases the value of other services.

The service provided by SAVS can be combined with other services such as food, medical, educational, and entertainment services. People just request to receive a restaurant service or hospital service, and necessary mobility to receive those services is automatically provided by SAVS.

We so far conducted the field tests of SAVS three times in Hakodate, and achieved the world's first full automatic management of the demand-responsive transportation, which assigns multiple passengers to a vehicle in response to users requests in real time.

One of the problems we found through the field tests is that a SAV (we use "SAV" to denote an individual vehicle used in SAVS) sometimes fails to pick up a passenger at a meeting place when the place is vast and crowded. We can use augmented reality to indicate the location of SAV for the user and user for the SAV driver if we have proper information environment. To improve the user interface of SAVS, we should extend our research into ambient intelligence.

Many of the researches in the ambient intelligence (AmI) are for systems operating indoor environments, such as an intelligent room. Since SAVS works outdoor environment citywide, we believe many new and interesting research issues arise from AmI point of view. It will be a city version of intelligent rooms.

In the rest of the paper, we first briefly describe SAVS and its implementation. As the basic SAVS is operational and we have some feedback from the users, we are ready for the next step. We address the design concept of MaaS in the light of AmI. Combining of information and mobility significantly increases the quality of urban life. We present the concept of citywide realization of AmI.

2 SAVS as a Demand-Responsive Transportation

2.1 Classification of DRTs

SAVS falls into a category called demand-responsive transportation (DRT) system, which is further classified into the following:

1. *Detour and/or free stop*
   Usually operates on fixed route with fixed schedule. When requested, the vehicle detours to the requested location or stops at any place on route. Vehicles operate by pre-scheduling, i.e., the route is determined before the vehicle starts.
   This system operates in many rural areas where the demand is very low.
2. *Flex-routing*
   The set of stops is fixed, but the route among them is determined according to the demand. Vehicles operate along the predetermined route and schedule.
   Examples: EU project DRTs [4], Souja city (総社市), and Convenicle (コンビニクル) [7]
3. *Full-demand DRT*
   Full-demand DRT has no fixed route or stops. It operates in response to demands. It is further categorized as follows:
   3.1. *Low-demand area DRT*
   Most of DRTs in the world are in this category (Fig. 1) [5].
   3.1.1. *Full-demand bus*
   In underpopulated areas of Japan, many small-sized full-demand bus systems have been introduced. Example: Nakamura city bus (中村まちバス) [6] and Convenicle (コンビニクル).
   3.1.2. *Shared taxi*
   In Japan, the law does not allow shared ride for taxis. It is operated only in designated areas.
   3.2. *Urban area DRT*
   3.2.1. *Special purpose DRT*
   DRT is often operated in urban areas for special purposes, such as transportation of disabled person or elderly people.
   3.2.2. *General-purpose DRT*
   General-purpose urban area DRT has a potential to replace current public transportation vehicle systems (taxis and buses).
   Example: SAVS only.

SAVS is classified as in 3.2.2 above, but it is *outside of the usual classification of DRT* as depicted in Fig. 1. SAVS is designed to replace current public transportation systems, i.e., bus systems and taxi systems. Although trams cannot be

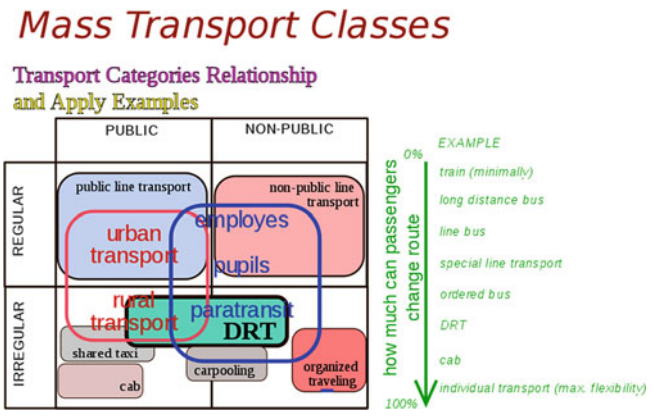

Fig. 1 Mass transport classification [5]. Note that SAVS does not fit into DRT in this classification, but covers the whole PUBLIC area

operated by SAVS, SAVS can coordinate with other transportation systems such as trams, inter-city trains, and airplanes. As far as we know of, SAVS is the only DRT designed to cover whole city areas.

The differences between 3.1 and 3.2 include the size of the operation area, the number of vehicles in service, and the density of demands arisen; the differences also affect many other aspects of service because there are many other services provided in urban areas and DRT service can be combined with them (more in Sect. 3).

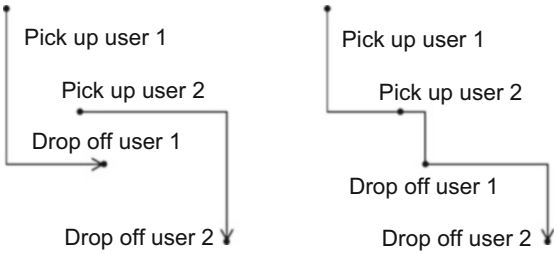

Fig. 2 Routes of uberX (*left*) and uberPOOL (*right*). SAVS also operates in the right-hand side mode

2.2 Convenicle

Convenicle (convenient and smart vehicle) is a full-demand bus system proposed and implemented by a group at the University of Tokyo [7]. It falls into category 3.1.1. The operating system is quite similar to SAVS. However, Convenicle is designed to operate in rural areas with a small number of vehicles, while SAVS is intended to be used in urban areas to replace *all* buses and taxis. Convenicle lacks the viewpoint of total public transportation system and thus does not need large-scale simulation or AmI environment.

2.3 Uber

Uber is a taxi-based service and therefore is not categorized as a DRT. However, when it is extended to shared taxi or car pool, the distinction becomes blurring.

Uber was founded as a dispatching limousine company in 2009, which used a smartphone application to order vehicles. Uber is expanding its services and overseas operations including Japan.

Table 1 classifies Uber services in terms of the vehicle/service types, vehicle capacity, and luxuriousness.

uberBLACK, the original service, is a limousine service. uberLUX is a luxury version of uberBLACK, and uberSUV provides more passenger capacity. uberTAXI and uberTAXILUX dispatch taxies and cost less than uberBLACK.

uberX and uberXL use private cars and drivers to carry users (these service types are not allowed in Japan). The users pay a lower cost than a taxi fare to the private drivers. The drivers can decide the duration of their own operation. After each trip, the user evaluates the driver by use of the smartphone application. Uber unregisters poor grade drivers based on the users' feedbacks.

Table 1 Uber services

	Four seats		
Service class	Standard	Luxury	Six seats
Limousine	uberBLACK	uberLUX	uberSUV
Taxi	uberTAXI	uberTAXILUX	–
Private car	uberX	–	uberXL

The latest service of Uber is uberPOOL, which is uberX with ride-sharing option. It rolled out in San Francisco, Paris, and New York City. Figure 2 illustrates the difference between uberX and uberPOOL. Since uberX vehicles carry only one (or one group) of passengers, most of them run with some empty seats. uberPOOL can carry several (groups of) passengers having similar routes together. Passengers can save up to 50 % per trip because of sharing, and the drivers spend more time earning money on longer trips. Uber claims that efficient usage of uberPOOL causes fewer cars on the road, fewer emissions from cars, and less traffic jams.

Uber, as Convenicle, is an individual vehicle-based operation and does not have the view of MaaS.

2.4 Smart Access Vehicle System

SAVS is designed to replace current urban public transportation systems – taxis and buses.

From users' point of view, the process of calling a SAV is very similar to reserving a demand bus:

1. A user contacts the system with the demand (the current location and the destination).
2. The system searches for the best vehicle considering their current position and future route.
3. The system tells the user the pickup place, the estimated time of pickup, and the estimated time of arriving at the destination (with a small margin of delay). The user has a choice to either accept or decline the service.

The features are:

1. SAVs operate in real time (reservation is optional). A user may call a SAV when the actual demand emerges. (In the future, when SAVS is unified with other services, it may be automatically called or reserved.)
2. Many (in the order of 1000 or more) vehicles are involved so that the operation is efficient.

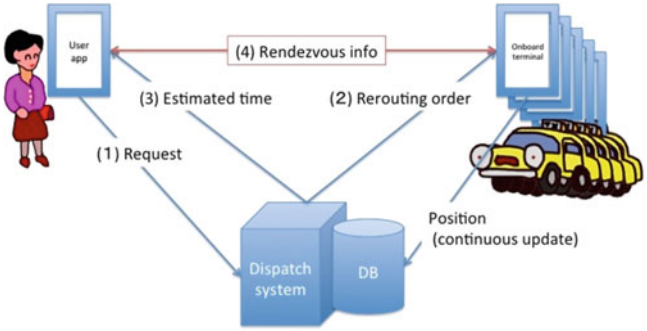

Fig. 3 Communication network and operations of SAVS

A central computer system manages all vehicles in SAVS. The system knows the locations and routes (destinations of passengers on board) of all vehicles. When a new demand arrives, the system searches for a vehicle that can pick up and deliver the passenger with minimum detour [8].

Figure 3 depicts the communication scheme of SAVS. When (1) a user request (pickup and deliver places and optional time limit to the destination) is sent to the dispatch system, SAVS selects the most appropriate vehicle and (2) informs the vehicle its new route and (3) tells the user estimated times for pickup and delivery. When the vehicle approaches, (4) rendezvous information should be presented to both of the user and the vehicle driver, but this rendezvous mechanism is not implemented yet (see Sect. 4.2).

We conducted field tests three times in Hakodate: a week in October 2013 with 5 SAVs, 1 day in April 2014 with 16 SAVs during the domestic annual conference of Society for Serviceology, and four days in May 2015 with 25 SAVs. We succeeded to operate SAVS in full automatic mode for the whole days in both tests. The basic operation system of SAVS has been completed. The next step is to enrich human interface of the system and enhance the system for better mobility services.

3 Mobility as a Service

Information processing and the Internet significantly changed our life by giving information to anyone, anywhere and anytime. The next step is to use computer power to enjoy mobility of things and people. Just like the Internet is a tool on top of which other services are provided, transportation systems are tools to provide mobility.

When we regard mobility as a service, not the goal, we can think of many kinds of service integration with other services, such as education, entertainment, tourism, accommodation, food, and medical care (Fig. 4).

Since SAVS is completely controlled by a computer system, it is flexible enough to be unified with other

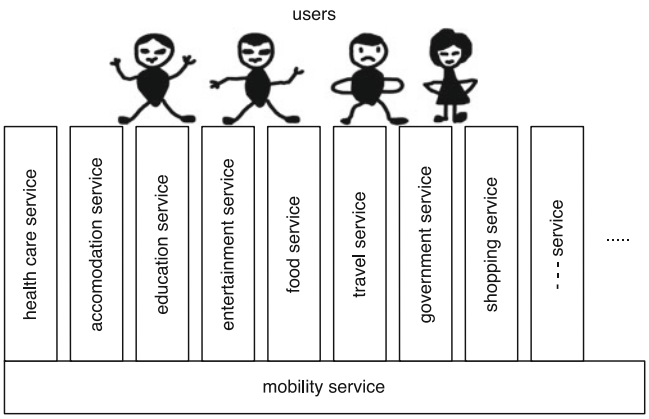

Fig. 4 Service combination over mobility

services with ease. For example, when a user books a restaurant, a SAV can be assigned automatically to pick up the user at home. And when the user is ready for paying the bill for the meal, a SAV is automatically called for the return trip.

Our first target is to use SAVS for hospital services. In many local cities where the public transportation is not very convenient due to small number of operation frequency and/or routes, hospitals have their own buses for patients. One of the hospitals in Hakodate is operating buses for the family of patients in the hospital.

When SAVS is unified with all other city-area services, SAVS becomes part of the blood vessel system of the city, as the same way the Internet forms the neural system of the city.

Once we come to this concept, mobility and information accessibility together form an intelligent infrastructure of a city, and become a base for AmI of the city environment.

4 Ambient Intelligence for Mobility Services

Ambient intelligence (AmI) [9] is a research area as well as a concept to make our environment "intelligent" by using sensors and actuators embedded in the environment.

4.1 SAVS and Ambient Intelligence

The relationship between SAVS and AmI is twofold. SAVS need AmI for better operation and interface, and SAVS can contribute to AmI as probes.

SAVS Needs AmI One of the problems we found through the field tests is that a SAV sometimes fails to pick up a passenger at a meeting place when the place is vast and crowded. For example, a large supermarket has many exits,

and the driver could not identify the location of the passenger, or there are so many taxis at a larger train terminal and the user could not locate the SAV. Indicating the location of the target on map is a minimum solution, but we need a better indication that is physically embedded in the environment (see Sects. 4.2 and 4.3).

SAVS Contributes to AmI Many of the researches in the AMI are for systems operating indoor environment, such as an intelligent room. Since SAV system works outside citywide, we believe many new and interesting research issues arise from the AmI point of view. It will be a city version of intelligent rooms. SAVs themselves act as probe cars to collect information about traffic situation; many sensors embedded in the city also provide useful information for SAVS operation; traffic lights act as actuators to control traffic. Moreover, SAVs can relay the information to drivers and passengers.

For example, as other vehicles run in a city, they may encounter unforeseen accidents and/or problems, including traffic jams, road works, and vehicle malfunctions. The traffic information is relayed to the operation center, and SAVS re-plans the routes of the SAVs in real time, combining incoming information with the traffic simulator. At the same time, a SAV functions as a user interface that collects the ambient information around the SAV and provides a passenger with service in the real world.

4.2 Augmented Reality

To enhance the user interface, the use of augmented reality (AR) should be considered. Here, we define AR as displaying and/or annotating the scene with useful information using some devices such as smartphones with camera.

One of the immediate applications is to support rendezvous of a passenger and the SAV assigned to the passenger. Rendezvous is particularly difficult where many people are waiting for many vehicles, such as train station and shopping plaza. In those cases, when the passenger picks up the smartphone used to call a SAV, and view the scenery through the camera of the phone, the target vehicle is indicated on the screen.

Another example is the use of head-up display of cars. Road and traffic information gathered by other cars and citywide sensors may be displayed to the driver using the HUD. There are many intelligent transportation system (ITS) researches in this direction, but they are based on peer-to-peer communication of individual vehicles. When we talk about AmI, we need citywide information gathering and processing such information with simulation.

4.3 SAVs as Probes

Since SAVs are running throughout a city in high density (e.g., in Hakodate, we estimate about ten vehicles per square kilometer), they are ideal for probe cars. Basically, they monitor traffic conditions – how fast they can move along streets. This monitoring is not only important for SAV operations; they can provide useful information to other vehicles or people who need transportation.

For example, in large cities, traffic controls for smooth flow is important. Adjusting timing of traffic signals is effective. But it needs sensors for traffic status at every intersection, which costs a lot. In contrast to the expensive sensor system, traffic information from SAVs comes free. Furthermore, sensors fixed at intersections cannot track one vehicle to coordinate the signal timing at the next intersection. A SAV can be traced all the way, and traffic signals along the route can be coordinated so that vehicles may not need to be stopped here and there.

Monitoring traffic condition is extremely important in case of irregular conditions such as snow or storm, traffic accidents, earthquake, flooding, and fire. It is well known that after large earthquakes in Japan, roadmaps of usable roads is maintained from actual drive data and proved useful [10, 11]. SAVS can do the same in its operational area.

5 Summary

The current status of SAVS and its future enhancement plans are shown. The basic operation system for SAVS is proven effective. The remaining task is improvement of the system's service (operational features and user interface).

Mobility itself is not a goal. It is means to support other services. Central computer control of SAVS is flexible enough to coordinate with other services.

The concept of ambient intelligence helps improve both SAVS usability (user interface) and utility (probe). This paper outlines improvements.

References

1. Nakashima H, Sano S, Hirata K, Shiraishi Y, Matsubara H, Kanamori R, Koshiba H, Noda I, 2014, One Cycle of Smart Access Vehicle Service Development, *ICServ2014*, pp. 287–295.
2. Hietanen S, 2014, 'Mobility as a Service' - the new transport model?, www.eurotransportmagazine.com, vol. 12, no 2. http://www.itsineurope.com/its10/media/press_clippings/ITSSupp_et214.pdf
3. Nakashima H, Fujii H, Suwa M, 2014, Designing Methodology for Innovative Service Systems, *Serviceology for Services, Selected papers of the 1st International Conference of Serviceology*, pp. 287–295, Springer.
4. Ambrosino J. and Nelson M.R. (Eds.), 2003, Demand Responsive Transport Services: Towards the Flexible Mobility Agency, Italian

National Agency for New Technologies, Energy and the Environment.
5. http://en.wikipedia.org/wiki/Demand_responsive_transport
6. http://www.city.shimanto.lg.jp/kanko/dbus.html
7. Tsubouchi K, Yamato H, Hiekata K, 2010, Innovative on-demand bus system in Japan, IET Intelligent Transportation System, Vol. 4, No. 4, pp. 270–279.
8. Noda I, Ohta M, Kumada Y, Shinoda K, Nakashima H, 2005, Usability of dial-a-ride systems, *Proc. AAMAS 2005*, pp. 1281–1282.
9. Nakashima H, Aghajan H, Augusto JC (Eds.), 2010, Handbook of Ambient Intelligence and Smart Environments, Springer.
10. Kodama N and Hada Y, 2008, Road Information Gathering and Sharing during Disasters Using Probe Vehicles, *International Journal of ITS Research*, Vol. 6, No. 2, pp. 97–104.
11. Noda I, 2012, Information sharing platform to assist rescue activities in huge disasters, *Synthesiology - English edition*, Vol. 5, No. 2, pp. 114–125.

Part II

Smart Service Systems

Customer Experience in Traditional and Modern Retail Formats: A Case Study of Vietnam

Nhung Tran Thi Tuyet and Yoshinori Hara

Abstract

Customer experience that is co-created by both sides of the service provider and customer becomes a main element toward competitive advantage. The purpose of this paper is to examine the customer experience toward two major retail types: the Vietnamese traditional retail format (wet market) and modern retail sector (supermarket). The data mentioned throughout this paper were obtained by a survey, and the results indicate that while the strengths of supermarkets are brought by the facility, safety, and hygiene products, the strength of the wet market is sustained by aspects such as freshness, relationship, and context. The results show that interpersonal relationships are the essential component that makes the way in which the wet market can maintain its sustainability. The results pave the way for recommendations of some policies.

Keywords

Modern and traditional retail formats • Customer experience • Consumer behavior • Developing countries • Experiential value

1 Introduction

In recent years, experience value is focused in much research. In today's economic and competitive retail environment, it is difficult to differentiate an object by its price or the functional value because the development in technology, ICT, has made key breakthroughs in mass production and commoditization progress. From that, the key to retailing success is customer experience. Customer experience becomes the main element in bringing a competitive advantage [1–3].

Customer experience is not unilaterally provided to customers from service providers; it is co-created by the interactions of the service provider and customer [4, 5].

The purpose of this paper is to consider and compare the customer experience in traditional and modern retail formats in Vietnam. Our research focuses on two questions: What is the customer experience seen inside the wet markets and supermarkets? How is it different between these two retail formats? This paper will pursue the idea whether customer experience is really the factor that creates the sustainability of wet markets.

2 Traditional and Modern Retail Formats in Vietnam

Nowadays, the development of Vietnam's retail industry is significant. Traditional retail formats such as wet markets continue developing, while modern retail formats such as supermarkets are introduced. In developed countries such as

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the USA and Japan, retail has had a long history and has gone through a similar process of development. But in developing countries like Vietnam, there has been a lack of history and process in this retrospect. To consider this issue, many retail formats have been introduced at almost the same time underlining the fact that this is a great feature of the modernization of Vietnam's retail industry.

The wet market (or often be called by other name "street market") is the traditional market in Vietnam. It has been said that it existed in the Vietnamese people's lives since humans exchanged economic behaviors. With the development and change of lifestyle, wet markets have also changed in structure and methods. Wet markets are categorized into two types: formal (organized) and informal. Formal wet markets can be defined as a market established by the local authorities. Informal wet markets (also called Cho Coc, "frog markets") are established spontaneously with the constant demands made by the consumers. In Cho Coc, products are mainly fresh foods which are laid out along the streets so it is convenient for customers because they can be on their motorbikes to buy items. Cho Coc is not controlled by local authorities, and they have plans to abolish this type of retail format but they haven't been successful yet.

The first supermarket was opened in 1993. There are many foreign chains such as METRO Cash & Carry, Malaysia's Parkson, French Bourbon Group, Groupe Casino, etc. and also many domestic investors. The number of supermarkets and other retail formats such as shopping malls has increased rapidly. The main reasons for the increase in supermarkets are the increase in foreign investment in food retailing and the support from the Vietnamese government, which is one of the most important factors affecting the development of the modern retail format [6]. The Vietnam Ministry of Industry and Trade has plans that encourage investors from all economic sectors to operate and expand distribution networks.

As mentioned above, in Vietnam, there are many retail formats coexisting in a short period of time, so there is a strong competition between these formats. At present, supermarkets have expanded the store network. However, wet markets still continue developing. According to the statistics of Vietnam Ministry of Industry and Trade (MOIT), in 2008, wet markets range over 7,871 locations and supermarkets have only 386 locations all over the country. It means that the wet market has approximately 20 times more locations than supermarkets. After 2008, the wet market also continued to increase. In 2011, it increased about 10 % compared to 2008 and reached 8550 locations (Fig. 1).

The wet market and supermarket have different purchasing processes. In the wet market, the purchase activity is based on the communication and interaction between the buyer and the seller. Customers start purchasing by communicating with sellers. They observe items that they want to buy and ask the sellers about the products, price, etc. or haggle to make buying decisions. There is no price and product information displayed on a certain product/item. All of the information is provided by the sellers. The price is not fixed. By negotiation or good relationship with the seller, the customer could buy the product with a lower price or receive extra items and service. In supermarkets, product information and fixed price are displayed on all items, and customers could choose and decide to buy without interaction with the sellers. These differences in the purchasing process give customers a different shopping experience.

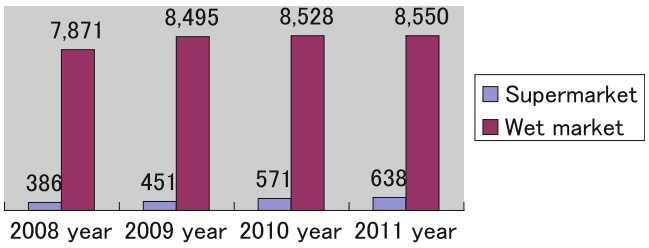


Fig. 1 Transition of store number of wet markets and supermarkets (Source: MOIT)

3 Research Design

3.1 Conceptual Framework

Customer experience is recognized as the key dimension in the value co-creation. "Co-creation is about the joint creation of value by the company and the customer" [4]. According to Vargo and Lusch [7], "there is no value until an offering is used – experience and perception are essential to value determination." Based on this logic, we can focus on the real meaning of the customer experience. Customer experience is the co-creation in a process including actions by both the service provider and the customer. It is created not only by the factors that the retailer can control such as product, price, and store atmosphere but also by the factors that can't be controlled such as the purpose of shopping, customers' emotions, etc. All these factors are always interactive in the shopping environment [1, 8].

Inheriting from the above researches, in this research, we focus on the customer experience as an evolution of the concept of relationship between the service provider (retailer) and the customer and put it in the customer's point of contact in service such as contact with product, store atmosphere, other customers, retailers, and context.

3.1.1 Experience Providers

There is much previous research that analyzes the factors creating customer experience. Schmitt [9] indicated that "Experience is private events that occur in response to some stimulation." Schmitt said experience is established by the stimulus. These stimuli are called experience providers (ExPro) such as communication, visual and verbal identity, product presence, electronic media, etc. Sathish and Venkatesakumar [10] indicate customer experience is created by four factors, namely, product, product information and display, store atmosphere, and convenience. Among these four factors, store atmosphere and display are the most important factors. Jain and Bagdare [11] used factor analysis in research and indicated that customer experience is created by six elements, namely, store atmosphere, customer service, customer background, customer emotion, product, and convenience. In the abovementioned research, there are many viewpoints about the factors that create customer experience, but it is often considered from a one-sided perspective. For example, Schmitt considered experience from service provider's side. The service provider may not be able to control the emotions of customers but can control the factors that evoke emotions. Service providers can create the promotion, product catalogs, and campaigns to bring information to stimulate the sense and connect with customers. Or they can make logos and symbols; name the brand, design, and package; and arrange products to suit the lifestyles and interests of customers. In the factor named "relate," Schmitt also stands on the side of providers when analyzing customer experience based on the control of provider such as salesperson, representatives of companies, and all of the people who may be involved with companies and brands. This is also the main concept in traditional experience marketing that has the tendency to focus on service providers' side.

In this research, we do not analyze one-sided customer experience. We consider customer experience that is created by many sides of service such as providers and customers. It means that customer experience is analyzed in relationship with many sides as shown below.

Customer Experience in Relationship with the Shopping Environment

Shopping facilities contain products (design, display, package, arrangement, etc.), stores (atmosphere, display, decoration, etc.), brands (logo, symbol mark, etc.), and marketing methods (promotion, sale events, etc.). In a shopping environment, customers can't be completely controlled by the service providers. In contrast, customers with knowledge about products and stores and with real purchasing experience in the past can observe and evaluate all shopping facilities and make decision in purchase behavior. It means that all shopping environment always contains two dimensions, and these two dimensions interact with each other. One is the message that service providers send to customer through products and shopping facilities, and the other is the information that customers give providers through the decision of purchasing.

Customer Experience in Relationship with People

All customer experience is generated based on human relationships, that is, the relationship with salespersons in the front stage of retail, with retailers and representatives of company in the background. Salespeople affect customer experience in a way that they can help customers have excellent experience with good manners and sincere attitudes, but they can also create a terrible experience for customers by irresponsibility. One more important thing is the relationship between customers and other customers in the shopping environment. For example, you cannot feel comfortable in a restaurant if the customer beside you makes noise and behaves in a bad manner. On the other hand, other customers can respect you and feel happy if you smile and behave politely.

Customer Experience in Relationship with Context

Customer has the context behind shopping behavior. Context [12, 13] has an important role in the purchase decision process. Context is all factors such as culture and history that have an impact on consumers' behaviors, preferences, and buying habits. For example, customers in high-context cultures and low-context cultures have different buying behaviors. Customers in high-context cultures consider many factors, with regard to human relationship as an important factor in purchasing and making their buying decisions through their rational thinking. Customers in low-context cultures make purchasing decisions based on personal needs. Vietnam is known to have a high-context culture. In a low-context culture, consumer is expected to present direct and immediate solutions. In contrast, Vietnamese consumers require a friendly approach with good relationship between buyers and sellers.

3.1.2 The Elements of the Customer Experience

From the previous research, customer experience has some elements in the model proposed by Schmitt [9] and Fornerino et al. [14]. Schmitt [9] identified five strategic experiential modules, namely, sensory experiences (sense); affective experiences (feel); creative cognitive experiences (think); physical experiences, behaviors, and lifestyle (act); and social identity experiences that result from relation to a reference group or culture (relate). In strategic experiential modules, the aspects of "sense," "feel," and "relate" are understandable, unlike "think" and "act." Fornerino et al. [14] identified five distinct dimensions,

namely, sensorial-perceptual, affective and physical-behavioral (components), and social and cognitive (facets), based on analyzing the case of an immersive consumption experience. It is suggested that the elements of the components and facets in the research of Fornerino are not differentiated clearly.

To find a more suitable and easier way to understand this topic, we think the factors of the customer experience should be sensorial factor, perceptional factor, emotional factor, and relational factor. Sensorial factor is created through the five senses, namely, sight, hearing, taste, touch, and smell. Perceptional factor is connected with thinking and intellectual process. Emotional factor is obtained through customers' inner feelings and emotions. Relational factor involves the relationship with other people and with context (culture, history, etc.). These four factors are related to each other in one process. Based on Kansei Engineering, followed by information processing model, the sensibility is the process of "sense → perception → cognition → emotion → representation" [15–17]. With the same logic, in our model, customer experience is created in the process of "sense → perception → emotion → relate." Everything obtained from the five senses composes the element of perception. Perception will create emotion. And emotions lead to relationships. This process is consistent with customer experience process in retail formats including both wet markets and supermarkets.

We then created the framework of customer experience in retail as shown in Fig. 2.

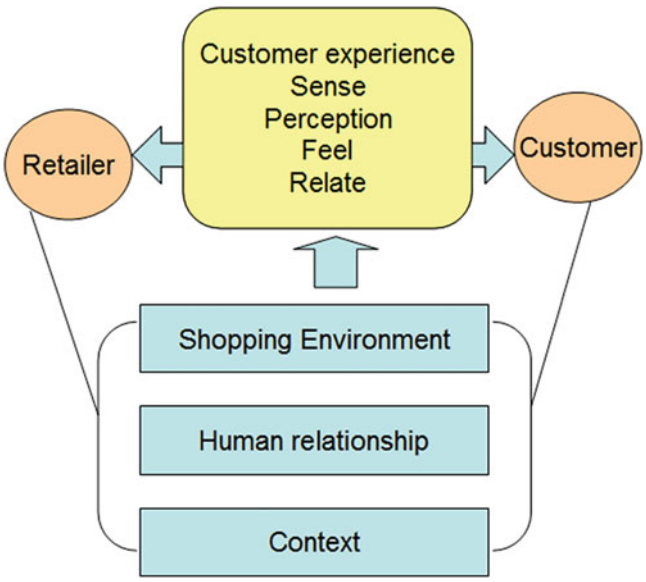


Fig. 2 Framework for customer experience in retail

3.2 Survey

To analyze Vietnamese consumer experience based on sense, perception, feelings, and relations, we created a survey that has four categories:

- The first is a group of questions on consumers' behaviors to find the real answer about situation of consumers using retail format in Vietnam. This paper focuses on the main topic which looks at whether the wet market or supermarket is the main shopping location for most Vietnamese people. It will also focus on the question of whether high-income consumers are also frequent users of wet markets. Those two questions are the main contents of this part.
- The second is the group of questions about shopping environment which contains product category and product factors such as freshness, product quality, price, shopping facilities, shopping atmosphere, etc.
- The third is the group of questions about the relationship between retailers and customers. In this group, we focus on the co-action (interaction) between retailers and consumers, the trust in relationship, and the repetition on consumers' behaviors.
- The final is the group of questions about the context under choosing and using the wet market or supermarket of consumer.

3.3 Sample and Data Collection

The investigation period of the survey is 2 weeks from January 26, 2015. The survey was conducted in Haiphong, the third metropolis of Vietnam where there are many wet markets and supermarkets. We distributed 250 surveys and collected 175 samples. One hundred sixty samples are valid to be analyzed. The attributes of the respondents are described in Table 1.

Table 1 Attributes of respondents

Gender	Female: 131 (82 %), male: 29 (18 %)
Age	20 years old: 26 (16 %), 30:53 (33 %)
	40:48 (30 %), more than 50:33 (21 %)
Occupation	Company employees: 38 (23.8 %)
	Government employees: 68 (42.5 %)
	Self-employed: 22 (13.8 %)
	Agriculture: 2 (1 %)
	Freelance: 30 (18.8 %)
Income	Low income: 50 (31.3 %)
	Middle income: 61 (38.1 %)
	High income 49 (30.6 %)
	(Low-, medium-, and high-income settings follow the income level that Vietnam Ministry of Economic Affairs and Regulations set)

The number of survey results (rate) has been rounded to the nearest two decimal places so sometimes the total is not 100 %

4 Main Findings

4.1 The Wet Market Still Is the Main Retail Channel

The result of the survey showed that 100 % of respondents use the wet market, 47 % go to the wet market "every day," and 32 % go to the wet market "three to five times/week" (Fig. 3). The total frequency is 79 %. This is a very high rate. This means that the majority of Vietnam consumers have a habit to use the wet market at a high frequency.

The percentage of using the supermarket is NOT 100 % as compared with the wet market. There is 1 % of respondents that do NOT use the supermarket. In regard to the frequency in use, more than half (56 %) go to the supermarket one to two times a month, and 24 % go one to two times a week (Fig. 4). As compared with the wet market, the frequency in use of the supermarket is lower.

From the frequency in use of the wet market and supermarket of high-income group, it is shown that 100 % of high-income group use the wet market, but NOT 100% use the supermarket (Figs. 5 and 6). This means even if a consumer has a high income, they still may not use the supermarket but use the wet market as the main shopping location. About the frequency of the high-income group, 34 % go to the wet market every day and 53 % go three to five times a week, having a total frequency of 87 %. In contrast, 0 % go to the supermarket every day, so the frequency of using the supermarket is only about 4 %. In comparison with all of the respondents, the frequency of going to the supermarket of the high-income group is higher but still lower compared with those who go to the wet market.

Results of the survey indicated that the wet market is not only for low-income group but is also often used by the high-income group. Therefore, it does NOT support the hypothesis that the continuity of the wet market is due to income (low-income group and high-come group choose the shopping locations differently). In Vietnam, the main shopping channel is the wet market.

About product category, in the wet market, the product category that is mainly consumed is food. Next is grocery. Although clothing and electronic products are also sold in the market, the purchasing rate is small. In contrast, in the supermarket, the main categories of products are food and grocery, but the rate of purchasing food is smaller than grocery.

About the volume of shopping at wet markets and supermarkets, we asked ten random households (among those surveyed) additional questions about the details of expenditures in household account books. Based on the

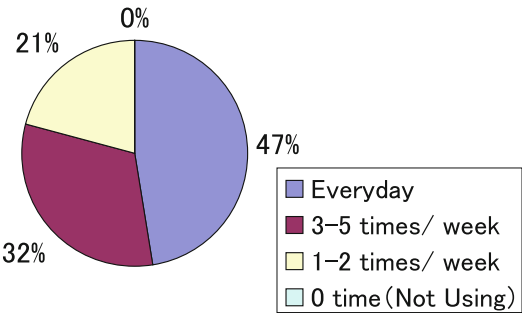


Fig. 3 Frequency of using the wet market

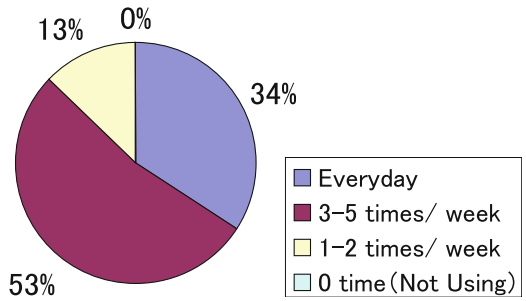


Fig. 5 Frequency of using the wet market of high-income group

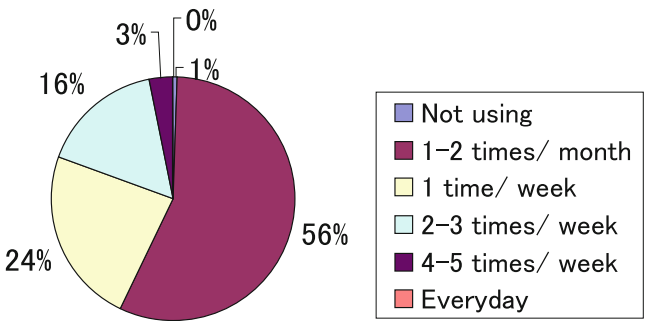


Fig. 4 Frequency of using the supermarket

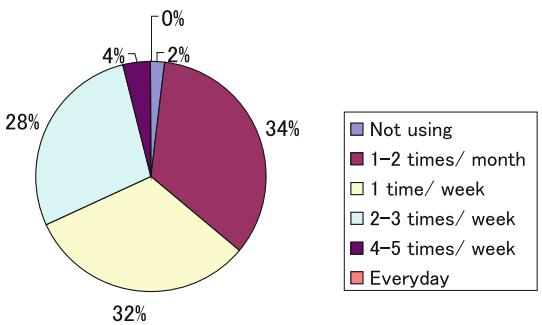


Fig. 6 Frequency of using the supermarket of high-income group

data of the frequency of using money at wet markets and supermarkets and the amount of money used each time recorded in household account books, we calculated the amount of money spent at wet markets and supermarkets within a month. The results showed that the average amount of money spent in one-time shopping at supermarkets is higher than that in one-time shopping at wet markets. However, the total amount of money used for shopping at wet markets is higher than that at supermarkets as people go to wet markets more often. (Specifically, the results showed that consumers spent from 100,000 VND to 300,000 VND for one-time shopping at wet markets and from 300,000 VND to 500,000 VND for one-time shopping at supermarkets. However, the total amount of money spent in 1 month at supermarkets is only 38 % than that at wet markets.)

4.2 The Main Reasons for Choosing the Wet Market and Supermarket

The main reasons for choosing the wet market and supermarket are shown in Figs. 7 and 8.

It can be concluded that there are four main groups of factors in the customer's choice of the wet market. The first and most attractive factor is freshness. The second includes "accustomed store," "product preliminary treatment," and "explanation and advice about products." This expresses the trust between the seller and buyer. The third includes "feel familiar and easy-to-use" shopping atmosphere. And the fourth is the negotiation of price.

Fig. 7 Reasons for choosing the wet market

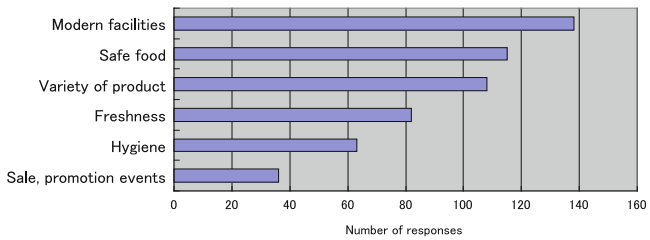


Fig. 8 Reasons for choosing the supermarket

The reasons for choosing the supermarket can be categorized into three: facilities, product (safe, hygiene, variety of products), and marketing promotion.

The main factors are analyzed and explained in detail below.

4.2.1 Freshness

As the result in Fig. 7 shows, freshness is the most important reason for choosing the wet market. To understand this result, we must know about Vietnamese consumers in the relationship with context. To Vietnamese, family is the most important aspect of life, and meals where all members in the family connect and share feelings are always carefully prepared. The main factor that makes a meal delicious is freshness. Vietnamese consumers do not have the habit of using frozen food because from the Vietnamese perspective, frozen food is not fresh. The fresh food means live fish, shrimp, and chicken and fresh vegetables. As the result of this research, in order to buy food in the fresh mode, they have to go to the market every day, even two or three times per day. They usually go to the wet market very early in the morning, about 5 am, because during this time, vegetables, pork, beef, poultry, and seafood still maintain their freshness. Nowadays, consumers' lifestyle goes through many changes because of the diffusion of refrigerators and the increased number of working women, but the habit of using fresh food doesn't seem to change much.

Freshness brings consumers exciting shopping experience. In wet markets, all items are displayed nakedly without proper packaging. Customers can see, smell, touch, hear, and feel the food in its natural form. This makes "sense" experience diverse. In supermarkets, all of the items are packed in boxes and plastic bags. Meat, seafood, and vegetables are divided into equal quantity and weight and they are packed in boxes. Customers can only identify the nature of products by seeing information on the packaging. The exciting experience that customers receive in wet markets cannot be provided in supermarkets. This could make consumers feel unsatisfied with the type of freshness in supermarkets.

About consumers' satisfaction of freshness in wet markets and supermarkets, the result of the survey showed that the satisfaction of freshness in wet markets is much higher than in supermarkets (Table 2).

Table 2 Satisfaction of customers on freshness

	Wet markets		Supermarkets	
	$n = 160$		$n = 160$	
Factor	Mean	Std. dev.	Mean	Std. dev.
Freshness	3.61	1.07	2.88	1.31

1–5 scale, 1 = very low satisfaction, 5 = very high satisfaction; the comparison of two means is conducted by the *t*-test, differences in mean of approximately 0.34 are significant at $p < 0.1$, and approximately 0.5 are significant at $p < 0.05$

This result is also the same result in research [6] which showed that the supermarket cannot respond to the demand of consumers for fresh food. Eight years had passed but it seems that this problem of supermarkets has not been solved.

4.2.2 Product Hygiene and Safety

Product hygiene and safety are the important reasons for consumers to go to supermarkets. The supermarket beats the wet market in this factor. In recent years, there have been many reports on problems with food safety and hygiene of the wet market. The food there has unknown origin and does not go through food safety inspection. This makes customers anxious when they use wet markets. On the other hand, it is not clear at all that supermarkets always provide safer food. In Vietnam, it has been found many times that merchandises in the supermarket have unknown origins. It also has rumors that goods in supermarkets are purchased from wet markets and sold with higher prices. This aspect confuses Vietnamese consumers.

4.2.3 Customer Experience on Price

The way to set up price in the wet market differs from the supermarket, so it brings customers another experience. To analyze customer experience about price in Vietnam, customer is seen in relationship with context. In the wet market, price is not fixed as in the supermarket. The customer can negotiate with the seller for the price that they think is reasonable. The final price is determined by the agreement between sellers and buyers.

To check the experience that customer received from price negotiation, we asked questions about the customer's opinion on price negotiation. The number of respondents that say "price negotiation is a meaningful action" and "Feel very happy when negotiation is successful" is ranked no. 1 and no. 2, respectively (Fig. 9).

This demonstrates that Vietnamese consumers have a positive attitude toward price negotiation. In this survey, "meaningful action" means that the fluctuated price enables people with lower income to choose and buy items at lower prices and those with higher income to buy items at a higher price. This means price negotiation creates an economic benefit, which is equality in the distribution of income. Specifically, rich people may pay more and poor people may pay less. Another important aspect is that negotiation is the behavior that brings customers not only the economic benefit but also the fun and happiness in their shopping experience. In many cases, the economic benefit may be small because the price buyers' pay is only slightly less than the price sellers proposed. But with only a little haggling, buyers may feel extremely happy when receiving products with a lower price and confident in their shopping ability. That is to say, bargain is a hobby, a pastime, and an interesting experience for Vietnamese consumers when shopping in wet markets.

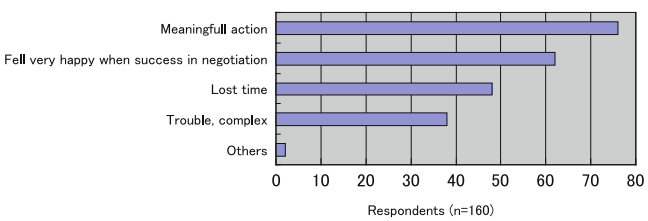


Fig. 9 Attitudes of consumers toward price negotiation

It is worth mentioning that the price may be affected by the relationship between sellers and buyers. Sellers may propose the correct price of the product or sell at a lower price for regular customers. The sales in the wet market also contained many other procedures related to the price as sellers do not reduce prices for customers but add to the regular customers an extra product or they can serve semi-processed products for free. For example, when you buy vegetables, sellers can give you some free onions, or when you buy eggs, they can give some herbs for free. Or when you buy meat, they can cut the part and give the quality that you required. They can also wash, cut, and mince the meat if it is necessary. This gives customers the psychological experience that makes them feel satisfied, and this experience gains consumer loyalty.

The relationship between the seller and the buyer affects not only commodity prices but also payment methods. In wet markets, regular customers may not need to pay at the time of purchase. They can pay the next time they will buy or at the time of appointment with sellers. This may help some low-income customers to buy food and store it in days when they do not have enough money especially before salary is given. The method of payment that is based on trust can only be found in wet markets.

Supermarkets give customers a variety of experiences as the way of setting price and payment method differs from wet markets. At the supermarket, the product prices have been fixed so there is no price negotiation, and customers must pay at the buying time. This can make customers feel comfortable when shopping in supermarkets because they won't waste their time for price negotiation. On the other hand, pricing in supermarkets may destroy shopping interest of consumers who consider price negotiation a pleasure like Vietnamese customers.

Consumers shop in different retail formats (such as in this survey, the majority of customers have shopping experience both in wet markets and supermarkets) for similar categories of products so that they can realize pricing strategies within a format or across formats. The comparison of customers' satisfaction on price level (expensive or cheap) in wet markets and supermarkets in this survey is shown in Table 3.

It can be seen from the result that the level of satisfaction with price in wet markets is higher than in supermarkets.

Table 3 Satisfaction of customers with price

	Wet markets		Supermarkets	
	$n = 160$		$n = 160$	
Factor	Mean	Std. dev.	Mean	Std. dev.
Price	3.65	0.93	3.08	1.05

1–5 scale, 1 = very low satisfaction, 5 = very high satisfaction; the comparison of two means is conducted by the *t*-test, differences in mean of approximately 0.34 are significant at $p < 0.1$, and approximately 0.5 are significant at $p < 0.05$

But this difference is not significant enough to make price become the factor that creates the competitiveness of wet markets. In other words, the price in wet markets may be lower than the supermarkets, but being expensive or cheap will not become the determining factor in customers' choice of shopping location. But the ability to negotiate price is one of the factors that make customers choose wet markets (Fig. 9). It proves that higher or lower price may not be the strongest attraction of wet markets, but the experience value that customers receive from the bargaining process is an element attracting customers to use wet markets.

4.2.4 Shopping Environment

Shopping environment consists of two elements: facilities and shopping atmosphere.

The survey result indicated that Vietnamese consumers feel more satisfied with the facilities in supermarkets. In contrast, they think shopping atmosphere in the wet market is more friendly, comfortable, and enjoyable (Table 4).

Wet markets in Vietnam are constructed many years ago and facilities are old, outdated, and deteriorated. In recent years, wet markets have not received any funding for renovation. Supermarkets that are invested by major funding from local and foreign investors have modern facilities such as counters and air conditioners. This makes the customers' satisfaction level with the facilities in supermarkets higher than wet markets.

Contrary to the satisfaction of facility, Vietnamese consumers are more excited with the atmosphere of wet markets. They feel shopping atmosphere in wet markets is more friendly, comfortable, and enjoyable. In wet markets, the shopping atmosphere is exalted by the sounds of the communication between and among buyers and sellers and many other sounds. These sounds seem to heighten purchasing emotions. In addition, the shopping process of wet markets contains many surprises and fun. Unlike supermarkets that have a simple purchasing process, customers just choose products and pay at one time, and wet markets have a repetitive process in many stores. To purchase different kinds of items, customers repeat the process of greeting, looking, chatting, touching, selecting, weighting, and paying. This may sound monotonous, but this is not a boring repetition. There are many changes in communication and behaviors based on emotions, ideas, and human factors. These changes enrich the customer shopping experience and create enjoyment and increase intellectual experience. In many cases, consumers go to wet markets to enjoy the atmosphere more than shopping. In the survey, with the question "Do you go to wet markets to enjoy the atmosphere more than shopping?", the number of "yes" is 76 %, and 21 % answered "usually" on the frequency of this behavior. Shopping atmosphere in wet markets gives customers sensorial, emotional, and intellectual experience, and that makes them loyal to wet markets.

Table 4 Customers' satisfaction with facilities and atmosphere in wet markets and supermarkets

	Wet markets		Supermarkets	
	$n = 160$		$n = 160$	
Factors	Mean	Std. dev.	Mean	Std. dev.
Facilities	2.34	1.03	4.88	1.15
Atmosphere	4.05	1.15	2.30	1.03

4.2.5 Trust Between Customers and Retailers

In Vietnamese wet markets, the purchase is based on trust. Customers have the habit of shopping at familiar stores. In the survey, we investigated the number of familiar stores with the question: "How many familiar stores do you have in wet markets?" The result is shown below.

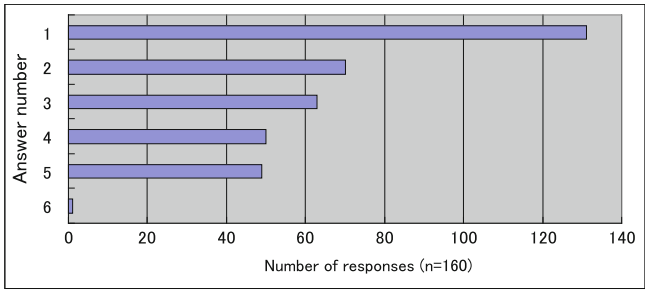
The survey result indicated that 94 % of consumers have two or more familiar stores. The percentage of consumers who have four or more familiar stores is over 50 % (Table 5). The reasons for choosing the familiar stores are good quality merchandise, friendly sales attitude with explanations in detail about goods, good advice to customers, lower price, and free pre-processing (Fig. 10).

In wet markets, salesmen or saleswomen are the shop owners. They know exactly about the products they sell. They can explain and share information about items such as the nature and origin of goods. They may give the customer advice about using items they sell in cooking. In many cases, customers go shopping but do not know exactly what they want for meals on that day. This may be common with many housewives because they depend on the goods that can be bought at the market to create the menu. Sellers may give instructions about the good items they have for the day and suggest quantity and menu for meal. What experience customers receive from these transactions? By interacting and communicating with sellers, customers get knowledge about merchandise and food. They may get psychological advantage for getting to know what to cook for the family today. Moreover, customers feel good when communicating. All of these experiences create loyalty to certain shops and raise trust in relationship with the sellers and the stores.

In supermarkets, sellers are machines. Information about merchandise is recorded on goods. There is not any

Table 5 Number of accustomed store in the wet market ($n = 160$)

More than 5 stores	43	Sum: 82 (51.9 %)	Sum: 149 (94.3 %)
4–5 stores	39		
2–3 stores	67		
1 store	7		Sum: 9 (5.7 %)
0 store	2		



1. Good quality merchandise
2. Friendly sales attitude
3. There are explanationsin detail about goods, and good advice given to customers
4. Cheaper price
5. Free pre-processing (for example: cleaning vegetables, cutting fish, meat, chickenetc.)
6. Others

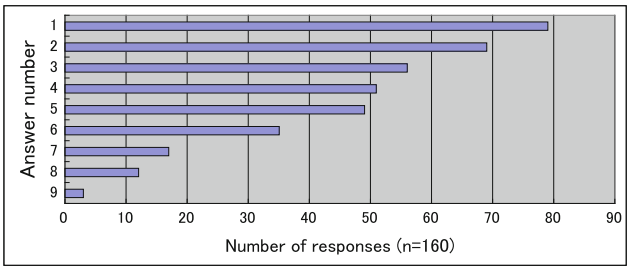
Fig. 10 Reasons for choosing familiar stores

communication and interaction between sellers and buyers. Merchandises sell themselves. Employees of supermarkets may know the location and price of particular products, but they may not know about the characteristics and differences of the products. If customers ask them about products, they will read the information and answer customers. Therefore, supermarkets are self-service form that can give customers freedom and hassle-free shopping. Supermarkets also promote independent decision-making of customers.

Vietnam has a high-context culture that not only businesses but also many other fields are based on human relationship. Wet markets, the retail format that exists based on trust between sellers and buyers, are highly consistent with the context of Vietnamese consumers.

4.3 The Meaning of the Presence of Wet Markets

For Vietnamese, wet markets exist sustainably. The wet market is the place where people can buy fresh food with



1. Places where you can enjoy a unique shopping atmosphere
2. Places that keep the culure of the region
3. Places to make a connection with the locals, and create a community
4. Good quality with good prices
5. Places where people communicate and share emotions
6. Just places to shop.
7. Old places and not appropriate with today's life
8. Noisy and inconvenient, so they do not fit the modern lifestyle
9. Others

Fig. 11 Meaning of the existence of wet markets

reasonable prices for everyday life. According to the results of the survey, in answering the question "What is the meaning of wet market for you?", respondents said that wet markets are the places where "people communicate, exchange emotion," "keep the culture of the region," and "make a connection with the locals and create community" (Fig. 11). This result indicated that wet markets are more than markets because they function as a center for people to gather in a community, share emotion, and maintain the culture of the region. Therefore, shopping in wet markets also brings customers a social and cultural experience. To understand any area in Vietnam, the first thing to do is to go to its wet market because it contains all factors of life including history and culture.

4.4 Continuity of Wet Markets

In the question "Should we maintain wet markets even if there's an increase in modern retail facilities in the future?", 77 % answered "yes" (Fig. 12). One of the main reasons to keep wet markets is that they are "suitable and convenient for all people." It means all people of low and high income could use wet markets and "create a community and regional culture," and "shopping is based on good relationships" (Table 6).

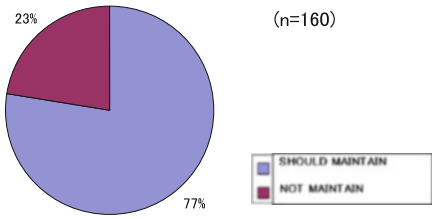


Fig. 12 Maintain wet markets in the future

Table 6 The reasons for keeping wet markets

Consumers' reasons to keep the wet markets (n = 160)		
Reasons	Total consumers	(%)
Shopping is based on and make a good relationships	152	95
Create a community and a regional culture	149	93
Suitable and convenient for all people	138	86
Other reasons: job opportunity, tourism/sightseeing, negotiable price, communication, etc.		

5 Conclusion/Discussion

The findings of this study have indicated that wet markets are strong at keeping food freshness, promoting relationships, and conforming with the cultural context. In contrast, supermarkets are stronger in facility, safety, and hygienic products. In wet markets, the important aspect is the relationship experience. Customers receive relationship experience through almost all behaviors in wet markets. Sellers are in direct contact with customers and usually know customers personally. Sellers may know many customers by name and may remember their food preferences and needs. Therefore, marketing in the wet market is done on a personal level. The huge size and no direct connection with customers make it more difficult for supermarkets to establish actual person-to-person relationships than wet markets. The person-to-person relationship is the strength of wet markets that make them exist. When retailers can understand and act correspondently with each customer, the retailers and customers can co-create the experience value that cannot be copied in other retail formats. The high speed of economic development and big investments help a number of supermarkets increase rapidly in a short time period. The person-to-person relationship is the factor belonging to context that is difficult to change in a short time. That is why, wet markets remain and develop even in the rise of a number of supermarkets.

Vietnam government has some policies to replace traditional wet markets with modern shopping centers and super- and hypermarkets in the process of economic modernization and social development. In detail, in 2009, Hanoi Department of Commerce established a plan to build 489 markets, 162 shopping centers, and 178 super- and hypermarkets until 2020. In the city, 402 current wet markets will be upgraded, which means that the large-scale wet markets will become shopping centers and small wet markets will be upgraded into supermarkets and convenience stores. To implement this plan, Hanoi has replaced many big, main, wet markets such as Hang Da Market, Cua Nam Market, and Cho Hom Market. But these renovation projects failed as no consumers go to shop at these big, new, modern supermarkets and trade centers. Instead, a new network containing many frog markets (frog markets are wet markets in a small scale that formed spontaneously without the permission of the local management) is established in the area near the old wet markets to serve the needs of consumers.

Based on the result of this research, the strengths of the wet market are freshness, relationship, and context, and the strengths of supermarkets are facilities, safety, and hygienic products. The strengths of supermarkets can be replicated. For example, if there is more investment, wet markets can be upgraded and have new equipments, improved hygiene, and safe food. But the factors that create the strengths of wet markets are difficult to replicate. It will take a long time to change the relationship and context of Vietnamese consumers. Another point is that it is not sure that these changes are good for the people and the society in the long term, with attention toward the country's cultural standing. In Europe and Asia, there are many countries that establish policies to protect traditional markets from the invasion of supermarkets. They are France, Spain, the Netherlands [18, 19], Hong Kong [20], and Thailand [21, 22]. Based on the results of this research, we suggest that instead of replacing wet markets with supermarkets, Vietnamese government should invest and upgrade wet markets in order to stay competitive in a rapidly developed economic environment. This is more feasible and consistent with the aspiration and the consumption habits of Vietnamese. This not only creates many economic values such as jobs for local workers and the support in life of both high- and low-income people but also builds up a strong community and continues to maintain and enrich social and cultural values.

6 Limitations and Directions for Future Research

This research is just based on customers' survey. To give the policy recommendations, the topic should be analyzed from the standpoint of suppliers, retailers, distributors, and investors and should consider the general economic and social policies. These will be the topic for further research.

References

1. Verhoef, Peter C., Katherine N. Lemon, A. Parasuraman, Anne Roggeveen, Michael Tsiros, and Leonard A. Schlesinger., 2009, Customer Experience Creation: Determinants, Dynamics and Management Strategies, Journal of Retailing, 85–2, 139–153.
2. Berry, Leonard L., Lewis P. Carbon, and Stephan H. Heackel, 2002, Managing the Total Customer Experience, MIT Sloan Management Review, 43–3, 85–89.
3. Kondo Kimihiko, Co-Creation Value in Retail: Management the Experience Value, 2013, Journal of Marketing 32(4), 50–62.
4. Prahalad, C. K. and Venkatram Ramaswamy., 2004a, The Future of Competition: Co-Creating Unique Value with Customers. Harvard Business School Press.
5. Prahalad, C. K. and Venkatram Ramaswamy., 2004b, Co-creation Experiences: The Next Practice in Value Creation, Journal of Interactive marketing, 18–3, 5–14.
6. Masayoshi Maruyama and Le Viet Trung, 2007, Supermarkets in Vietnam: Opportunities and Obstacles, Asian Economic Journal, 21–1, 19–46.
7. Vargo, S., and Lusch, R., 2006a, Service-dominant logic. The Service-dominant Logic of Marketing: Dialog, Debate, and Directions, 46.
8. Vargo, S., and Lusch, R., 2006b, Service-dominant logi: What it is, what it is not, what it might be. The service-dominant logic of marketing: Dialog, Debate, And Directions.
9. Schmitt, B.H., 1999, Experiential Marketing: How to Get Customer to Sense, Feel, Think, Act and Relate to Your Company and Brands, The Free Press.
10. Sathish, A. S. and Ramakrishnan Venkatesakumar., 2011, Customer Experience and Store Loyalty in Corporate Retailing: With Special Reference to 'Sony World', Annamalai International Journal of Business Studies & Research, 3–1, 67–76.
11. Jain, Rajnish and Shilpa Bagdare., 2009, Determinants of Customer Experience in New Format Retail Stores, Journal of Marketing & Communication, 5–2, 34–44.
12. Hall, E.T., 1976, Beyond Culture, Anchor Books.
13. Suzuki, S., and Takemura, K., 2014, "The Internationalization Process of High-Context Communication Services", ICServ2014.
14. Fornerino, M., Helme-Guizon, A. and de Gaudemaris, C., 2006, Mesurer L'immersion dans une experience de consummation: Premiers developments, Proceedings of the XXIIth Congress de I'AFM, Nantes.
15. Nagasawa Shinya, 2002, (感性をめぐる商品開発その方法と実際) [Product Development Method of Sensibility], Japan publishing service.
16. Nagasawa Shinya, Nagasawa laboratory-Business School of Waseda University (Yamamoto Taro, Yoshida Masahiro, Irisawa Yusuke, Yamamoto Norihiro, Enoki Shinji), 2005, (ヒットを生む経験価値創造-感性を揺さぶるものづくり-) [The Experience Value Creation of Hit Product – The Sensibility in Manufacturing], JUSE Publisher.
17. Nagasawa Shinya, Nagasawa laboratory-Business School of Waseda University (Irisawa Yusuke, Takashi Someya, Tsuchida Teppei), 2006, (老舗ブランド企業の経験価値創造 - 顧客との出会いのデザインマネジメント-) [The Experience Value Creation of Long-established Brand Companies – Design Management of Encounter with Customers], Doyukan.
18. Esselink et al., 2004, Markt in zicht! Results of ational market research in the Netherlands 2004. I&O research for CVAH.
19. Hoogerwerf, 2007, Diversity of markets makes Amstermdam a world city. City of Amsterdam.
20. Lui Sze-ki, 2008, An Ethnographic Comparison of Wet Markets and Supermarkets in Hong Kong. The Hong Kong Anthropologist. 2.
21. Mutebi, A., 2007, Regulatory Responses to Large-format Transnational Retail in Southeast Asian Urban Studies, 44–2.
22. Cathy Banwell, Jane Dixon, Sam-Ang Seubsman2, Suttinan Pangsap, Mathew Kelly, 2010, Fresh markets, a way of life and public health under threat: governance dilemmas for Thailand, Australian National Universit.

A Combinatorial Auction-Based Approach to Staff Shift Scheduling in Restaurant Business

Nobutada Fujii, Jumpei Oda, Toshiya Kaihara, and Takeshi Shimmura

Abstract

This study focuses on improving the productivity of restaurant business. The productivity of restaurant business in Japan is lower than other service industries because the approach to improve the productivity has depended on experience and intuition by human workers in the service field. This study tries to adopt engineering/science approaches to staff shift scheduling in restaurant business; combinatorial auction is applied. Combinatorial auction-based staff scheduling is a negotiation-based approach between workers and a manager to reach an agreement in the multi-objective optimization problem; workers want to work as much as they can. On the other hand, the manager tries to reduce the number of workers if the service level can be kept with high enough to fulfil the customer's requirements. Resulting from the negotiation, the proposed method tries to find the staff shift schedule to realize maximization of service satisfaction composed by customer satisfaction, employee satisfaction and manager satisfaction. The effectiveness of the proposed method is discussed using the results of computer experiments using real data obtained from the Japanese cuisine restaurant.

Keywords

Restaurant business • Staff shift scheduling • Combinatorial auction

1 Introduction

This paper describes co-creation-based personnel shift planning method to maximize the service satisfaction consisting from not only customer satisfaction (CS) and employee satisfaction (ES) but management satisfaction (MS) intended for food industry in which the productivity is relatively low among service industries [1].

The personnel shift planning (staff scheduling) [2] is to create a shift schedule that considers the desired shift of each employee, taking into account the fairness of work among employees. The site manager is often performed by his/her own experiments and intuition; the manager needs large effort and long time to achieve feasible solutions. To support the managers creating the suitable staff shifts, scientific and/or engineering-based methods have been tried. Nurse scheduling [3, 4] to create a nurse work schedule in a hospital is a typical example. The nurse scheduling is one of combinatorial optimization problems and is often to be solved as a constraint satisfaction problem (CSP) because it is difficult to obtain feasible solutions [5] due to enormous search space and complicated constraints: nurse's ability, request for work time, affinity to other nurses and so on. However, nurse scheduling problem considers constraints while guaranteeing the quality of care and does not sufficiently consider the management perspective.

On the other hand, in the food service industry, seasonal, and even in daily hourly demand, fluctuation is large. It is

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needed to employ many non-permanent workers to adapt to the fluctuation and realize flexibility in the personnel shift. Because the food industry has also commercial purposes rather than public sector affairs content such as the hospital, management satisfaction (MS) also needs to be emphasized as well as customer satisfaction (CS) and employee satisfaction (ES). In addition, there is often a trade-off relationship among the satisfactions; it is important to consider the balance between indicators, rather than simply to improve one index. In this study, the staff scheduling has attempted modelling and seeking solutions as multi-objective problem. However, instead of obtaining the Pareto solutions (or portion thereof) using a mathematical planning approach modelled as multi-objective optimization problem, the approach to find a satisfactory solution to each other as a result of negotiations between the employees and management has been focused even keeping the quality of service. The framework of these negotiations in the actual food service industry is similar to the negotiation process of the auction protocol to repeat the bids and awards and finally to obtain feasible solutions. Combinatorial auction [6, 7] is applied to the staff shift scheduling in this study, and the basic effectiveness has been confirmed in the previous work [8]. The proposed method is applied to the real-scale problem, and the effectiveness of the proposed method is discussed by the results of computer experiments using the data from an actual Japanese cuisine restaurant.

2 Staff Shift Scheduling Using Combinatorial Auction

2.1 Outline of the Proposed Method

Japanese cuisine restaurant is chosen as the research target in this study. Because Japanese cuisine requires special technique for cooking, there is a distinction between staff roles, kitchen staff mainly corresponding for cooking. In turn, hall staff is responsible mainly for customer service. In this paper it is assumed that the target is only hall staff as the first stage of the research.

The shift schedule in the actual field of Japanese restaurants is planned as the following steps:

1. Each employee submits desired shift to the manager.
2. The manager determines the shifts by combining the desired shift submitted by each employee.
3. If each employee is not satisfied, adjustment is done by the manager, and the above steps are repeated until achieving the agreement of each employee.

Referring to the negotiation process with the manager and employees, a combinatorial auction that is one of the auction algorithms is adopted. In the combinatorial auction, the creation of each employee's desired shift in the above step 1 corresponds to the process of the bid determination problems. Shift decision in the above step 2 is equivalent to solving the winner determination problem of solving a combination of bids. When it is assumed that all possible combinations of work shifts are estimated, the solution of winner determination problem must be the optimal one. However, the search space is enormous and it is not a realistic problem to solve in the practical time. So the bid is set to a subset of all combinations, and repetition of bid and award processes is executed to obtain quasi-optimal solutions. This repetition corresponds to the process 3 in the above. Also in the actual restaurant, the employee chooses one possible shift from some candidates due to certain criteria; the employee sometimes compromises with the manager and other workers as the results of negotiations. An overview of these negotiation processes is shown in Fig. 1.

The entire algorithm of the proposed method using the combinatorial auction is depicted in Fig. 2. Auction bidders are each employee; the auctioneer is assumed to be the store manager. First, each bidder tries to explore the shift to maximize its own satisfaction (bid value maximization problem). Neighbourhood solutions of the obtained best solution are set to the bids in the initial iteration loop. In the next and following iterations, neighbourhood solutions of the solution awarded in the former iteration are set to the bids. In turn, a combination with highest satisfaction for the store manager is searched from a combination of the bids from all bidders (winner determination problem). With the use of combinatorial auction as described above, employees try to maximize employee satisfaction, and at the same time, the store manager is possible to solve the problem as maximizing management satisfaction; the structure of the multi-objective problem is decomposed along the auction structure. However, the bid creation process is carried out independently for each employee, so that not always feasible solution is obtained even with the bids of all employees. Therefore, by using Big-M method that can be considered as a kind of penalty method, the auction continues by selecting the least solutions in constraint violation if feasible solution cannot be obtained. In the following, each step is explained in more detail.

2.2 Nomenclature

$i = \{1, 2, \ldots, I\}$: The number of employee.
$d = \{1, 2, \ldots, D\}$: The number of planning period (day).
$t = \{1, 2, \ldots, T\}$: The number of planning period (time).
$n = \{1, 2, \ldots, N\}$: The number of times worked.
$p = \{1, 2, \ldots, P\}$: The number of work position.

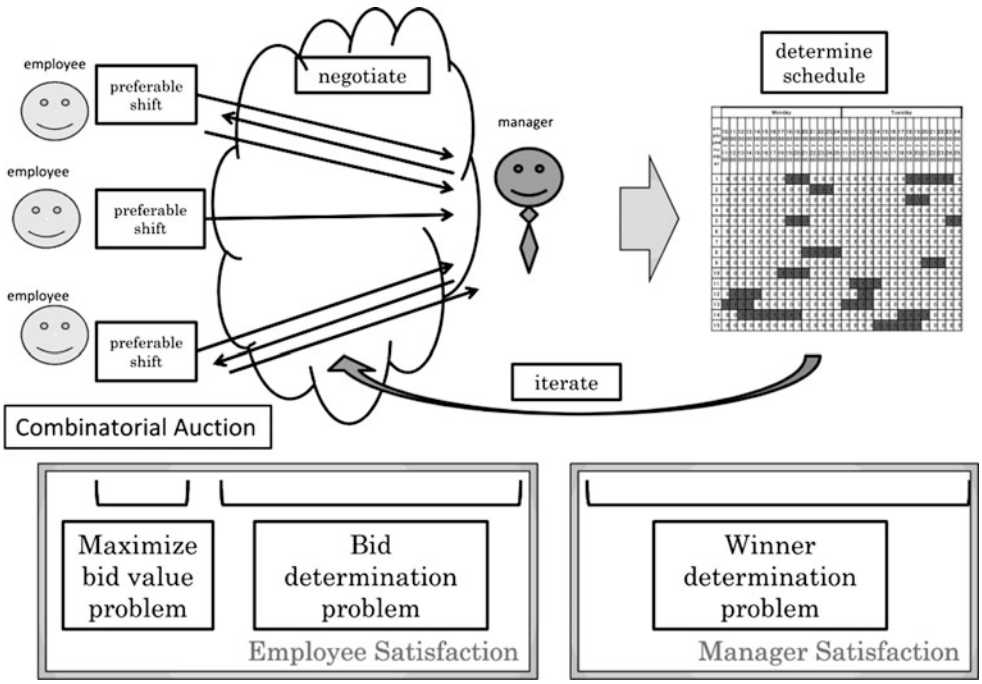

Fig. 1 Staff scheduling as negotiation process between the manager and employees

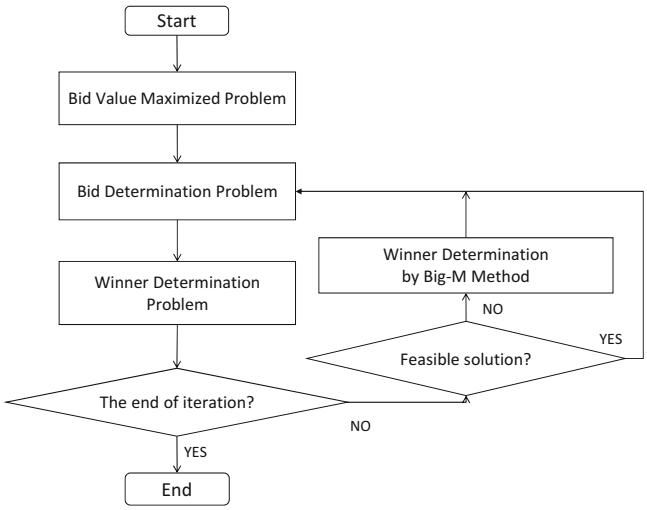

Fig. 2 Flow chart of the proposed auction-based method

$j = \{1, 2, \ldots, J\}$: The number of bids.
$c_{i,p}$: Ability of employee i working on p.
$c_i^{\max}$: Best ability of employee i.
$p_{i,j}$: Bid value of bid j of employee i.
$P_i^{\max}$: Best bid value of employee i.
$S_{i,d,t}$: Desired shift. If employee i can't work at time t on the day d, the value is set to 0. If employee i can work at time t, value is set to 1. If employee i can work at time t but he/she wouldn't like to work, then the value is set to -0.2.
$T_{\max}$: Upper limit of working hours in a day.
$T_{\min}$: Lower limit of working hours in a day, only if employee works on the day.
T_{rest}: Break time required to work up to the next.
$N_{d,t,p}$: Lower limit of ability at position p at time t on day d.
L_{week}: Upper limit of working hours in a week.
$st_{i,j,d}$: The start time of date d.
$ed_{i,j,d}$: The end time of date d.
α: Threshold.
$\tau_{i,j,d,t}$: Decision variable. If employee i works in the j-th bid at time t on day d, value is set to 1. Else if employee i does not work, the value is set to 0.
$\sigma_{i,j,d}$: Dependent decision variable. If employee i works in the j-th bid at day d, value is set to 1. Else if employee i does not work, the value is set to 0.
$x_{i,j}$: Decision variable in bid j of employee i, whether the bid is chosen or not.
w_i: Labour cost in 1 h of employee i.
y_n: Decision variable in Big-M method which means if the n-th constraint violation occurs, then the value is set to 1, otherwise 0.

2.3 Bid Value Maximization Problem

There are seven types of tasks that the hall staffs do: usher, reception, checkout, drink, banquet, catering and washing. It is assumed that each worker can perform all possible tasks within the same time. Each employee builds the desired work shift: the value 1 is set if the work is allowed in each

Table 1 An example of the desired shift

	10:00–11:00	11:00–12:00	12:00–13:00	13:00–14:00	14:00–15:00	15:00–16:00	16:00–17:00	17:00–18:00	18:00–19:00	19:00– 20:00	20:00–21:00	21:00–22:00	22:00–23:00
Mon.	0	0	0	0	0	0	1	1	1	1	1	1	0
Tue.	0	0	0	0	0	0	1	1	1	1	1	1	0
Wed.	0	0	0	0	0	0	1	1	1	1	1	1	0
Thu.	0	0	0	0	0	0	1	1	1	1	1	1	0
Fri.	0	0	0	0	0	0	−0.2	−0.2	−0.2	−0.2	−0.2	−0.2	0
Sat.	−0.2	−0.2	−0.2	−0.2	−0.2	−0.2	1	1	1	1	1	1	0
Sun.	1	1	1	1	1	1	1	1	1	1	1	1	0

time zone; else if working cannot be allowed, 0 is set; and −0.2 is set if he/she does not want to work even possible. Table 1 represents the desired shift of an employee where the unit time of the shift is one hour, and the period of the plan is set to 1 week.

Based on the desired work shift, in order to create a bid maximizing the evaluation value for each employee, the problem is formulated as a {0, 1} binary integer programming problem. By solving this problem, it is possible to obtain a bid with the maximum employee satisfaction for each employee:

$$\text{maximize} \quad \sum_{d=1}^{D}\sum_{t=1}^{T}\tau_{i,j,d,t}S_{i,d,t} \quad (\forall i, j=1) \tag{1}$$

subject to

$$\begin{cases} L_{\min}^{\text{day}} \le \sum_{t=1}^{T}\tau_{i,j,d,t} \le L_{\max}^{\text{day}} & \left(\text{if}\sigma_{i,j,d}=1\right) \\ \sum_{t=1}^{T}\tau_{i,j,d,t}=0 & (\text{otherwise}) \end{cases} \quad (\forall i, \forall d, j=1) \tag{2}$$

$$st_{i,j,d+1} - ed_{i,jkd} + 24 \ge T_{\text{rest}} + 1 \quad \left(\text{if} \quad \sigma_{i,j,d+1}=1\right) \quad (\forall i,\ d=1,2,\ldots,D-1, j=1) \tag{3}$$

$$\sum_{d=1}^{D}\sum_{t=1}^{T}\tau_{i,j,d,t} \le L_{\max}^{\text{week}} \quad (\forall i, j=1) \tag{4}$$

$$\tau_{i,j,d,t}=0 \quad (\text{if} \ \ S_{i,d,t}=0) \quad (\forall i, \forall d, \forall t, j=1) \tag{5}$$

$$\sum_{d=1}^{d}\sigma_{i,j,d} \le LD_{\max}^{\text{week}} \quad (\forall t, j=1) \tag{6}$$

$$\begin{cases} \sigma_{i,j,d}=1 & \left(\text{if} \ \sum_{t=1}^{T}\tau_{i,j,d,t} \ge 1\right) \\ \sigma_{i,d,d}=0 & (\text{otherwise}) \end{cases} \quad (\forall i, \forall d, j=1) \tag{7}$$

$$\begin{cases} \tau_{i,j,d,t}=1 & \left(\text{if} \quad st_{i,j,d} \le t \le ed_{i,j,d}\right) \\ \tau_{i,j,d,t}=0 & (\text{otherwise}) \end{cases} \quad (\forall i, \forall d, j=1) \tag{8}$$

$$\begin{cases} 1 \le st_{i,j,d} \le T - L_{\min}^{\text{day}} + 1 & \left(\text{if} \quad \sigma_{i,j,d}=1\right) \\ st_{i,j,d}=0 & (\text{otherwise}) \end{cases} \quad (\forall i, \forall d, j=1) \tag{9}$$

$$\begin{cases} L_{\min}^{\text{day}} \le ed_{i,j,d} \le T & (\text{if} \quad \sigma_{i,j,d} = 1) \\ ed_{i,j,d} = 0 & (\text{otherwise}) \end{cases} \quad (\forall i, \forall d, j = 1) \tag{10}$$

$$\tau_{i,j,d,t}\sigma_{i,j,d}\{0,1\} \quad (\forall i, \forall d, \forall t, j = 1) \tag{11}$$

The objective function is expressed as the Eq. (1). The decision variable in the bid value maximization problem is $\tau_{i,j,d,t}$; the value is set to 1 if employee i in j-th bid works in d-th day of time period t, otherwise 0. $S_{i,d,t}$ represents the desired shift; the value 1 means the employee i can work at day d and time t, "work possible". The value 0 represents the employee i cannot work, "work not permitted", and the value -0.2 means the situation in which employee can work but doesn't want to work, "work possible but does not want". The objective function represents how work shift of each employee meets much to the desired work shift; the objective function value becomes a larger value if the employee i works at the time zone of the "work possible". In turn, when employee i works at time zone "possible but does not want", the objective function value decreases.

The optimal solution obtained in this problem is included in the first bids, and the optimum value is also set as $P_i^{\max}$.

Constraints are expressed as the following: Eq. (2) represents the constraint on the upper and lower limits of the working hours of the day; Eq. (3) means the constraint by which each employee needs taking rest between former and latter works. Equation (4) represents the constraint on the upper limit in 1 week of working hours, Eq. (5) shows the decision variable is set to zero if the employee i cannot work at date d and time t and Eq. (6) represents the constraint on the maximal number of working days. Equation (7) defines the dependent variable $\sigma_{i,j,d}$, Eq. (8) represents the constraint on the start and end time of work and Eqs. (9) and (10) are the constraints on the dependent variables $st_{i,j,d}$ and $ed_{i,j,d}$.

2.4 Bid Determination Problem

In the bid determination problem, bids are created; at the initial step of iteration in the combinatorial auction, the bid with bid-number one is set as the combination of solutions of the bid value maximization problem of each worker. At the following steps of the iteration, the bid awarded in the previous iteration is set to the bid with bid-number one; elite strategy is adopted to prevent obtaining worse solutions than the previous iteration. Finally, the number of bids created as the neighbourhood is J-1.

How to create the neighbourhood solutions from the awarded solution is by first selecting a day from the shift with random manner, and then one algorithm is also applied randomly from the following nine algorithms. It is necessary to satisfy all constraints in the bid value maximization problem; the bid is discarded if the bid created does not satisfy the constraints, and the new bid is created again applying the neighbourhood creation algorithm.

1. One hour earlier the work start time.
2. One hour later the work start time.
3. One hour earlier the work end time.
4. One hour later the work end time.
5. One hour earlier the work start and end time for both.
6. One hour later the work start and end time for both.
7. Eliminate the work of the day.
8. Add a new work.
9. Eliminate work for the day, and choose randomly 1 day without work shift and add new works at that day.

In order to prevent that the bid value is much worse than the maximized employee satisfaction as the solution of bid maximization problem, the following additional constraint is provided:

$$p_{i,j} \ge \alpha P_i^{\max} \quad (\forall i, \forall j) \tag{12}$$

where $P_i^{\max}$ represents the maximal bid value obtained by solving the bid value maximization problem and α is the threshold value with the range from 0 to 1. When the value of α is set to relatively high, the bid value also keeps relatively high value; employee satisfaction keeps high. In turn, management satisfaction can be high if the value of α is set to small value because the bid value can be small. The obtained solutions can be adjusted between employee satisfaction preferred solution and management satisfaction preferred solution according to the settings of the threshold value of α.

2.5 Winner Determination

In the winner determination problem, the combination of bids is determined from each worker's bids to minimize the objective function; a work shift of the entire store is built by choosing one work shift from alternative shifts of each worker. The objective function is set to minimize total labour input costs; management satisfaction is concerned in the winner determination problem. The winner determination problem is formulated from Eqs. (13), (14), (15), and (16):

$$\text{minimize} \quad \sum_{d=1}^{d} \sum_{t=1}^{T} \sum_{i=1}^{I} \sum_{j=1}^{J} x_{i,j} \tau_{i,j,d,t} w_i \tag{13}$$

subject to

$$\sum_{j=1}^{J} x_{i,j} = 1 \qquad (\forall i) \tag{14}$$

$$\sum_{i=1}^{I}\sum_{j=1}^{J} x_{i,j}\tau_{i,j,d,t}c_{i,p} \geq N_{d,t,p}^{\min} \qquad (\forall d, \forall t, \forall p) \tag{15}$$

$$x_{i,j}\{0,1\} \qquad (\forall i, \forall j) \tag{16}$$

Decision variable in the winner determination problem is $x_{i,j}$. The value is set to one if the j-th bid of employee i is selected, otherwise the value is set to zero. The objective function calculates the total labour cost which multiplies the labour cost per unit time by the total working hours of each employee. Constraint represented in Eq. (14), in turn, only one bid per employee can be selected; the constraint represents only one proposal of work shift is awarded per one employee. Equation (15) represents the constraint on the necessary capability level; the constraint on the necessary capability value indicates the quality of adequate service provided by the employees, so that it can be maintained in the position p of d-th day of the time t. It is assumed that enough customer satisfaction is obtained by service provision from the employees. The winner is chosen in the winner determination problem, which is used to create neighbourhood solutions in the next bid determination problem.

2.6 Introducing Big-M Method

For bid for each employee to be created independently, not always feasible solution is obtained in the winner determination problem. Especially for the repetition of the early stages in combinatorial auction, small solution space consists only in the neighbourhood of the bid to be a satisfaction maximum of each employee or to be a winner in the former winner determination problem; there is a case in which it does not satisfy the constraints. In order to carry out the search process continuously even if feasible solution cannot be obtained in the winner determination problem, it is necessary to select a bid to be the winner. Therefore, the search space should be extended by relaxing some constraints, so that the feasible solution can be obtained.

This study employs the Big-M method that is a kind of penalty method to enable the derivation of feasible solutions as soon as possible during the repetitions of trials; the bid combination of less constraint violation is selected. The Big-M method by adding 0–1 variable that is a dummy variable relaxes constraints of the original problem and allows the inconsistencies in the original problem constraints. It is possible to specify infeasible part of the original problem by giving a value to the dummy variable.

Application of the Big-M method in the proposed method is realized by relaxation of the constraint Eq. (15) in the winner determination problem. The formulation is as follows:

$$\text{minimize} \qquad \sum_{n=1}^{N} y_n \tag{17}$$

subject to

$$\sum_{i=1}^{I} x_{i,j} = 1 \qquad (\forall i) \tag{18}$$

$$\sum_{i=1}^{I}\sum_{j=1}^{J} x_{i,j}\tau_{i,j,d,t}c_{i,p} + My_n \geq N_{d,t,p}^{\min} \qquad (\forall d, \forall t, \forall p, \forall n) \tag{19}$$

$$x_{i,j}, y_n\{0,1\} \qquad (\forall i, \forall j, \forall n) \tag{20}$$

Decision variables in the problem are $x_{i,j}$ and y_n; if the j-th bid of employee i is chosen, the value is set to one, and zero otherwise. When constraint Eq. (15) is violated, y_n is set to one, otherwise zero. The objective function is minimization of the sum of decision variables y_n, which means to minimize the number of violations of constraints Eq. (15). Another constraint Eq. (18) means one bid per each employee can only be selected, and constraint Eq. (19) represents constraint Eq. (15) has been relaxed by the Big-M method. Constant M is set to relatively big value as the penalty for constraint violation.

By performing the winner determination problem using the Big-M method, it is possible to select a winner work shift if the capability of employee in a working time zone is less than the minimal value. It can be also expected that feasible solutions can be reached soon so that the number of constraint violation is kept to be small. Furthermore, by examining the y_n, it is possible to determine the time zone and the day when the capacity is insufficient in which working position; the manager can negotiate with employees and modify relatively easily the work shift.

3 Computer Experiments

3.1 Experimental Settings

Hall staff in the Japanese cuisine restaurant is selected as the target, and computer experiments are conducted. The following data is obtained from the real restaurant:

Table 2 Experimental setting

Number of employee	22
Regular employee	3
Non-regular employee	19
Planning term (days)	7
Planning term in a day (hours)	13
Number of bid	50
Upper limit of work (hours/day)	12
Lower limit of work (hours/day)	2
Break time to next work (hours)	12
Weekly upper limit of work (hours/week)	60
Weekly upper limit of work (days/week)	5
Number of work positions	7

- Desired work shift of each worker
- Determined shift built by the manager
- Required number of people in each position p necessary capability value
- Labour cost of each worker

The hall staff has 22 people in the targeted store; three of them are full-time workers, and the rest of the 19 people are non-regular employees. Regular employees are required to work at least 40 h in 1 week and are modelled as employees with such constraint. Experimental conditions for more in detail are shown in Table 2. Each from the top in the table follows the number of employee, the number of full-time employees, non-regular employees, planning period (day), planning period (time) in 1 day, the number of bid, the upper/lower limits for working hours in a day, minimum break time for the next work, upper/lower limits in a week, and business position number (guide, service, cash register, drink, banquet orders, catering, the washing place). In the experiments, the threshold value α in the bid determination problem is varied from 0.0 to 1.0 in increments of 0.1, and the relationships between the ES and MS are discussed.

3.2 Results and Discussion

Experimental results are shown in Table 3. Max ES in the table is the sum of the evaluation values of bids obtained in the bid value maximization problem. ES means the sum of the evaluation values of bids of final winners, and MS indicates the value of the winner determination problem (yen). Also, time units in the calculation time required for combinatorial auction are second. The resulting value is the average of all 10 trials.

It is confirmed that ES decreases and MS increases as the threshold decreases; in turn, ES increases and MS decreases as the threshold value increases. When the value of the threshold is large, the desire of employee can come true because neighbourhood solutions are created only in the neighbourhood of the best solution at the bid value maximization problem (the value of the MaxEX). On the other hand, because the value of the threshold value is small, the value of ES is small as compared with the values of MaxEX; it becomes compromised solution for employees. Labour costs are reduced conversely and the management satisfies. From the above results, it is confirmed that there is trade-off relationship between ES and MS.

Table 3 Experimental results

α	Max ES	ES	MS	Time
0	659	306.2	411041	49.08
0.1	659	306.2	413235	48.73
0.2	659	312.5	418507	49.68
0.3	659	324.2	427758	46.6
0.4	659	347.4	450076	48.12
0.5	659	382.3	479238	49.52
0.6	659	420.5	512247	46.65
0.7	659	476	572314	45.84
0.8	659	543	652852	45.34
0.9	659	608	731390	45.77

If the actual shift in the targeted restaurant is evaluated in the same one week of labour costs to the original, it is about ¥ 618,000, and to correspond with the experimental results, threshold corresponds to between 0.7 and 0.8.

This shift in the actual restaurant can be considered to indicate that it is a shift in consideration of the desire of employees.

These results suggest the efforts to further improve labour productivity although employee capacity values are divided into simple three levels in this study and it is not considered to model all the differences between the proposed model and the actual capacity of employee representation.

In the viewpoint of calculation time, each experiment also finishes in about 50 s; it is possible to derive the solution in the short time. It is revealed that the proposed method is possible to support the manager by using a computer support to create a shift deriving over several hours in the actual restaurant.

4 Concluding Remarks

In this paper, the negotiation process is focused between the employees and the store manager in the personnel shift planning of a real shop, so that a method was proposed to develop a personnel shift plan by applying the framework of combinatorial auction. Computer experiments were performed to verify the proposed method by using the data of the actual Japanese cuisine restaurant, and it was confirmed that the proposed method could handle a trade-off relationship between employee satisfaction and management satisfaction. Also, by comparing the labour costs in

the actual store, it was suggested that there was a potential for further efficiency.

Customer satisfaction is currently introduced as a constraint condition; it is modelled as any solutions can obtain sufficient customer satisfaction. In the future work, the customer satisfaction should be also modelled in the objective function; co-creative design method of staff shift scheduling will be realized, in which customer, employee and manager can be satisfied.

References

1. T. Takenaka, T, Shimmura, T. Ishigaki, Y. Motomura, S. Ohura, Process management in restaurant service – A case study of Japanese restaurant chain –, Proc. of International Symposium of Scheduling 2011 (ISS2011), pp. 191–194, 2011.
2. M. Krishnamoorthy B. Owens A. T. Ernst, H. Jiang and D. Sier. An annotated bibliography of personnel scheduling and rostering. Annals of Operations Research, Vol. 127, pp. 21–144, 2004.
3. B. Cheang, H. Li, A. Haibing, and B. Rodrigues, Nurse Rostering Problems : A Bibliographic Survey. (2003). European Journal of Operational Research., Vol. 151, No. 3, pp. 447–460, 2003.
4. A. Ikegami, A. Niwa, A Study of Nurse Scheduling in Japan, The Journal of Human Ergology Vol.30, No. 1–2, pp. 71–76, 2001.
5. H. Hattori, T.Ito, T.Ozono, T.Shintani, "A Nurse Scheduling System based on the Dynamic Constraint Satisfaction Problem", In the Proceedings of the 17th International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems (IEA/AIE-2005), pp. 799–808, 2005.
6. S.de Vries and R. Vohra: "Combinational auctions - A survey", INFORMS Jornal on Computing, Vol. 15, No. 3, pp. 284–309, 2003.
7. T. Kaihara, N. Fujii, H. Hasegawa and S. Kurose, A study on optimization method with combinatorial auction - Application to resource allocation problem of re-entrant flow shop -, Proceedings of the 7th International Conference on Machine Automation, pp. 245–250, 2008.
8. N. Fujii, T.Kaihara, T.Nonaka, J. Oda, T.Shimmura, A Study on Planning Method for Staff Shift Improving Service Satisfaction in Restaurant Business - Proposal of Scheduling Considering Difference in Employee Abilities -, Proceedings of 2014 International Symposium on Flexible Automation (ISFS2014) (CD-ROM), 2014.

Enhancing Kitchen Layout and Training to Improve Management and Employee Satisfaction at a Multiproduct Japanese Cuisine Restaurant

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Abstract

This study was conducted to improve both management and employee satisfaction (ES) at multiproduct Japanese cuisine restaurants. Conventionally, restaurant industry research has emphasized the improvement of management satisfaction. However, restaurants must improve employee satisfaction because it deeply affects labor productivity and food quality. For this study, the kitchen layout was remodelled, a cell production system was introduced to a multiproduct Japanese cuisine restaurant, and the kitchen was designed using a kitchen simulator to enhance cooking time and to improve the working environment of staff members. Salary and promotion systems were changed to encourage staff members to adopt the cell production system. Cooking times were measured (existing layout, immediately after remodel, and 2 months after remodel) as KPI to confirm the efficacy of the redesigned kitchen. Questionnaires were administered to confirm employee satisfaction (as same times as measuring cooking speed). Results show that (1) remodelling of the kitchen layout using a kitchen simulator is useful to enhance the food preparation rate of a multiproduct Japanese cuisine restaurant, (2) the rate worsens immediately after remodelling because staff members are not accustomed with new kitchen layout, and (3) employees estimate that the remodelled kitchen layout is better than the existing kitchen and that the new salary system is reasonable for them, but they do not want to advance their skills because of their age and difficulty (some are already multiskilled workers).

Keywords

Restaurant • Simulation • Cooking operation • Employee satisfaction

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1 Introduction

In the 1970s, the Japanese restaurant industry introduced chain store operation systems to reduce the price of dishes and to expand the market scale. The purpose of the system was to minimize labor costs to realize a low-price strategy because dining out was a leisure activity [1, 2].

Restaurants reduced the menu item number to reduce operations at restaurant kitchens. Furthermore, food factory systems were introduced, with a central kitchen, to limit restaurant kitchen cooking staffs. The restaurant industry realized low-price restaurants: the industry rapidly expanded

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sales revenue. In the 1990s, the restaurant industry became a key Japanese industry [2].

As the Japanese restaurant market has matured, customer preferences have diversified [3]. In the 1970s, dining out was a novel leisure activity for Japanese consumers. Therefore, simple and low-price menus fit customer requirements because customers valued the dining experience itself. However, as customers experienced various restaurants, they started to demand unique dishes they had never experienced. A critical gap arose, separating customer needs and restaurant operation systems, simultaneously requiring diversification and simplification. The restaurant industry must introduce a new operation system to realize both multiple menus and reasonable prices.

Dinner restaurants, which mainly present dishes prepared by chefs, are adequate operation systems for today's restaurant market. Such restaurants provide various dishes because chefs master a variety of cooking skills. Moreover, chefs can adjust the taste, texture, and temperature of dishes based on customer requirements. Recently, dinner restaurants have a growing market share in the Japanese restaurant market [4].

However, dinner restaurant labor productivity is low compared to other restaurant categories because a chef-based operation system requires numerous chefs. Especially, restaurants should hire salaried master chefs with experience, thereby differentiating themselves from competitors. Dinner restaurants should evolve operation systems to resolve productivity problems. Nevertheless, dinner restaurants hesitate to change operation systems because they regard traditional operation systems as superior to new cooking and operation systems [4].

The authors have continually introduced new operation systems and methods to enhance the productivity of Japanese cuisine dinner restaurants. Process management systems were introduced to realize both cooking time reduction and the adoption of customer requirements for dishes [5]. In addition, cell production systems are introduced to reduce labor input and to improve labor elasticity in the kitchen [4]. Moreover, a kitchen operation simulator was developed to design an efficient kitchen layout with adequate capacity of cooking devices [6].

Although some challenging studies are practiced, some problems remain. First, the introduction of cell production systems does not focus on improving employee satisfaction. The quality of dishes deeply depends on a chef's skill. Dinner restaurants cannot provide fine dishes if the chef motivation is low. Improving the operation system can be expected to improve ES, as well as management satisfaction. Second, a kitchen simulation system must be applicable to an actual restaurant. In a conventional study, the kitchen layout was redesigned and the cooking time was simulated on a computer. The study did not apply a redesigned kitchen layout for an actual restaurant. To confirm the simulation effectiveness, the kitchen layout designed by simulation should be applied to an actual restaurant.

To resolve problems, a remodelled kitchen layout was formulated based on the kitchen simulator results. It included a cell production system and was introduced in an actual restaurant to improve the cooking time and working environment for staff members. In addition, the salary and promotion system was replaced to improve the motivation of kitchen staff members.

2 Changing the Kitchen Layout and HR

The kitchen layout of Japanese cuisine dinner restaurant A (Osaka, Japan) was redesigned in 2014 using a kitchen simulator. Restaurant A has 2 floors, 264 sheets, and 2 kitchens (sushi and washoku). Around 10–13 staff members work in kitchens, including 4 skilled chefs and 6–9 part-time kitchen staff members.

To simulate restaurant A cooking operations, some databases were produced. The cooking time and position (e.g., fryer, simmer, sushi) of each menu of restaurant A was measured to produce a dish database. The production capacity, size, situation, and direction of cooking machines of restaurant A were measured to produce a machine database. The staff members' cooking skills were evaluated by a supervisor (skill rank = high, middle, low/ability = yes/no) to produce a staff database.

First, the cooking lead time of an existing kitchen layout is simulated as the KPI of efficacy of kitchen because the cooking time deeply depends on labor productivity [7]. The POS data of restaurant A are provided for order information. The work records of staff members are provided for work shift information. Figure 1 shows the existing kitchen layout of restaurant A.

Based on the simulation results, the cooking times of dishes are totaled, followed by calculation of the average, mode, and standard deviation of cooking time position by position. Based on the simulation results, problems of the current kitchen layout of restaurant A are discussed, and the remodelled kitchen layout was designed. The remodelled kitchen is equipped with a cell kitchen module. Figure 2 presents the remodelled kitchen layout of restaurant A.

Second, the cooking time of remodelled kitchen layout is simulated for comparison to that of the existing kitchen. The same POS data and work records are used to unify the simulation conditions. Based on results of the second simulation, the mode and standard deviation of the cooking time are calculated position by position. The final remodelled kitchen layout is designed based on the first simulation results. The remodelled kitchen has one cell module to enhance the cooking idle time [4].

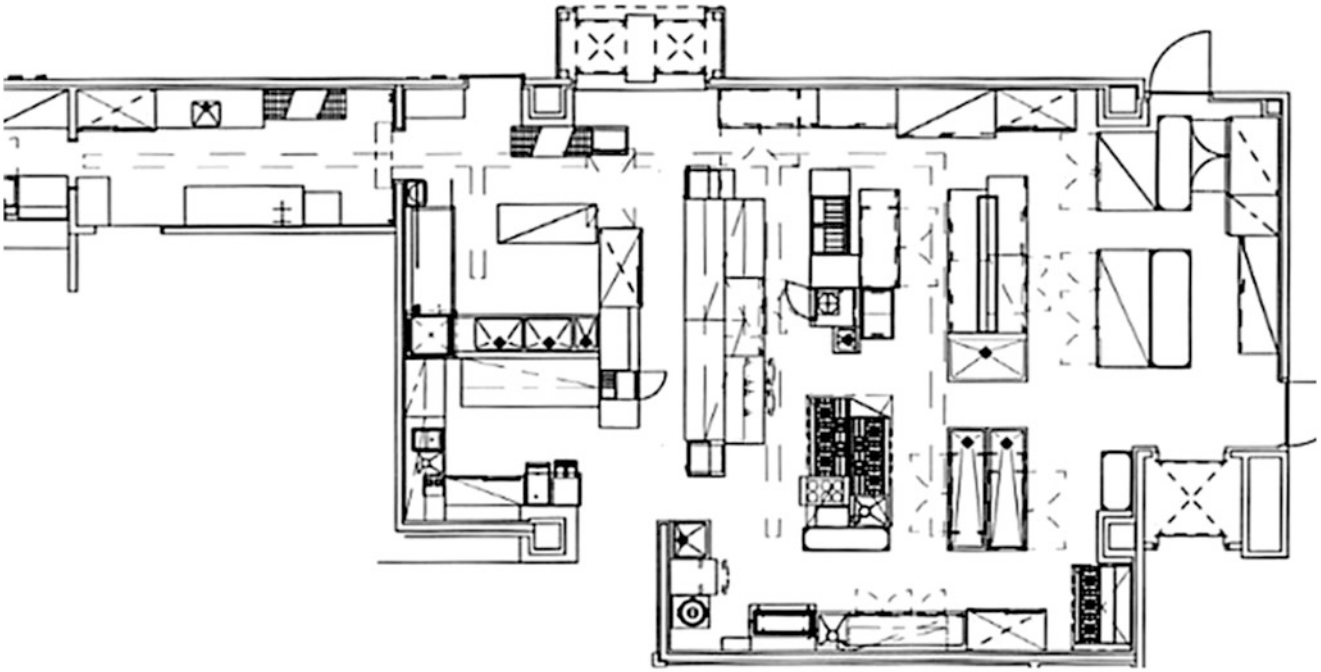

Fig. 1 Prior kitchen layout of restaurant A

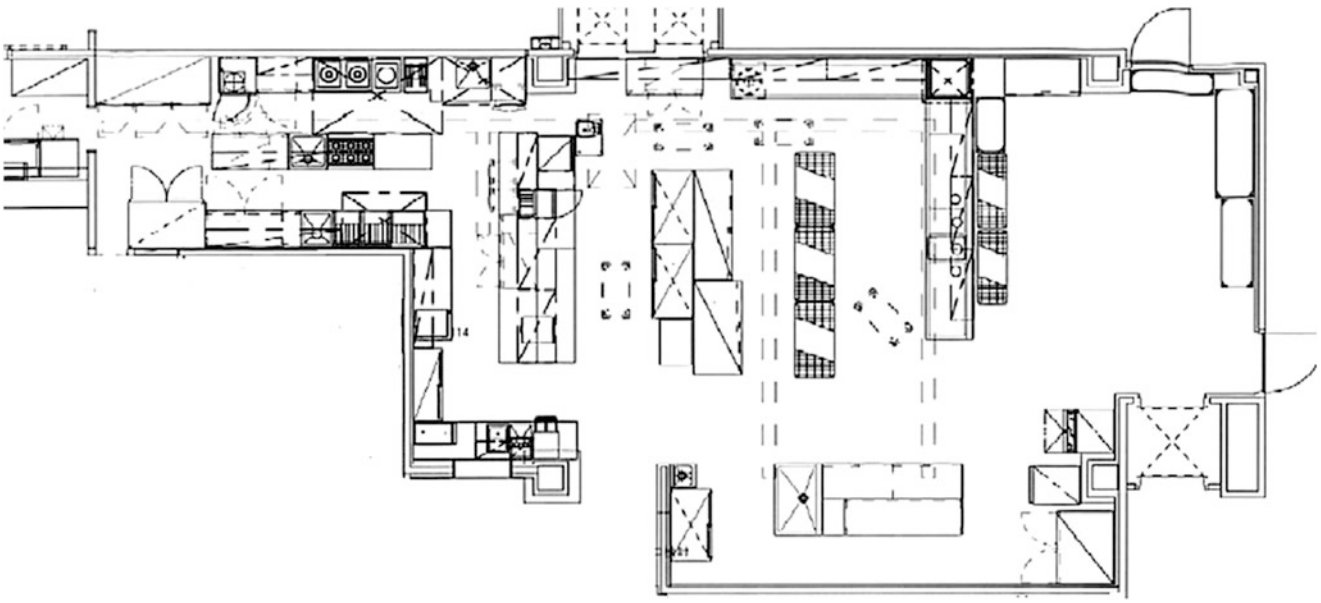

Fig. 2 Remodelled kitchen layout of restaurant A

The kitchen layout of restaurant A, which includes one cell kitchen module, was remodelled actually. To introduce the cell kitchen module, chefs should be trained because chefs are not accustomed with the module. Traditionally, Japanese cuisine chefs cook a particular type of dish each day: if a chef cook simmered foods, the chef does not cook other types of food. In addition, restaurant A also hires part-time workers: they do not master various cooking skills. They should master several cooking skills to operate in the module.

Actual cooking lead times were recorded three times for 1 week each: existing layout, immediately after remodelling, and 2 months after remodelling. The order-received time was recorded and printed using the POS system. The

cook-finished time was written by kitchen staff members: they refer to a time-synchronized clock. The lead time was calculated by subtracting the order-finished time from the order-received time.

Based on the results of records, actual cooking times of dishes are totaled. Then the calculated average, mode, and standard deviation of cooking time position by position are used to discuss the utility and problems of simulation and cell production systems.

Restaurant A changed the promotion and salary systems for employee. The existing kitchen layout presumes a single trained worker. By contrast, a cell production system presumes cross-trained workers. It is apparent that adopting a cell production system brings them a higher workload ratio and harder training for obtaining various cooking skills. Motivation of staff members will decrease if they do not receive any incentive. Supervisors explained the new promotion and salary system to restaurant A staff members: a staff member mastering new cooking skills and operating in the cell module can receive a higher salary.

Questionnaires were administered three times to confirm motivation for getting skills and satisfaction for the new work environment: before introducing the system, immediately after remodelling, and 2 months after remodelling. The questionnaires assess two factors: A = evaluation for kitchen equipment and operation system, B = motivation for job and satisfaction for HR system (Table 1). Staff members respond to the survey on a six-response Likert scale (most positive = 1, most negative = 6). Answers were classified into three categories: positive, neutral, and negative.

Table 1 Questionnaire

A-1	Kitchen equipment and utensils for smooth cooking operations
A-2	Working environment for smooth cooking operations
A-3	Work scheduling for smooth cooking operations
A-4	Efficiency of cooking operations
A-5	Understanding the purposes of cell production systems
A-6	Understanding the importance of collaboration
B-1	Satisfaction with skill evaluation and salary level
B-2	Understanding the salary promotion system
B-3	Motivation for enhancing existing cooking skills
B-4	Motivation for mastering other cooking skills
B-5	Interests of multiskilled workers

Table 2 Results of simulations (cooking time)

	Existing layout			Remodelled layout		
Kind of food	Mean	Mode	SD	Mean	Mode	SD
Fried food	8.48	8.40	2.46	9.05	7.55	3.61
Baked food	8.17	8.18	1.21	7.21	7.73	0.93
Simmered food	7.64	8.00	3.14	7.89	8.00	2.45
Salad	7.37	5.10	4.80	5.81	3.18	3.67
Sushi, sashimi	5.71	4.32	3.05	6.37	4.25	3.78
Total	6.88	7.25	3.30	8.28	4.50	7.38

Unit = minutes

Table 3.1 Cooking times of existing layout

	Cooking time		
Kind of food	Mean	Mode	SD
Fried food	7.35	4.00	0.54
Baked food	9.58	6.00	0.76
Simmered food	12.38	6.00	1.28
Salad	7.53	2.00	0.58
Sushi, sashimi	4.08	0.00	0.32
Total	7.16	5.00	0.16

Unit = minutes

Table 3.2 Cooking times immediately after remodelling

	Cooking time		
Kind of food	Mean	Mode	SD
Fried food	7.84	6.00	0.47
Baked food	10.16	4.00	0.58
Simmered food	11.37	9.00	1.04
Salad	7.56	3.00	0.42
Sushi, sashimi	3.83	0.00	0.28
Total	7.21	5.00	0.15

Unit = minutes

3 Results

Table 2 presents results of the simulation of the existing kitchen layout and those of the remodelled kitchen layout. Table 3.1 shows the actual cooking lead time of existing kitchen layout. Table 3.2 shows that immediately after remodelling of the kitchen layout. Table 3.3 shows that of 2 months after remodelling of the kitchen layout. Table 4 presents questionnaire results.

4 Discussion

4.1 Improving Cooking Time (MS)

First, the results of simulations are discussed. As Table 1 shows, the average cooking time in the remodelled kitchen worsened compared to that of the existing kitchen layout, although the remodelled layout was intended to reduce the cooking time. By contrast, the greatest value of cooking time of remodelled kitchen layout was improved compared to that of the existing kitchen layout. Why did the average cooking time worsen and the best value of cooking time improve?

The standard deviation reveals the reason. Figure 3 shows a distribution of simulated cooking time of fried foods in

both existing and remodelled kitchen. As Fig. 3 shows, the remodelled kitchen seemed to reduce the cooking time of fried food. However, the cooking time of remodelled kitchen has a long tail. A worker processes orders one by one if one order is entered. A worker batches the orders if plural orders are entered. If numerous orders are entered, then the simulator batches the orders. Then the worker does not cook another order. Therefore, the cooking time takes a long tail if numerous orders are entered. The long-tail cooking time worsens the average cooking time of fried food.

However, in a practical sense, a worker, especially a skilled chef, prepares plural orders simultaneously. There are two cooking processes: a hands-on process (e.g., muddle, stair, and dish) and a standby process (e.g., heating and cooling). A worker will cook another kind of order using a standby process of order to reduce the lead time. The simulator should be refined to show the simultaneous cooking operations of kitchen staff.

Second, results of actual cooking time are discussed. As compared with Tables 3.1 and 3.2 shows that the cooking times immediately after remodelling worsened compared to those of the existing kitchen layout in general (except that the average cooking times of simmered foods, sushi, and sashimi improved along with the best values of baked foods).

Table 3.3 Cooking times 2 months after remodelling

	Cooking time		
Kind of food	Mean	Mode	SD
Fried food	7.16	4.00	0.52
Baked food	7.28	8.00	0.40
Simmered food	7.79	5.00	0.67
Salad	5.37	1.00	0.47
Sushi, sashimi	5.18	0.00	0.54
Total	6.53	5.00	0.14

Unit = Minutes

Cooking times depend greatly on the placement of cooking utensils and ingredients, not only on the kitchen layout. Immediately after remodelling, staff members chose the placement of kitchen utensils and ingredients for new layouts based on their hypotheses. The placements were not the best places. Therefore, they removed places continuously to improve the placement. Staff members should look around to find out ingredients and cooking utensils for cooking. Consequently, the search time prevented them from reducing the cooking time.

The cooking time depends closely on the habituation of staff members. They have probably been cooking at the existing kitchen layout for years. Naturally, they have become accustomed to the existing kitchen layout. Although the remodelled kitchen layout is better than the existing layout, cooking time worsened under this unfamiliar layout.

By contrast, cooking times of all cooking positions, except for sushi and sashimi, had improved at 2 months after remodelling, compared to those of the existing layout. The greatest values of fried food, simmered food, and salad

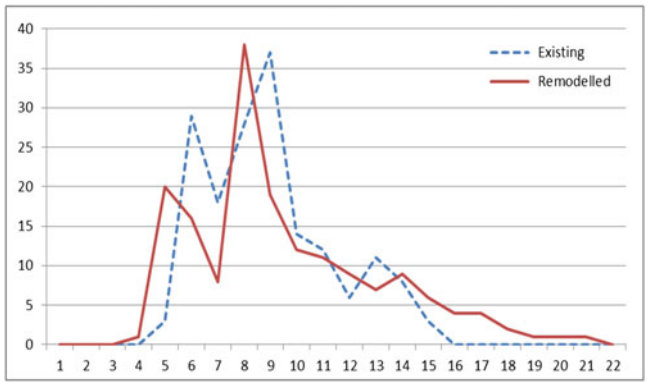

Fig. 3 Simulated cooking times of fried foods (*horizontal*, minutes; *vertical*, number of dishes)

Table 4 Results of questionnaires (percentage)

	Before ($N = 13$)			Immed. after ($N = 9$)			2 months after ($N = 10$)		
	P	–	N	P	–	N	P	–	N
A-1	0 %	100 %	0 %	0 %	100 %	0 %	60 %	40 %	0 %
A-2	15 %	69 %	15 %	11 %	56 %	33 %	40 %	60 %	0 %
A-3	46 %	46 %	8 %	33 %	44 %	22 %	40 %	50 %	10 %
A-4	23 %	54 %	23 %	33 %	22 %	44 %	40 %	60 %	0 %
A-5	0 %	100 %	0 %	0 %	100 %	0 %	40 %	60 %	0 %
A-6	0 %	100 %	0 %	0 %	100 %	0 %	50 %	50 %	0 %
B-1	0 %	100 %	0 %	0 %	100 %	0 %	40 %	60 %	0 %
B-2	0 %	100 %	0 %	0 %	100 %	0 %	40 %	60 %	0 %
B-3	85 %	15 %	0 %	67 %	33 %	0 %	60 %	40 %	0 %
B-4	77 %	23 %	0 %	67 %	33 %	0 %	60 %	40 %	0 %
B-5	85 %	15 %	0 %	67 %	33 %	0 %	70 %	30 %	0 %

P positive, – neutral, *N* negative

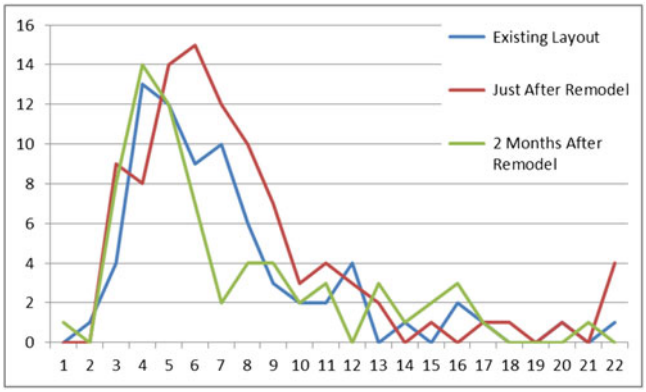

Fig. 4 Actual cooking times of fried foods (*horizontal*, minutes; *vertical*, number of dishes)

improved. However, the greatest values of baked foods, sushi, and sashimi did not improve.

As explained before, staff members continuously change the placement of kitchen utensils and ingredients to better places. It apparently took several weeks to fix their placement. After they were fixed, staff members gradually memorized them and became accustomed with the new placement. Results show that the time for searching was reduced. Eventually, the cooking time improved compared to the existing kitchen layout.

In addition, actual cooking operations do not have a long tail. Figure 4 presents a distribution of actual cooking times of fried foods in the existing layout, immediately after remodelling, and 2 months after kitchen remodelling. As discussed earlier, staff members cook numerous orders simultaneously in an actual kitchen. Therefore, the cooking times of order-rushed dishes do not so differ among the results. Results reflect the standard deviation. The actual standard deviation is less than the simulated value.

Moreover, staff members became accustomed with new kitchen layout. Several weeks were necessary to become accustomed to the new kitchen layout and cooking machines because some were changed for new models. After some time, workers improved the traffic line and reduced operation times for cooking machines. Eventually, the cooking times improved compared to the prior kitchen layout.

However, the sushi and sashimi cooking times were decided by the staff skill. Sushi and sashimi should be prepared one order at a time and manually. The kitchen layout has nothing to do with the cooking time of sushi and sashimi. Therefore, remodelling of the kitchen layout did not reduce the sushi and sashimi cooking time. Apparently, improving the average cooking time immediately after remodelling and that 2 months later are attributable to the skill of the sushi chef.

4.2 Results of Questionnaires (ES)

As Table 3.1 shows for kitchen equipment, responses obtained immediately after remodelling evaluation are worse than those for existing kitchen layouts. As explained in section "Improving cooking time (MS)", kitchen staff members become accustomed to the existing kitchen layout and cannot cook smoothly with the remodelled kitchen layout. Therefore, they did not report that the remodelled kitchen improved cooking operations.

By contrast, kitchen staff members reported that the remodelled kitchen equipment improved cooking operations compared to the existing kitchen layout, 2 months after remodelling. As discussed in section "Improving cooking time (MS)", kitchen staff members gradually became accustomed to the remodelled kitchen. They also continuously improve the placement of kitchen utensils and ingredients. Two months later, they reported that the remodelled kitchen layout improved cooking operations compared to the existing kitchen layout. The facility layout depends closely on workability. It is therefore an important factor for the fatigue burden for kitchen staff members. Improving the kitchen layout also improves employee satisfaction, not only management satisfaction.

As Table 3.1 shows for the job motivation and job satisfaction for the HR system, responses to questions B-1 and B-2 worsen immediately after remodelling and improved 2 months after remodelling. By contrast, answers for B-3, B-4, and B-5 worsen immediately after remodelling and 2 months after remodelling.

Staff members understand the purposes of the salary and promotion system. They feel their salary is reasonable for the skills and job. However, they do not want to master cooking skills of another kind to earn a higher salary. As explained before, four staff members are skilled chefs (full-time workers). Most part-time workers of restaurant A are older staff members.

Promotion and salary systems are important for unskilled workers because, if they master new cooking skills, they can receive a higher salary. It is also important for younger workers because they can master new cooking skills earlier. However, the system is meaningless for skilled workers because they have already mastered a full range of cooking skills. Therefore, they can receive a higher salary. Moreover,

it is difficult for older staff members to accept the challenge of gaining new cooking skills. Therefore, responses for B-3, B-4, and B-5 did not improve at restaurant A.

5 Conclusions

This study was conducted to improve both management and employee satisfaction. The restaurant A kitchen was redesigned using a kitchen simulator to enhance cooking time and to improve the staff member working environment. The remodelled kitchen includes a cell module to improve the cooking idle time. Salary and promotion systems are changed to encourage staff members to obtain various cooking skills to adopt new cooking operations (cell module). Cooking times were measured three times (existing layout, immediately after remodel, and 2 months after remodel) as KPI for confirming the efficacy of the redesigned kitchen. Questionnaires were administered to assess employee satisfaction. Results show that the remodelling of the kitchen layout using a kitchen simulator is useful to enhance the cooking speed of a multiproduct Japanese cuisine restaurant. Actually, the cooking speed worsens immediately after remodelling because staff members are not accustomed with the new kitchen layout. Furthermore, employees report that the remodelled kitchen layout is better than that of an existing kitchen and that the new salary system is reasonable for them, but they do not want to improve their skills because of their age and experience (some are already multiskilled workers).

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References

1. R. B. Chase and U. M. Apte: "A history of research in service operations: what's the big idea?" *Journal of Operations Management*, Vol.25, No.2, pp.375-386 (2007)
2. J. R. Pickworth: "Service delivery systems in the food service industry", *International Journal of Hospitality Management*, Vol. 7, No. 1, pp. 43–62 (1988)
3. T. Takenaka and T. Shimmura: "Practical and Interactive Demand Forecasting Method for Retail and Restaurant Services", *Proc. of International Conference Advances in Production Management Systems*, No. 3–4:2, Stavanger, 2011
4. T. Shimmura, T. Takenaka, and S, Ohura: "Improving productivity and labor elasticity at multiproduct Japanese cuisine restaurant introducing cell production system", *Proc. of International Conference Advances in Production Management Systems*, pp. 11–17, 2013, Pennsylvania
5. R T. Shimmura, T. Takenaka and M, Akamatsu: "Real-Time Process Management System in a Restaurant by Sharing Food Order Information", *Proc. of International Conference on Soft Computing and Pattern Recognition*, Malacca, December, 2009, pp. 703–706
6. N. Fujii, T. Kaihara, Toshiya, M. Uemura, Minami, T. Nonaka, and T. Shimmura: "Facility Layout Planning of Central Kitchen in Food Service Industry – Application to the real-scale problem", *Proc. of International Conference Advances in Production Management Systems*, pp. 33–40, Pennsylvania, September, 2013
7. T. Shimmura, T. Takenaka, M. Akamatsu: "Improvement of Restaurant Operation by sharing Order and Customer Information", *International Journal of Organization and Collecting Intelligence*, Vol. 1, No. 3, pp. 54–70 (2010)

The Efficient Provision of Culture-Sensitive Services: A Modularization Approach

Andreas Janson, Christoph Peters, and Jan Marco Leimeister

Abstract

This paper presents first guidelines for the cultural adaptation and efficient global provision of services. For this purpose, it elaborates on how to consider culture-specific components of a service on the basis of systematic service modularization. This is illustrated by the example of an IT-mediated learning service, which is usually perceived differently in diverse cultures. To this end, a process model is described based on culture theory and systematic modularization in order to identify culture-specific and culture-independent components of a learning service for its consideration within global service provision. This contribution to practice is complemented by the theoretical contribution of the inclusion of culture-theoretical components into service modularization.

Keywords

Service modularization • Culture • Learning service • Technology-mediated learning

1 Introduction

Globalization has become a frequently discussed topic for companies. Therefore, the global education and training of employees is a critical success factor in the context of globalization. These market needs also affect the service industry. Thus, currently, about one in four German education providers exports the German education abroad, which is assumed a growing need [1]. Against this background, the relevance of technology-mediated learning services needs to be considered in order to allow cost advantages in terms of education export [2].

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However, problems may arise when exporting a service. Services such as the here mentioned education and vocational trainings cannot be adopted one to one from, for example, Germany by another country. There are significant inhibitory factors that complicate the *export of services*. These include, e.g., legal barriers or the adaptation of the service to the target market, with the latter constituting major problems for many education and vocational training providers [2]. In addition to the linguistic assimilation, a cultural understanding of the target country is an important factor when adapting such a service [2]. *Culture*, hereby defined as the shared values of a group of individuals [3], is a construct that can adversely affect the perception of a service [4–6]. This also applies to technology-mediated learning services [7, 8], e.g., in the context of global differences in learning and teaching approaches [9].

The enabling of a *culture-sensitive* adaptation and provision of a service therefore relies on the concept of modularization. The selective identification of standardized modules firstly allows the implementation of cost advantages. Additionally, the modularization offers potentials in order to meet the challenges regarding the

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culture-sensitive adaptation of a service described above [10]. The present paper aims at formulating first guidelines on how to achieve the culture-sensitive provision of a service by means of systematic modularization. This contribution is therefore based on the following research questions (RQ):

RQ1: How can culture be considered in terms of service modularization?
RQ2: How should a methodology be designed in order to include culture systematically in the modularization process?

The theoretical contribution of this paper lies in the consideration of culture-theoretical principles for the modularization of services, while the practical contribution lies in the provision of a systematic practical method allowing the export of a technology-mediated learning service. In order to achieve the aim of this paper and to answer the above research questions, this article is based on theory-driven, design-oriented research [11–13] and is structured as follows. First, the theoretical principles concerning IT-mediated learning services, culture, and service modularization are presented. Based on this, the third chapter illustrates how national culture can be used as a starting point for the systematic modularization of technology-mediated learning services. Section 3.1 elaborates on how culture influences such learning services. Following, the methodology is described in Sect. 3.2, before being exemplarily evaluated in Sect. 3.3, using the model of a service export from Germany to China. The fourth chapter discusses according results. The paper concludes with limitations and possible future research in chapter "A Creed for Service Designers" and concludes in chapter "Design Support System for Sightseeing Tours".

2 Theoretical Background

2.1 Technology-Mediated Learning Services

Technology-mediated learning services (*TMLS*) are subsequently defined as environments of technology-supported interaction between learners and learning materials such as scripts or assignments, fellow learners, and/or lecturers [14]. These types of services are becoming more and more relevant and should be regarded as socially necessary. They are complex services, namely, consisting of IT parts as well as non-IT parts that are characterized by a strong focus on people and knowledge intensity. Referring to IT support, these learning services are in practice often equated with e-learning, and their according terms are used interchangeably [15]. It should be noted that such TMLS work in many forms and may combine different learning styles and methods in practice. Therefore, these learning services are referred to as blended learning concepts, which can by way of example be configured as follows [16]:

- Web or computer based
- Asynchronous or synchronous
- Lecturer centered or learner self-directed
- Individual or collaborative learning

This variety of options for service configuration and their consideration poses particular challenges for research. In order to address these challenges, the subsequent sections refer to the theoretical principles of Gupta and Bostrom [16], who have developed a holistic framework for TMLS based on *adaptive structuration theory* (AST) [17]. AST allows to examine the complex relationships between technology in social structures, which were first investigated in group decision support systems and their use in organizations [17]. The framework incorporates input and output factors of the service and, in contrast to previous research methods, the learning process, which is particularly important for the actual learning outcomes and thus the quality and productivity of the service [14, 18, 19].

Referring to AST, this framework is based on two basic assumptions [16]. The first one refers to the *structures* embedded in a specific context and defined as rules, resources, and possibilities in a given context [17]. If this assumption is adopted to the context of TMLS, the applied learning methods as well as the service structures can be considered as a potential dimension. They are reflected by the learning environment, the use of IT, and applied learning techniques.

The second basic assumption relates to the design of the *learning process*. This process view considers the interaction of learners with the learning service structures described above [16], e.g., by means of the learner's adaption to the applied learning methods and materials. The focus on the learning process can be explained by the transfer of these ideas to the field of service research and service systems [20]. Customer integration and simultaneous production and consumption of person-oriented services, the so-called uno-actu principle, strengthen the result of a service, e.g., the learning satisfaction for an IT-supported learning service. In this interactive process, the learner thus plays a very important role and should be considered with their individual, cultural differences, which arise from the specific context of the learning service (e.g., the country in which the learning service is provided). Therefore, recent research has considered the learning process and examined procedural factors of learning services centering around the interaction between learners and the learning service [15].

Both assumptions affect the *output factors* of a learning service, e.g., learning success or the learning satisfaction. In addition, a learning service is always embedded in a certain context. This can, e.g., relate to organizational

aspects or, as in the present paper, to the cultural aspects that are important in terms of the learning service provision.

2.2 Culture

Although *culture* has been an important research topic in various fields such as anthropology, cross-cultural psychology, and economics for over a hundred years, relevant research is still ongoing [21]. One reason is that culture itself is a complex construct associated with different reference levels. So far, research has mainly focused on national and organizational culture as the main reference levels. Both levels have been regarded as separate research lines focusing on values that distinguish one group from another [22].

National culture is used to distinguish attitudes and behavioral differences between individuals from different countries. Research primarily applies Hofstede's cultural dimensions theory [23] to explain cultural differences [22]. For this purpose, Hofstede originally derived four dimensions of national culture in cooperation with IBM: power distance, individualism-collectivism, masculinity-femininity, and uncertainty avoidance. Long-term orientation and indulgence-restraint were later added to reflect the cultural values of other nations, such as China in terms of long-term orientation [24]. Thus, Table 1 presents a brief definition for each value dimension.

Besides Hofstede, there are several other researchers who have proposed value-based approaches to investigate cultural values of a nation, including Yoo et al. [27] and Schwartz [28].

The other line of research examines cultural values practiced by members of certain organizations. This research area referred to as *organizational culture* is to be distinguished from national cultural values [24]. According to Schein [29], organizational culture can be distinguished on three characteristic levels, including:

- Artifacts as the topmost and only visible level reflecting structures and processes in organizations.
- One level below exist no longer visible cultural values that are reflected in organizations' core values and common values of organization members.
- At the lowest level are basic assumptions ingrained in an organization.

However, it should be noted here that although these two research lines are often approached separately, national and organizational values are strongly interlinked under certain circumstances [25]. Since the present paper emphasizes the need for an internationalization of TMLS, it further focuses on the understanding of national cultural differences and refers to Hofstede's cultural dimensions described above.

2.3 Modularization of Services

In the context of projects, *modularization* is understood as the division of a whole project into groups. In the context of services however, modularization is understood as the decomposing of such a service into individual elements, namely, modules. These combinable module elements are firmly linked to each other and fulfill a specific function as an entity [30].

It is characteristic that modularization is based on two fundamental principles, cohesion and loose coupling [31], with cohesion referring to the intra-module cohesion of the module elements and loose coupling to the inter-module dependency between the individual modules [32]. Loose coupling aims at low dependencies between the individual modules in combination with the following two requirements. When decomposing a service, the chosen interfaces must consider the combination of heavily dependent elements into one module [33]. This causes less dependency between the respective modules. The remaining dependencies between the individual modules are then easily detectable. The internal module properties remain invisible from the outside [34]. Cohesion focuses on precisely these internal properties and thus describes the extent of the correlation and dependency between the elements within a module, respectively. A high cohesion indicates a very

Table 1 Cultural dimensions according to Hofstede

Value dimension	Definition
Individualism-collectivism	The extent to which an individual prioritizes their own benefit over the benefit of the group and thus preferably acts as an individual rather than a member of the group
Power distance	The extent to which an individual accepts large differences in power and inequality as normal
Uncertainty avoidance	The extent of risk emphasizing rule obedience, ritual behavior, and safety measures accepted by an individual
Masculinity-femininity	The extent to which an individual accepts gender inequality
Long-term orientation	The extent of long-term orientation versus short-term orientation toward the future
Indulgence-restraint	The extent to which members of a society control their own desires and impulses

Source: [24–26]

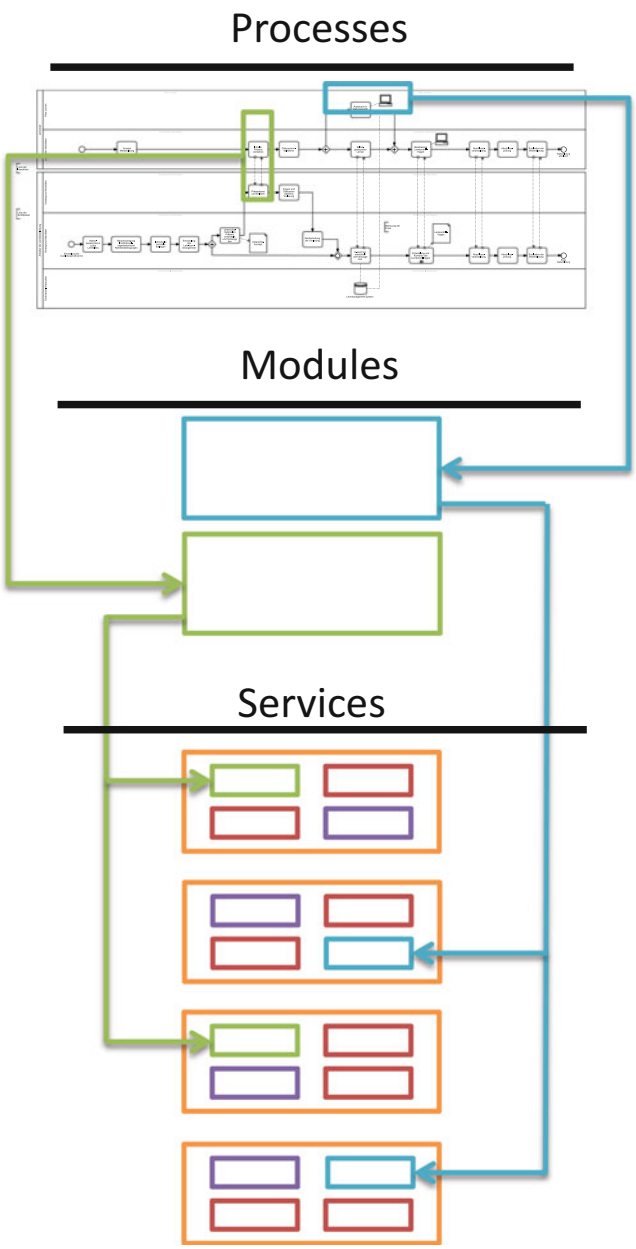

Fig. 1 From service process to a module-based service

similar target function of the individual elements within a module while simultaneously allowing a high reusability [35]. Specifically, this means that individual service processes can be combined into modules and that new services can then be configured based on these modules. This idea of service modularization and the steps of the service process for module-based and reconfigured services are collectively illustrated in Fig. 1.

These basic characteristics of modularization conclude the following advantages [36]:

- Reusability not only allows the module to be used across multiple services but also entails a cost advantage.
- Modularity allows a simple and rapid development of the modules since the individual modules have to be adapted to certain services only.
- Innovations can be applied directly to a specific module in order to create specific competitive advantages.
- The high extent of independency between the modules allows a flexible reconfiguration of services, ensuring a customer-centric mass production.

Since a one-to-one adaptation of a service into a different (cultural) context is often not possible in the course of the internationalization of services [10], modularization allows the identification of independent and interdependent modules. This can also be applied to the internationalization and thus culture-sensitive *reconfiguration* of learning services. Since there is a lack of a systematic approach to culture-specific modularization, according starting points will be presented in the following.

3 National Culture as Starting Point for the Modularization of TMLS

In order to consider national culture as a starting point for the design and modeling of a service, it will be shown how culture can influence the perception of learning services. Based on this theoretical background, Sect. 3.2 illustrates how the cultural dependencies of the individual learning service components can be considered by means of modularization in the course of design-oriented research. For this purpose, Sect. 3.3 points out initial possibilities for a practical implementation by giving an example.

3.1 The Influence of National Culture on TMLS

In order to determine the influence of national culture on TMLS, the following sections are based on the already introduced theoretical principles concerning cultural values according to Hofstede. It is assumed that these values have a moderating influence on the service with its individual modules. Referring to the dimension of uncertainty avoidance (UAI), it is assumed that this value will affect the results of the provided learning methods and structures [37]. Here, specific reference is made to the influence of UAI in respect to the use of e-learning components in a learning service. If such components are unknown and therefore new to a learner, they will no longer feel comfortable with a high UAI in this situation. This might be expressed by anxiety, nervousness, and the need for a predictable behavior of the e-learning component [25]. In addition, research results show that UAI is associated with an inhibitory effect

on the acceptance of IT artifacts [25, 38]. If these ideas are transferred to the context of TMLS, it can be assumed that this is similar for modules including IT support, for if the learner does not engage such modules, e.g., web-based training for self-regulated learning, the effects of the provided learning methods and structures are to no avail.

Additionally, it is assumed that the learning process is affected by the cultural values of masculinity-femininity (MAS-FEM), individualism-collectivism (IDV-COL), and power distance (PDI). The dimensions of long-term orientation and indulgence-restraint will not be considered regarding their impact on learning services, since there is still need for a theoretical foundation in order to make any assumptions regarding the modularization of learning services in this context. Regarding MAS-FEM, it is assumed that the learning process and thus initiated interaction between lecturer and learner are affected. In masculine cultures, it may be the case that lecturers selectively set good learners apart, thereby preventing interaction with average and below average students. Consequently, it can be assumed that the learning outcomes of these learning groups may be affected adversely [39]. This can also be applied to the value of IDV-COL in a modified form, meaning that collaborative learning in a group is appropriate for collectivist cultures and self-directed learning is more applicable in individualistic cultures [9, 39]. In addition, this paper argues that PDI affects the results of the learning process. In cultures with a high PDI, interaction may be limited during the learning process. This might be the case if a learner does not dare to actively participate in discussions or ask self-directed questions concerning comprehension problems during a vocational training session. From this, it is concluded that a limited interaction negatively affects the output perspective of a learning service.

3.2 Methodology for a Culture-Sensitive Service Modularization

To allow a systematic and culture-sensitive modularization of services, an according *methodology* pursuing this goal is presented below. A methodology is the detailed description of a collection of activities [40] allowing the modularization. The activities of the methodology are divided into sequential five steps, which are illustrated in Fig. 2.

3.2.1 Status Capturing

The methodology process starts with a recording of the status quo in order to receive a detailed overview regarding the modularization object [41]. For this purpose, detailed analyses should be carried out by means of empirical research methods, mostly qualitative interviews, observations, and document analyses [42 S. 308ff.]. The according objective is the documentation of the service process, which is used as an input for the next phases of the proposed methodology.

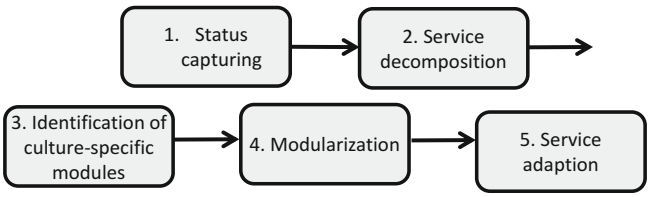

Fig. 2 Methodology for a culture-sensitive service modularization

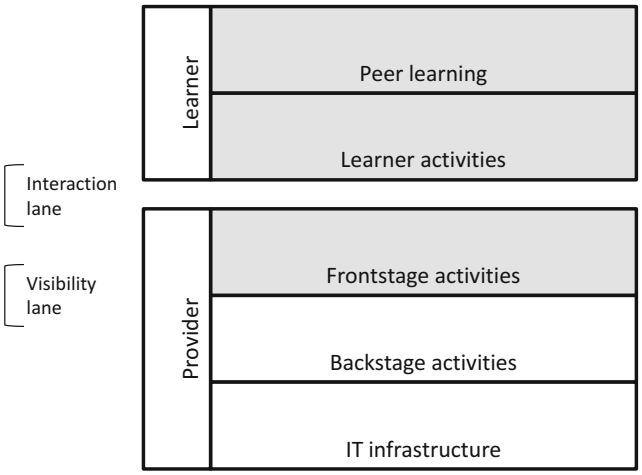

Fig. 3 Service blueprint modification

3.2.2 Service Decomposition

In the second step, namely, the *decomposition*, the process documentation from the first step is used to decompose the service into its individual components at the process level. To formally illustrate this decomposition, this paper refers to a modification of the Business Process Model and Notation (BPMN) in order to provide the necessary information for the next steps.

The necessary modifications in this case relate to the inclusion of the *service blueprint* concept [43]. This is necessary in order to transparently map the interactions of the various stakeholders involved in the process. The typical BPMN pools are used for the according stakeholders, while the lanes of a pool are used to identify front-stage and backstage activities of a stakeholder pool. Therefore, the relevant lanes of interaction (between the pools) and visibility (between the lanes of a pool) are inserted at this point. This will then allow the identification of specific process steps dependent and independent of culture, respectively. In this context, it is assumed that invisible backstage processes are independent of culture and visible as well as interactive processes are potentially culture dependent. This approach to learning service design is summarized in Fig. 3. The shaded lanes are therefore potentially culture dependent.

3.2.3 Identification of Culture-Specific Modules

The identification of culture-specific modules is based on the theoretical principles of cultural conflict [22]. The main assumption of this theory is that cultural values remain unnoticed as long as no cultural gap exists. However, different cultural values cause conflicts and the different nature of certain cultures becomes visible including corresponding consequences.

Therefore, the individual process steps of the process map are first evaluated regarding their importance for the perception of cultural differences by the service consumer and learner, respectively. After this evaluation, culture-independent and culture-dependent process steps follow.

3.2.4 Modularization

Now, the *cultural gaps* between different countries providing a service are determined for a specific case. This determination is concluded on the basis of the empirical studies conducted by Hofstede. Following, the individual culture-specific process steps are evaluated regarding the different cultural perceptions by the learner in terms of Hofstede's cultural dimensions.

On this basis follows the *culture-sensitive modularization*. The individual *culture-specific* process steps are summarized based on their properties and cultural dependency with other modules. Thus, dependent modules are combined in dependency to specific cultural values. These modules are therefore characterized by a high cohesion and can be loosely coupled with other modules.

In addition, the *culture-independent* process steps can be summarized as a kind of basic module that is globally recognizable and therefore conducts the core of the learning service. However, it should be noted that a further modularization is also possible at this point, e.g., based on further modularization parameters.

3.2.5 Service Adaptation

The last step of the culture-sensitive modularization is the adaptation of the service to a culturally different market. For this purpose, the basic modules as well as the modules generating no cultural conflicts are used. Finally, the other culture-specific service components are included in the service configuration. After completing these five steps, the modularization process is completed, and the different modules can be configured and offered according to the relevant culture-sensitive context.

3.3 Culture-Sensitive Design of an TMLS by Means of Modularization

To illustrate the first steps toward a culture-sensitive service, the present paper describes the export of a TMLS from Germany to China. For this purpose, the methodological steps presented in Sect. 3.2 are considered by means of a fictional example.

3.3.1 Status Capturing

To impose the status quo with respect to the current service provision in Germany, two main steps should be performed: first, on the basis of interviews with the learning service providers. In the present case, lecturers as well as human resource developers are suitable interviewees. In order to conduct a holistic overview on the training, observational studies must be carried out by in-class consultation. Document analyses, e.g., with respect to the learning objectives of a specific training, complete this methodology process step in this (fictional) case.

3.3.2 Service Decomposition

The learning service process is visualized in the source country, based on the status quo imposed in the first step, and decomposed into the individual processes. A simplified process design of a *TMLS*, which plays a role in vocational training as in the present paper, is exemplarily illustrated in Fig. 4.

For this purpose, two pools were used to illustrate the sub-activities of the service on the part of the service providers and the learner. The pool regarding the stakeholder of learners consists of two lanes above the interaction lane, meaning that these activities are self-directed and carried out by the learner. The second lane of this pool is used with respect to the activities taking place between different learners. This distinction is already successfully applied in other areas dealing with complex services [44]. In this context, the present paper considers collaborative learning processes such as group discussions [45]. In addition, the provider is taken into account in this process mapping comprising three lanes. Here, the visible (front-stage activities) and not directly visible process steps need to be distinguished, as indicated by the visibility lane. The backstage activities as well as the IT infrastructure of the provider are located below this lane.

3.3.3 Identification of Culture-Specific Modules

To facilitate the identification of culture-dependent and thus also culture-independent modules, the process steps within the present process map of the learning service are evaluated regarding cultural dependency. This is determined by whether the consumer of the service or the learner perceives cultural differences. The evaluation is carried out on the basis of the service blueprint visualized in the second step, distinguishing between front-stage and backstage activities. Since it can be assumed that the backstage activities cannot be perceived by the learner, they can be combined into basic modules, namely, in the present case, the development of

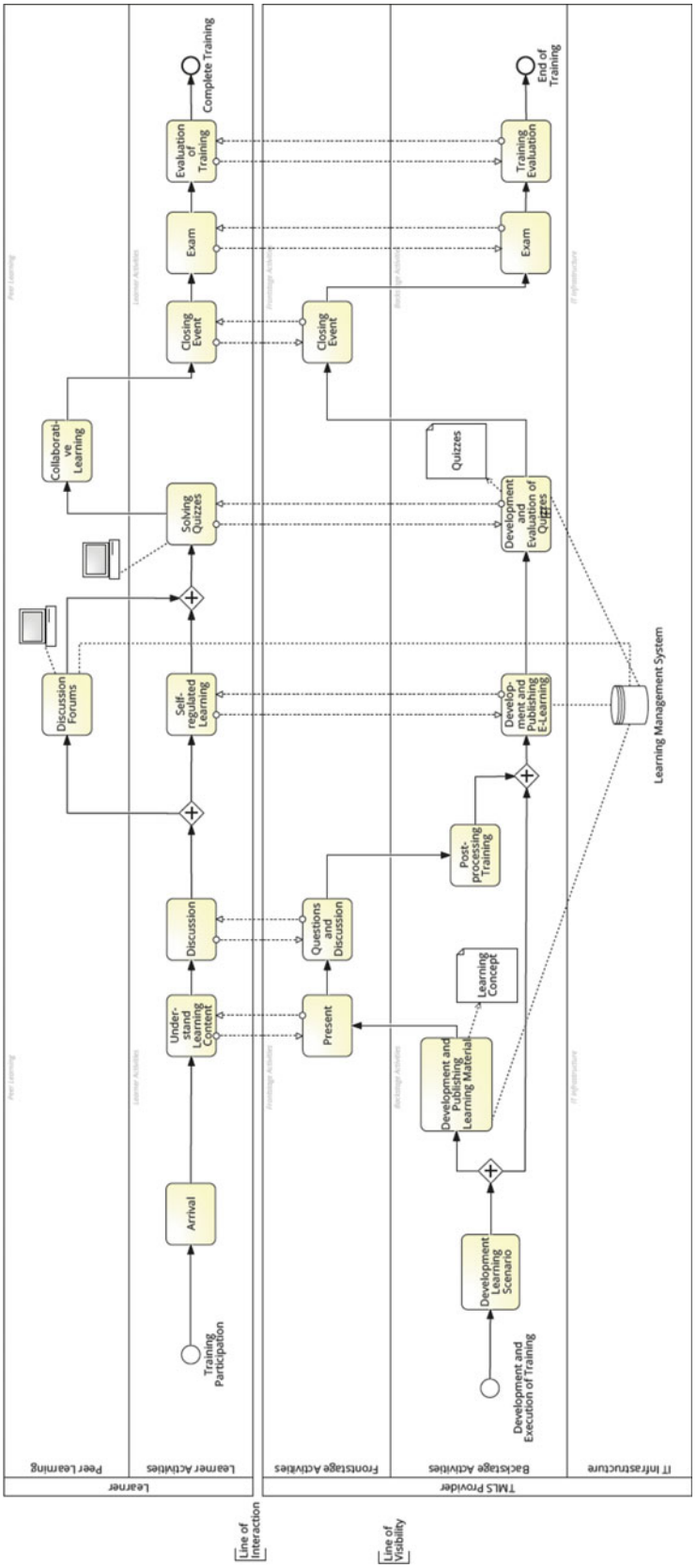

Fig. 4 Process design of a TMLS

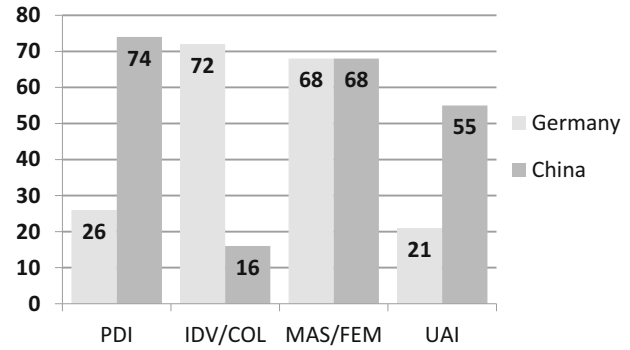

Fig. 5 Cultural differences between Germany and China (Source: [24])

teaching and learning arrangements (depending on a culture-sensitive configuration of the learning service), the development and editing of learning materials, the post-processing of the vocational training, and the development of learning assessments, as well as exams and evaluations.

3.3.4 Modularization

Now, the cultural gaps between the source country of the service and the target country are determined for further analysis. For this purpose, the present paper considers results by Hofstede [24], who conducted quantitative studies on the basis of the cultural dimensions described in Sect. 2.2 in order to identify global *cultural differences*. The results referring to Germany and China are presented in Fig. 5.

Based on these empirical findings, cultural differences between Germany and China regarding PDI, IDV-COL, and UAI can be identified, while the values for MAS-FEM are identical for both countries. The next step is now devoted to the evaluation of culture-dependent process steps with respect to cultural conflicts in the process of the TMLS. For this purpose, the theoretical insights regarding the influence of culture on TMLS obtained in Sect. 3.1 are used. Concerning the present case, this means that the in-class teaching, self-directed learning by means of e-learning, learning assessment by means of e-learning, collaborative learning among students in the form of an exchange in discussion forums, and group assignments, as well as the evaluation in respect to each cultural influence (positive and negative), are evaluated regarding value dimensions and value pairs, respectively. The according results can be found in Table 2.

We now use these empirical insights and abstract them to dependency matrices. If there is a culture conflict between two processes, we assign the value "1" to these two processes. Otherwise, if there is no cultural conflict, we assign the value "0" to indicate that these two processes have no cultural conflicts. For instance, considering the two processes, self-directed learning and the formative learning assessments, we assign the value "0" for this specific process couple, because both processes are preferred by individualistic cultures. In contrast, self-directed learning and collaborative learning with e-learning would induce a cultural conflict, and, hence, this process couple would be assigned with the value "1." Since we draw on the cultural dimensions of Hofstede, we use the original four cultural dimensions for building services modules and, thus, create four dependency matrices that we accumulate in one matrix. This matrix shows the accumulated cultural conflicts across all modules and cultural value dimensions. If there are no or just low cultural conflicts, we are able to form a module of the processes; otherwise, we do not propose a module.

Table 2 Cultural influence on culture-specific processes

Processes	Influence cultural dimension
In-class teaching	MAS (+)/FEM (−); PDI (−)
Self-directed learning	COL (−)/IDV (+); UAI (−)
Learning assessment	COL (−)/IDV (+); UAI (−)
Collaborative learning by means of e-learning	COL (+)/IDV (−)
Group assignments	COL (+)/IDV (−)
Evaluation	MAS (+)/FEM (−)

Based on these results, the formation of three modules is proposed, namely, in-class teaching and evaluation (module 1), self-directed learning and learning assessment (module 2), as well as collaborative learning on the basis of e-learning and group assignments (module 3). Regarding these three modules, it is assumed that the individual components do not produce any mutual cultural conflicts and are thus applicable as modules in an according cultural context. Module 3, e.g., constitutes collaborative learning techniques and is therefore suitable for use in collectivist cultures.

3.3.5 Service Adaptation

First, the basic culture-independent modules are applied in course of the service configuration. The next step is the specific design of the learning service for the particular cultural context without possibly inducing cultural conflicts. In the present case of China, this is achieved by means of modules 1 and 3.

Further aspects need to be considered during the subsequent implementation and testing phases. While module 1 (in-class teaching and evaluation) does not conclude cultural conflicts with respect to the value pair MAS-FEM and is thus applicable in Germany and China, adaptations concerning the module design need to be considered regarding the different values of PDI in both countries. In the context of this module, vocational training discussions could, e.g., be offered by means of IT support, allowing learners not to lose face by anonymously participating in

the discussion. In contrast, this kind of adaptation would not be necessary in Germany. Finally, the modularization process would be completed and learning effects could be applied to other cases.

4 Discussion

After chapter "A Method for Supporting Customer Model Construction: Using a Topic Model for Public Service Design" presented approaches of systematic modularization for a culture-sensitive service provision, the suitability of such an approach will be discussed below. The systematic modularization facilitates the *reusability* of modules in general, as well as in a cultural context, and culture-independent modules in the present case, respectively. Identifying these modules allows for globally standardized basic modules for the export of a (learning) service in order to promote reusability. Besides the usual benefits, such as learning effects and cost benefits, the potential of the possible IT support for such modules is to be mentioned as well. The advantage of *innovation* across modules provides the possibility to selectively invest in culture-sensitive service modules that are connected to a strong demand, a distinguished in-house expertise, as well as particularly promising expected competitive advantages. This way, it is also possible to promptly react to culturally determined market needs. Finally, the systematic detection of culture-dependent and independent modules allows a flexible *reconfiguration*, whereby the described service can be easily adapted to the context of other countries and cultures, irrespectively of the example give in Sect. 3.3. Thus, it can be observed that the Anglo-Saxon export of learning services is very successful due to the provision of modules with small learning units, whereas German educational offers are very inflexible [2], therefore enabling service providers to develop new and successful business models [46]. However, it should be noted that this reconfiguration has its limits. Hence, a learning service is always subject to certain conditions, e.g., that learners achieve specific learning objectives and accordingly take a final exam before obtaining a certification. These conditions must therefore be taken into account in course of the service configuration. The cultural modification of mandatory modules yet allows the consideration of cultural issues. If e-learning modules are necessary, a cultural adaptation of the IT component would be applicable [47]. When dealing with procedural components of the service on the other hand, a culture-sensitive reference modeling of these modules applies [48].

5 Limitations and Future Research

The present paper has some *limitations* and accordingly allows for future research. Although the findings of this paper are theoretically profound, there is still a lack of sufficient substantiated empirical results regarding the influence of individual cultural dimensions on the individual components of a learning service. Although the research results by Hofstede et al. [24] provide first guidelines for the design of culture-sensitive services, particularly the differences identified in the present paper disclose the limitations of this approach. Thus, it seems unlikely that MAS-FEM is culturally developed alike in Germany and China. Additionally, other study results elaborate on the diversity of Chinese culture and particularly stress the importance of subcultures in a Chinese context [49]. Therefore, an empirical verification on an individual level would be necessary to consider factors such as group or organizational cultures [50]. This is not possible using the results by Hofstede [24]. In addition, the derived methodology has not yet been *evaluated* accordingly. Therefore, the methodology should eventually be evaluated regarding its suitability for a systematic modularization in the context of design-oriented research by means of expert evaluations and experimental settings. Accordingly, this methodology is only a first step toward a holistic culture-sensitive service design. However, first service offerings that are exported from Germany to China show the potential of the proposed method. It should also be noted that culture is only one criterion for modularization among many others. Therefore, it would be worth examining how culture behaves as *modularization parameter* in interdependency with other parameters [51]. Therefore, existing methods for the modularization of complex services should be reinforced in the future, and available literature should accordingly be scanned for such modularization approaches in a systematic manner, for instance by considering systematic workshop approaches to identify cultural-dependent modules. Referring to cultural dimensions, the influence of the more recent Hofstede dimensions of long-term orientation and indulgence-restraint remains to be evaluated. There is still a lack of theoretical foundations, which can however be developed on the basis of empirical work described above. Finally, the *inclusion* of other stakeholders from the learning environment should be considered for further reflection, since it has proved effective in other settings of complex services [52, 53]. Along with this, it should also be noted that the present (fictional) case study is overly simplified in order to convey the basic idea of a culture-sensitive service modularization to the reader.

6 Summary

The present paper described how the *culture-sensitive provision of a service* can be implemented based on a systematic application of modularization. To answer the question of how the aspect of culture can be considered in the course of service modularization (RQ1), a theoretical background

on culture was given, followed by an illustration of how culture influences TMLS. Additionally, it was shown how *culture* can be included *as a criterion for service modularization* based on the theory of cultural conflict. This was followed by the provision of design guidelines for a methodology including culture in the modularization process (RQ2). For this purpose, a methodology consisting of five steps was introduced and illustrated with an exemplary TMLS. Thus, the contribution of this paper lies firstly in the theoretical enhancement regarding modularization theory by inclusion of culture and secondly in the practical provision of a method.

Hence, the present paper is a first step toward globally providing culture-sensitive services based on modularization. Further planned steps are the evaluation of the methodology in practice and the inclusion of additional criteria for modularization in an international context, because culture is indeed an important construct but still only one among many others.

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References

1. iMOVE (2013) Trendbarometer: Exportbranche Aus- und Weiterbildung. https://www.imove-germany.de/cps/rde/xbcr/imove_projekt_de/p_iMOVE_Trendbarometer_2013_sicher.pdf
2. Fraunhofer MOEZ (2012) Treibende und hemmende Faktoren im Berufsbildungsexport aus Sicht deutscher Anbieter. http://berufsbildungsexport-meta.de/system/publications/documents/000/000/001/original/FraunhoferMOEZ_Studie_Treiber_Hemmnisse_final.pdf?1371046861
3. Straub D, Loch K, Evaristo R et al. (2002) Toward a Theory-Based Measurement of Culture. Journal of Global Information Management 10(1): 13–23
4. Donthu N (1998) Cultural Influences on Service Quality Expectations. Journal of Service Research 1(2): 178–186. doi: 10.1177/109467059800100207
5. Mattila AS (1999) The Role of Culture in the Service Evaluation Process. Journal of Service Research 1(3): 250–261. doi: 10.1177/109467059913006
6. Raajpoot N (2004) Reconceptualizing Service Encounter Quality in a Non-Western Context. Journal of Service Research 7(2): 181–201. doi: 10.1177/1094670504268450
7. Gerbic P (2005) Chinese learners and computer mediated communication: Balancing culture, technology, and pedagogy. In: Proceedings of the 22nd Annual Australian Society for Computers in Learning in Tertiary Education Conference: Balance, Fidelity, Mobility: Maintaining the Momentum
8. Hornik S, Tupchiy A (2006) Culture's Impact on Technology Mediated Learning. Journal of Global Information Management 14(4): 31–56. doi: 10.4018/jgim.2006100102
9. Fischer B, Kopp B (2007) Evaluation of a Western training concept for further education in China. interculture journal 6(4): 57–76
10. Schermann M, Böhmann T, Prilla M et al. (2012) Service Modularization for Customer-Specific Service Design Based on Highly Standardized Services. In: Böhmann T, Burr W, Herrmann T et al. (eds) Implementing International Services: A Tailorable Method for Market Assessment, Modularization, and Process Transfer. Gabler Verlag/Springer Fachmedien Wiesbaden GmbH, Wiesbaden, Wiesbaden, pp 101–118
11. Hevner AR, March ST, Park J et al. (2004) Design science in information systems research. MIS Quarterly 28(1): 75–105
12. Arazy O, Kumar N, Shapira B (2010) A Theory-Driven Design Framework for Social Recommender Systems. Journal of the Association for Information Systems 11(9)
13. Gehlert A, Schermann M, Pohl K et al. (2009) Towards a Research Method for Theorydriven Design Research. Wirtschaftinformatik Proceedings 2009
14. Alavi M, Leidner DE (2001) Research Commentary: Technology-Mediated Learning--A Call for Greater Depth and Breadth of Research. Information Systems Research 12(1): 1–10. doi: 10.1287/isre.12.1.1.9720
15. Gupta S, Bostrom R (2013) An Investigation of the Appropriation of Technology-Mediated Training Methods Incorporating Enactive and Collaborative Learning. Information Systems Research 24(2): 454–469. doi: 10.1287/isre.1120.0433
16. Gupta S, Bostrom R (2009) Technology-Mediated Learning: A Comprehensive Theoretical Model. Journal of the Association for Information Systems 10(9): 686–714
17. DeSanctis G, Poole MS (1994) Capturing the complexity in advanced technology use: Adaptive structuration theory. Organization Science 5(2): 121–147
18. Bitzer P, Janson A (2014) Towards a Holistic Understanding of Technology-Mediated Learning Services - a State-of-the-Art Analysis. ECIS 2014 Proceedings
19. Janson A, Thiel de Gafenco M (2015) Engaging the Appropriation of Technology-mediated Learning Services - A Theory-driven Design Approach. ECIS 2015 Proceedings
20. Kwan S, Min, Jae, H. (2008) An Evolutionary Framework of Service Systems: Presented at the International Conference on Service Science Beijing, China, April 17–18, 2008
21. Kummer T, Leimeister JM, Bick M (2012) On the Importance of National Culture for the Design of Information Systems. Business & Information Systems Engineering 4(6): 317–330
22. Leidner DE, Kayworth T (2006) Review: A Review of Culture in Information Systems Research: Toward a Theory of Information Technology Culture Conflict. MIS Quarterly 30(2): 357–399. doi: 10.2307/25148735
23. Hofstede G (1980) Culture's consequences: International differences in work-related values. Sage Publications, Inc
24. Hofstede GH, Hofstede GJ, Minkov M (2010) Cultures and organizations: Software of the mind: intercultural cooperation and its importance for survival, 3rd ed. McGraw-Hill, New York
25. Srite M, Karahanna E (2006) The Role of Espoused National Cultural Values in Technology Acceptance. MIS Quarterly 30(3): 679–704. doi: 10.2307/25148745
26. Yoo B, Donthu N, Lenartowicz T (2011) Measuring Hofstede's five dimensions of cultural values at the individual level: Development and validation of CVSCALE. Journal of International Consumer Marketing 23(3–4): 193–210
27. Hall ET (1977) Beyond culture. Random House Digital, Inc
28. Schwartz SH (1990) Individualism-Collectivism: Critique and Proposed Refinements. Journal of Cross-Cultural Psychology 21(2): 139–157. doi: 10.1177/0022022190212001
29. Schein EH (1990) Organizational culture. American psychologist 45(2): 109–119
30. Schilling MA (2000) Toward a General Modular Systems Theory and Its Application to Interfirm Product Modularity. Academy of management review 25(2): 312–334. doi: 10.5465/AMR.2000.3312918
31. Balzert H (2000) Lehrbuch der Software-Technik – Software-Entwicklung. Lehrbuch der Software-Technik – Software-Entwicklung, Heidelberg
32. Peters C, Leimeister JM (2013) TM^3 - A Modularization Method for Telemedical Services: Design and Evaluation. In: 21st

European Conference on Information Systems (ECIS), Utrecht, Netherlands
33. Bask A, Lipponen M, Rajahonka M et al. (2011) Framework for modularity and customization: service perspective. Journal of Business & Industrial Marketing 26(5): 306–319. doi: 10.1108/08858621111144370
34. Parnas DL (1972) On the criteria to be used in decomposing systems into modules. Commun. ACM 15(12): 1053–1058. doi: 10.1145/361598.361623
35. Baldwin CY, Clark KB (1997) Managing in an age of modularity. Harvard Business Review 75(5): 84–93
36. Böhmann T, Krcmar H (2006) Modulare Servicearchitekturen. In: Bullinger H, Scheer A (eds) Service Engineering. Springer-Verlag, Berlin/Heidelberg, pp 377–401
37. Swierczek FW, Bechter C (2010) Cultural Features of e-Learning. In: Spector JM, Ifenthaler D, Isaias P et al. (eds) Learning and Instruction in the Digital Age. Springer US, Boston, MA, pp 291–308
38. Straub DW (1994) The Effect of Culture on IT Diffusion: E-Mail and FAX in Japan and the U.S. Information Systems Research 5(1): 23–47. doi: 10.1287/isre.5.1.23
39. Hofstede G (1986) Cultural differences in teaching and learning. International Journal of Intercultural Relations 10(3): 301–320. doi: 10.1016/0147-1767(86)90015-5
40. Brinkkemper S (1996) Method engineering: engineering of information systems development methods and tools. Information and Software Technology 38(4): 275–280. doi: 10.1016/0950-5849(95)01059-9
41. Dubberly H, Evenson S, Robinson R (2008) On modeling the analysis-synthesis bridge model. interactions 15(2): 57. doi: 10.1145/1340961.1340976
42. Bortz J, Bortz-Döring, Döring N (2009) Forschungsmethoden und Evaluation: Für Human- und Sozialwissenschaftler ; mit 87 Tabellen, 4th edn. Springer-Medizin-Verl., Heidelberg
43. Shostack GL (1984) Designing services that deliver. Harvard Business Review 62(1): 133–139
44. Peters C, Elm C, Söllner M et al. (2014) Blueprint-driven Telemedicine Process Modeling - The Interdisciplinary Development and Evaluation of a Modeling Language for Telemedical Services. In: Annual AIS SIG Services Pre-ICIS Workshop 2014, Auckland, New Zealand
45. Janson A, Söllner M, Leimeister JM (2016) The Appropriation of Collaborative Learning – Qualitative Insights from a Flipped Classroom. 49th Hawaii International Conference on System Sciences (HICSS): 84–93
46. Peters C, Blohm I, Leimeister JM (2015) Anatomy of Successful Business Models for Complex Services: Insights from the Telemedicine Field. Journal of Management Information Systems 32(3): 75–104. doi: 10.1080/07421222.2015.1095034
47. Reinecke K, Bernstein A (2013) Knowing what a User Likes: A Design Science Approach to Interfaces that Automatically Adapt to Culture. MIS Quarterly 37(2): 427-A11
48. Schermann M, Prilla M, Böhmann T et al. (2012) Designing Services as Adaptable Reference Models. In: Böhmann T, Burr W, Herrmann T et al. (eds) Implementing International Services: A Tailorable Method for Market Assessment, Modularization, and Process Transfer. Gabler Verlag/Springer Fachmedien Wiesbaden GmbH, Wiesbaden, Wiesbaden, pp 276–292
49. Martinsons M, Ma D (2009) Sub-Cultural Differences in Information Ethics across China: Focus On Chinese Management Generation Gaps. Journal of the Association for Information Systems 10 (11)
50. Ernst S, Janson A, Söllner M et al. (2015) When in Rome, do as the Romans do – Overcoming Culture Conflicts in Mobile Learning. ICIS 2015 Proceedings
51. Peters C (2014) Together They are Strong - The Quest for Service Modularization Parameters. Proceedings of the 22nd European Conference on Information Systems (ECIS). Tel Aviv, Israel
52. Peters C, Leimeister JM (2014) Modellierung telemedizinischer Dienstleistungen mit der Blueprint-driven Telemedicine Process Modeling Language. In: Schultze W, Möller K (eds) Produktivität von Dienstleistungen. Springer, Germany
53. Haas P, Blohm I, Peters C et al. (2015) Modularization of Crowdfunding Services – Designing Disruptive Innovations in the Banking Industry. ICIS 2015 Proceedings

Nurse Bed Care Activity Analysis for Intelligent Training Service

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Abstract

Bed care skills are highly demanded in an elderly society. Therefore, intelligent training service begins to appear for automatically transferring a skill. In this paper, we proposed a bed care activity analysis framework containing three entities: nurse, patient, and environment. Nurse activity was represented by actions with patient or environment. These interactions were recognized by body part gesture and represented by agent-motion-target type in linguistics. The bed care task-patient repositioning carried out in motion capture system was analyzed by the proposed framework and represented by linguistic description. Thus, activity was automatically observed in the training service.

Keywords

Activity analysis framework • Training system • Semantic motion recognition

1 Introduction

The fast-growing aging population in the world and the chronic illness increasing with age result in increased demand for health-care service. To help a patient move and be comfortably positioned is one of the most important bed care nursing skills. Correspondently, the need for new nurses to master the bed care skill is highly demanded. To acquire good bed care skill not only can provide comfortable care for the patients but also can reduce the risk of musculoskeletal disorders especially low back pain [1]. One-to-one training mode brings better learning achievements for learners, but the actual trainers are usually insufficient to support this training mode. Instead, a one-to-many training approach is used in actual training activities. Such an approach to learn often affects learners' effectiveness [2].

Therefore, more researches are beginning to analyze the nursing skill and to construct a training system [1, 3, 4]. Meanwhile, skill training has evolved from real tutor face-to-face training to an intelligent training system that a computer system aims to provide immediate and customized instruction or feedback to trainees [5]. Therefore, an intelligent training system will provide trainees with the benefits of one-to-one instruction. In order to effectively transfer the skill to a trainee without intervention from a real human trainer, the system should have enough knowledge and observe the trainee's motion. Thus, a key part in the intelligent system is to let the computer know what is happening in the system. According to the knowledge and the observation, the head of the system computer can give specific interpretation and diagnosis in training for each individual trainee.

Before providing intelligent training diagnosis, the system should have the capability to observe trainees' motion. What should be observed and how to observe will be the first step for the system. Therefore, what bed care task aspects should be observed and how to observe will be analyzed. We understand the bed care situation contains three aspects: nurse, patient, and environment. However, most researches focus on only a single aspect.

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It is useful to view the nursing care task from the viewpoint of interactions among the three aspects, which will give a comprehensive observation to the training system. The nurse-patient interaction includes the nurse's action to the patient and patient's reaction to the nurse. Nurse's action includes moving the patient in bed from side to side, turning over the patient, moving the patient up to bed, etc. Patient's feeling and the body parts to be cared, such as feeling comfortable, feeling uncomfortable, the hands crossed on chest, etc. are as the reaction of the patient.

The nurse-environment interaction includes the environment influence and the nurse's reaction to the environment. For example, the environment influence includes the equipment used, the space, the bed height, etc. and the nurse's reaction includes what's needed, whether or not help is needed, which method should be adopted, etc.

The environment-patient interaction includes environmental influence on patient and the patient's reaction. The environmental influence includes adding equipment, bed height changing, etc. and the patient's reaction includes like, dislike, etc.

In this paper, we proposed a framework based on our analysis domain to observe and interpret the nurse bed care activity. Our approach is distinct from previous approaches, most of which aim at analyzing strict steps for the care task [1], right positions check [3], or body parts posture [4]. We aim at developing a semantic observation scheme for bed care activity, in order to endow the system the ability to observe a trainee's motion. Therefore, the computer will substitute a real human trainer to understand the task activity. Thus, in the intelligent service, based on the understanding, the system will give a trainee specific diagnosis and instruction according to his or her own motion pattern.

2 Activity Analysis Framework for Bed Care Task

According to our analysis domain, bed care analysis framework was proposed as shown in Fig. 1, which contains three entities: nurse, patient, and environment. However, most of the researches focus on one part of this task. Observing the task from the three entities lets the system be more like a real tutor, who will diagnose the skill from the main aspects included in the task. Moreover, only training the novices to handle properly the relationships of the three entities, the skill can be really mastered.

Repositioning the patient is one of the typical bed care tasks to give a patient care in bed. As shown in Fig. 2, in order to reduce the nurse's load and increase patient's comfort, a sliding sheet is used. A nurse pulls the sliding sheet to reposition a patient in bed. Here we take this task, for example, to give a detailed explanation of analysis framework.

During this task, in order to care a patient in bed, a nurse will make actions to a patient, such as changing the patient's

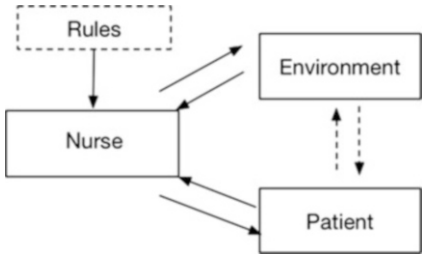

Fig. 1 Analysis framework for bed care task

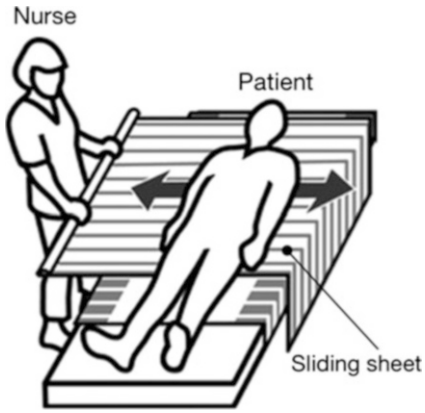

Fig. 2 Bed care task repositioning using sliding sheet

position, helping the patient sit up, etc. The patient will react to or affect the nurse, such as patient's weight, patient's body situation, etc. Or a nurse will make actions to the environment including using a sliding sheet to help the patient, changing the bed height, etc. The environment will also affect the nurse's motion, such as the bed height, the tool, etc. Meanwhile, a nurse's motion should follow the rules due to pure manual work, such as no-lift policy, body mechanism, etc., to prevent musculoskeletal disorders, especially low back pain [6].

The interaction between patient and environment in the bed care task, at most times, is caused by nurse's action and for this reason the interaction is illustrated as a dotted line. For example, a nurse changes the environment conditions, the changing will affect the patient, and the patient will also cause an effect to the environment due to the nurse performing the task, such as moving or turning, with respect to the bed.

Therefore, in all interactions, the nurse's actions play a primary role in the bed care task. The nurse's action to the patient and environment will be mainly discussed. In order to understand the nurse's action, the representation of nurse activity is based on the notion of hierarchy [7]. A nurse's action consists of multiple body part gestures such as arm motion, torso motion, and leg motion. Each body part gesture is an elementary event of motion and all these elements construct higher-level motion to accomplish the task. The action target will be the patient or environment. The schematic levels of the hierarchy are illustrated in Fig. 3. First, the

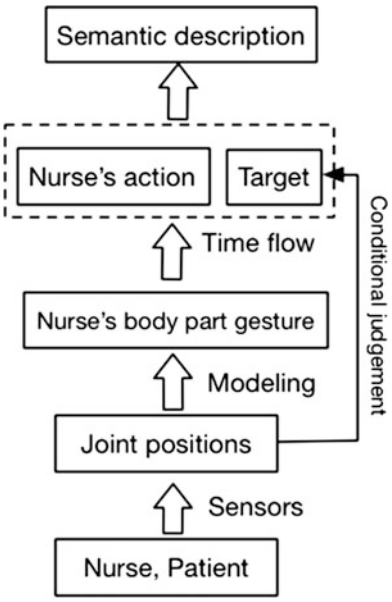

Fig. 3 The diagram for semantic level description

nurse and patient's main joints are obtained by sensors and then the nurse's body part gestures are obtained by modeling. The nurse's action will be formed from body part gestures. In order to determine the action target, conditional judgment will be applied. Therefore, the task activity will be interpreted as the nurse's action to target. The system will understand what actions are made during the task process.

3 Bed Care Task Analysis

In order to determine the body part gesture, a body vector model was proposed to represent the body part, with each vector representing a body segment. A movement space was proposed to determine the motion direction in a semantic level. The action target will be determined by conditional judgment. For the representation of semantic observation results, we adopt the agent-motion-target type in linguistics [8].

3.1 Body Vector Model

Body vector model was proposed to represent the human body of a nurse, as shown in Fig. 4. This model represents human motion or posture by nine vectors. Thus, a motion can be analyzed by vector operation. Moreover, a vector including magnitude, direction, and origin defines a movement in a simplistic model that can later be analyzed in a semantic way. The human skeleton in a frame consists of nine body segment vectors. In the body vector model, vector 1 represents the torso; vectors 2, 3, 4, and 5 compose the arm

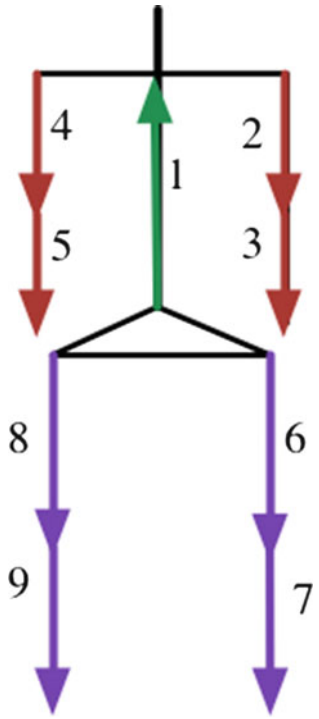

Fig. 4 Body vector model

part; and vectors 6, 7, 8, and 9 compose the leg part. The information of human skeleton can be obtained either by RGB-D sensor or motion capture system.

At time t, body part vector $\mathbf{b}_t^n = \left(i_t^n, j_t^n, k_t^n\right), n = 1, \ldots, 9$, and the $\mathbf{b}_t^n$ will represent the posture of the body part. At time s, body part vector $\mathbf{b}_s^n = \left(i_s^n, j_s^n, k_s^n\right), n = 1, \ldots, 9$. The vector value will be the end joint point subtracted from the start point. The movement direction of body segment n will be

$$\mathbf{d}^n = \mathbf{b}_s^n - \mathbf{b}_t^n \tag{1}$$

The movement direction of a body segment vector is actually the movement direction of vector end joint point compared to vector start point. For example, the movement direction of $\mathbf{d}^2$ will be the movement direction of left elbow joint compared to left shoulder joint.

Although we can determine the movement direction, it is actually not meaningful for the system to interpret it. In order to determine the semantic meaning of direction, the movement space was proposed to label the direction as we usually see, such as front, left, up-left, etc.

3.2 Movement Space

Movement space will determine the movement direction in our human observation way, such as left, up, front, etc. As shown in Fig. 5, X, Y, Z is the world coordinate system,

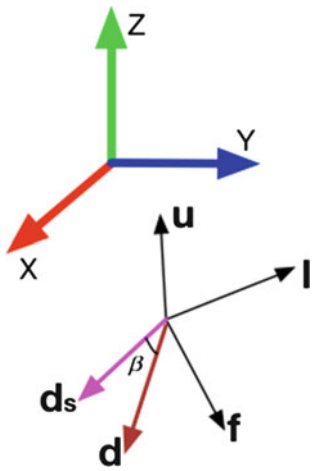

Fig. 5 Movement space

which is determined by our sensor system. The movement space is determined by the human body itself. **f** is the human facing direction and **l** is orthogonal to **f** and **u** is orthogonal to the plane determined by **f** and **l**. For example, for the standing pose motion, **u** will be (0,0,1) to represent up direction, **f** is the front direction, and **l** is the left direction. According to the three main directions in the movement space, there are detailed 27 movement directions determined:

$$\mathbf{d}_s = (f, l, u), \forall f, l, u\{1, 0, -1\} \tag{2}$$

In Eq. 2, value 1 means that motion changes in this direction, value 0 means that motion has no change in this direction, and value −1 means that motion has opposite changes in this direction. For example, if $\mathbf{d}_s = (1,1,0)$, that means the movement direction is front-left. Thus the motion direction dictionary can be listed as Eq. 3:

$$\begin{aligned} &\text{motion\_direciton} = (md_1, md_2, md_3), \\ &md_1 = \{\text{front, null, back}\}, \\ &md_2 = \{\text{left, null, right}\}, \\ &md_3 = \{\text{up, null, down}\}. \end{aligned} \tag{3}$$

For the real motion direction, we normalize it to one of the directions in the movement space; thus the motion can be understood in human direction. As shown in Fig. 5, the direction of **d** will choose the direction $\mathbf{d}_s$, which has minimum vector angle with **d**.

For the arm or leg part, its direction is determined by a four-vector integrated direction in order to give a semantic description. For the left arm as an example, vectors 2 and 3 are joined together; the two vectors' directions are always related. The body segment, which has larger movement distance, will be as the dominant body segment part in this time period. For the left arm, the movement direction is $\mathbf{d}_s^l$ and the right arm movement direction is $\mathbf{d}_s^r$:

$$\mathbf{d}_s^l - \mathbf{d}_s^r = (d_1, d_2, d_3) \tag{4}$$

If any value of $\mathbf{d}_1$, $\mathbf{d}_2$, or $\mathbf{d}_3$ is equal to 2 or −2, meaning two arms move in the opposite direction, then the arm part movement directions are considered left arm and right arm separately. In other situations, the left arm and right arm are almost in the same direction and we choose the common directions as the unified arm direction.

3.3 Action Target

The interaction target of bed care task is the patient or environment. First, we should determine if the interaction target is the patient or environment. In the bed care task, if a nurse makes an action directly to a patient, the wrist height should be higher than the bed height; meanwhile in certain region, the patient's body joints should be found. Then we design the following steps to detect the interaction target:

Step1: compare the wrist height (wh) and the patient's hip height (h).
Step2: if $wh > h$ and the patient body joint can be found in a certain region of the nurse's wrist, then the interaction target is the patient. The identified patient body joint can determine the acted body part of patient.

3.4 Semantic Representation

The observation result will be represented as triplet = <agent-motion-target> according to the theory of "verb argument structure" in linguistics [8]. Table 1 illustrates the argument definition.

4 Experiment

Repositioning, a bed care task, using sliding sheet was analyzed in the experiment. The task scene was set up in the motion capture system, and two expert nurses carried out the positioning task.

4.1 Repositioning Task Set Up

Repositioning task using sliding sheet was set up in optimal motion capture system (MAC3D) with eight cameras (HMK-200RT; Motion Analysis Corp.). The capture frame is 200 Hz.

Table 1 Representation by verb argument structure

Set definition for nurse action
Universe set of interaction: U
$U = \{\text{Interaction}\vert\text{Interaction} = < \text{nurse} - \text{motion} - \text{patient/environment} >\}$
Nurse set: N
$N = \{N_h \vert N_h = \text{nurse's body parts}\} = \{\text{arm}, \text{torso}, \text{leg}, \text{null}\}$
Patient set: P
$P = \{P_j \vert P_j = \text{patient's body parts}\} = \{\text{arm}, \text{torso}, \text{leg}, \text{null}\}$
Environment set: E
$E = \{E_i \vert E_i = \text{environment components}\} = \{\text{bed}, \text{sliding sheet}\}$
Motion set: M
$M = \{M_l \vert M_l = \text{movement of body part}\} = \{\text{motion\_direction set}\}$

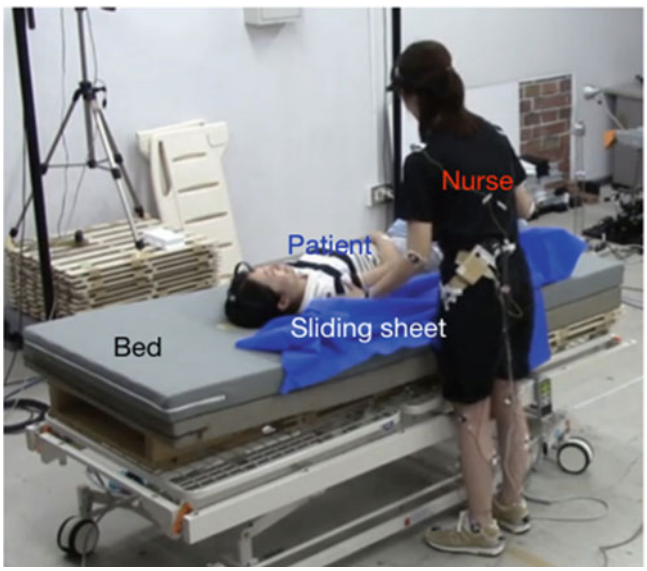

Fig. 6 Repositioning task

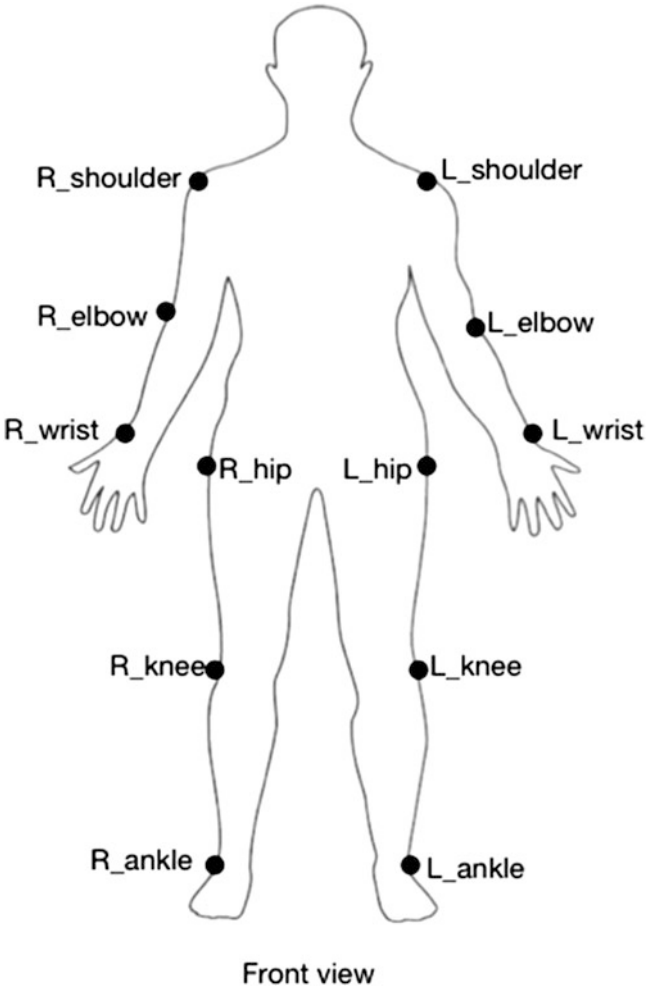

Fig. 7 Measured markers

Table 2 Activity descriptions

Repositioning	Description
Pulling	Arm left-backward sliding sheet, torso down-back, leg left
Pushing	Arm forward patient's leg, torso forward, leg natural

Nurse's activity was carried out around the bed region. The domain was built as shown in Fig. 6. In this task, the patient was laid on the bed with a sliding sheet (the blue material) to reduce the friction. The nurse repositioned the patient using the sliding sheet since the patient could not move by herself. In order to prevent tissue breakdown, the nurse should reposition the patient about every two hours. In this experiment, two expert nurses carried out the task with the same patient. In this task analysis, the goal is to detect how nurses make actions to the patient and environment.

As Fig. 7 illustrates, the 12 main joints of the body such as shoulder joints, elbow joints, wrist joints, hip joints, knee joints, and ankle joints are measured, labeled in R/L_position format. For example, the joint of the right shoulder was labeled R_shoulder. In the task, both the nurse and patient were measured in this way and these joints' 3D coordinates were measured to record the movements of nurse and the postures of patient.

4.2 Exemplar Tasks

In this paper, we concentrated on the exemplar activity nurse bed care task. The characteristics of the test actions are summarized in Table 2. The nurse action is depicted in

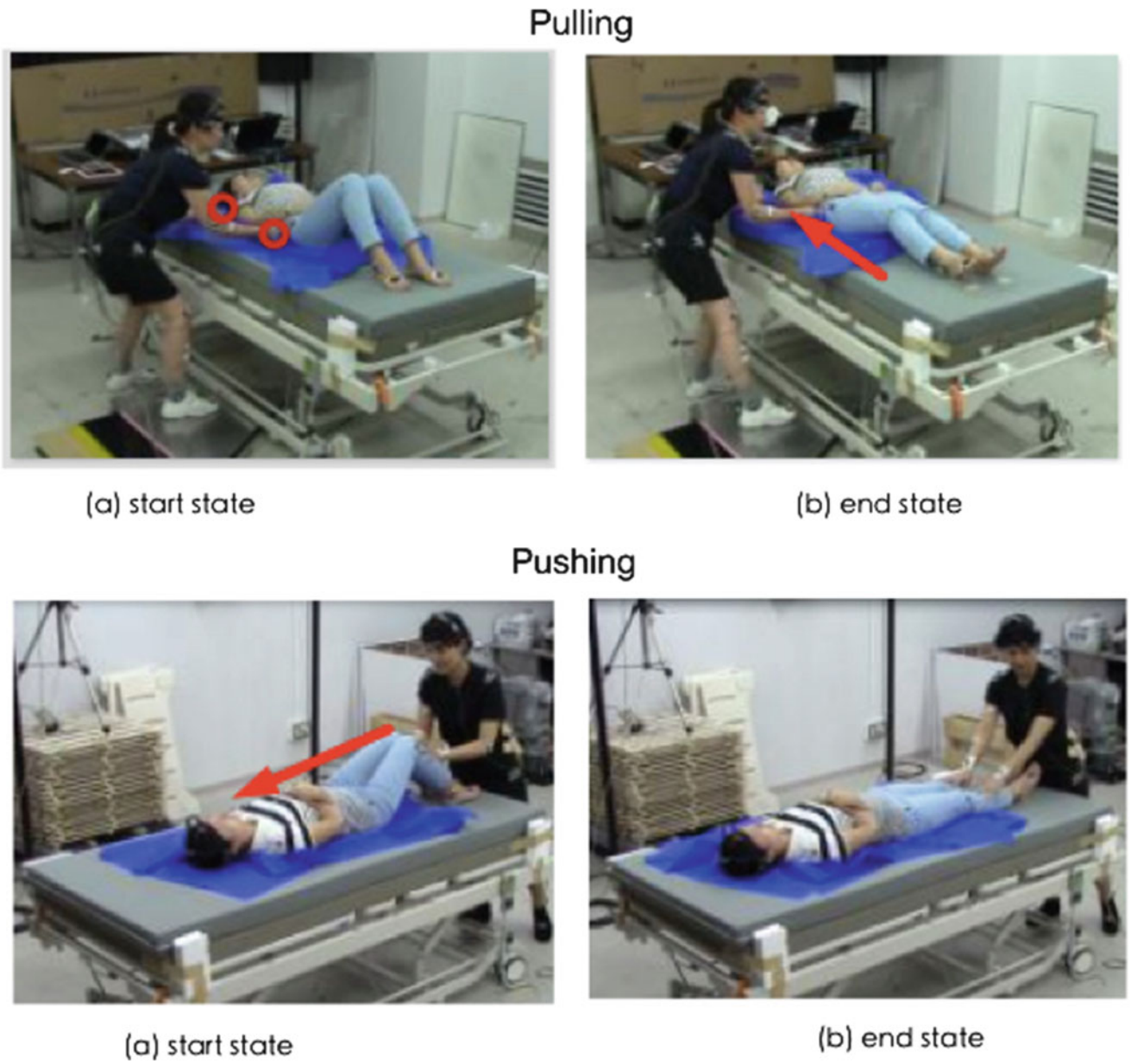

Fig. 8 Exemplar tasks

Fig. 8. In pulling repositioning, the nurse draws a sliding sheet to move up the patient. This motion mainly uses the nurse's body to reposition the patient. The arm motion mainly moves backward and left to accomplish the task; meanwhile, the torso and leg will coordinate with arm motion to make this activity. In the pushing motion, the nurse directly pushes the patient's leg to move up the patient. Accordingly, arm and torso motion will move forward and downward to give a force to move up the patient, while the legs are in almost no motion in this task.

5 Results

All the tasks were captured in motion capture system as we mentioned before. All the captured data had been post-processed in the software EVaRT 4.2 to denoise, smooth, and patch the missed data. After the post-process, the captured data can represent the fluent human motion. First, the body part motion was estimated using the proposed method to check the effectiveness of the method.

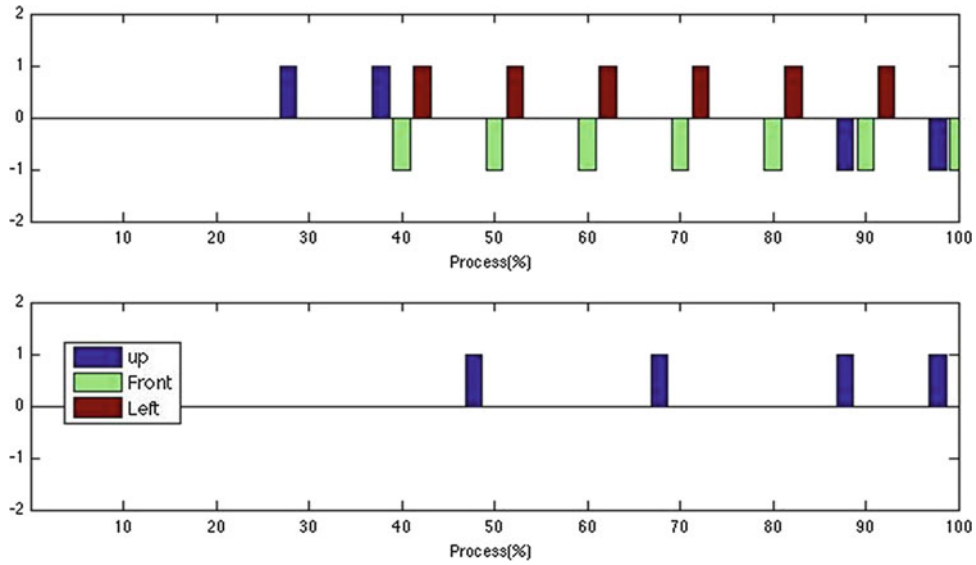

Fig. 9 Arm motion in pulling task

5.1 Body Part Gesture

For the nurse's left direction,

$$\begin{aligned} \mathbf{l} &= \frac{(LR\_\text{shoulder}\_x, LR\_\text{shoulder}\_y, 0)}{\|LR\_\text{shoulder}\_x, R\_\text{shoulder}\_y\|}, \\ LR\_\text{shoulder}\_x &= L\_\text{shoulder}\_x - R\_\text{shoulder}\_x, \\ LR\_\text{shoulder}\_y &= L\_\text{shoulder}\_y - R\_\text{shoulder}\_y \end{aligned} \tag{5}$$

$\mathbf{f} \perp \mathbf{l}$, and $\mathbf{u} = (1,0,0)$.

For the torso vector, the center of right shoulder and left shoulder will be the end of torso vector and the center of right hip and left hip will be the start of torso vector.

In Fig. 9, the top image indicates the left arm motion and the down image indicates the difference between left arm and right arm. There is no 2 or -2 difference, which means there are no opposite movement directions of two arms, thus having coordination to accomplish the task. According to our method, we choose the common movement direction as arm direction. The main movement direction for the arm motion is left-back direction.

As shown in Fig. 10, the solid line is the start posture of arm motion and the dotted line is the end posture of arm motion. This motion direction is mainly up, left, and back. Thus by our method, the rough movement direction is estimated. There are two reasons to choose movement direction to describe the motion. First, a human cannot produce identical motion for the second time even for the same person. Thus the direction can give a fuzzy description of the motion. Second, for a skill, a thousand people will have a thousand expressions. Meanwhile, to achieve a skill, movement direction is always the first step for us to learn the skill.

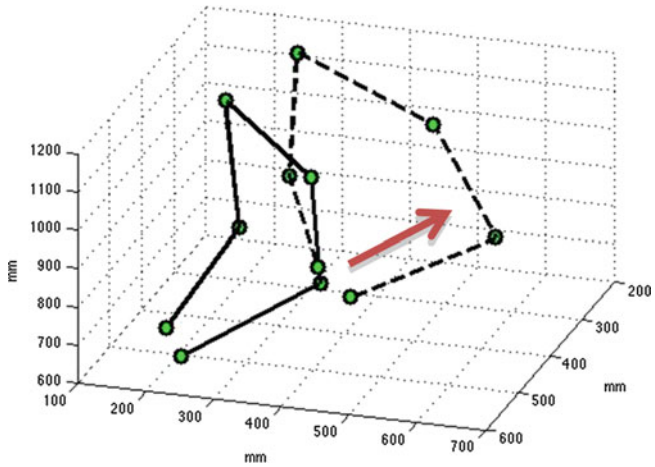

Fig. 10 Real arm motion

5.2 Action Target

In the pulling and pushing repositioning task, the patient's hip height was at constant value $h = 887$ mm. During the task process, the nurse's wrist height (wh) was compared to the h. For the patient's body parameters, the largest distance of two neighboring joints is 500 mm; therefore, we choose 250 mm region as the certain region of the wrist. If the $wh > h$ and there are joints in the 250 mm region, the interaction target will be the patient body part. As shown in Fig. 11, the blue lines (left wrist) or red lines (right wrist) represent the different values of $wh - h$. During the pulling

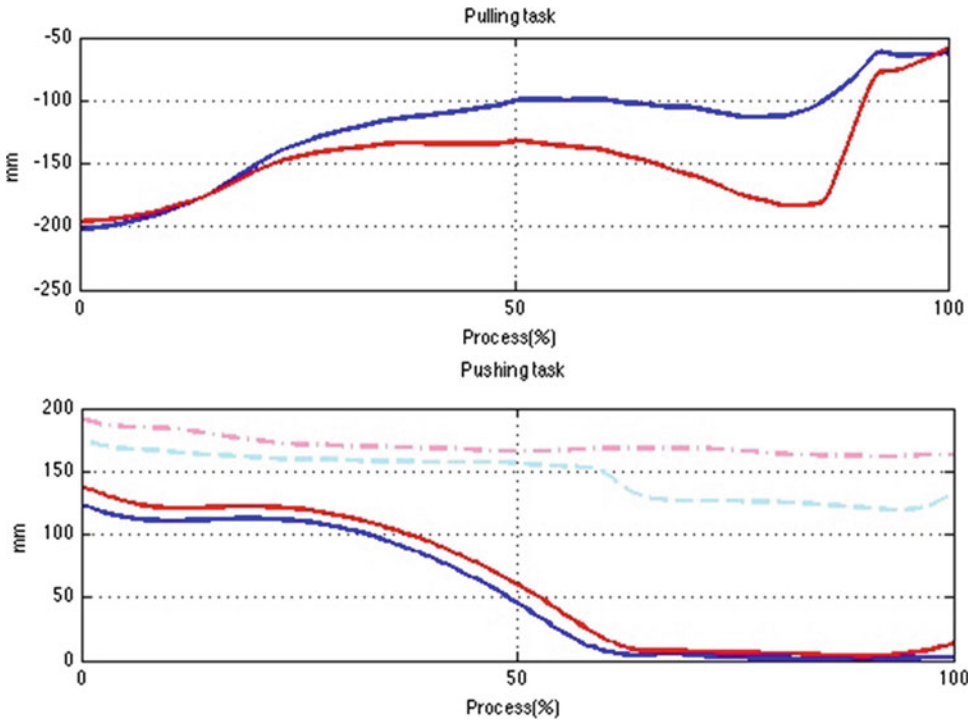

Fig. 11 Action target judgment

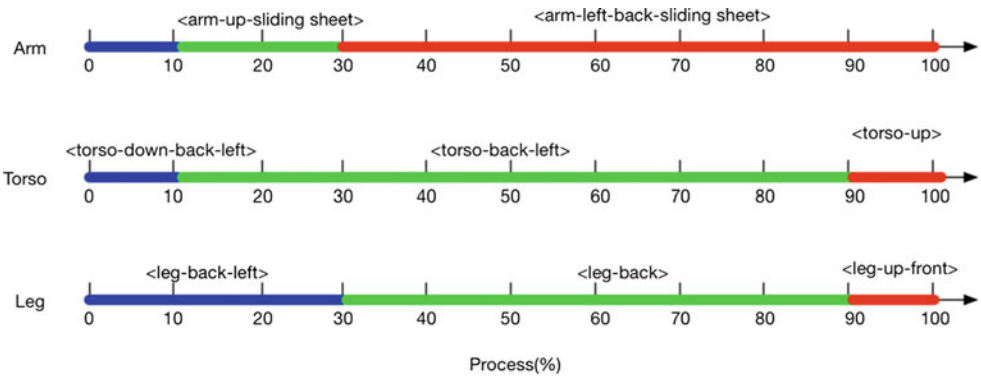

Fig. 12 Pulling task

task, *wh* is always lower than *h*, with the value being always negative. During the pushing task, *wh* is always higher than *h*, with the value being always positive. Furthermore joints in the wrist region are shown as light color dotted line. According to our judgment method, the pulling task target is the sliding sheet and the pushing task target is the patient, and we can also find the nearest joint to infer the body part.

5.3 Semantic Description

Low-level description can be efficiently summarized and represented by the operation triplets. And the interaction target can also be judged by the proposed method. All these body part descriptions and target determination can form a semantic description of the task. The semantic representation of bed care activity is shown in Figs. 12 and 13 for the pulling repositioning task and pushing repositioning task. The same color on the axis is the same description. No description means that there is no motion on this phase.

The semantic description is almost the same as we observe the motion that was described in Table 2. It means that the system can observe the movement direction similarly as real human tutor who can observe a trainee how the relations of body part motion. The results have some subtle differences as we described due to complicated human motion. This requires to improve the algorithm to improve the robustness and accuracy. Moreover, for a human motion, motion direction is only one of the features. An intelligent training system will have the ability to judge the coordination according to the body part semantic description, which we will also further focus on.

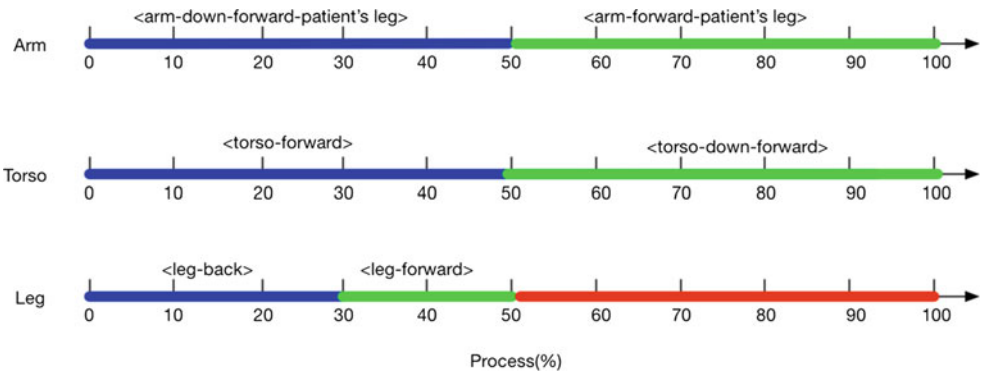

Fig. 13 Pushing task

6 Conclusion

In this paper, we have shown a framework for nurse bed care activity analysis. Our framework includes three aspects: nurse, patient, and environment. Therefore, the activity can be represented by the interaction between the nurse and patient or nurse and environment. This framework provides a more comprehensive way to understand the bed care activity for the intelligent training system. We also proposed the body vector method to determine the motion direction from human body's aspect, which defined a simplistic model for semantic analysis. However, for a multitask activity, task to task should be recognized. Meanwhile, this semantic understanding of the activity should be used for automatic evaluation and diagnosis in an intelligent training system. After the evaluation, the system will give specific diagnosis to the trainee including the errors, how to improve, and sometimes guidance when a trainee doesn't know what to do. Meanwhile, not only the motion in the skill but also power, velocity, acceleration, etc., in the effort domain are analyzed.

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References

1. Huang, Z., Nagata, A., Kanai-Pak, M., Maeda, J., Kitajima, Y., Nakamura, M., Aida, K., Kuwahara, N., Ogata, T., Ota, J., 2014, Self-Help Training System for Nursing Students to Learn Patient Transfer Skills. Learning Technologies, IEEE Transactions on 7, 319–332.
2. Stalmeijer, R.E., Dolmans, D.H.J.M., Wolfhagen, I.H.A.P., Scherpbier, A.J.J.A., 2009. Cognitive apprenticeship in clinical practice: can it stimulate learning in the opinion of students? Adv Health Sci Educ Theory Pract 14, 535–546.
3. Wu, P.H., Hwang, G.J., Su, L.H., Huang, Y.M., 2012. A Context-Aware Mobile Learning System for Supporting Cognitive Apprenticeships in Nursing Skills Training. Educational Technology & Society,15,1, 223–236.
4. Nakagawa, J., An, Q. Ishikawa, Y., Yanai, K., Wen, W., Yamakawa, H.,Yasuda, J., Yamashita, A., Asama, H., 2014, Extraction and Evaluation of Proficiency in Bed Care Motion for Education Service of Nursing Skill, ICserv, 064,1–6.
5. Aguirre, A., Lozano-Rodero, A., Matey, L.M., Villamane, M., Ferrero, B., 2014. A Novel Approach to Diagnosing Motor Skills. Learning Technologies, IEEE Transactions on 7, 304–318.
6. Nelson, A., Baptiste, A., 2004. Evidence-based practices for safe patient handling and movement. Online Journal of Issues in Nursing.
7. Park, S., Aggarwal, J.K., 2004. Semantic-level Understanding of Human Actions and Interactions using Event Hierarchy. Computer Vision and Pattern Recognition Workshops, 1–9.
8. Sarkar,A., and Tripasai, W., 2002, Learning verb argument structure from minimally annotated corpora. In proceeding of COLING, Taiwan.

An Evolving Service System in Microfinance: A Case Study in BRAC, Bangladesh

Md. Abul Kalam Siddike, Youji Kohda, and Monirul Hoque

Abstract

The prime objective of this paper is to propose an evolving service system for cocreation of value in microfinance. Close monitoring and the role of the customer service assistant (CSA) are the key components of this evolving service system. A semi-structured interview strategy was used to elucidate the evolving service system. We conducted 25 interviews with employees of BRAC's microfinance program, Bangladesh, and its borrowers. The results show that CSA particularly plays a key role in the evolving service system to provide higher financial literacy than before through their professional activities including pre-disbursement orientations and giving 4 days of training to borrowers.

Keywords

Microfinance services • Service system • Value cocreation

1 Introduction

Microfinance is a proven effective tool in alleviating poverty, particularly among populations living on less than a dollar a day [1]. Basically, microfinance is the issuance of small, collateral-free, and unsecured loans to individuals or groups for the purpose of starting or expanding business [2]. Globally, more than 3,500 institutions are meeting the demands of 205 million clients [3]. From the customer viewpoint, microfinance is a self-employment service [4–6]. On the other hand, for social enterprises, it is a business investment opportunity. As such, social enterprises need to generate profit for the continuation of their business.

Close monitoring is one of the main factors in the success of microfinance because microfinance is risky to both sides (servicer providers and customers). From the social enterprise side, they provide collateral-free loans to people who have dropped out of the regular financial service system. In addition, most people in poverty are illiterate and unfamiliar with financial transactions. Sometimes, people in poverty take out loans from multiple organizations. Therefore, it is very important for social enterprises to reduce the risk at the frontline. Frontline employees of social enterprises are those who are directly involved with the people they are trying to serve through the creation of self-employment opportunities.

The main objective of this paper is to propose an evolving service system in microfinance for cocreation of value. More specific objectives are to explore the current microfinance services of BRAC Bank, Bangladesh, to identify factors contributing to the success of microfinance services offered by BRAC, and to investigate how BRAC's frontline employees and its borrowers have been involved in the

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cocreation of value. To achieve these objectives, this study attempts to answer one major research question (MRQ) and three subsidiary research questions (SRQs):

MRQ: How have BRAC's frontline employees and its borrowers been involved in cocreation of value?
SRQ1: What are the current transactions of the microfinance services of BRAC?
SRQ2: What are the key innovations in the microfinance services of BRAC?
SRQ3: How have microfinance services been developed for borrowers?

The rest of the paper is organized in the following order: Sect. 2 is a review of literature on microfinance business models, cocreation in microfinance, and conceptualization of service systems in microfinance in the paradigm of service-dominant logic (SDL). Section 3 discusses the case organization and research methodology. Section 4 shows the results of the data analysis, and Sect. 5 proposes an evolving service system for cocreation of values in microfinance. Finally, we conclude with a brief summary and outline of future research directions in Sect. 6.

2 Literature Review

2.1 Microfinance Business Models

Microfinance offers several innovative solutions to the problems of adverse selection, moral hazard, and high transaction costs. Individual microloans are commonplace in certain countries, but across the world microfinance is known for popularizing "group-based" lending [2]. Most of the research literature we surveyed indicate that microfinance services are offered through "group-based lending" [2, 7, 8]. Several microfinance models or approaches have been developed in different countries and serve clients with diverse sociocultural backgrounds [9]. Associations, bank guarantees, community banking, cooperatives, credit unions, the Grameen model, group, individual, intermediaries, nongovernment organization, peer pressure, rotating savings and credit associations (ROSCAs), small business, and village banking are all models of microlending in the world [10]. Usually, social enterprises form groups consisting of 5–10 or 20–30 people that work as a platform for launching and offering microfinance services. Through this group-based lending, social enterprises ensure close monitoring for generating employment opportunities [6, 11].

2.2 Cocreation in Microfinances

Cocreation plays a central role as the base of the pyramid (BOP) market. It is considered to be the key to unlocking the opportunities in these markets [12]. For this reason, we reviewed the literature on cocreation in BOP markets and related to microfinance services. The review showed that cocreation in BOP markets is either of a business model or of a market through collaboration with companies from developed countries, local NGOs, and people in the community [12–16]. Cocreation is about joint creation of value by the company and the customer. It is not the firm trying to please the customer [12]. Interactions play an important role in cocreation of value. Dialogue, access, risk-benefits, and transparency (DART) are emerging as a basis for interaction between the consumer and the firm. Dahan et al. [14] broadened the business model concept to incorporate cross-sector collaborations and argued that such partnerships can create and deliver both social and economic value, which can be mutually reinforcing. In addition, Yunus et al. [15] proposed a social business model incorporating experience gained in the Grameen Foundation. They showed the evolution of Grameen's expertise in formulating social business models including new value proposition, value constellations, and profit equations. Furthermore, Simanis and Hart [13] developed the BOP protocol that seeks to develop a new business process that enables partnerships with BOP communities for codeveloping sustainable, economically viable businesses that serve the communities' needs and aspirations. The process begins with the selection of appropriate BOP project sites, the formation and training of a multidisciplinary corporate field team, and the selection of a local community partner. Finally, Ashta [16] showed how venture capital firms can use the concept of cocreation to create a multipronged attack on poverty while maintaining a profit motive. She also showed how different organizations have invested to serve the poor people through microfinance.

2.3 Service System Perspective

A service ecosystem is a relatively self-contained, self-adjusting system of resource-integrating actors that are connected by shared institutional logic and mutual value creation through service exchange [17]. Four elements help define a service ecosystem: it is a (1) relatively self-contained, (2) self-adjusting system of resource-integrating actors incorporating (3) shared institutional logic and (4) mutual value creation through service exchange. Service ecosystems should not be viewed as one-dimensional or flat,

micro-level structures of interacting and service-exchanging actors. Rather, they are multilevel in nature. From the micro system, a meso system emerges and from the meso system a macro system emerges. In turn, the macro system filters its way down to meso and micro systems and influences the actors in these systems. All of this occurs over a time and geographic scale that will vary depending on the context and circumstances. Moreover, it occurs in a sea of change, making all of the systems inherently dynamic. Service ecosystems begin with actor-to-actor (A2A) interactions and service exchange or what comprises the micro level of the service system. At this micro level, small numbers of actors interact with one another. The A2A interactions and service exchanges accumulate and result in emergent structures at the meso level.

For instance, emerging out of A2A service exchange at the micro level can be a set of actors that provide services as market makers such as brokers and wholesalers or service rights intermediaries such as bankers and financial institutions or arbiters of disputes such as lawyers and judges. Also emergent may be a common place where the interactions and service exchange occur. These can be central cities or markets, districts within cities, bazaars, or trade fairs. In the case of microfinance, program organizers, branch managers, customer service assistants (CSA), microfinance institutions themselves, and stakeholders of microfinance services can all be seen at the micro level. In addition, different interactions occur through village organizations and direct interactions between microfinance service providers and recipients. At this level, providers as well as customers receive different kinds of training to enhance their qualities and capacities. Interestingly, the role of the CSA is very important in this phase for providing financial literacy through pre-disbursement orientations and training to make their customers more aware of their services. In addition, customers get a variety of hands-on training to build up their capacity. Furthermore, customers get health checkup services. Finally, the branch offices of microfinance institutions are where the credit and other services are exchanged.

The meso level system involves a diverse set of actors organized around a particular approach to solve problems. In the case of microfinance institutions, the name of the organization is treated as a brand label. In some cases, the product or service itself is used as a brand name. In microfinance services, there are different kinds of exchange, including microloans, training, and other self-development services.

The meso level system in turn – as it functions over time – creates yet higher level emergent structures, referred to as the macro system. The macro-level system is much more rigid, more stabilizing, and less subject to fluctuation. Stated alternatively, it self-adjusts but very slowly. Some of the features that characterize the macro structure are common knowledge, long-standing and durable institutions, and rules for how the actors at the micro level and macro level assemble into communities. In this service system, the micro helps to create the meso and the meso the macro, but once the macro arises, it has a downward influence on the meso and micro levels. If we think about microfinance services, it soon becomes clear that different cultures, languages, and religions play important roles in constructing this level of the service system. Table 1 shows the different relationship layers in a microfinance service ecosystem.

Table 1 Different relationship layers in a microfinance service ecosystem

Levels	Relationship	Service exchange	Microfinance cases
Macro level	Shared superordinate institutions	Religion	Most of them are Muslim (Bangladeshi culture) and Hindu
		Culture	Bangladeshi local cultures (different regions have different cultures)
		Polity	Bangladesh (it is based on the country)
Meso level	Shared institutions	Brands	Organization's name use as a brand. In some cases, product or service itself is a brand
		Norms of exchange	There are different kinds of exchanges including loans, trainings, and other services exchanged
Micro level	Value cocreation	Resource integration	Employees, customers, community members, and governments work together and use donors' knowledge and experience to offer microfinance services
		Repeat patronage	Microfinance institutions offer services
			CSA provides financial education through pre-disbursement orientation and 4 days of training
			Livestock rearing, sewing, and other kinds of training
			Health services including general health checkups, specific blood pressure and tuberculosis (TB) checkups, and other social services
	Reciprocal exchange	Service for service	Program organizer, branch manager, and customer service assistant interact with borrowers and prospective borrowers
			Capacity enhancement services are provided for self-development

3 Research Methodology and Case Organization

3.1 Research Design

A qualitative case study is an appropriate approach, given the need to develop an in-depth understanding of a relatively unexplored area [18]. Case studies are well suited to creating theoretical constructs, propositions, and/or midrange theories [19]. In this study, we were inclined toward the descriptive approach. Here, some scholars view qualitative case-study research as highly descriptive and stress the social construction of reality [20]. Therefore, a qualitative case study used as a research methodology tends to take an inductive approach rather than a deductive one of testing hypotheses or theories.

3.2 Case Organization

The study was conducted in BRAC, Bangladesh, one of the most successful nongovernment organizations (NGOs) in the world. BRAC is a development organization dedicated to alleviating poverty by empowering the poor and helping them to bring about positive changes in their lives by creating opportunities for them. BRAC began in 1972 in Bangladesh, and over the course of its operations, it has recognized and tackled the many different realities of poverty. BRAC believes that there is no single cause of poverty; hence, it fights poverty on multiple fronts. Its services are now offered in 11 countries, including Afghanistan, Pakistan, Philippines, Sri Lanka, Myanmar, Liberia, Sierra Leone, South Sudan, Tanzania, Uganda, and Haiti. BRAC provides a number of services, including microfinance, health, education, agricultural, legal aid, safe drinking water and sanitary latrines, livelihood training, support for safe migration, and assistance during natural disasters [21]. This research only focuses on BRAC's microfinance services, which started in 1974 and have since become one of the world's largest providers of financial services for the poor. Microfinance services are seen as part of BRAC's broader, holistic approach to development, by helping to build livelihoods, boost consumption, and improve access to a range of social services. All microfinance clients have access to BRAC's other programs in education, healthcare, and legal aid. BRAC currently operates microfinance programs in Bangladesh, Pakistan, Sierra Leone, Uganda, Liberia, Tanzania, and Myanmar. In 2013, these programs disbursed USD 1.5 billion to 4.2 million borrowers [21].

BRAC's microfinance has two basic products: loans and savings. There are three types of loan: Dabi, Progoti, and migration. **Dabi**, a loan package exclusively for women who are part of village organizations (VOs), is for small enterprise ventures such as rearing poultry and livestock, growing vegetables, and making handicrafts. Loans range from USD 100 to 1,000, with an average size of USD 275. In 2013, USD 810 million was distributed in loans among 4 million borrowers. **Progoti** loans are intended for micro and small entrepreneurs, whose shops, agricultural business, or manufacturing activities that do not qualify for credit from commercial banks. Basically, this loan is for small enterprise development. Given to both men and women, the loans range from USD 1,000 to 10,000, with an average size of USD 2,200. In 2013, a total of USD 668 million was distributed in Progoti loans among 300,000 borrowers. **Migration loans** are provided to migrants to finance their outgoing costs and the immediate needs of their household after their departure. Loans range from USD 600 to 4,000, with an average size of USD 2,300. In 2013, USD 82 million was distributed in loans to 40,000 borrowers. The Dabi program was selected as the research target. This program is a suitable case for several reasons. Firstly, only the women who are members of a VO can receive the loans. Secondly, only clients of Dabi get financial training. Thirdly, 92 % of borrowers are from the Dabi program and they get 52 % of the loans. Finally, the clients of the Dabi program also receive different kinds of social development training so that they can become more aware of means for developing themselves [21].

3.3 Data Collection

The research was carried out by interview. An interview is a process in which a researcher and participant engage in a conversation focused on questions related to a research study [22]. The main purpose of the interviews with providers (BRAC's employees) and customers (clients or borrowers) was to investigate the value cocreation process in microfinance services in Bangladesh in order to develop an evolving service system. The interviews were conducted using a semi-structured interview protocol. In this regard, two sets of interview protocols were used. One set was for providers (BRAC's microfinance employees), and the other set was for the clients of BRAC's microfinance. To get access to the microfinance program, an e-mail was sent to the director on 15 November 2014. One week later, the director assembled a small research team, and they sent an e-mail inviting us to send them our research proposal, permission letter from JAIST, and visit plan. After that, all the necessary documents were submitted to the research team. After reviewing those documents, they invited us to visit BRAC on the 14th of December 2014 for meetings on the final plan. After having a fruitful discussion with the team, they finalized the case-study areas and interviews based on the research objectives and interview protocols. We started

interviewing on the 17th of December 2014 and finished with a short presentation to BRAC's head office on the 6th of January, 2015.

3.4 Interview Participants

A total of 25 interviews were conducted with 11 employees of the BRAC microfinance program, including a senior manager, senior regional manager, area manager, senior branch manager, branch manager and program organizer, and 14 borrowers of the Dabi program. The employees were selected after a discussion with the research team. The team selected the interviewees on the basis of the research objectives and interview protocols. In particular, it selected two persons from the head office and nine persons from seven branches of BRAC. The 14 borrowers were from 7 branches of BRAC. They were randomly selected after a discussion with the managers of the respective branches. As Eisenhardt and Graebner [19] mention, interviews should be countered with highly knowledgeable informants. In addition, we participated in one VO meeting in the Darshana branch, Rangpur, for the purpose of observing their activities. We also observed pre-disbursement orientations in the Gabtoli branch, Nandigram branch, and Kaligonj branch in order to gain an understanding of their financial education system. An e-mail invitation was sent by the coordinator of the research project of BRAC's microfinance program to the regional managers (RMs) of the selected areas. After that, face-to-face interviews were conducted from December 17, 2014 to December 29, 2014 using semi-structured interview protocols. The interviews ran for an average 50 min and were audio and video recorded using a Sony recorder and iPhone 5. All the interviews were conducted by the corresponding author at the respective BRAC branch offices. In addition, for the customers' (borrowers) interviews, 14 borrowers were selected randomly after discussions with the respective branch managers. In this regard, we interviewed two borrowers from each branch. The borrowers' interviews also recorded by using Sony recorder and iPhone 5. The interviews ran for 25–30 min on average and were conducted by the corresponding author with the help of the respective branch manager. To ensure the standards of "human subject research," we obtained consent from the interviewees using a consent form.

3.5 Data Analysis

All the interview data were analyzed through a detailed systematic examination and interpretation using content analysis [23]. Thematic analysis was conducted for the data cross cases, and coding was used as the basic analytic strategy. Thematic analysis is a search for themes that emerge as important to the description of the phenomenon [24]. The process involves the identification of themes through "careful reading and re-reading of the data," where emerging themes become the categories for analysis. According to Lapadat [25], thematic analysis is widely used for its power of yielding insightful interpretations. The data analysis was done in several steps. First, we converted the recorded interviews into an Excel spreadsheet by listening again and again and verifying the content of the recorded interviews several times to ensure that no important information was missed. Second, we read the textual data again and again to understand the themes within the data. Here, we also printed out the data and read it. Third, we generated the key concepts for the categories. Corbin and Strauss [26] identified three kinds of coding, i.e., open coding, axial coding, and selective coding. Open coding includes an initial pass through the data to come up with candidate concepts for categories. Axial coding includes combining categories into major categories (axial coding). Selective coding is the core categories. Fourth, we combined the key categories into major categories (broad categories) and generated the core categories after a thorough scanning of the major categories. To ensure anonymity, P1, P2 . . . P11 codes were used for the employees of BRAC and C1, C2 . . .. C14 codes were used for the borrowers of BRAC.

4 Results of the Data Analysis

4.1 Microfinance Services

The results reveal that BRAC follows an unique "credit plus" approach to address the special needs of various target populations such as rural women, youth and adolescents, landless poor, marginal farmers, migrant workers, and small entrepreneurs. Figure 1 shows the microfinance services provided by BRAC. First, its microfinance program provides two types of service: financial and social. The findings show that there are three types of financial service: loans, savings, and insurance. Loan services include general loans for women, medical loans, good loans, and agricultural loans to eradicate poverty. BRAC provides proper financial security through savings which enable families to plan better, absorb shocks, and get out of poverty. Moreover, the results indicate that there are two types of saving services: mandatory passbook savings and deposit services. Passbook savings are integrated with borrowing loans, and monthly deposits, usually around $3, can be removed at any time. Poor people typically do not have the habit of saving. Therefore, BRAC mandatorily enforces savings. There are different

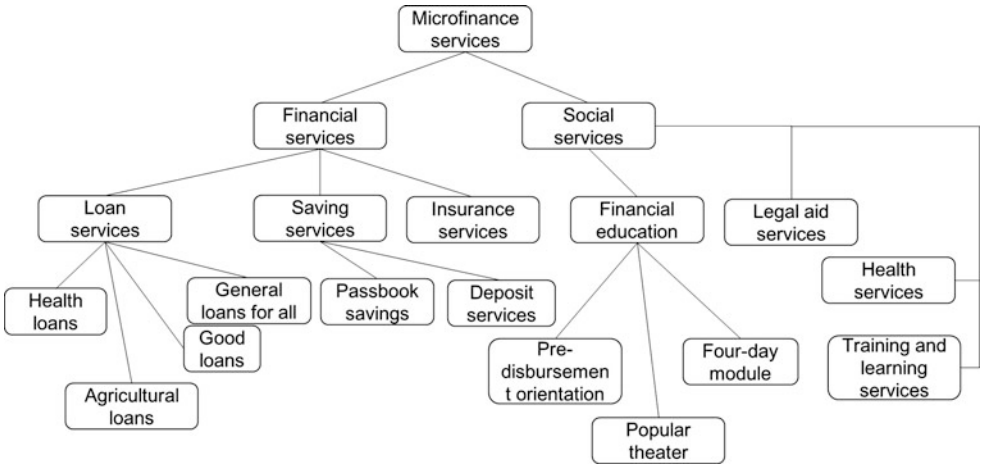

Fig. 1 Microfinance services

types of deposit services, including a monthly deposit scheme and monthly profit scheme. Our results show that deposit schemes are open to all people in the society, not just members. Anyone can participate in the deposit scheme. In addition, our results reveal that BRAC provides insurance services (without any premium) to VO members, which include giving 5,000 taka (TK) to the family in case of the death of a member (or husband) to cover funeral expenses and contribute (cut off 20,000 TK from the remaining outstanding loan after the adjustment with to member's saving balance) to repayment of remaining liabilities.

The results show that BRAC provides a range of social services, including awareness building services, learning services, financial literacy, health services, and legal aid services. BRAC provides awareness building services through their unique platforms like the VO and the customer service department. In this case, the program organizers (POs) and branch manager (BMs) disseminate messages related to dowries, child marriage, and health-related problems through VO meetings. In addition, the clients of the microfinance program as well as general customers receive legal aid services through BRAC's human rights and legal aid services program. Furthermore, our results reveal that besides health loans, the clients of the microfinance program as well as the people of the community receive a variety of health services through the health, nutrition, and population (HNP) program. Clients get checkups during pregnancy by BRAC's nurses (Shasto Sebika). In addition, clients get cough examinations to determine whether they have tuberculosis or not. Moreover, clients get blood pressure checkups and care for children with diseases. Interestingly, clients also receive sanitary latrine facilities under BRAC's water, sanitation, and hygiene (WASH) program. Finally, our results show that clients receive different kinds of training to improve their capacity.

4.2 Current Innovations in BRAC's Microfinance

The interview results show that BRAC innovates new resources and services to create more benefits for itself as well as for its clients to reduce poverty sustainably. Micro-insurance, the pictorial passbook for maintaining transparency, and CSAs for providing financial literacy are three key current innovations in the microfinance services. BRAC has introduced CSAs at more than 900 branches to provide higher financial literacy than before to borrowers through their professional activities, such as a pre-disbursement orientation and a 4-day training module. Our results reveal that every member needs to attend a 30 min pre-disbursement orientation session just before the loan is disbursed and CSAs provide financial literacy using pictorial materials and entertainment-education through the telling of local stories and visual humor. Through this orientation, clients develop basic financial literacy. In addition, our results show that BRAC targets "at risk" women who lack financial awareness and are unaware of how to make the right decision in its 4 days of training. The first day, clients come to know what kinds of problems occur because of greediness and how to identify safe and unsafe institutions. The second day focuses on financial planning. The third day covers the risks of taking out too many loans and discrimination in loan counting. The final day reviews the previous 3 days' discussions, clients' rights, and the grievance redress mechanism. One customer shared her experiences as follows: "I came to know through educational training about not to take out loans from multiple organizations, to make installments in a timely manner, and not to hand over the passbook to others. Through this training, I became more aware" (C1).

The findings of the study show that the pictorial passbook is a new innovation of BRAC's microfinance program. Sometimes, it is difficult for illiterate clients to read the dates and amounts of installments and the signatures of the

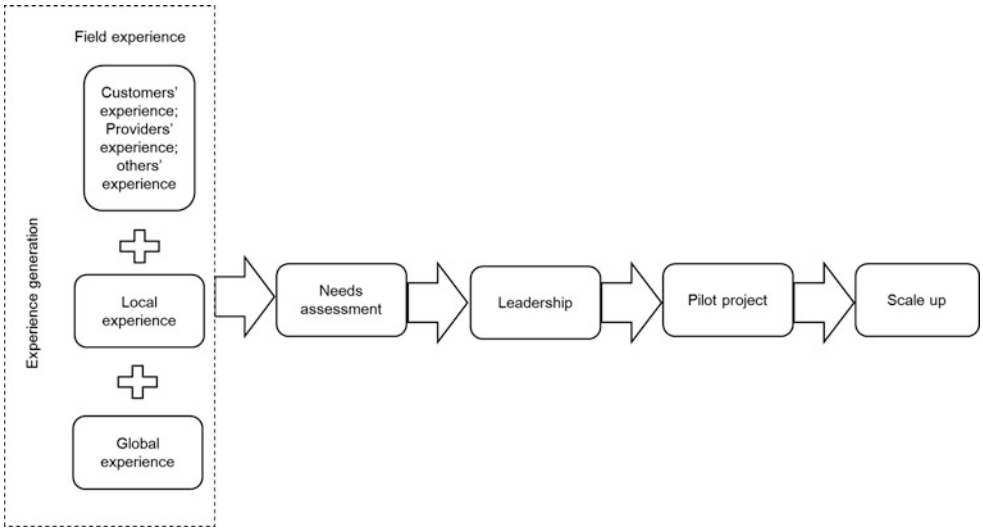

Fig. 2 Service innovation process

respective POs who collected the installments. The pictorial passbook was developed at the clients' behest. One senior manager stated that: "Almost 57 percent of our borrowers cannot read or write. We needed to do something for this huge proportion of borrowers. When we were piloting our financial education project, our clients often complained that they could not read or write. They couldn't identify the amount of money deposited, the date installments were made, or the name of the person who took their installments. At that time, we consulted with an expert from outside. After the consultation, we decided to develop the pictorial passbook for our clients" (P2).

The interview results reveal that micro-insurance is the latest innovative service of BRAC's microfinance program. It is credit insurance to secure the loan. It is based on the loan, and it has to be paid within the loan period. Microfinance is not risk-free; to make loans more secure, BRAC introduced this service called "credit shield" and is currently conducting a pilot study at one or two branches. One senior regional manager said that "we provide a credit shield to our borrowers. If a member dies during the loan period, his or her whole loan will be withdrawn and whatever money he or she paid will be returned" (P1).

4.3 Service Innovation Process

The interview results show that the service innovation (SI) process of microfinance is also unique. First of all, for innovating and developing new services, BRAC's microfinance program focuses on experience generation including field experience, local experience, and global experience. Second, it performs assessments through baseline surveys, observations, and interactive focus group sessions. Leadership plays an important role in making any new innovation a reality. New innovations are piloted before being scaled up. Figure 2 shows the SI process in microfinance services.

4.3.1 Experience Generation

The analysis of the interviews shows that BRAC focuses on gaining experience from multiple sources, including field experience, local experience, and global experience. In the field, BRAC collects ideas from its valued borrowers as well as its valued employees. In addition, it collects ideas from community members. Furthermore, BRAC has long experience working in local Bangladeshi communities. Finally, BRAC synthesizes global experience through its social innovation lab and other sources.

The results show that most service providers are based in the field and spend their days with their valuable customers. Regarding field experience, BRAC's microfinance program generates ideas or gains experience from its valuable customers and skilled employees as well as from the community (anyone in society). One senior manager stated that "Most of BRAC's microfinance innovations come from recognizing our clients' needs. Actually, our clients' needs are expressed in the VO, and our POs understand what their needs will be. Then our managers hear the clients' needs from the POs and managers transfer this information to the areas, from areas it goes to regions, and eventually, the clients' demands or experiences reach the senior leaders (head office)" (P2).

Customers' idea/experience generation: The analysis shows that BRAC designs services based on the requirements and demands of its valuable customers. Service providers try to generate ideas from customers in different ways and customers share their complaints and requests with the POs and BMs. Each and every client spontaneously shares demands, complaints, and ideas with

the POs and BMs. In addition, they also share their ideas with their relatives and neighbors about the financial dealings of BRAC and the behaviors of its employees. One customer stated that "I am a school teacher. I tell my colleagues about BRAC and its different services. In addition, I tell my head mistress that BRAC can provide us with different kinds of loans including health loans and good loans with other social services" (C7).

Employees' idea generation: The results of interview indicate that the microfinance program tries to generate ideas from their employees internally. As the program has very strong human resources from the field level to top level, there is a strong monitoring and evaluation regime from low level (PO) to top level (RM). For example, each PO is monitored by a BM, each BM is monitored by an AM and RM, the AM is monitored by the RM, and the RM is also monitored by leadership in the head office. One senior regional manager stated that "our BMs and POs visit VOs regularly and get ideas from our borrowers and other people in society. They present these ideas in the monthly forum meetings. Every quarter, we have a meeting with the RMs, and all the ideas and logic regarding them are presented to the board of directors" (P1).

Through this bottom up process, the head office can incorporate their employees' ideas and experiences when designing new products and services. One senior manager shared a new product or service innovation experience:

> *The pictorial passbook is an innovation based on our clients' needs. When we were doing our pilot project on financial education, we were making our clients aware that you must check the financial calculations of whom you are dealing, especially whether how much you pay back is written there or not. At that time, some clients asked us how they could check as they didn't have the level of education. After that, we hired consultants who gave us the idea of making the pictorial passbook. The passbook enables clients to easily understand where the amount of the loan is printed, where the date is, where the person's signature is and so on. The pictorial passbook is now running as a pilot project. It's an innovation brought about by our learning from our clients* (P2).

4.3.2 Needs Assessment

The interview results show that a needs assessment is another important step of SI in microfinance. After gathering ideas and experiences from different sources, the BRAC microfinance program performs needs assessments through baseline surveys, observations, focus group discussions, and interviews. One senior manager indicated that "We did a needs assessment through a baseline survey on financial education, and we determined whether we needed to work on it or not" (P2).

4.3.3 Leadership

BRAC believes in creating good leadership qualities in their employees. After getting ideas from different sources, decisions as to piloting and scaling up any ideas depends on the leadership. In this regard, all decisions are based on the needs assessment survey (baseline survey). One senior manager said that "The baseline survey helps policy makers to make policy. In addition, leadership decisions are based on it" (P2).

4.3.4 Pilot Project

The results show that after leadership makes a decision, a pilot project incorporating this decision is conducted. In this connection, one senior manager indicated that "Before scaling up any new products or services, we do a pilot study" (P1).

4.3.5 Scaling Up

When BRAC's leadership team observes that any project is changing quality and quantity of the lives of the rural people, then they scale it up. One senior manager expressed that "Our financial education program was piloted in 2012 and we scaled it up afterwards" (P1).

4.4 Value Cocreation Process in Microfinance

The results of this study show that BRAC's frontline employees, including the PO, are mainly responsible for communicating with the members of the VO as well as prospective customers. The BM also communicates with members of the VO for verification purposes as well as to identify prospective new borrowers. In addition, the results reveal that BRAC recently introduced the role of the customer service assistant (CSA) in their customer service department for providing customized information and support to all clients as well as those who come to branches for any sort of support. Furthermore, the results show that the pictorial passbook is another new innovation. Finally, they show that the numbers of customers are increasing exponentially.

By examining the factors identified in our analysis, we devised a value cocreation process model for microfinance services (Fig. 3). There are mainly three stakeholders in this value cocreation process model: the PO/BM, CSA, and customers. Direct interactions with consumers and their communities are critical in the cocreation process [12]. The results show that frontline employees have direct interactions with customers (borrowers) through the VO. Most of the customers stated to the effect "service

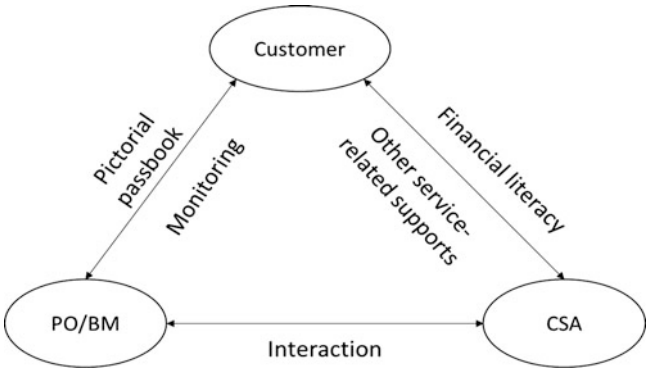

Fig. 3 Value cocreation process in BRAC's microfinance

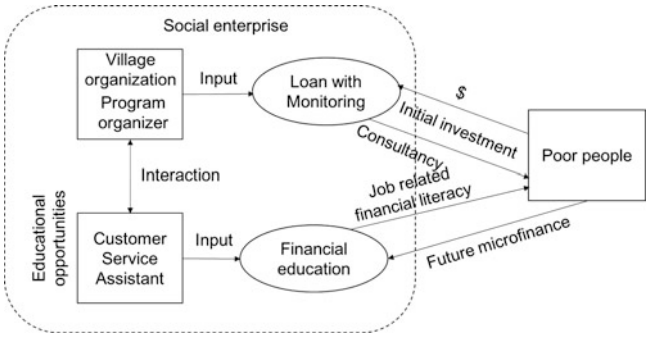

Fig. 4 Evolving service system for cocreation of value

providers (POs or BMs) directly come to VO meetings and interact with us there" (C1–C14). Every service is offered at the VO. In this regard, one branch manager stated that "we communicate with our borrowers by going to the VO" (P6). In addition, customers can directly interact with service providers by visiting the branch. One customer said that "if I need any service urgently, I go to the office and contact the branch manager" (C5). Furthermore, for any urgent reason, service providers can directly contact the respective customer by visiting her home. In this regard, one branch manager stated that "I personally meet with customers regularly" (P8).

The findings of this research show that the service provider and customer also interact over mobile phones. Every passbook contains the mobile phone number of the respective PO and the PO also has the mobile numbers of every customer of that particular VO. One branch manager stated that "The PO has the mobile number of every customer, and he or she can phone them directly" (P3). In the same way, one customer expressed that "I can contact the BM or PO on my mobile phone as I have their numbers" (C4). For monitoring the services, the pictorial passbook plays an important role between customers and the PO.

5 Evolving Service System in Microfinance for Cocreation of Values

This study illustrates an evolving services system model for cocreation of value in microfinance services that is unique in nature; no previous research has developed any service system for the cocreation of value [12–16]. Most of the earlier cocreation models were either codevelopment of new business models or cocreation of new products or services in collaboration with corporations and NGOs. Based on the major findings and the literature review, we developed a theoretical model of an evolving service system for cocreation of value that is valid for microfinance institutions all over the world. Figure 4 shows the theoretical model that was devised on the basis of the results of this research.

The service system model has two main components. The first component is very well known; social enterprises provide financial services to people in poverty through close monitoring so that they can have the initial capital for investing in their household business. In addition, social enterprises offer consultancy services through well-established platforms like the village organization (VO) for developing the capacity and skills of the people. In this way, social enterprises are expanding their customer base exponentially. On the other hand, frontline employees are not increasing in the same proportion, considering cost-effectiveness. The findings of this research show that social enterprises face challenges in innovating new resources and services for the organization's benefit as well as for the customers' benefit. Therefore, the second component of this service system is job-related financial literacy through introduction of the new role of the CSA. Furthermore, social enterprises can develop new resources like the pictorial passbook and micro-insurance which help to reduce their own risks. These also help to build the capacity of people in poverty and increase self-employment opportunities. In this service system, frontline employees (PO or BM) also interact with the CSA for providing better services. Finally, social enterprises cocreate value through direct interaction between different stakeholders (CSA, PO, BM, and people in poverty).

5.1 Lending and Monitoring

Social enterprises usually provide financial services to people in poverty. But most people in poverty are not well educated, and many cannot read or write. As a result, disbursing huge collateral-free loans to them is very risky. To reduce the risk to their business, social enterprises need a well-developed monitoring system for closely monitoring of people in poverty. In addition, social enterprises should provide consultancy services through their unique platforms

(e.g., the VO) for enhancing the capacity of people in poverty. In these ways social enterprises can sustain their business.

5.2 Educational Opportunities

Social enterprises provide additional educational materials for developing different skills, including leadership, literacy, and computer skills, for poor people in order to create employment opportunities [27]. In this service system, social enterprises provide financial education through the role of the CSA. The CSA is responsible for providing financial literacy through pre-disbursement orientations and 4-day training sessions. In addition, the pictorial passbook plays an important role in maintaining the transparency of each and every transaction of financial services in a social enterprise.

5.3 Employment Opportunities

Additional educational opportunities create employment opportunities for rural people in developing countries [27]. Through their service system, social enterprises provide education and training for creating self-employment opportunities. Lending and monitoring help the people to invest in their household businesses, and financial education as well as training and consultancy help them to enhance their capacity and skills that ultimately increase their self-employed hours. Through these concerted efforts, social enterprises cocreate unique financial and social value for the sustainable alleviation of poverty.

6 Conclusion and Future Research Directions

Social enterprises are still evolving by focusing on different levels of customers. Here, the service system has evolved through the introduction of the new role of the customer service assistant (CSA) for providing financial education through a pre-disbursement orientation and a 4-day training program. Social enterprises are innovating new resources and services to meet the demands of diverse customers. This research focused on how "financial literacy" is promoted for creating awareness among customers to eradicate poverty sustainably. This research show that global microfinance institutions would benefit by promoting "financial literacy" to meet the challenges in microfinance services and reduce the "risk" of providing such services to poor and illiterate clients. Global microfinance institutions can replicate the same "financial literacy" education model or modify it in the perspective of the local culture.

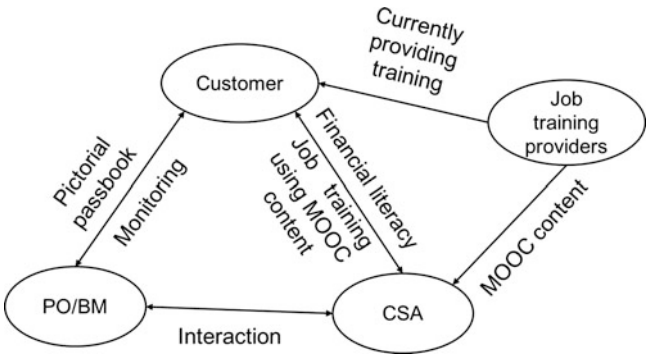

Fig. 5 Proposed model for immersion of job training with CSA through rMOOCs

The broad objective of microfinance is to create self-employment opportunities through boosting the skills and capacity of poor people. This research highlighted the role of the CSA for providing financial education to poor people. But we assume that financial education only is not enough to boost the skills and capacity of poor people. That is, social enterprises should provide a variety of training aimed at enhancing skills and capacity. Providing training independently is costly for social enterprises. Therefore, we assume to merge the training with the customer service department. In this regard, the CSA can provide job training. Job training is more complex than financial education and could prove to be very challenging for CSAs. E-learning tools offered by the CSA like rMOOCs (redefined massive open online courses) could help to provide job training to people in poverty. Figure 5 shows a tentative model for providing job training through the CSA with the help of rMOOCs.

Usually massive open online courses (MOOCs) are developed by higher educational institutions of developed countries. But in this regard, social enterprises could use it as a business tool. Most CSAs are well educated and are able to use e-learning tools. Therefore, the re-definition of MOOCs is necessary. As such, we re-define MOOCs as "use of MOOCs platforms for providing job training to customers through the assistance of the CSA." Here, CSA will play an intermediary role of collecting and sharing feedback from customers. Finally, we believe that the incorporation of job training with the CSA through rMOOCs will not only be cost-effective for social enterprises but also provide job training with entertainment facilities.

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References

1. Abed, F. H., 2005, Microfinance interventions to enable the poorest to improve their asset base, In J. von Braun, R. Vargas Hill & R. Pandya-Lorach (Eds.), The Poorest and Hungry: Assessment, Analyses, and Actions, International Food Policy Research Institute, Washington DC.
2. Khavul, S., 2010, Microfinance: creating opportunities for the poor? Academy of Management Perspective, 54(3): 57–71.
3. Maes, J. P. and Reed, L. R., 2012, State of the Microcredit Summit Campaign Report 2012, Microcredit Summit Campaign, Washington DC.
4. McKernan, S. M., 2002, The impact of microcredit programs on self-employment profits: do non-credit program aspects matter? The Review of Economics and Statistics, 84(1): 93–115.
5. Al-Mamun, A., Wahab, S. A. and Malarvizhi, C. A., 2011, Examining the effect of microcredit on employment in Peninsular Malaysia, Journal of Sustainable Development, 4(2): 174–183.
6. Jia, X., Xiang, C. and Huang, J., 2013, Microfinance, self-employment and entrepreneurs in less developed areas of rural China, China Economic Review, 27: 94–103.
7. Morduch, J., 1999, The microfinance promise, Journal of Economic Literature, 37(4): 1569–1614.
8. Armendariz, B. and Morduch, J., 2010, The economics of microfinance, MIT Press, Massachusetts.
9. Rahman, M. W., Wang, X., Ahmed, S. and Luo, J., 2011, The synthesis of Grameenbank, BRAC and ASA: microfinance approaches in Bangladesh, IPRCC Working Paper Services, 4: 1–33.
10. Grameen Bank, 2015, Credit lending models. http://www.grameen.com/index.php?option=com_content&task=view&id=43&Itemid=93 (Accessed on 01 February, 2015).
11. Khandker, S. R., Samad, H. A. and Khan, Z. H., 1998, Income and employment effects of micro-credit programmes: village-level evidence from Bangladesh. Journal of Development Studies, 35(2): 96–124.
12. Prahalad, C. K. and Ramaswamy, V., 2004, Co-creation experiences: the next practice in value creation, Journal of Interactive Marketing, 8(3): 5–14.
13. Simanis, E. and Hart, S., 2009, Innovation from the inside out, MIT Sloan Management Review, 50(4): 77–86.
14. Dahan, N. M., Doh, J. P., Oetzel, J. and Yaziji, M., 2010, Corporate-NGO collaboration: co-creating new business models for developing markets, Long Range Planning, 43(2–3): 327–342.
15. Yunus, M., Moingeon, B. and Ortega, L. L., 2010, Building social business models: lessons from the Grameen experience, Long Range Planning, 43(2–3): 308–325.
16. Ashta, A., 2012, Co-creation for impact investment in microfinance, Strategic Change, 21(1–2): 71–81.
17. Lusch, R. F. and Vargo, S. L., 2014, Service-dominant logic: premises, perspectives, possibilities, Cambridge University Press, UK.
18. Yin, R. K., 2014, Case study research: design methods (5th Ed.), Sage, London.
19. Eisenhardth, K. M. and Graebner, M. E., 2007, Theory building from cases: opportunities and challenges, Academy of Management Journal, 50: 25–32.
20. Gephart, J. H., 2004, Qualitative research and the Academy of Management Journal, Academy of Management Journal, 47: 554–562.
21. BRAC's Annual Report, 2013, BRAC annual report. http://www.brac.net/sites/default/files/annual-report-2013/BRAC-annual-report-2013.pdf (Accessed on 23rd January, 2015).
22. DeMarrais, K, 2004, Qualitative interview studies: learning through experience, In K. deMarrais & S. D. Lapan (Eds.), Foundations for research (51–68), Erlbaum, Mahwah, NJ.
23. Berg, B. L, 2009, Qualitative research methods for the social sciences (7th Ed.), Allyn & Bacon, Boston.
24. Daly, J., Kellehear, A. and Gliksman, M., 1997, The public health researcher: a methodological approach, Oxford University Press, Melbourne, Australia.
25. Lapadat, J. C., 2009, Thematic analysis, In Mills, A. J., Wiebe, E. and Durepos, G. (Eds), Encyclopaedia of Case Study Research, Vol. 2, Sage Publications, Thousand Oaks, CA.
26. Corbin, J. and Strauss, A., 1990, Grounded theory research: procedures, canons, and evaluative criteria, Qualitative Sociology, 13(1): 3–21.
27. Siddike, M. A. K., Kohda, Y. and Haque, I. T., 2014, Service system for social innovation in education: a developing country perspective, The 3rd Asian Conference on Information Systems, Nha Trang, Vietnam, 1–3 December: 172–179.

Part III

Service Marketing

Developing an Ad Hoc Questionnaire Model for Extracting Consumer Behaviour in Service Encounter

Hisashi Masuda and Yoshinori Hara

Abstract

Many types of enterprises have to handle a variety of criteria of consumers in accordance with the business expansion in the global and service economy. How do we extract consumers' service processes considering their criteria for service evaluation by using simple survey methods? We develop an ad hoc questionnaire model which is to involve consumers in making the questionnaire linked their service processes in prepurchase stage, and after their service encounter, they modify/complete it. We present six interpretations based on this concept through our web questionnaire survey for restaurants in Japan. This ad hoc questionnaire model can propose the opportunity to understand consumers' context more deeply.

Keywords

Customer satisfaction • Consumer behaviour • Service process • Web questionnaire

1 Introduction

1.1 Background

Many types of enterprises have to handle a variety of criteria of customers in accordance with the business expansion in the global and service economy. From a world perspective in 2012, the service sector accounted for 65.9 % of nominal gross domestic product (GDP), and additionally, in a developing country, the service sector constituted approximately 51.7 % of nominal GDP [9]. Also, developments of information and communication technology (ICT) all over the world are progressed rapidly. "Equally, as the digital divide narrows, service have enabled less-developed countries to participate on a leveller playing field in business and trade" [8]. That is, in service sector, there is high potential of a lot of participants who have different cultural backgrounds in the future.

It is important in this economic situation to understand contexts of each customer and reflect the understanding for their operations. In current service researches, the importance of service process is claiming. In the service production, process is one of the main characteristics of services [7]. A representation of service consumption is proposed in three stages: prepurchase, service encounter and post-encounter stage [5, 6].

A lot of standard approaches in service evaluation are seen in a post-encounter stage. Generally, fundamental variable in service evaluation is customer satisfaction (CS), e.g. a well-known disconfirmation model [4]. We can analyse these variables like CS and connect several consumer behaviours, e.g. repeat purchase, repurchase intention, loyalty, positive word of mouth and so on.

From a service process view, critical incident technique (CIT) approach for clearing unique experiences in service encounter was conducted by Bitner [3]. In response to the CIT approach, sequential incident technique (SIT) was conducted by Stauss as a more general approach for analysing consumer behaviour [2].

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However, it is difficult to extract a linkage between consumers' service processes and their evaluation by conducting simple survey methods. Collecting the process information of each consumer is a costly and time-consuming activity. Additionally, if we don't share consumers' context of services, we cannot follow the explicit reasons of consumer behaviour. For solving this issue, several approaches from ethnography [1] are proposed. But there is less potential to conduct continuously such surveys by small- and medium-sized enterprises (SMEs).

1.2 Research Question and Purpose

How to develop a model for connecting between consumer behaviour and service evaluation is the main issue of our research. It is also related to this question, that is, how do we extract consumers' service processes considering their criteria for service evaluation by using business research methods?

The purpose of this paper is to develop a method for extracting each customer service criterion based on consumer behaviour and the relation to overall CS. By standard well-known CS survey, we are able to understand that she/he is satisfied or not. But if we want to have a deep understanding of the survey, it requires high costs and manpower. There are barriers for conducting them for SMEs in service sector.

1.3 Approach

We propose an ad hoc questionnaire model which involves consumers in making the questionnaire including their service processes in prepurchase stage, and after their service encounter, that is, in post-encounter stage, they modify/complete it. In prepurchase stage, consumers write down their estimating service processes by using our proposed web questionnaire system for their evaluation at the post-encounter stage. In service encounter stage, the consumers experience the services and gain information related to their service process and evaluation. In post-encounter stage, consumer can modify or complete the prepared linked questionnaires in relation to service evaluation methods. By involving customers to make their questionnaires, we can extract their perspectives for services.

Proposed web questionnaire system consists of three functions. First function is for preparing the questionnaire in prepurchase stage. Second one is for modifying the prepared questionnaire after service encounter stage. Third one is for completing the prepared questionnaire.

We conducted a survey research by using a proposed web questionnaire system. The participants of the survey consist of 45 persons; they are research monitors of a research firm in Japan. The date of the survey is 14–23 February 2015. We got 108 completed questionnaires from participants through our web questionnaire system.

We presented six interpretations for a linkage between overall CS and service process linked with each CS. A set of consumers are divided into three subsets of positive, neutral and negative overall CS. These groups are explained by using each CS related to service processes.

We could give more deep suggestion on how to modify or enhance their service based on the results of an ad hoc questionnaire model. Especially, we are able to interpret why she/he checked this bad/good answer in the questionnaire by referring a linkage between the overall CS and each CS-linked service process.

For the next section, we explain related researches. Section 3 is for a concept of our proposed model. Section 4 is the results gained from a survey by using a proposed model. Section 5 is for implication, then, Sect. 6, we end as a conclusion.

2 Related Works of Service Process and Service Evaluation View

We divide previous works related to consumer behaviour based on a service process-oriented or a service evaluation-oriented view. A service process-oriented view includes service encounter researches, collecting service scripts and so on. On the other hand, service evaluation-oriented one includes, for instance, customer satisfaction approaches and so on.

In service encounter, CIT contributes to a clear extreme experience of services. On the other side, SIT tries to represent more usual experiences of services in addition to extreme ones.

There are a lot of customer satisfaction approaches, e.g. well-known disconfirmation model which was used widely in an area. A kind of approaches like the disconfirmation model is used for interpretation of customer satisfaction in terms of customer expectation.

How we connect a service process view to a service evaluation one (Fig. 1) is a more important challenge in this rapid changing economy. We might bridge this gap by conducting deep survey methods (ethnography,

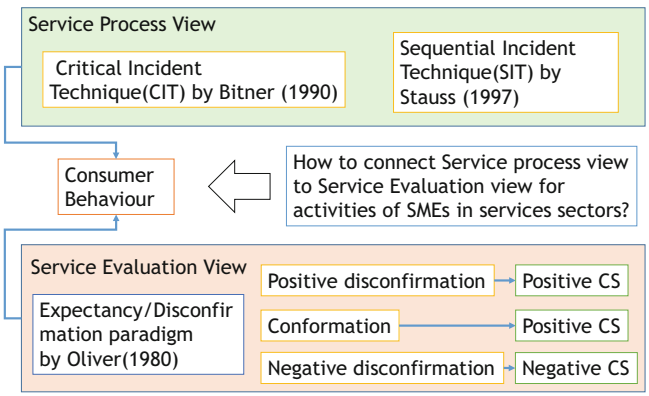

Fig. 1 Overview of a posed issue

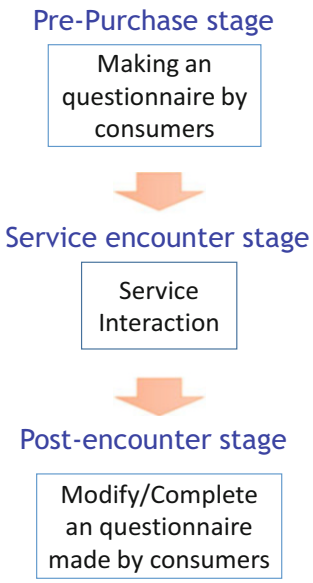

Fig. 2 Overview of an ad hoc web questionnaire system

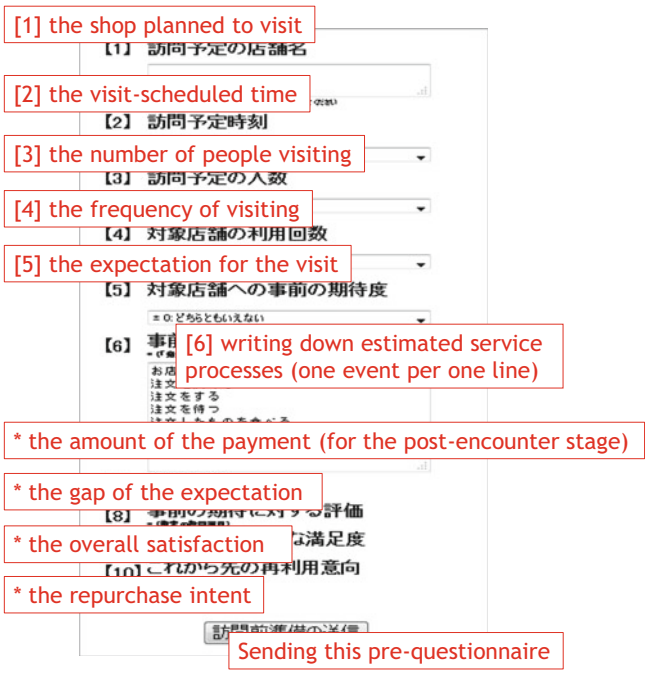

Fig. 3 Questionnaire for the prepurchase stage

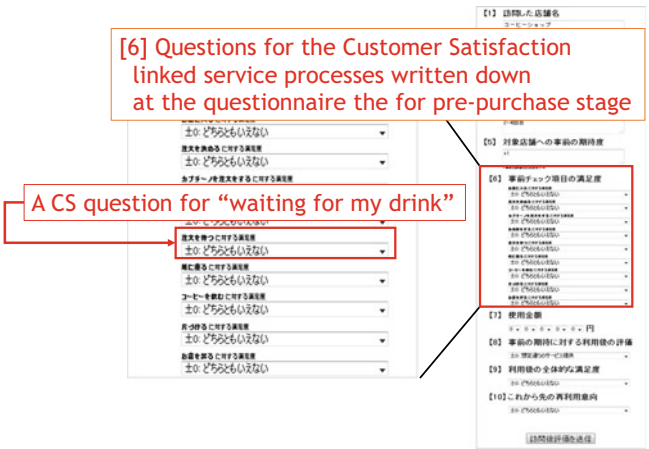

Fig. 4 Questionnaire for the post-encounter stage

focus group interview, action research and so on). But these methods are costly for SMEs in service sectors. This paper proposes one approach on how to handle this problem using questionnaire survey methods. In particular, we develop a web questionnaire system related to service communications/processes in terms of consumers' point of views as well as conventional items.

3 Developing an Ad Hoc Questionnaire Model

Our approach can be divided into three steps (Fig. 2). The first step is to develop a proposed web questionnaire system. The second one is to conduct a survey by using a proposed web questionnaire system. The third one is to analyse the data gained from this survey.

Proposed web questionnaire system consists of three main components: first is for preparing the questionnaire in the prepurchase stage, second is for modifying the questionnaire after service encounter stage and final component is for completing the prepared questionnaire. For preparing the questionnaire, the main function is to write a list for estimating service process. To be more precise, one event, e.g. entering a restaurant, ordering and so on, is represented by a single line of text in the list (Fig. 3).

After service encounter stage, we can answer some questions linked with these events by a list format (Fig. 4).

3.1 Conducting Survey by Using a Proposed System

In prepurchase stage, the participants of this survey prepare a questionnaire by entering a proposed ad hoc web questionnaire system for the service encounter. They fill the following items in the web form, e.g. the visiting date, expectation before receiving the service and estimating service process. For the representation of service processes, a list format is used. One line in the list format represents one event of a service encounter.

After service encounter stage, that is, post-encounter stage, they modify or complete the questionnaire. The variables of the questionnaire we set are in relation to the following service evaluation items: the expectation value (EV), gap of expectation (GAP), customer satisfaction (CS) and repurchase intention (RI). After experiencing a service, they can modify or complete the prepared questionnaire attached the above service evaluation items. In particular, each question item generated by the list for the serivce processes is associated with customer satisfaction (CS) per one process. These variables are made on Likert-type scale from "−3" to "+3", e.g. CS +3 means very satisfied and so on.

3.2 Analysis for Ad Hoc Web Questionnaire Data

For analysing data gained from the proposed method, we conduct two step approaches. The first step is to divide the data into positive, neutral and negative CS based on the overall CS level. The second is to divide the three groups based on each CS-linked service process.

Positive CS group which have positive overall CS are divided into subgroups based on whether there are negatives in each CS-linked service process. For neutral CS group, we divide them based on whether there are negatives in each CS of service processes or positive in each CS-linked service process. For negative CS group, we divide them based on whether there are positives in each CS of service processes or none.

4 Six Interpretations from an Ad Hoc Questionnaire Model

We present six interpretations from our survey for restaurants in Japan by connecting overall CS and each CS based on their service processes. The number of participants consists of 45 persons, and we got 108 completed questionnaires. They have filled their questionnaires at least twice or more than twice. The data are collected by using our proposed system in '14–23 February 2015 with the cooperation of an investigation firm.

First, we can mainly divide into three groups: positive, neutral and negative CS groups. Second, we give the six interpretations for groups 1–6 based on a linkage between overall CS and each CS-connected service process.

4.1 Six Interpretations for a Linkage Between Overall CS and Each CS-Linked Service Process

Group 1 consists of positive overall CS and no negative CS-linked process (Table. 1). These relationships between consumers and firms are successful cases of service experiences.

Group 2 consists of positive overall CS and partially negative CS-linked process (Table. 2). Consumers of group 2 have good relationship with firms, and they have a potential to become better just like in group 1 by improving and solving their partial problems.

Group 3 consists of neutral overall CS and no negative CS-linked process (Table. 3). Overall CS is not positive, but it remains to have some positive relationship between consumers and firms.

Group 4 consists of neutral overall CS and no positive CS-linked process (Table. 4). In consumers of group 4, overall CS of each experience is not negative, but there might be potential that it becomes worse.

Group 5 consists of negative overall CS and partially positive CS-linked process (Table. 5). There are several ways to satisfy consumer; thus, it is important to improve their customer satisfaction.

Group 6 consists of negative overall CS and no positive CS-linked process (Table. 6). Those are extremely bad cases, and service providers require overall modification to improve such service experiences.

5 Implication

This ad hoc questionnaire model proposed the opportunity to understand consumers' context more deeply by involving them into making the questionnaires including their service processes. We could gain the direction for how to change or enhance services based on these results.

For instance, we can point out some good points based on a proposed method like why this customer checked a good answer related to his service experience. On the other hand, we can clear some bad points related to why he checked a bad answer, e.g. some consumer who has negative CS has problems at the partial point in his service encounter, but someone has problems in his overall service encounter

Table 1 Group 1: positive overall CS and no negative CS-linked service processes

User id	Service id	Persons	Frequency	EV	Cost (yen)	GAP	CS	RI	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS
31	10	2	5–7	1	967	1	2	3	Entering the store	3	Deciding the order	3	Ordering	3	Waiting	3	Taking out	3	Paying	3	Leaving	3
31	19	1	2–4	0	450	2	2	2	Entering the store	3	Deciding the order	2	Ordering	3	Waiting	3	Taking out	3	Paying	3	Leaving	3
11	7	3	more than 11	2	4300	3	3	3	Entering the store	3	Deciding the order	3	Ordering	3	Waiting	2	Having a meal	2	Paying	3	Leaving	3
28	40	2	1	3	1340	3	3	3	Entering the store	3	Deciding the order	3	Ordering	3	Paying	2	Waiting	3	Having a meal	3	Leaving	3
11	6	2	more than 11	2	3100	2	3	3	Entering the store	3	Deciding the order	2	Ordering	2	Waiting	2	Having a meal	3	Paying	3	Leaving	3
49	17	1	8–10	2	1080	2	3	2	Entering the store	2	Deciding the order	2	Ordering	1	Waiting	2	Having a meal	2	Paying	3	Leaving	3
25	13	2	2–4	1	1500	1	3	3	Entering the store	1	Deciding the order	1	Ordering	2	Waiting	2	Having a meal	3	Paying	3	Leaving	3
38	40	1	more than 11	1	710	3	2	3	Entering the store	1	Deciding the order	1	Ordering	3	Waiting	2	Having a meal	3	Paying	3	Leaving	3
82	31	3	2–4	1	1274	3	2	3	Entering the store	1	Deciding the order	3	Ordering	1	Waiting	1	Having a meal	2	Paying	1	Leaving	3
78	37	1	5–7	1	680	2	2	2	Entering the store	2	Deciding the order	1	Ordering	2	Waiting	1	Having a meal	1	Paying	2	Leaving	2
30	33	3	1	3	3380	2	2	2	Entering the store	3	Deciding the order	2	Ordering	2	Waiting	3	Having a meal	2	Paying	3	Leaving	1
24	38	1	5–7	0	270	1	1	1	Entering the store	1	Deciding the order	1	Ordering	2	Waiting	2	Having a meal	1	Paying	2	Leaving	1
78	22	1	8–10	2	780	2	2	2	Entering the store	2	Deciding the order	2	Ordering	1	Waiting	1	Having a meal	1	Paying	1	Leaving	1
30	40	3	more than 11	3	1500	3	1	1	Entering the store	1	Deciding the order	2	Ordering	2	Waiting	1	Having a meal	3	Paying	2	Leaving	1
24	51	3	1	0	4147	1	2	1	Entering the store	1	Deciding the order	1	Ordering	1	Waiting	1	Having a meal	2	Paying	2	Leaving	1
46	32	2	more than 11	1	1482	0	1	3	Entering the store	1	Deciding the order	1	Ordering	1	Waiting	1	Having a meal	1	Paying	1	Leaving	1
46	30	4	2–4	1	1540	1	1	3	Entering the store	1	Deciding the order	1	Ordering	1	Waiting	1	Having a meal	1	Paying	1	Leaving	1
28	37	1	more than 11	3	450	0	3	3	Entering the store	3	Deciding the order	3	Ordering	0	Paying	3	Taking the change	3	Taking a soup	1	Having a meal	3
74	46	1	more than 11	3	3600	3	3	3	Entering the store	3	Deciding the order	0	Ordering	0	Waiting	3	Having a meal	3	Having a meal	3	Paying	3
45	18	1	more than 11	3	2320	3	3	3	Entering the store	3	Deciding the order	0	Ordering	3	Waiting	2	Taking a soup	2	Having a meal	3	Paying	3
69	59	3	1	0	9000	1	1	1	Entering the store	0	Confirming the seat	0	Deciding the order	1	Ordering	1	Waiting	0	Having a meal	1	Paying	1
39	39	3	5–7	1	1400	1	1	1	Entering the store	1	Returning the plate	2	Selecting a side dish	1	Paying	1	Seating	1	Taking a soup	0	Having a meal	2
39	13	2	5–7	1	698	0	1	1	Entering the store	0	Seating	1	Deciding the order	1	Ordering	1	Taking a glass ordering	0	Carrying	1	Having a meal	2

(continued)

Table 1 (continued)

User id	Service id	Persons	Frequency	EV	Cost (yen)	GAP	CS	RI	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS
7	17	2	1	0	1620	3	3	3	Entering the store	0	Deciding the order	2	Ordering	2	Waiting	3	Having a meal	3	Paying	3	Leaving	3
49	7	2	2–4	2	1620	2	2	2	Entering the store	2	Deciding the order	1	Ordering	0	Waiting	1	Having a meal	2	Paying	3	Leaving	2
39	21	3	1	1	2615	2	2	2	Entering the store	1	Seating	1	Deciding the order	1	Waiting	1	Having a meal	2	Paying	0	Leaving	2
7	7	1	more than 11	3	1080	2	2	2	Entering the store	0	Deciding the order	3	Ordering	3	Waiting	0	Having a meal	2	Paying	2	Leaving	2
38	16	1	2–4	1	940	2	3	3	Entering the store	3	Deciding the order	2	Ordering	2	Waiting	0	Having a meal	3	Paying	3	Leaving	2
25	27	1	more than 11	0	390	0	1	3	Entering the store	1	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	3	Paying	0	Leaving	2
82	11	3	5–7	2	2311	0	1	2	Entering the store	1	Deciding the order	0	Ordering	3	Waiting	0	Having a meal	2	Paying	3	Leaving	2
64	55	2	5–7	2	1880	1	1	3	Entering the store	0	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	3	Paying	1	Leaving	2
5	37	1	more than 11	0	450	0	1	2	Entering the store	0	Deciding the order	1	Ordering	1	Waiting	1	Having a meal	2	Paying	1	Leaving	1
71	27	2	2–4	1	720	1	1	1	Entering the store	0	Deciding the order	1	Ordering	0	Waiting	1	Having a meal	1	Paying	0	Leaving	1
16	64	1	8–10	0	720	1	1	1	Entering the store	0	Deciding the order	0	Paying	0	Ordering	1	Waiting	2	Having a meal	2	Leaving	1
6	19	2	5–7	0	324	0	2	2	Entering the store	1	Deciding the order	1	Ordering	1	Waiting	0	Drinking	1	Paying	1	Leaving	1
26	34	3	more than 11	0	650	0	1	2	Entering the store	0	Deciding the order	1	Ordering	1	Waiting	0	Having a meal	1	Paying	1	Leaving	1
18	62	1	more than 11	0	830	0	1	2	Entering the store	2	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	3	Paying	0	Leaving	1
43	60	2	1	2	1000	1	1	1	Entering the store	0	Ordering	0	Showing a coupon	1	Waiting	0	Having a meal	2	Paying	1	Leaving	1
69	9	1	more than 11	1	450	0	1	1	Entering the store	0	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	1	Paying	1	Leaving	1
16	15	1	8–10	1	320	2	2	2	Entering the store	1	Deciding the order	2	Ordering	2	Paying	2	Waiting	2	Drinking	3	Leaving	0
5	44	1	more than 11	0	380	0	1	1	Entering the store	0	Deciding the order	1	Ordering	1	Waiting	2	Having a meal	2	Paying	1	Leaving	0
29	19	2	more than 11	0	623	1	1	1	Entering the store	0	Deciding the order	2	Ordering	1	Waiting	1	Having a meal	2	Paying	0	Leaving	0
42	4	1	1	1	1080	0	1	1	Confirming the seating	1	Deciding the order	1	Ordering	0	Waiting	1	Having a meal	1	Paying	0	Leaving	0
47	13	2	2–4	0	1098	0	2	2	Entering the store	0	Deciding the order	1	Ordering	1	Waiting	1	Having a meal	1	Paying	0	Leaving	0
73	2	2	1	2	2680	1	1	1	Entering the store	1	Deciding the order	1	Ordering	0	Waiting	0	Having a meal	3	Paying	0	Leaving	0
26	54	4	8–10	1	13,645	1	1	2	Entering the store	1	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	2	Paying	2	Leaving	0

4	61	1	8–10	0	550	1	2	1	Entering the store	0	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	0	Paying	0	Leaving	0
32	20	2	2–4	0	3000	0	1	3	Entering the store	0	Having a conversation	0	Ordering	0	Waiting	0	Having a meal	0	Paying	0	Taking a glass ordering	0
43	49	2	more than 11	1	702	0	1	2	Entering the store	0	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	1	Paying	0	Leaving	0
64	63	1	2–4	1	750	0	1	2	Entering the store	0	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	1	Paying	0	Leaving	0
73	41	2	1	3	2760	1	1	1	Entering the store	0	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	3	Paying	0	Leaving	0
1	58	2	more than 11	3	600	1	3	3	Entering the store	1	Ordering	3	Waiting	3	Having a meal	3	Paying	3	Leaving	3		
81	53	1	more than 11	0	680	0	2	3	Entering the store	3	Paying	0	Passing	0	Waiting	0	Having a meal	0	Leaving	3		
89	37	1	more than 11	0	100	0	3	3	Entering the store	0	Deciding the order	0	Ordering	0	Paying	0	Having a meal	0	Leaving	0		

We translated these representations to English from Japanese

Table 2 Group 2: positive overall CS and partially negative CS-linked service processes

User id	Service id	Persons	Frequency	EV	Cost (yen)	GAP	CS	RI	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS
88	68	2	more than 11	3	1372	1	2	3	Entering the store	1	Deciding the order	2	Ordering	2	Waiting	−2	Having a meal	3	Ordering	2	Waiting	1
88	45	4	5–7	3	2980	2	3	3	Entering the store	2	Deciding the order	2	Ordering	2	Waiting	0	Having a meal	3	Ordering	−2	fraying	1
66	1	2	5	1	580	0	1	1	Entering the store	1	Having a conversation	−1	Deciding the order	0	Ordering	0	Paying	0	Waiting	0	Drinking	1
45	65	2	more than 11	1	2300	0	1	3	Entering the store	0	Selecting a side dish	0	Deciding the order	3	Ordering	0	Waiting	1	Having a meal	1	Paying	−1
19	40	1	2–4	3	710	1	1	1	Entering the store	2	Deciding the order	1	Ordering	1	Waiting	1	Having a meal	−1	Paying	1	Leaving	2
11	37	2	more than 11	2	680	1	2	2	Entering the store	1	Deciding the order	1	Ordering	2	Waiting	1	Having a meal	2	Paying	−1	Leaving	2
62	3	1	1	2	980	1	1	1	Entering the store	1	Deciding the order	1	Ordering	−1	Waiting	0	Having a meal	1	Paying	1	Leaving	2
38	12	2	2–4	2	2905	2	2	3	Entering the store	2	Deciding the order	1	Ordering	2	Waiting	−1	Having a meal	3	Paying	2	Leaving	2
1	48	2	more than 11	3	480	0	3	3	Being in line	−1	Deciding the order	1	Waiting	−1	Entering the store	2	Having a meal	3	Paying	1	Leaving	1
47	29	2	1	1	8445	0	1	1	Entering the store	−2	Deciding the order	2	Ordering	1	Waiting	1	Having a meal	1	Paying	0	Leaving	1
61	66	1	8–10	2	780	1	1	2	Entering the store	−1	Deciding the order	0	Ordering	1	Waiting	1	Having a meal	2	Paying	1	Leaving	1
17	43	3	2–4	1	8813	0	1	1	Entering the store	1	Deciding the order	0	Ordering	0	Waiting	−1	Having a meal	1	Paying	0	Leaving	1
62	28	1	1	3	2138	0	2	2	Entering the store	1	Deciding the order	1	Ordering	2	Waiting	−2	Having a meal	2	Paying	2	Leaving	1
89	5	1	2–4	3	8500	0	1	2	Entering the store	0	Deciding the order	3	Ordering	1	Waiting	1	Having a meal	−1	Paying	−1	Leaving	0
74	30	1	8–10	−2	750	0	1	1	Entering the store	1	Deciding the order	1	Ordering	0	Waiting	0	Paying	−2	Having a meal	−1	Leaving	0
33	14	1	2–4	1	680	0	1	1	Entering the store	−1	Deciding the order	0	Ordering	1	Waiting	0	Paying	0	Having a meal	1	Leaving	0
81	24	2	2–4	3	5400	0	3	3	Entering the store	−3	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	0	Paying	0	Leaving	0
35	26	2	2–4	2	5821	−1	1	2	Entering the store	−1	Deciding the order	0	Ordering	−1	Waiting	−1	Having a meal	2	Paying	1	Leaving	0
35	19	2	more than 11	0	766	1	2	3	Entering the store	3	Deciding the order	2	Ordering	1	Paying	3	Waiting	−1	Having a meal	3	Leaving	−1
29	6	2	more than 11	2	1473	0	1	1	Entering the store	3	Deciding the order	−1	Ordering	3	Waiting	2	Having a meal	0	Paying	−2	Leaving	−1

We translated these representations to English from Japanese

Table 3 Group 3: neutral overall CS and no negative CS-linked service processes

User id	Service id	Persons	Frequency	EV	Cost (yen)	GAP	CS	RI	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS
33	15	1	2–4	1	500	0	0	1	Entering the store	1	Entering the store	1	Having a conversion	0	Paying	0	Having a meal	1	Leaving the store	0		
36	37	1	5–7	0	648	0	0	1	Entering the store	0	Deciding the order	0	Ordering	0	Paying	0	Having a meal	0	Leaving the store	0		
4	36	1	more than 11	0	270	0	0	0	Entering the store	0	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	0	Paying	0	Leaving the store	0
42	37	1	more than 11	1	200	1	0	1	Taking the change	0	Having a meal	0	Leaving the seating	0								
43	23	2	more than 11	3	780	0	0	1	Entering the store	0	Deciding the order	2	Ordering	0	Paying	0	Waiting	0	Having a meal	0	Leaving the store	0
43	50	5	1	2	2600	0	0	0	Entering the store	1	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	1	Paying	0	Leaving the store	0
45	38	2	2–4	1	1091	0	0	0	Entering the store	0	Deciding the order	1	Ordering	1	Waiting	0	Having a meal	2	Paying	0	Leaving the store	1
6	13	2	5–7	0	280	0	0	2	Entering the store	1	Ordering	0	Waiting	0	Drinking	0	Paying	0	Leaving the seating	0		
66	10	1	more than 11	1	100	0	0	2	Entering the store	0	Confirming the seat	0	Showing a coupon	0	Ordering	0	Waiting	0	Paying	0	Drinking	1

We translated these representations to English from Japanese

Table 4 Group 4: neutral overall CS and partially negative CS-linked service processes

User id	Service id	Persons	Frequency	EV	Cost (yen)	GAP	CS	RI	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS	Process	Cs	Process	CS
17	57	3	more than 11	0	1590	0	0	1	Entering the store	0	Deciding the order	−1	Ordering	−1	Waiting	−1	Having a meal	0	Paying	0	Leaving the store	0
18	38	1	more than 11	0	700	0	0	1	Entering the store	0	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	3	Paying	−3	Leaving the store	0
31	42	3	1	0	4900	1	0	0	Entering the store	−1	Deciding the order	2	Ordering	3	Waiting	2	Having a meal	2	Paying	2	Leaving the store	2
32	53	2	5–7	0	1400	0	0	3	Passing	0	Having a conversation	2	Having a meal	0	Waiting	−1	Having a meal	0	Leaving the store	3		
36	15	1	2–4	0	432	0	0	1	Entering the store	1	Deciding the order	1	Ordering	2	Having a meal	2	Paying	−1	Leaving the store	−1		
37	23	1	2–4	2	1120	1	0	−1	Entering the store	1	Confirming the seat	1	Deciding the order	1	Ordering	2	Paying	1	Waiting	3	Having a meal	−2
40	23	1	5–7	0	300	0	0	1	Entering the store	0	Deciding the order	0	Ordering	0	Paying	−1	Waiting	0	Having a meal	0	Leaving the store	0
71	8	2	1	1	1139	1	0	0	Waiting	1	Entering the store	1	Having a conversion	0	Ordering	0	Waiting	−1	Having a meal	1	Paying	1
8	17	5	5–7	1	2550	1	0	1	Entering the store	−1	Deciding the order	1	Ordering	1	Waiting	0	Having a meal	1	Paying	1	Leaving the store	1
89	25	2	more than 11	1	3440	1	0	3	Entering the store	1	Deciding the order	0	Ordering	2	Waiting	−1	Having a meal	2	Paying	2	Leaving the store	0

We translated these representations to English from Japanese

Table 5 Group 5: negative overall CS and partially positive CS-linked service processes

User id	Service id	Persons	Frequency	EV	Cost (yen)	GAP	CS	RI	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS
35	19	1	more than 11	0	399	−1	−1	2	Entering the store	−1	Deciding the order	1	Ordering	0	Paying	−1	Waiting	−1	Having a meal	3	Leaving the store	−1
37	38	1	5–7	3	388	0	−1	3	Entering the store	0	Confirming the seating	0	Deciding the order	2	Ordering	2	Paying	2	Having a meal	−2	Leaving the store	0
43	35	2	1	0	3000	−1	−1	0	Entering the store	−1	Showing coupon	0	Having a conversation	1	Ordering an extra meal	1	Paying	0	Leaving the store	−1		
61	52	3	2–4	1	4500	−1	−1	0	Entering the store	1	Waiting	1	Having a meal	−1	Paying	0	Leaving the store	0				
63	53	1	more than 11	0	330	0	−1	0	Entering the store	−1	Deciding the order	1	Ordering	−1	Waiting	−1	Having a meal	0	Paying	0	Leaving the store	−1
8	10	1	2–4	2	1050	−1	−1	−1	Entering the store	2	Deciding the order	2	Ordering	1	Waiting	0	Having a meal	−1	Paying	0	Leaving the store	1

We translated these representations to English from Japanese

Table 6 Group 6: negative overall CS and no positive CS-linked service processes

User id	Service id	Persons	Frequency	EV	Cost (yen)	GAP	CS	RI	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS	Process	CS
19	37	1	more than 11	3	419	−2	−1	1	Entering the store	0	Deciding the order	0	Ordering	0	Waiting	0	Having a meal	0	Paying	0	Leaving the store	0
40	10	1	1	0	290	−1	−1	1	Entering the store	0	Deciding the order	−1	Ordering	0	Paying	0	Waiting	0	Having a meal	0	Leaving the store	0
63	67	2	1	2	10,483	−2	−2	−2	Entering the store	−3	Deciding the order	0	Ordering	−1	Returning	−1	Waiting	0	Having a meal	−1	Paying	−1
30	56	5	2–4	1	10,590	−3	−3	−3	Entering the store	0	Deciding the order	−2	Ordering	−3	Waiting	−3	Having a meal	−3	Paying	−3	Leaving the store	−3
35	47	2	1	3	9467	−3	−3	−3	Entering the store	−3	Deciding the order	−1	Ordering	−2	Waiting	−3	Having a meal	−2	Paying	−3	Leaving the store	0

We translated these representations to English from Japanese

Fig. 5 Why did she/he check the bad answer?

1. Expectation, Customer Satisfaction, Repurchase Intention

user id	service id	persons	Frequency	EV	Cost(yen)	GAP	CS	R.I.
19	37	1	11-	3	419	-2	-1	1
40	10	1	1	0	290	-1	-1	1
63	67	2	1	2	10483	-2	-2	-2
30	56	5	2-4	1	10590	-3	-3	-3
35	47	2	1	3	9467	-3	-3	-3

2. Each process and the Customer Satisfaction

user id	service id	Process	CS	Process	CS	Process	CS	Process	CS
19	37	Entering the store	0	Deciding the order	0	Ordering	0	Waiting	0
40	10	Entering the store	0	Deciding the order	-1	Ordering	0	Paying	0
63	67	Entering the store	-3	Deciding the order	0	Ordering	-1	Returning tl	-1
30	56	Entering the store	0	Deciding the order	-2	Ordering	-3	Waiting	-3
35	47	Entering the store	-3	Deciding the order	-1	Ordering	-2	Waiting	-3

EV: Expectation Value
Gap: Gap of Expectation
CS: Customer Satisfaction
R.I.: Repurchase Intention

Process	CS	Process	CS	Process	CS
Having a me	0	Paying	0	Leaving	0
Waiting	0	Having a meal	0	Leaving	0
Waiting	0	Having a meal	-1	Paying	-1
Having a me	-3	Paying	-3	Leaving	-3
Having a me	-2	Paying	-3	Leaving	0

Note: we translated these representation to English from Japanese.

(Fig. 5). We are required to handle different treatments for such two cases.

6 Conclusion

How do we extract consumers' service processes considering their criteria of service evaluation by using simple survey methods? We presented six interpretations from a proposed ad hoc web questionnaire model by connecting overall CS and each CS linked with their service processes of restaurants in Japan. This ad hoc questionnaire model proposed the opportunity to understand consumers' context more deeply by involving them into making the questionnaires including their service processes.

As a limitation of our proposed methods, questionnaires made by customers depended on consumers' characteristics. Proactive consumers may write detailed processes for representing their service experiences. But some consumers may be less interested to depict their experiences and so on.

In order to solve these problems, we will improve this type of surveys representing each service and clear the key components of common and not common parts in relation to a linkage between service process and service evaluation. We could set such key components in an ad hoc questionnaire system extracting consumer behaviour in service encounter more correctly.

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References

1. UNCTAD, 2014, Handbook of Statistics, TD/STAT.39: http://unctad.org/en/Pages/Publications/Handbook-of-Statistics.aspx
2. UNCTAD, 2014, UNCTAD Findings on Services, Development and Trade: http://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid = 549
3. Grönroos, C., 2000, Service reflections: service marketing comes of age, in Teresa A. S. and Dawn I. (eds), Handbook of Services Marketing & Management, Sage Publications Inc.: 13–20.
4. Lovelock, C., Wirtz, J., 2011, Services Marketing: People, Technology, Strategy, 7th ed., Upper Saddle River, New Jersey: Prentice Hall.
5. Tsiotsou, R. H., Wirtz, J., The Three-stage Model of Service consumption, the handbook of Service business: Management, Marketing, Innovation and Internationalisation, by J.R. Bryson and - P.W. Daniels (eds.), Chelternham: Edward Elgar, 13 August 2014.
6. Oliver, R. L., 1980, A cognitive model of the antecedence and consequences of customer satisfaction dexisions, Journal of Marketing Research, 17(September): 460–469.
7. Bitner, M. J., Bernard H. B., Tetreault, M. S., 1990, The service encounter: diagnosing favorable and unfavorable incidents, The Journal of Marketing:71–84.
8. Stauss, B., Winlick, B., 1997, Process-oriented measurement of service quality: Applying the sequential incident technique, European Journal of Marketing, Volume 31 (1): 23-Feb.
9. Elliott, R., Fankel-Elliott, N., 2003, Using ethnography in strategic consumer research, Qualitative Market Research: An international Journal Volume 6 Number 4: 215–223.

Building a Conceptual Preference Model Based on Personal Purchase Records for Retail Service Improvement

Marina Fujita, Wei Wenpeng, Toshiko Aizono, and Koji Ara

Abstract

Retailers need to understand customer preferences precisely in order to improve customer satisfaction. This research aims to correct retailers' conceptual misunderstandings of preference based on actual purchase behavior. To this end, a novel conceptual preference model is introduced. This model can be defined by persons on the basis of their own knowledge and is updated utilizing actual data of purchase behavior. Typical patterns of misunderstanding are classified into three types: incorrect relationship, weak relationship, and unexpected relationship. A novel method has been developed for evaluating the model to extract these patterns of misunderstanding and validated by conducting an experiment comprised of a cafeteria analysis. The conceptual model includes 11 preference types defined on the basis of retailers' knowledge and was evaluated utilizing ID-POS data. Results showed that the three patterns of misunderstanding could successfully be extracted. It was confirmed that this method is helpful for retailers to understand the appropriate preference model and that a model built by using the proposed method can help improve the business processes in a retail setting.

Keywords

Customer behavior • Retail service • Consumer preference

1 Introduction

To increase customer satisfaction in retail settings, it is necessary to provide items and services tailored to the preferences of the consumer. Many shops display their wares according to not only the category of the item but also to characteristics of the item that they feel are linked to consumer values (low price, luxurious, healthy, etc.), with the idea that such displays will assist consumers in identifying the items they wish to purchase. Personal coupon services, which offer specific items to consumers who have been selected on the basis of assumed consumer preferences, are also designed to attract the consumer's attention.

In order for these consumer-oriented services to succeed, the person in charge of merchandising and service planning needs to understand consumer preference tendencies and which items/services are likely to attract consumers with which tendencies. Preference type analysis is required to help such personnel clarify their understanding of consumer preference and the effect it has on purchase behaviors.

With the current widespread use of point cards and electronic money, large amounts of personal purchase data are being stored by retail companies [1, 2]. These records are expected to help clarify consumer behavior and preferences, and the effective utilization of these data for improving consumer-oriented services is crucial.

The objective with this research is to build a model and accompanying method to assist retailers in obtaining

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knowledge about consumer preference tendencies and to effectively utilize personal purchase records.

In Sect. 2, related works are briefly discussed, and the problems related to improving human understanding for utilizing personal purchase records are explained. The proposed model and accompanying method to resolve these problems are proposed in Sect. 3, and in Sect. 4 the experiment is described. The results are presented and discussed in Sect. 5 and important conclusions are presented in Sect. 6.

2 Related Works

There are already many methods in place that utilize personal purchase records for analysis and extract consumer preference characteristics and items that attract the particular consumer group that exhibits the preference tendencies.

Various clustering methods have been developed for the consumer segmentation task [3, 4]. These methods extract consumer groups containing buyers who exhibit the same purchase patterns and then estimate representative preference tendencies by assuming that consumers in the same group have a common preference tendency. Other studies have focused on the utilization of e-commerce recommendations [5, 6], with information filtering methods such as item-based collaborative filtering and content-based filtering proposed to extract items that are considered likely to be preferred by each consumer.

There are two main advantages to these methods. First, consumer groups who seem to have the same preference tendency can be understood quantitatively. For example, it is fairly simple to estimate the number of consumers and the similarity of purchase patterns in a particular group by means of clustering. The second point is that a large number of consumers can be analyzed and then representative purchase patterns and items that are assumed to be preferred by each consumer can be extracted. However, since these methods only uncover the patterns of data, sometimes the preference tendencies hidden behind these patterns are not interpreted. The persons in charge therefore have a hard time understanding consumer preference tendencies by just analyzing the results.

There are also methods that analyze specific preference tendencies that have been defined manually. Many company (such as Tesco) utilize data with customer ID information (ID-POS data) to estimate each consumer's preference type [7, 8]. A preference type represents a segment of consumers who seem to have the same value when determining which items to purchase. For example, the preference type "health-conscious" refers to the segment of consumers who set a high value on health and tend to purchase healthy items. In these methods, preference types are defined manually and each consumer's type is estimated on the basis of actual data. An example of this type of estimation is shown in Fig. 1 [8].

First, the person in charge of consumer marketing makes two decisions: one, defines the item attributes, which represent the determination criteria for purchases, and two, identifies which group of items has those attributes.

Second, the preference type of each consumer is estimated on the basis of the manual definitions of item attributes.

Finally, the estimation results are utilized for various retail-related tasks designed to help retailers understand each consumer's preference types and how many customers belong to each type.

Since the preference types to be analyzed are defined manually, the persons in charge obtain consumer information about preference tendencies that they can understand. Any preference type can be analyzed if the item attributes suitable for the preference type can be defined. However, this manual method has limits to how precisely the preference tendency can be estimated because it is easy to misunderstand the relation between an item attribute and a preference type on the basis of human knowledge alone. For example, although some people might think that a health-conscious individual would want to purchase supplements, this is not always the case. It is also difficult to understand all of the important item attributes for some of the preference types, and it is easy to make a mistake when deciding which group of items have which attributes. In these ways, manual definitions sometimes diverge from actual consumer purchase behavior, which can cause the efficiency of the service to decrease.

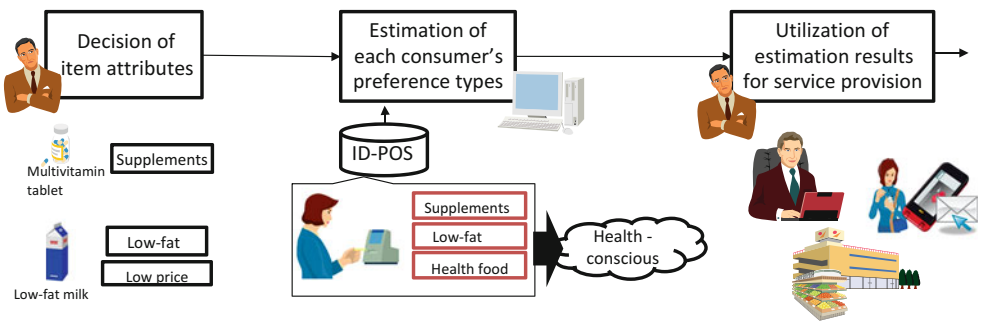

Fig. 1 Estimation of each consumer's preference type for service providing

From the above, it can be concluded that conventional methods are not sufficient to improve understanding of consumer preference tendencies and the items preferred by a particular preference type. The data-centric methods are often not able to extract knowledge that is easy for humans to understand, and the manual methods often do not reflect empirical tendencies precisely. There are essentially two problems that need to be addressed here:

Problem 1. There is no practical model that represents both human conceptual understandings of preference types and the actual tendencies reflected in empirical data.
Problem 2. There is no method to evaluate and modify manual definitions of preference type.

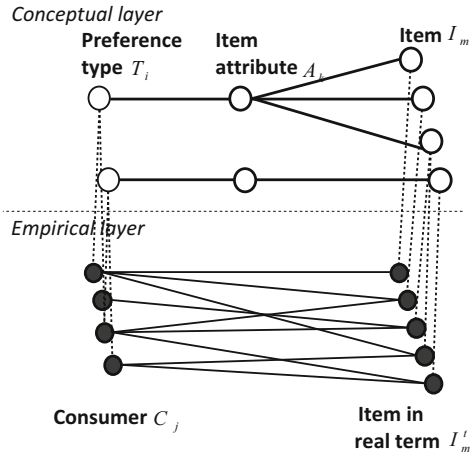

Fig. 2 Conceptual preference model

3 Proposal

The following two solutions are proposed to address the problems stated in the previous section:

Solution 1. Define a unified model that can represent both the human understanding of a model and an empirical data model (explained in Sect. 3.1).
Solution 2. Develop a method to validate the human definition of the proposed model on the basis of the data.

For solution 2, the following two things should be clarified.

- Classifications of human misunderstanding (explained in Sect. 3.2)
- Method to evaluate these misunderstandings and update the human understanding model (explained in Sect. 3.2)

3.1 Conceptual Preference Model

For solution 1, a conceptual preference model is proposed that represents preference types (shown in Fig. 2). The proposed model has two key characteristics: one, it has two layers, a conceptual layer and an empirical layer, so as to represent the difference between human understanding and knowledge based on data, and two, these two layers link up to each other and the correspondence between the two is represented. The preference types from human understanding and from data can thus be described in one unified model.

The conceptual layer represents preference types as defined by human understanding. The model in the conceptual layer has three types of node, preference type T_i, item attribute A_k, and item I_m, and two types of link, one of them between preference type T_i and item attribute A_k, which means that consumers with preference type T_i tend to purchase items that have attribute A_k, and the other between item attribute A_k and item I_m, which means that item I_m has an attribute A_k. This layer is defined manually.

The empirical layer represents the relationships between consumers and actual items in real terms. These relationships are built on the basis of purchase records with customer ID information. The link between a consumer C_j and an item in real term I_m^t means that C_j purchased item I_m at time t.

Two types of link between the two layers represent the correspondences between the conceptual layer and the empirical layer. The first is a link between item I_m and an item in real term I_m^t, and the second is a link between T_i and C_j. This second link means that consumer C_j is a member of preference type T_i. Since the link between item I_m and an item in real term is obvious, only the second type of link (between T_i and C_j) needs to be estimated to realize unified representation. These links can be estimated by using the Tesco estimation method based on the manual definition described in the conceptual layer. The detailed steps are as follows [8].

Items in real terms I_m^t purchased by each consumer are summed up for each group of items that are related to each preference type T_i in the conceptual layer. The average number of items purchased by each consumer per day for each group is then calculated and compared with the standard value, namely, the average number of purchased menu items per consumer per day. Here, a person whose average number of purchased items is twice as high as the standard value is considered a consumer of that preference type. Preference types are estimated for all consumers who have more than ten purchase records.

3.2 Classifications of Human Misunderstanding

The conceptual layer consists of three types of node and two types of link, as shown in Fig. 2. All nodes except items I_m are concepts, and the meaning of each node is defined by the links that are ultimately connected to items I_m. A preference type is defined by the links between the type and the item attributes, while an item attribute is defined by the links between the item attribute and the items. Therefore, the misunderstanding of a preference type definition can be considered the misunderstanding of a link definition.

Figure 3 shows an example of a preference type model containing misunderstood links. The misunderstandings are classified into the following three patterns.

(a) Incorrect relationship
(b) Weak relationship
(c) Unexpected relationship

The model shows the structure of relationships pertaining to a "health-conscious" preference type. The solid lines in Fig. 3 represent relationships defined by persons, and the dotted lines are relationships that were unexpected. This model shows that the persons in charge think "health-conscious" consumers are likely to purchase low-fat items and supplements.

Misunderstanding (a) refers to relationships that have been incorrectly defined because the person doing the manual definition observed no relations in the actual world. For example, if consumers who belong to the "health-conscious" preference type avoid having a snack between meals, they are unlikely to purchase snacks even if the snacks are low fat. In such cases, a low-fat snack food such as low-fat potato chips would have no relation.

Misunderstanding (b) expresses misunderstanding of quantity. Sometimes a few relations will be weaker than others. In this case, while "health-conscious" persons are likely to purchase supplements, they are expected to do so less frequently than they purchase low-fat items. That is, consumers who belong to the "health-conscious" type have a tendency not to prefer supplements as much as items in the low-fat category—except for snack foods, because (as the reader will recall) they are less likely to snack between meals. The strength of each relationship needs to be examined individually.

Misunderstanding (c) occurs when relationships are not defined even though they have a relation in the actual world. In this example, actual consumers who belong to the "health-conscious" type have a tendency to exercise frequently and are therefore likely to purchase exercise gear, so the "health-conscious" type should show an additional relationship with exercise gear in the model in order to reflect the actual behavior.

When relying on human knowledge alone, it is difficult to provide a perfect definition that avoids the misunderstandings discussed here. In most cases, people do not understand all of the item attributes and items that should be considered, typically looking at only the qualitative relationships between preference types and items. Therefore, a data analysis method is required that can improve upon the preference type model by calculating a quantitative index of relation strength in order to build a preference type model that accurately reflects the actual world.

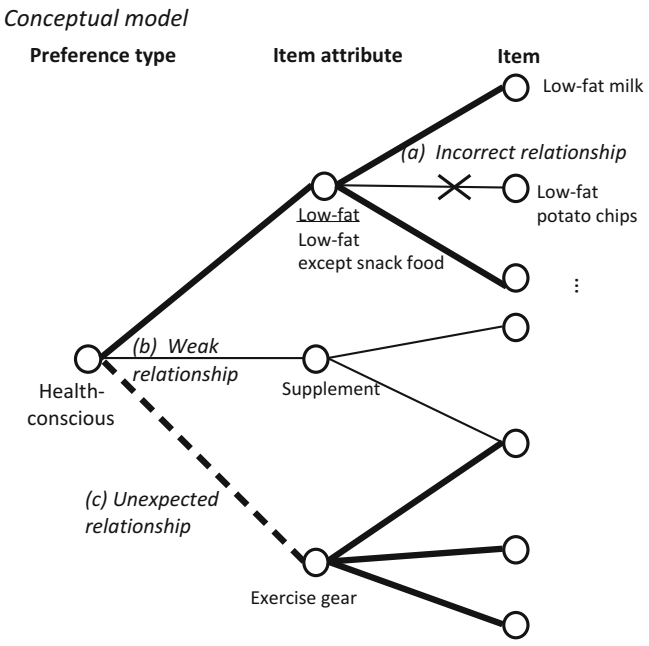

Fig. 3 Example of preference type model in conceptual layer

3.3 Proposed Method to Evaluate Preference Type Model

Figure 4 shows the approach to evaluating and building an accurate conceptual preference model. There are three steps:

Step 1: Estimate relationships between preference types T_i and items in real term I_m^t.
Step 2: Evaluate the strength of preference types T_i and item attributes A_k and the relationships between item attributes A_k and items I_m.
Step 3: Specify the misunderstood definition and update the model.

Steps 1 and 2 are discussed in detail in Sects. 2.3.1 and 2.3.2, respectively. Step 3, in which the misunderstanding is specified, has already been carried out by the authors on the

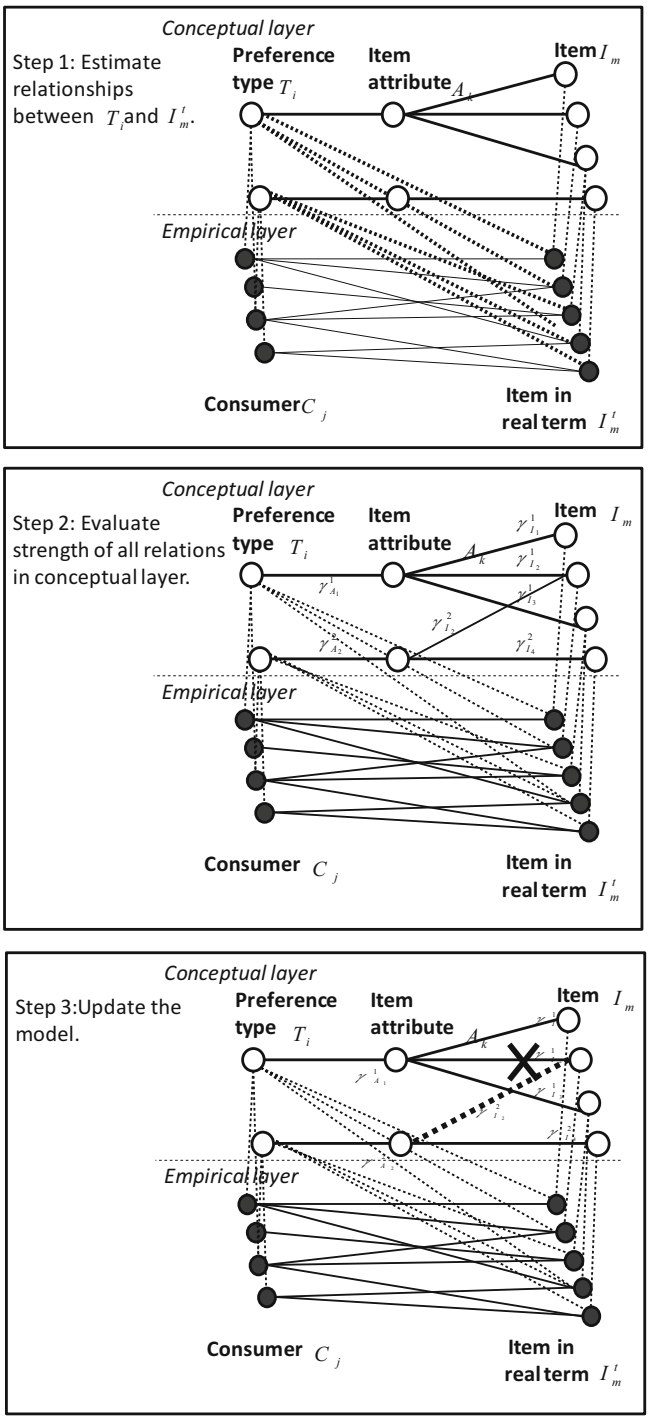

Fig. 4 Approach to building a precise preference type model

basis of the quantitative evaluation results in this research. Automatic modification of the model is the future work.

3.3.1 Process Flow of Step 1

In step 1, each item in real term I^t_m is analyzed, and direct links between T_i and I^t_m are estimated on the basis of actual purchases. Direct links between T_i and I^t_m are estimated in the case that an I^t_m is purchased more frequently by consumers of T_i than by other consumers. The following three calculations are done for this estimation:

- Calculating purchase frequency ratio h^i_{mt} of T_i and the whole for I^t_m
- Calculating cumulative probability α^i_{mt} derived by probability distribution $P_h\left(x\middle|N^{whole}_{mt}\right)$
- Estimating links between T_i and I^t_m

Purchase frequency ratio h^i_{mt} is calculated as

$$h^i_{mt} = N^i_{mt}/N^{whole}_{mt}, \tag{1}$$

where N^i_{mt} is the average purchase number of I^t_m per consumer for consumers with preference type T_i at time t and N^{whole}_{mt} is the average purchase number of purchasing I^t_m per consumer for all consumers. Ratio h^i_{mt} evaluates how likely item I_m is to be purchased at time t by consumers with T_i. When ratio h^i_{mt} is higher, the consumers with T_i are considered more likely to purchase I^t_m. However, these indices cannot be compared to each other when N^{whole}_{mt} are largely different because the degree of ratio h^i_{mt} also depends on N^{whole}_{mt}. On the other hand, cumulative probability α^i_{mt} represents the deviation degree of h^i_{mt} from the average ratio in the case of I^t_m. If $P_h\left(x\middle|N^{whole}_{mt}\right)$ could be estimated, cumulative probability α^i_{mt} can be an index of the purchase tendency among all I^t_m. In this research, $P_h\left(x\middle|N^{whole}_{mt}\right)$ is assumed to follow two hypotheses:

Hypothesis 1 $P_h\left(x\middle|N^{whole}_{mt}\right)$ is expressed by parametric distribution.

Hypothesis 2 Parameters for $P_h\left(x\middle|N^{whole}_{mt}\right)$ can be estimated by N^{whole}_{mt}.

If these hypotheses are correct, $P_h\left(x\middle|N^{whole}_{mt}\right)$ can be estimated by estimating the parameters calculated by N^{whole}_{mt}. These hypotheses are verified and the parameter expressions are learned in Sect. 3.

Finally, links between T_i and I^t_m are estimated. These links indicate if the purchase tendency of consumers of T_i for I^t_m has deviated from the usual tendency, making them more likely to purchase the item. All links between T_i and I^t_m are determined when α^i_{mt} is more than a threshold (set as 0.95).

3.3.2 Process Flow of Step 2

In step 2, all possible relationships in the conceptual layer are evaluated in terms of the strength of relationships represented by $\gamma^i_{A_k}$ and $\gamma^i_{I_m}$. The strength of relationships

between T_i and A_k is evaluated by $\gamma^i_{A_k}$:

$$\gamma^i_{A_k} = L^i_{A_k}/Z_{A_k}, \quad (2)$$

where Z_{Ak} is number of I^t_m that define the relations to A_k through nodes of I_m in conceptual layer and $L^i_{A_k}$ is the number of I^t_m that have a direct link to T_i estimated in step 1 on the basis of actual data. The index $\gamma^i_{A_k}$ represents the rate of days that items are estimated as likely to be purchased by T_i. When the rate of purchased days $\gamma^i_{A_k}$ is high, it means that consumers who belong to T_i are likely to purchase any item of I_m that belongs to A_k at any time of t. The $\gamma^i_{A_k}$ shows an index of the positive influence of T_i consumers on A_k items.

Similar to $\gamma^i_{A_k}$, the index $\gamma^i_{I_m}$ represents the rate of days that items are estimated as likely to be purchased by T_i compared with overall days that items defined as related to I_m are offered.

When the rate of purchased days $\gamma^i_{A_k}$ is high, it means that consumers who belong to T_i are likely to purchase I_m at any time.

4 Experiment

The proposed method was used to qualitatively evaluate a model of preference types defined manually. Anonymous ID-POS data from a company cafeteria was analyzed.

In the experiment, first, preference types were defined on the basis of knowledge from cafeteria workers and then used to estimate each consumer's types (detailed in Sect. 4.2).

Second, direct links between T_i and I^t_m based on actual purchases were estimated. For the link estimation, a method was developed for estimating the probability distribution of purchase ratio $P_h\left(x|N^{whole}_{mt}\right)$ (explained in Sect. 4.3).

Finally, the model was quantitatively evaluated in the conceptual layer from these estimation results (discussed in Sect. 4.4).

4.1 Data Setting

The lunchtime purchase records (with anonymous user IDs) over the course of 72 days were analyzed. The average daily number of consumers at lunchtime was 417 and the total number of consumers was 1689. The number of purchase records was 92,713.

This cafeteria had 11–15 categories on its main menu and 20–30 on its side menu. Each menu category offered one corresponding menu item; these were rotated on a daily basis.

4.2 Manual Definition and Link Estimation

In the experiment, it was assumed that certain consumers would prefer particular categories and purchase menu items from the preferred category more often than other persons. Eleven typical main menu categories were chosen as item attributes. The preference types that correspond to each category were defined (listed in Table 1). For example, one of the preference types is "Cost-efficient" and the type related to it is the Low-Price Lunch category.

In this model, items I_m represent menus. Since each menu belongs to one category, only one link from an item I_m to an item attribute A_k is defined. An item in real term I^t_m represents menu I_m offered on day t. Some of the same menu items were offered on several different days over the course of the experiment, while others were offered on only 1 day.

All categories had menu items on offer every day except for Special Ramen, which offered items on only 65 of the 72 days of the experiment. That is, all preference types except for Special Ramen Fan are related to 72 items in real terms and Special Ramen Fan is related to 65.

Each consumer's preference types were estimated on the basis of these definitions. A total of 970 consumers were considered to belong to at least one preference type. The average number of consumers for each preference type was 173. Standard deviation among types was 21 people and all preference types had at least 100 people.

The evaluation of the manual definition was conducted on the basis of this model and is elaborated upon in the following sections.

4.3 Probability Distribution of Purchase Ratio Estimation Based on Actual Data

As mentioned in Sect. 3.3.1, probability distribution $P_h\left(x|N^{whole}_{mt}\right)$ is assumed to be estimated on the basis of actual data according to the following two hypotheses:

Table 1 Definition of preference types

Preference type	Item attribute (category)
Cost-efficient	Low-price lunch
Standard lunch fan	Standard lunch
Health conscious	Healthy lunch
Light meal fan	One plate lunch
Luxury oriented	Special set
Ethnic lunch fan	Ethnic lunch
Pasta fan	Pasta
Curry fan	Curry
Japanese noodles fan	Japanese noodles
Ramen fan	Ramen
Special ramen fan	Special ramen

Hypothesis 1 $P_h\left(x\middle|N_{mt}^{whole}\right)$ is expressed by parametric distribution.

Hypothesis 2 Parameters for $P_h\left(x\middle|N_{mt}^{whole}\right)$ can be estimated by N_{mt}^{whole}.

In order to verify these hypotheses, all of N_{mt}^{whole} and all of N_{mt}^{i} for each I_m^t and T_i were calculated by utilizing the ID-POS data in the cafeteria. The max and min values of N_{mt}^{whole} were 0.69 and 0.0018, respectively. The max and min values of N_{mt}^{i} were 1.00 and 0.00, respectively.

As explained in the Sect. 3.3.1, h_{mt}^{i} is derived from the value of N_{mt}^{whole} and N_{mt}^{i}. In this research, the data sets of N_{mt}^{whole} were made according to the size of logarithms of the N_{mt}^{whole} before the calculation of h_{mt}^{i}. The reason of this operation is to create data sets of h_{mt}^{i} which can ignore the dependence of h_{mt}^{i} on N_{mt}^{whole}. The step width for each set was 0.1. Then, data sets of h_{mt}^{i} were calculated by the data sets of N_{mt}^{whole}.

To verify hypothesis 1, a Shapiro-Wilk normality test was administered for each data set of h_{mt}^{i} except in cases where h_{mt}^{i} was zero. All of data sets were shown to follow a normality distribution significantly ($p < 0.01$). It can be said that the distribution of each data set can be estimated by three parameters: parameters of normality distribution, that is, average and standard deviation, and the probability that h_{mt}^{i} is zero. Thus, hypothesis 1 is validated.

Next, to verify hypothesis 2, the relationship between each N_{mt}^{whole} and each parameter was investigated for distribution. Average and standard deviation and zero probability for each range of data set were calculated, and the correlation between the average of the common logarithms of N_{mt}^{whole} for each range and each parameter for each range were then analyzed. Results showed significant negative correlations for all parameters. Therefore, regression expression utilizing N_{mt}^{whole} for each parameter was defined, and the weights of each expression were learned by utilizing the calculation results of h_{mt}^{i}. Since all coefficients of determinations were more than 0.9, it can be said that each parameter could be approximated by N_{mt}^{whole}. Thus, hypothesis 2 is validated.

In this experiment, the links between T_i and I_m^t were estimated according to the expressions for the distribution parameters of h_{mt}^{i}, $P_h\left(x\middle|N_{mt}^{whole}\right)$, and α_{mt}^{i}. The estimation results were then utilized for the calculation in step 2, thus realizing quantitative evaluation. In the next section, the results of the model evaluation are explained.

4.4 Evaluation Results of Model in Conceptual Layer

The evaluation results of the model in the conceptual layer are shown in Fig. 5. Relationships in which $\gamma_{A_k}^{i}$ and $\gamma_{I_m}^{i}$ are more than 0.2 can be been seen. Links between T_i and A_k represent the relationship between T_i and A_k. Thick lines represent strong relationships with indices over 0.8.

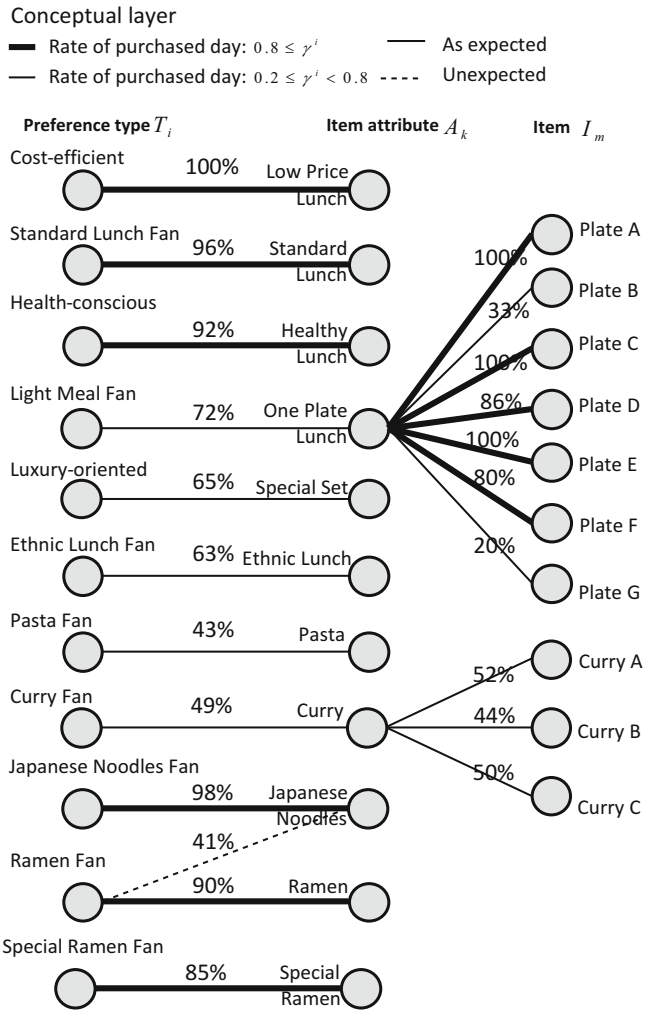

Fig. 5 Evaluation results of model in conceptual layer

The strengths of the relationship between T_i and A_k are different, ranging from 20 % to 100 %. For example, take the index of the link between Cost-efficient and Low-Price Lunch, which shows 100 %. That is, a Cost-efficient consumer purchased the Low-Price Lunch much more often than other consumers on 100 % of the days on which low-price menu items were offered. It can be concluded that the Cost-efficient consumers had a strong preference for the Low-Price Lunch. On the other hand, Pasta Fans only purchased Pasta items on 43 % of the days they were offered. The days Pasta Fans strongly preferred Pasta accounted for less than half of all the days.

The dotted line in Fig. 5 means that the links were not as expected from the manual definition. There was only one

such case, where a Ramen Fan had been considered to prefer not only Ramen but also Japanese Noodles, which turned out to be incorrect.

Links between A_k and I_m represent the relationship of I_m to T_i linked with A_k. For example, the link between One Plate Lunch and Plate A shows the relationship between the Light Meal Fan and Plate A. The fact that the $\gamma^i_{I_m}$ of the link is 100 % indicates that the Light Meal Fan prefers Plate A at all times. Links between A_k and T_i which are not strong were investigated in this research. The preference types are considered as not strong in case that the $\gamma^i_{A_k}$ of the link as expected was less than 0.8. The relationships with items offered on more than 5 days were analyzed and ten relationships were observed.

5 Consideration

5.1 The Utility of the Evaluation Results for Preference Type Understanding

In the experiment, the preference type model was built on the basis of human knowledge. The manual definition was evaluated to determine if the proposed model was useful in terms of improving the understanding of consumer preference, and three patterns of misunderstanding, as shown in Fig. 6, were extracted from the results.

Misunderstanding (a) was observed in relationships between Light Meal Fans and items included in the One Plate Lunch category. The evaluation results showed that some items were preferred as expected while other items were not preferred as much. It is possible that actual items attracting that group of consumers are partially as expected, even though seven items are assumed to attract the Light Meal Fans. To confirm this, the rate of purchased days $\gamma^i_{A_k}$ is calculated by removing the link of items that showed a low degree of $\gamma^i_{I_m}$. Compared with the $\gamma^i_{A_k}$ of the first definition, the degree of the calculated results increased, as shown in Fig. 6a. The group of consumers assumed to be Light Meal Fans can be interpreted as Specific Light Meal Fans, that is, a group that prefers only certain items in the One Plate Lunch category.

Misunderstanding (b) was observed in relationships pertaining to the Curry Fans. The evaluation results show that Curry Fans are likely to purchase Curry Lunch more than other persons on 49 % of the days but not on the other days. It is also shown that there is no difference of preference degree among items. That is, any curry is considered not purchased so frequently, even though Curry Fans like Curry much more than other consumers. Compared with other preference types (such as those shown in Fig. 6a, c), the relationship strength of Curry Fans is weaker. It is concluded

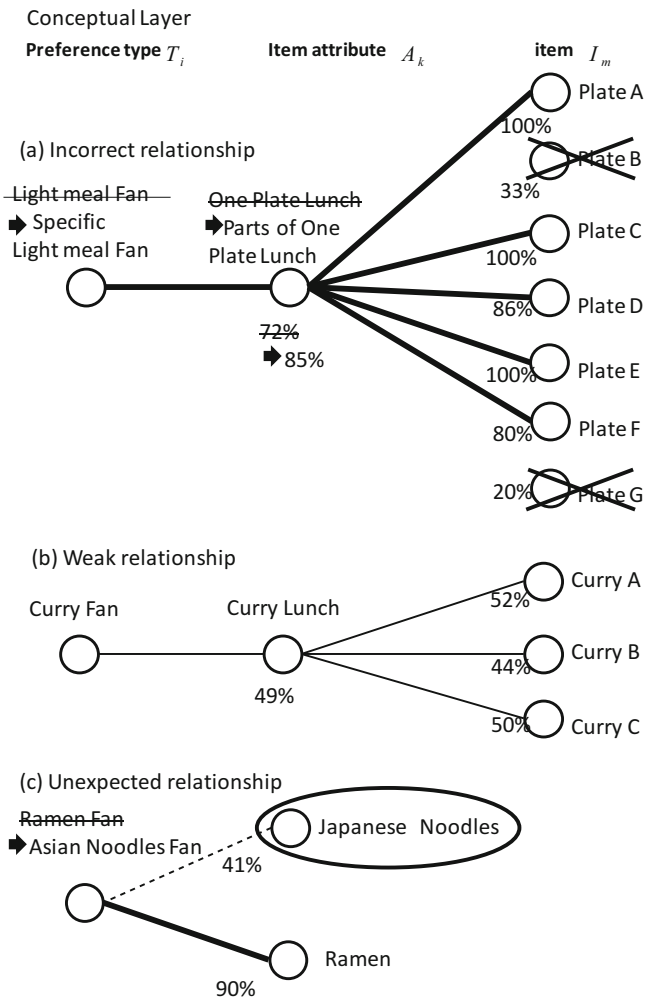

Fig. 6 Evaluation results of model in conceptual layer

that the preference tendencies of each group are different, though some groups who liked particular item groups were extracted. This demonstrates the importance of quantitative evaluation for precise understanding of preference tendency.

Misunderstanding (c) was observed in the relationships of the Ramen Fans to the item attributes. In this case, consumers who preferred purchasing Ramen also purchased Japanese Noodles. The group of consumers assumed to be Ramen Fans can therefore be reinterpreted as Asian Noodles Fans, that is, a group that likes not only Ramen but also Japanese Noodles. This group has no relationship with Special Ramen, and because Special Ramen is much more expensive than other Asian noodles, it can be assumed that this type of consumer likes all noodles with the exception of expensive ones.

The above considerations demonstrate that defining a conceptual model utilizing only a person's knowledge results in various patterns of misunderstanding and that the proposed method is useful to detect these misunderstandings. It can be said that the proposed solutions help with the precise building

of a conceptual model of preference and helps people change their quantitative and qualitative understanding of consumer preference tendencies.

5.2 The Utility of the Method for Service Improvement

In this section, the utility of the proposed method and model for service improvements was considered. The model has three key advantages:

1. The relationships between consumers and items shown in the conceptual layer of the model are understandable.
2. It shows the strength of relationships quantitatively.
3. The model is related to actual data in the empirical layer.

According to points 1 and 2, the model is helpful in both the conceptual and quantitative planning of services, such as new product development, merchandising, and marketing strategy planning.

Conceptual planning refers to tasks such as coming up with concepts for new products, promotions, and stores. In terms of the planning, precisely understanding how the structure of the concept is reflected in the actual purchasing behavior is essential. As shown in Fig. 6a, c, the method can point out where people are misunderstanding the concept and help them modify their thinking and understand the correct structure of each concept in terms of the purchase tendency of the consumer group and how items attract a particular consumer group.

In the planning process, quantitative consideration of the effectiveness of a service plan, such as predicting the market scale of each preference type, is also integral. The model helps people understand the quantitative relationships between consumer groups and items. For example, from the results of the experiment, it can be understood that Curry Fans prefer curry not every day but on 49 % of days. The model is considered to be quite useful for such quantitative considerations. The model also has potential in terms of the quantitative prediction of service effectiveness based on the quantitative evaluation results.

The model also contributes to the embodiment of effective services because it precisely links behavior to actual data. For example, once a person selects a target preference type, the actual consumers related to the type and the items related to those consumers can be extracted in accordance with the model. This enables the realization of services that recommend items to consumers. As shown in Fig. 6a, the precision of extracting items considered to be purchased by a consumer group improves after modification of the model. This indicates that the model can improve service effectiveness in the process of embodying the service.

6 Conclusion

The aim with this research is to build a conceptual preference model that helps the persons in charge obtain precise knowledge about consumer preference types. There are two main problems when it comes to realizing an understandable and precise preference type model: one, there is no practical model that represents both human conceptual understanding of preference types and knowledge based on data, and two, there is no method that can evaluate and modify manual definitions of preference types.

To solve these problems, a model with two layers that can independently reflect knowledge from both human and data sources was proposed. An evaluation method was also proposed for detecting human misunderstanding patterns by calculating the degree of strength of all possible relationships on the basis of relationships in the empirical layer.

An experiment in a company cafeteria was performed to determine the effectiveness of the proposed model and method. Eleven preference types were defined on the basis of retailers' knowledge, and consumers who belonged to these types were then estimated utilizing ID-POS data. The results of evaluation by the proposed method showed that the model could detect all patterns of misunderstanding. It is concluded that this quantitative evaluation based on data helps with the building of a precise preference conceptual model that assists the persons in charge with their conceptual understanding of consumer preference tendencies.

The results also suggest that the proposed method and model help with the planning of new product developments, merchandising, and marketing strategy planning and improve service effectiveness in retailers.

The future works will focus on the following.

1. Development of an automatic modification method
2. Validation of the method with more complex conceptual preference models such as models with a hierarchical structure of item attributes and models that can detect personal fluctuations of preference
3. Development of a method for precise quantitative prediction of service effectiveness based on the model
4. Evaluation of the utility for service improvement with various types of retailer

References

1. Tsukasa I., Takeshi T., and Yoichi M., 2010, Computational Customer Behavior Modeling for Knowledge Management with Automatic Categorization Using Retail Service's Datasets, IEEE 7th International Conference on ICBE, Shanghai, 10–2 Nov, pp. 528–533.

2. Chao-Jung C., Singa Wang C., Chi-Bin C., and Jiun-Yi W., 2012, Customer lifetime value prediction by a Markov chain based data mining model: Application to an auto repair and maintenance company in Taiwan, Scientia Iranica, vol. 19, 3 June, pp. 849–855.
3. Chieg-Yuan T. and Chuang-Cheng C., 2004, A purchase-based market segmentation methodology, Expert Systems with Applications, vol. 27, 2 August, pp. 265–276.
4. Girish P. and David W.S., 1983, Cluster Analysis in Marketing Research: Review and Suggestions for Application, Journal of Marketing Research, vol. 20, 2 May, pp. 134–148.
5. John B. S., Joseph A. K., and John R., 2001, E-Commerce Recommendation Applications, Data Mining and Knowledge Discovery, vol. 5, 1–2 January, pp. 115–153.
6. Pasquale L., Marco de G., and Giovanni S., 2011, Content-based Recommender Systems: State of the Art and Trends, Recommender Systems Handbook, pp. 73–105.
7. Berry B., 2006, Developing an Effective Customer Loyalty Program, California Management Review, vol. 49, no. 1, Fall, pp. 23–48.
8. Clive H. and Terry H., 2004, Scoring Points: How Tesco is Winning Customer Loyalty, Kogan Page Publishers, pp. 50–52.

Are Superior Services Always Good for Satisfaction Formation? Consideration of Indebtedness to a Contact Person

Takahiro Chiba

Abstract

A contact person has attempted to achieve a higher level of customer satisfaction by providing superior services. However, do higher-quality services always lead to *higher* customer satisfaction? The model developed by social psychologists, Greenberg and Westcott, Indebtedness as a mediator of reactions to aid. In: Fisher JD, Nadler A, DePaulo BM (eds) New directions in helping, volume 1: recipient reaction and aid. Academic Press, New York, pp 85–112, 1983, connotes that customers are likely to feel negative affect toward a contact person via indebtedness and/or other mediators, but this model has remained unexamined empirically. This study integrates these mediators into five factors and empirically tests the effects of customer benefit on satisfaction mediated by five factors and indebtedness. The results of SEM show that indebtedness caused by customer benefit decreases satisfaction.

Keywords

Service • Satisfaction • Indebtedness • Contact person

1 Introduction

A contact person (CP) in firms often influences customers' decision-making process in purchasing by providing useful information to customers or by making them feel superior through polite services. If a CP recommends a specific product, then customers may accept the recommendation and buy the recommended product. Thus, superior services provided by the CP may be a key to increasing loyalty to a firm rather than to competitors [1]. This is why firms attempt to provide superior services for higher customer benefit, to achieve higher customer satisfaction and, thus, higher sales.

Then, does higher customer benefit from superior services always lead to higher customer satisfaction? Services marketing researchers may answer yes to that question. They have developed and tested models describing that higher customer benefit leads to higher customer satisfaction [1–3]. Some researchers have shown that customer satisfaction with the CP has a positive effect on satisfaction with the firm and that these two kinds of satisfaction lead to higher loyalty and positive word of mouth and, therefore, to repurchasing behavior [1].

On the other hand, some social psychologists may answer "no" to the same question. They developed a conceptual model describing how a recipient of aid is likely to feel negative as well as positive affect toward a donor/helper via indebtedness and/or other mediating variables [4, 5]. In the context of services, when a CP provides extra information to help a customer, the customer may be *less* satisfied because he/she may feel embarrassed or indebted for having received superior services and feel that there is some need to repay the CP. This is an important point that service marketing researchers have not yet discussed. The model developed by social psychologists may be more realistic than those of service marketing researchers. However, the former model

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has remained unexamined empirically, and some of the constructs in the model are similar to, or near opposites of, each other.

This study aims to present a clear picture of the formation of customer satisfaction in the real world by elaborating and testing the model developed by social psychologists. The results of structural equation modeling show that customer benefit has not only positive effects but also negative effects on customer satisfaction only through customer indebtedness to the CP.

2 Literature Review

2.1 Effects of Customer Benefit on Satisfaction

Some customer satisfaction researchers have claimed that superior services yielded customer benefit and satisfied customer needs [3, 6, 7] have extended the concept of customer benefit and claimed that customer benefit may be divided into confidence, social benefit, and special treatment benefit.

Other researchers have shown effects of customer benefit on satisfaction. Van Dolen et al. [8] claimed that a CP's services were divided into the contact employee level and the interaction level and that these services positively affected satisfaction with the CP and the firm. Reynolds and Beatty [1] claimed that customer benefit was divided into functional and social benefits and that these benefits have positive effects on satisfaction with the CP and the firm, which, in turn, positively affected loyalty and positive word of mouth.

However, even if superior services yield customer benefit, customers may not always feel satisfied [9] and, therefore, may not always engage in an exchange with the firm again in the future. Indebtedness theory may provide a clue to revealing customer psychology in this situation.

2.2 Indebtedness Theory

Social psychologist, Greenberg [4], focused on the situation in which a favorable assistance did not always result in a favorable recipient's affective reaction. This notion is based on the norm of reciprocity [10]. Greenberg [4], incorporating the norm, defined indebtedness as "a state of obligation to repay another" (p. 4).

Later, Greenberg and Westcott [5] extended the indebtedness theory by developing a conceptual model that described how a recipient of aid is likely to feel negative as well as positive affect toward a donor/helper via indebtedness and/or the other ten mediating variables: (i) facilitating goal achievement, (ii) indicating a donor's positive regard for the recipient, (iii) indicating a recipient's higher status, (iv) indicating the value of the recipient's resources, (v) legitimizing future interactions with the donor, (vi) attributing manipulative intent, (vii) restricting the recipient's freedom, (viii) assessing the costs of repayment, (ix) interfering with goal achievement, and (x) threatening the recipient's self-esteem.

Of these, (i)–(v) are the reasons a recipient feels positive affections. In service context, (i) facilitating goal achievement means that superior services are perceived to reduce the task of searching for products/services. (ii) Indicating a donor's positive regard for the recipient means that superior services are perceived as a CP's kindness. (iii) Indicating the recipient's higher status means that superior services are perceived to suggest a higher status for the customer than that for the CP. (iv) Indicating the value of a recipient's resources means that superior services are perceived to lead a customer to the right choice of products/services. (v) Legitimizing future interactions with the donor means that superior services are perceived to make the long-term relationship between the CP and the customer more valuable.

Meanwhile, (vi)–(x) are reasons a recipient feels negative affections. In service context, (vi) attribution of manipulative intent means that superior services are perceived to be provided for self-serving reasons. (vii) Restricting the recipient's freedom means that superior services are perceived to restrict the customer's freedom to choose. (viii) Assessing costs of repayment means that superior services are perceived to be costly to repay. (ix) Interfering with goal achievement means that superior services are perceived adversely, making it more difficult for the customer to search for products/services. (x) Threatening to the recipient's self-esteem means that superior services are perceived to be provided because the CP thinks that the customer's ability to select is low.

Greenberg and Westcott [5] considered individuals who act not only in self-interest but also with altruism and, thus, thought out ten mediators. However, these mediators lack empirical testability and even logical validity because some of the mediators are conceptually similar to, or near opposites of, each other.

3 Model Development

3.1 Ten Mediators to Five Factors

Service researchers have overlooked the point that a customer may be *less* satisfied because he/she feels indebted to a CP, whereas social psychologists, Greenberg and Westcott [5], have not. However, some of the constructs in their model are just similar or opposite to each other, and thus, they have to be put in order and reduced. This study integrates (i–x)

Table 1 Integrating (i–x) mediators

(i–x) Mediators [5]		Five factors (this study)
Sources of positive affections	(i) Facilitating goal achievement	(a) Task reduction (TR)
	(ii) Indicating a donor's positive regard for a recipient	(b) Status indication (SI)
	(iii) Indicating a recipient's higher status	
	(iv) Indicating the value of a recipient's resources	(c) Relationship benefit (RB)
	(v) Legitimizing future interaction with a donor	
Sources of negative affections	(vi) Attribution of manipulative intent	(d) Conflict of interest (CoI)
	(vii) Restricting a recipient's freedom	
	(viii) Assessing costs of repayment	(e) Costs of repayment (CoR)
	(ix) Interfering with goal achievement	(a) Task reduction (TR)
	(x) Threatening to a recipient's self-esteem	(b) Status indication (SI)

mediators to the following five factors and enhances the empirical testability of the model: task reduction, status indication, relationship benefit, conflict of interest, and costs of repayment, as shown in Table 1.

First, (i) facilitating goal achievement and (ix) interfering with goal achievement are just about opposites, and both of them mean a reduction in a customer's search task to achieve his/her shopping goal. These are integrated into (a) task reduction (TR). Second, (ii) indicating a donor's positive regard for the recipient, (iii) indicating a recipient's higher status, and (x) threatening to a recipient's self-esteem are involved in perceived CP condescension toward a customer. These are integrated into (b) status indication (SI). Third, (iv) indicating the value of a recipient's resources and (v) legitimizing future interactions with a donor are involved in the benefit of the relationship between a customer and a CP. These are integrated into (c) relationship benefit (RB). Fourth, (vi) attribution of manipulative intent and (vii) restricting a recipient's freedom are involved in the situation in which a CP's services are perceived as being against a customer's needs. These are integrated into (d) conflict of interest (CoI). Finally, (viii) assessing costs of repayment (CoR) is independent of the other mediators.

3.2 Effects of Customer Benefit

This study considers the degree of help attempt in Greenberg and Westcott [5] as customer benefit and assume that mediating factors discussed in the previous section are positively affected by customer benefit [2] whereas this study hypothesizes that (d) conflict of interest is negatively affected by customer benefit. Greenberg and Westcott [5] suggested that conflict of interest occurs even if a CP would like to provide superior services.

Thus, the following hypotheses are proposed:

H1: Customer benefit (CB) has a positive effect on (a) task reduction (TR).
H2: Customer benefit (CB) has a positive effect on (b) status indication (SI).
H3: Customer benefit (CB) has a positive effect on (c) relationship benefit (RB).
H4: Customer benefit (CB) has a negative effect on (d) conflict of interest (CoI).
H5: Customer benefit (CB) has a positive effect on (e) costs of repayment (CoR).

3.3 Effects of Five Factors

Customer satisfaction has been treated as a customer's affective reaction [11]. Satisfaction is positively affected by (a) task reduction, (b) status indication [3], and (c) relationship benefit and negatively affected by (d) conflict of interest and (e) costs of repayment [5].

Thus, the following hypotheses are proposed:

H6: (a) Task reduction (TR) has a positive effect on satisfaction (Sat.).
H7: (b) Status indication (SI) has a positive effect on satisfaction (Sat.).
H8: (c) Relationship benefit (RB) has a positive effect on satisfaction (Sat.).
H9: (d) Conflict of Interest (CoI) has a negative effect on satisfaction (Sat.).
H10: (e) Costs of repayment (CoR) has a negative effect on satisfaction (Sat.).

3.4 Effects of Customer Benefit via Indebtedness

Customer benefit can affect indebtedness positively [5]. Greenberg and Westcott [5] claimed that (iv) indicating the value of a recipient's resources, (v) legitimizing future interactions with a donor, (vi) attribution of manipulative intent, (vii) restricting recipient's freedom, and (viii) assessing costs of repayment were positively affected by indebtedness.

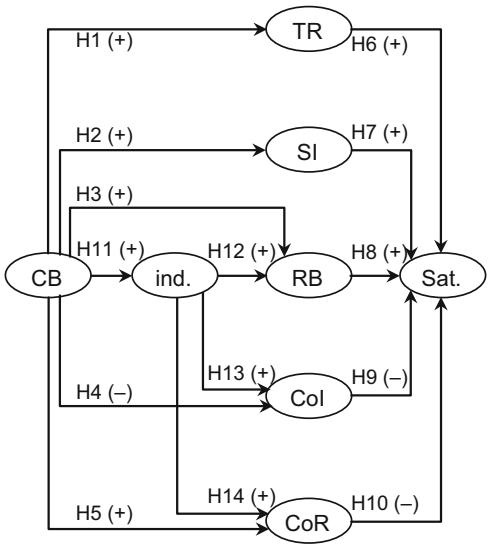

Fig. 1 Proposed model

Thus, the following hypotheses are proposed:

H11: Customer benefit (CB) has a positive effect on indebtedness (Ind.).
H12: Indebtedness (Ind.) has a positive effect on (c) relationship benefit (RB).
H13: Indebtedness (Ind.) has a positive effect on (d) conflict of interest (CoI).
H14: Indebtedness (Ind.) has a positive effect on (e) costs of repayment (CoR).

The set of hypotheses can be summarized as shown in Fig. 1.

4 Empirical Test

4.1 Measurement and Data Collection

This study sets multiple items for each construct. The scale items used to assess customer benefit were based on the work of Reynolds and Beatty [1]. The scales for indebtedness were based on Dorsch and Kelley [12]. The scales for satisfaction were based on the works of Oliver [11] and Reynolds and Beatty [1]. The scales for the other constructs were developed deliberately based on Greenberg and Westcott's [5] description. This study used a seven-point scale (1, strongly disagree; 7, strongly agree). The scale items are presented in Table 2.

This study conducted an online survey and collected consumer data pertaining to shopping experiences involving interaction or communication with a CP. Respondents were asked to recall a particular service experiences with the CP. Questionnaires were administered to 2290 respondents, which of them 417 were deemed usable after list-wise deletion (18.2 %).

Cronbach's alpha for customer benefit was 0.67, but those for the other constructs were between 0.74 and 0.91. Scale composite reliabilities for all constructs were between 0.65 and 0.98 which were above the recommended level of 0.60, and average variance extracted for all constructs were between 0.53 and 0.75 which were above the recommended level of 0.50 [13].

Table 2 Summary of scale items

Customer benefit (CB)
The contact person helps my good shopping
I talk with the contact person friendly
I enjoy shopping thanks to the contact person
Task reduction (TR)
I think that it is reasonable if I make a purchase as the contact person recommends
I think that I do not make a mistake if I make a purchase as the contact person recommends
I consider the contact person's advice to be convincing
Status indication (SI)
The contact person takes good care of me
The contact person respects me
The contact person explains features of a product too much (r)
Relationship benefit (RB)
In the future the contact person will resolve my problems
In the future I will talk to the contact person
In the future I will ask the contact person about a product
Conflict of interest (CoI)
The contact person persistently recommends a product to me
It is difficult to understand the contact person quickly
Costs of repayment (CoR)
I have difficulty in expressing my gratitude
It is bothering to buy something at the shop
It takes time to buy something at the shop
Indebtedness (Ind.)
I have a strong sense of personal duty to repay the favor received from the contact person
It is very important for me to repay the favor received from the contact person
I expect to repay the favor received from the contact person
I have a strong sense of professional duty to repay the favor received from the contact person
I have a strong sense of duty to repay the favor received from the contact person
Satisfaction (Sat.)
I am satisfied with the services offered by the contact person
I am happy to talk with the contact person

4.2 Model Estimation

The structural equation was estimated using maximum likelihood procedure. Results are presented in Table 3.

Table 3 Estimation results

H1: CB =(+)=> TR	0.575	$(t = 7.99)^{***}$
H2: CB =(+)=> SI	0.780	$(t = 9.45)^{***}$
H3: CB =(+)=> RB	0.737	$(t = 0.754)^{***}$
H4: CB =(+)=> CoI	−0.749	$(t = -6.76)^{***}$
H5: CB =(+)=> CoR	−0.611	$(t = -6.53)^{***}$
H6: TR =(+)=> Sat.	0.090	$(t = 2.66)^{***}$
H7: SI =(+)=> Sat.	0.513	$(t = 12.40)^{***}$
H8: RB =(+)=> Sat.	0.247	$(t = 6.01)^{***}$
H9: CoI =(+)=> Sat.	−0.192	$(t = -4.95)^{***}$
H10: CoR =(+)=> Sat.	−0.073	$(t = -2.19)^{**}$
H11: CB =(+)=> Ind.	0.577	$(t = 7.37)^{***}$
H12: Ind. =(+)=> RB	0.073	$(t = 1.28)^{n.s}$
H13: Ind. =(+)=> CoI	0.450	$(t = 5.36)^{***}$
H14: Ind. =(+)=> CoR	0.426	$(t = 5.48)^{***}$

$\chi^2_{(216)} = 1020.85$, GFI = 0.82, AGFI = 0.77, RMSEA = 0.09, AIC = 1140.85, SBC = 1382.83

*** is significant at 1 % level, ** is significant at 5 % level, and $^{n.s}$ is not significant

The χ^2 for the proposed model was 1020.85, and the χ^2/d. f. was 4.73, which was within the recommended range (not higher than 5.00) [14]. The goodness-of-fit index (GFI) and the GFI adjusted by the degree of freedom (AGFI) were 0.82 and 0.77, respectively, which were lower than the recommended level (not lower than 0.90) [13], but these were probably due to the large model and the relatively small sample size. In this case, a useful index is the root mean square error of approximation (RMSEA), a parsimony measure that accounts for potential artificial inflation due to the estimation of many parameters. The RMSEA was 0.09, which was equal to the recommended level of 0.09 [15]. The results indicated a close fit of the data to the proposed model, even though some indices did not fall within the recommended range.

All parameter estimates were significant with the exception of H12 (positive effects of indebtedness on relationship benefit). This may be because indebtedness is psychological burden and it may not provide a customer's interest or benefit. Also, contrary to the hypothesis, the sign of the parameter estimate of H5 (positive effects of customer benefit on costs of repayment) was negative. This may be because a help attempt by contact person is not always good for a customer, whereas customer benefit always means a good help attempt, and thus, benefit in the model may be opposite to costs of repayment.

4.3 Effects of Customer Benefit via Five Factors

H1-H4 and H6-H10 were supported, but H5 was not. Thus, higher customer benefit resulted in higher satisfaction via increased task reduction, status indication, and relationship benefit and via decreased conflict of interest and costs of repayment. The results showed that when customers receive superior services, they might be satisfied because the benefits (1) reduce the search task, (2) indicate their higher status, (3) increase the value of the relationship, (4) decrease conflicts of interest, and/or (5) decrease the costs of repayment.

4.4 Effects of Customer Benefit via Indebtedness

H11, H13, and H14 were supported, but H12 was not. Thus, higher customer benefit resulted in higher indebtedness, which, in turn, resulted in lower satisfaction via increasing conflict of interest and costs of repayment. The results also showed that when customers receive superior service, they might feel indebted and thus be dissatisfied because the benefits (1) increase the conflict of interest and (2) increase the costs of repayment.

5 Discussion and Conclusion

Without describing any psychological mechanism, service marketing researchers have claimed that customer benefit from superior services has a positive effect on customer satisfaction [1, 2]. The results of this study indicate that positive effects of customer benefit on satisfaction are mediated by five factors – task reduction (cf. [8]), status indication (cf. [3]), relationship benefit (cf. [1]), conflict of interest, and costs of repayment – whereas negative effects are mediated by two pairs of factors, indebtedness and conflict of interest/costs of repayment. Customers who feel indebted for superior services perceive costs of repayment and conflict with a CP with regard to their interest and, in turn, are dissatisfied with the CP as a result. Greenberg and Westcott's [5] study is less state-of-the-art in terms of oldness, but their findings provide fruitful insights for service marketing research.

Managerially, because superior services may increase indebtedness and thus decrease customer satisfaction, service firms should pay more attention to preventing their customers from feeling indebted. Even if customers were indebted against a CP's will, he/she can prove for their needs and/or be easy for the customers to talk with to avoid conflict of interest and/or costs of repayment. In conclusion, by elaborating a social psychological model and applying the model to service marketing research, this study makes an important contribution to the research on the formation of customer satisfaction with a CP.

6 Limitations and Future Research

This study has several limitations. First, the results showed that some overall fit indices did not fall within recommended ranges due to the large model and the relatively small sample size. Second, this study integrated Greenberg and Westcott's [5] ten mediators (facilitation of goal achievement, indication of donor's positive regard for recipient, indication of recipient's higher status, indication of value of recipient's resources, legitimization of future interaction with donor, attribution of manipulative intent, restriction of recipient's freedom, assessment of the costs of repayment, interference of goal achievement, and threat to recipient self-esteem) to five factors (task reduction, status indication, relationship benefit, conflict of interest, and costs of repayment) without several times of exploratory and confirmatory factor analyses even if the results of SEM showed high convergent and discriminant validity. These limitations should be addressed in the future work.

Further research should consider various customer and/or product (service) characteristics that might yield different results. Moreover, this study could also consider the relationship duration between a customer and a CP [16]. The incorporation of these recommendations in further research should result in an increased understanding of the determinants of customer satisfaction with services.

References

1. Reynolds, K. E., Beatty, S. E., 1999, Customer Benefits and Company Consequences of Customer-Salesperson Relationships in Retailing, Journal of Retailing 75 (1): 11–32.
2. Mohr, L. A., Bitner, M. J., 1995, The Role of Employee Effort in Satisfaction With Service Transaction, Journal of Business Research, 32 (3): 239–252.
3. Gwinner, K. P., Gremler, D. D., Bitner, M. J., 1998, Relational Benefits in Services Industries: The Customers Perspective, Journal of the Academy of Marketing Science, 26 (2): 101–114.
4. Greenberg, M. S., 1980, A Theory of Indebtedness, Gergen, K. J., Greenberg, M. S., Willis, R. H., eds., Social Exchange: Advances in Theory and Research, Plenum Press, New York, 3–26.
5. Greenberg, M. S., Westcott, D. R., 1983, Indebtedness as a Mediator of Reactions to Aid, Fisher, J. D., Nadler, A., DePaulo, B. M., eds., New Directions in Helping, Volume 1: Recipient Reaction and Aid, Academic Press, New York, 85–112.
6. Beatty, S. E., Mayer, M. L., Coleman, J. E., Reynolds, K. E., Lee, J., 1996, Customer-Sales Associate Retail Relationships, Journal of Retailing, 72 (3): 223–247.
7. Bitner, M. J., 1995, Building Service Relationships: It's All About Promises, Journal of the Academy of Marketing Science, 23(4): 246–251.
8. van Dolen, W., de Ruyter, K., Lemmink, J., 2004, An Empirical Assessment of the Influence of Customer Emotions and Contact Employee Performance on Encounter and Relationship Satisfaction, Journal of Business Research, 57 (4): 437–444.
9. Ono. A., Chiba, T., 2010, Indebtedness as a Determinant of Satisfaction: An Extension of the Expectancy Disconfirmation Model, Brady, M. K., Hartline, M. D., eds., 2010 American Marketing Association Winter Educators' Conference Proceedings, 21: 19–20.
10. Gouldner, A. W., 1960, Norm of Reciprocity: A Preliminary Statement, American Sociological Review, 25 (2): 161–178.
11. Oliver, R. L., 2010, Satisfaction: A Behavioral Perspective on the Consumer, McGraw Hill, New York.
12. Dorsch, M. J., Kelley, S. W., 1994, An Investigation into the Intentions of Purchasing Executives to Reciprocate Vendor Gifts, Journal of the Academy of Marketing Science, 22 (4): 315–327.
13. Bagozzi, R. P., Yi, Y., 1988, On the Evaluation of Structural Equation Model, Journal of the Academy of Marketing Science, 16 (1): 74–94.
14. Bollen, K. A., 1989, Structural Equations with Latent Variables, Wiley, New York.
15. Browne, M. W., Cudeck, R., 1993, Alternative Ways of Assessing Model Fit, Bollen, K. A., Long, J. S., eds., Testing Structural Equation Models, Sage, Thousand Oaks, 136–162.
16. Cooli, B., Keiningham, T. L., Akson, L., Hsu, M., 2007, A Longitudinal Analysis of Customer Satisfaction and Share of Wallet: Investigating the Moderating Effect of Customer Characteristics, Journal of Marketing, 71 (1): 67–83.

An Analysis of Key Factors of the "Omotenashi Consumption" in Restaurants

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Abstract

"Omotenashi" is basically the Japanese term, which refers to the marking of a special occasion or the displaying to a person or persons their importance to you. Omotenashi can include birthdays, retirement parties, the giving of special gifts, and so on. In this study, the authors explore success factors in "omotenashi consumption (OC)" where consumers used restaurants. Using the critical incident technique, the data involving 1080 cases (incidents) was collected from the perspective of the omotenashi organizer (host). The authors developed a framework to analyze OC based on service encounters and customer encounters. "Customer encounter" refers to the interaction between the host(s) and guest (s). Finally, based on the findings of our study on OC in relation to restaurants, the importance of analyzing consumer-to-consumer interactions during the service consumption is discussed.

Keywords

Omotenashi • Service marketing • Consumer-to-consumer interaction • Critical incident technique

1 Introduction

We have heard the term *omotenashi* more often in recent years. Omotenashi is one of the hot topics in the hospitality industries and service marketing. Omotenashi explains the reason why Japanese people take care of each other or their guests. On the website of the Society of Serviceology, "the tradition of high service quality and culture of omotenashi" is cited as one of the reasons why the Society was started in Japan.

The reality, however, is that the meaning of "omotenashi" remains vague to many. The term is used for the sake of convenience, and its form can be different according to the situation.

This study sheds light on the concept of omotenashi from the standpoint of consumer behaviors. It focuses on "omotenashi behaviors," which are understood as behaviors of a consumer who gives omotenashi resulting from his or her intent to please someone. Examples include organizing a social event or a trip to thank one's mentor or relative or arranging a meal with one's friend or partner. The use of dining and drinking services for the purpose of omotenashi is referred to as "omotenashi consumption" and is also covered by this research. Because these services are consumed as a means of pleasing someone, they must meet not only the needs of the person who plans omotenashi but also those of the person being entertained. In that sense, omotenashi consumption may be characterized differently than the consumption behaviors of the services that are considered in the context of a one-on-one relationship between the service provider and the customer. Omotenashi is basically the use of various forms of hospitality for the purpose of building and consolidating personal and professional relationships. It is

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very different from two friends or co-workers just eating lunch together which would not be considered as omotenashi. So, the unique point of this study stems from this relationship between the consumers themselves. Because Japanese people understand the concept of omotenashi and practically every Japanese person has used OC at one time or another, then, it was very easy to find various examples of OC for this study.

On a more practical note, omotenashi creates opportunities for the consumption of high-unit-price services involving multiple participants who intend to acknowledge or celebrate special occasions. In other words, omotenashi can have important marketing implications in terms of opportunities to consume high-margin services.

2 Conceptual Foundations

2.1 Concept of Omotenashi

Nagao and Umemuro [13] examine the concept of omotenashi from the viewpoint of business management theories and review literature related to hospitality [2, 3, 10, 17] as well as those that illuminate the traditional concepts of omotenashi in Japan found in tea ceremony [6], a ryokan (Japanese-style inn) and hanamachi, which were traditional Japanese red-light districts [12, 15, 20]. Nagao and Umemuro [13] provide an organized survey of related literature while also validating the prescribed concept by interviewing experts in the hospitality industry. Indeed, Nagao and Umemuro [13] define omotenashi from multiple perspectives. This study uses the definition of omotenashi in Nagao and Umemuro [13], which is "direct or indirect behavior exhibited by a person to please and satisfy someone from the other person's point of view, based on careful attention to the purpose, situation and/or need of that someone."

As mentioned previously, in the context of this study, the consumption of goods or services for the purpose of omotenashi is referred to as "omotenashi consumption." Because many dictionaries use the verb *chiso*, meaning treating someone to food and drink to define the term omotenashi, omotenashi consumption is often accompanied by the consumption of dining and drinking services. Accordingly, the consumption behaviors of dining and drinking services are analyzed in this study.

2.2 Consumer-to-Consumer Interaction

Omotenashi consumption based on dining and drinking is a group service encounter [5] involving consumers playing different roles: the consumer who gives omotenashi (host) and the consumer who receives omotenashi (guest).

One approach to the analysis of this group encounter is the role theory approach, in which a service encounter is considered a theatrical experience and the roles of different participants – such as the theater employee, the customer, and his or her companion [8,18] – are studied. This approach is viewed as an effective framework for the comprehensive study of service encounters [16]. In this perspective, when analyzing omotenashi consumption, we should also focus on the interaction between the customers. The host and guest play different roles. The interaction of customers has, in recent years, been discussed primarily by a group of relationship marketing researchers with "customer-to-customer interaction (CCI)" as the keyword. Nicholls [14] reviews the outcomes of CCI studies in service consumption and points out, with reference to the future direction of this field, the importance of case studies on services in which CCI is a key element of value creation.

Given the abovementioned previous studies, this study draws on Parker and Ward [16] and tries to understand omotenashi consumption as a group encounter using the "role theory approach," whereby the relationships of various participants in the encounter are analyzed in the context of employee versus customer and customer versus customer. In doing so, both of these viewpoints with which to analyze customer-to-customer interaction are important.

3 Method and Procedure

3.1 Framework of Analysis

Figure 1 shows the framework of analysis used in this study. Consumer (1) is the giver of omotenashi or the host. Consumer (2) is the receiver of omotenashi or the guest. The restaurant staff provides service to the host and guest consumers through a service encounter. Here, the exchange of omotenashi between the host and guest is referred to as

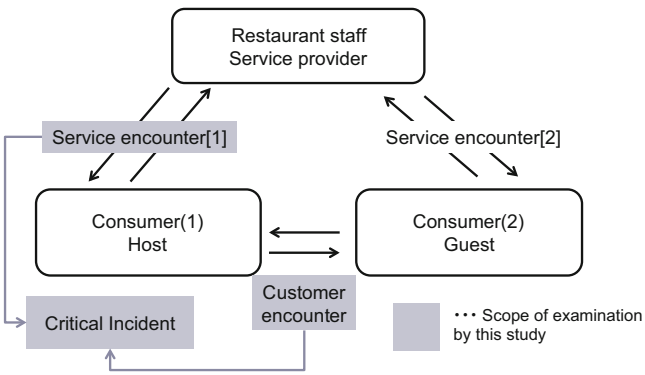

Fig. 1 Omotenashi consumption

the "customer encounter" so as to differentiate the experience from the service encounter that represents the provision of service by the restaurant staff to the consumer.

This study analyzes omotenashi consumption from the viewpoint of the host consumer. The presence of the service encounter and customer encounter is a unique characteristic of omotenashi consumption. The host consumer voluntarily purchases dining and drinking services as a means for omotenashi entertainment. Moreover, the host consumer is the provider of omotenashi. Accordingly, the elements of service encounter and customer encounter can be analyzed through the analysis of omotenashi consumption from the standpoint of the host consumer.

Once this is done, omotenashi consumption from the standpoint of the host is put into perspective using the "consumer evaluation model," which shows how the host consumer evaluates his/her own omotenashi consumption. Giving one's omotenashi consumption a high mark means the host gives an evaluation that he/she could please the other person. In this study, a high mark on omotenashi consumption is referred to as "self-assessed success," and omotenashi consumption being a "self-assessed success" is analyzed.

3.2 Method

Because few prior studies are available on omotenashi consumption, some exploratory investigation and analysis is required. This study uses the "critical incident technique (CIT)" [4], where the perceived evaluation of service by the consumer in the service encounter is analyzed in an exploratory manner. CIT has been utilized frequently in service research [7]. Bitner [1] used exploratory analysis of the structure of favorable incidents and unfavorable incidents in the service encounter. Analysis was conducted using coding technique of consumer's free answer data gathered by CIT. After coding, Bitner [1] divided data samples and made a number of groups depending on the content of the incident. Then, the structural difference between the groups was examined using the chi-square test. Because Bitner [1] has often been quoted by a number of other researchers, this approach is widely accepted as being an effective approach. So, this study will be in accordance with the method of Bitner [1]. In addition, incidents in this study are found in three different stages: (1) CCI in the customer encounter, (2) contribution by the service provider in the service encounter [1], and (3) the factor of the eventual self-assessed success of omotenashi consumption. Normally the CIT requires the gathering and analysis of only critical incidents, with regard to the factors of self-assessed success of omotenashi consumption (stage (3)). In this study, however, incidents of stages (1) and (2) are also gathered as experimental steps leading to a critical incident so that the background leading to an eventual critical incident can be examined. This sequential CIT approach is proposed by Stauss and Weinlich [19], to cover any weakness in the general CIT.

3.3 Research Questions

This study places a particular emphasis on the relationship between (1) CCI in the customer encounter and (3) the factor of the eventual self-assessed success of omotenashi consumption. To be specific, the following research questions are examined in the order given:

RQ1: What are the factors of customer-to-customer interaction (CCI) that led to the self-assessed success of omotenashi consumption?
RQ2: What are the factors of the eventual self-assessed success of omotenashi consumption?
RQ3: What are the relationships between the factors of the eventual self-assessed success of omotenashi consumption and CCI?

Regarding RQ1, the content of customer-to-customer interaction (CCI), as evaluated in the customer encounter, is analyzed as a means of evaluating the steps leading to the factor of self-assessed success of omotenashi consumption. To be specific, the content of CCI that the host consumer believes contributed to the pleasing of the other person in omotenashi consumption is analyzed. This is hereinafter referred to as the "CCI-factor." Under RQ2, the factors of the eventual self-assessed success of omotenashi consumption, or critical incidents, are put into perspective. Thereafter, the relationships between the factors of self-assessed success of omotenashi consumption and the CCI-factors are analyzed as a means to derive practical implications.

3.4 Data Collection

A survey sheet was sent to, and responses were received from, 1000 males and females, represented by five different age groups (20s, 30s, 40s, 50s, over 60s). Each group was equally represented. The survey subjects were selected from around Japan from a list of registered members of an Internet survey panel. Candidates were asked if they had ever experienced dining or drinking service for the purpose of omotenashi, and those who gave a "yes" answer were selected. Excluding invalid responses, 939 data samples were collected.

The concept of measurement is described as follows. The questions regarding CCI-factors, incidents in service encounter [1] (Fig. 1), and factors of self-assessed success

of omotenashi consumption (critical incidents) were all created with reference to Bitner [1]. As for CCI-factors, responses were received by classifying the factors influencing the success of omotenashi consumption into three steps: "preparation stage," "omotenashi stage (after entering the restaurant)," and "follow-up stage (after exiting the restaurant)." For example, one question used to check omotenashi behaviors in the preparation stage reads: "Write down the steps you took in preparing for the day and that you think led to the pleasing of the other person in particular."

4 Results

4.1 Incidents in Customer Encounter (RQ1)

4.1.1 Coding of CCI-Factors

The procedure of coding CCI-factors is according to Bitner [1] and Toya [11] and described as follows. The free-response data analyzed was gathered in the three steps of "preparation stage," "omotenashi stage (after entering the restaurant)," and "follow-up (after exiting the restaurant)." Three different researchers (coders) coded the data. First, the gathered free-response data was input by two researchers (coders), who exchanged opinions as necessary when classification rules were vague. Then, those data samples containing multiple incidents were broken down further, and classification codes were determined. Then, a coder different from those who determined the classification codes classified the incidents again. Whenever they had a difference of opinion in classification, the coders would discuss it and the incidents where no agreement was reached were classified under "other." As a result of coding, the incidents were classified into five groups: the assurance type, staging type, empathy type, communication (with the guest) type, and "other."

The types of CCI-factors are explained in detail below. The first type is defined as an effort on the part of the host consumer to reliably perform his/her omotenashi and is referred to as the "assurance type." Specific responses included checking the restaurant beforehand, making a reservation, selecting a location that could be accessed easily, ordering the dishes, and preparing for transport to/from the establishment. The factors of the second type, or the "staging type," included preparing a bouquet of flowers, a commemorative gift, or other present, giving a speech, etc. For the third type, or "the empathy type," responses included finding out the preferences of the person (guest) through friends, giving consideration such as allowing the person to decide on the menu or choose what he/she wants to do. Cited factors of the final type, or the "communication type," included actively providing topics of conversation and focusing on being a good listener.

4.1.2 Clustering of Data Samples Based on CCI-Factors

This section discusses the classification of data samples according to which CCI-factors, discussed in Sect. 4.1.1, were evaluated. To be specific, the clustering of data samples based on the CCI-factors of "assurance type," "staging type," "empathy type," and "communication type" is attempted. Because consideration of the specific stages of preparation, omotenashi, and follow-up would make the hierarchy somewhat complicated, the initial classification ignored the specific stages. Each respondent was classified by the same manner as Toya [11] that explained in Sect. 4.1.1. For example, respondents who evaluated the assurance-type CCI-factors were classified as being of the assurance type (respondents). Respondents who evaluated two or more CCI-factors, such as evaluating an assurance-type factor in the preparation stage and staging-type factor in the omotenashi stage, were classified as the integrated type. This resulted in the clustering of data samples into the five types: assurance type (179 samples), staging type (255 samples), empathy type (140 samples), communication type (122 samples), and integrated type (198 samples).

4.2 Critical Incidents (RQ2)

Critical incidents were gathered using the question, "Write down the events that you believe were decidedly important when all things are considered, in that they determined the success or failure of your omotenashi that day; you can repeat previous answers," without differentiating whether the incidents were related to customer encounter or service encounter.

Table 1 shows the specific examples of critical incidents. Six categories were identified, including "menu provided by the restaurant," "service provided by the restaurant," " appearance of interiors and exteriors," "communication between the customers," "mutual staging by the customers," and "ambience." Specific examples of each critical incident are shown below.

Table 2 shows the classified results of critical incidents. On checking the breakdown of critical incidents, there were 469 cases in which service encounter factors such as menu, service, and appearance of interiors and exteriors were cited as factors of the eventual self-assessed success; 421 cases in which CCI-factors such as staging and communication were cited as factors of the eventual self-assessed success; 153 cases that offered integrated evaluations citing ambience, etc.; and 37 cases classified as "other." There were roughly equal numbers of CCI-factors arising from customer encounter and CCI-factors arising from service encounter.

Critical incidents related to CCI-factors classified as mutual staging by customers were most frequently cited.

However, not many assurance-type CCI-factors were cited as critical incidents. Due to their relatively small number, assurance-type CCI-factors are classified as "other" in Table 2. Assurance-type CCI represents the preparatory behaviors often found in the preparation stage, which aren't typically recognized as factors of the eventual self-assessed success.

More menu-related critical incidents were cited than were service-related ones. In the context of a special occasion such as omotenashi consumption, menu-related critical incidents such as custom-made menus and unique ingredients were easily remembered. Fewer restaurant services were cited as factors of the eventual self-assessed success, probably because service behaviors between the customers, such as staging-type CCI-factors, were more memorable than restaurant services were.

Table 1 Specific examples of critical incidents

Code name	Specific examples
Menu provided by the restaurant	Satisfying dishes
	Menu using unique ingredients
	Were able to eat fresh sushi
Appearance of interiors and exteriors of restaurant	Clean interior
	Appearance of the restaurant
	Ambience of the restaurant
Service provided by the restaurant	How the waitress treated my grandmother and explained the dishes
	Well-timed service
	Smiling staff
Mutual staging by the customers	Birthday surprise
	The children's performance made the event special
	My mentor was invited
Communication between the customers	Engaging conversations
	I could see the happy faces of my parents
	I could honestly convey my sense of appreciation
Ambience	Ambience of the store
	Had a relaxing time without worrying about time
	I could relax

4.3 Factors Influencing Critical Incidents (RQ3)

This study focused on customer encounters, but now the differences of incidents that are cited as CCI-factors and their correlation with critical incidents will be examined. A matrix table of clusters of extracted CCI-factors per 4-1-2 on the left side with critical incidents at the top (Table 3) was created, and the independence of incidents was tested. As a result, a correlation was found between the evaluation-type of CCI-factors and the critical incidents ($x^2(20) = 81.5$ $p < 0.01$).

Residual analysis was also conducted on the matrix table in Table 3. Residual analysis utilizes the fact that the standardized residual, being calculated by dividing the difference between the expected frequency and actual frequency of each cell of the matrix table by the square of the expected value, is further divided by the standard error to see whether the adjusted standardized residual approximates the normal distribution. A symbol (+) or (−) is indicated for the cells associated with a 5 % significance as a result of residual analysis. A relatively large number of those consumers who cited an assurance-type CCI-factor cited a critical incident related to the restaurant menu and space, and a relatively small number of them cited a critical incident related to the communication between or mutual staging by the customers. These results can be interpreted as a tendency of consumers citing an assurance-type CCI-factor to ultimately cite not a customer encounter event but instead a service encounter event such as one related to the restaurant menu and space, as a factor of the eventual self-assessed success. However, many of the consumers who cited a staging-type CCI-factor cited a factor of the eventual self-assessed success (critical incident) also related to the mutual staging by the customers or restaurant service, but few of them cited a critical incident related to the appearance of interiors and exteriors of the restaurant. Among the cases (97 data samples) in which the restaurant's service was perceived to have influenced the self-assessed success of omotenashi consumption, the respondent not only appreciated the overall service highly but also expressed a

Table 2 Classification of critical incidents

Code name		Number of cases	
Arising from service encounter (469 cases)	Menu provided by the restaurant	241	22 %
	Appearance of interiors and exteriors of restaurant	125	12 %
	Service provided by the restaurant	103	10 %
Arising from customer encounter (421 cases)	Mutual staging between the customers	274	25 %
	Communication between the customers	147	14 %
Overall evaluation	Ambience	153	14 %
	Other	37	3 %
	Total	1080	100 %

Table 3 Incidents in customer encounter and critical incidents

(Classification of critical incidents)								
		Menu provided by the restaurant	Service provided by the restaurant	Appearance of interiors and exteriors of restaurant	Communication type (omotenashi)	Staging type (omotenashi)	Ambience	Total
(Omotenashi types in customer encounter)	Assurance type	35 % (+)	9 %	16 % (+)	10 % (−)	14 % (−)	17 %	200
	Staging type	20 %	14 % (+)	8 % (−)	12 %	33 % (+)	12 %	273
	Empathy type	25 %	9 %	20 % (+)	13 %	22 %	10 %	157
	Communication type	17 %	6 %	9 %	23 % (+)	29 %	17 %	126
	Integrated type	19 %	8 %	8 % (−)	15 %	31 %	18 %	237

Note: Independence test: chi-square value = 81.5, degree of freedom = 20, p-value < 0.01
As a result of residual analysis, a cell whose observed value was significantly greater or smaller than the expected value (significance level: 5 %) was indicated by (+) or (−), respectively

relatively strong interest in using the restaurant again and/or recommending it to others.

A relatively large number of the consumers who cited an empathy-type CCI-factor cited a critical incident related to the restaurant space. When the host succeeded in accurately understanding what the guest liked, a spatial factor such as how the room looked or was decorated, or how the table was, tended to be a factor of the eventual self-assessed success, as opposed to a factor of human intervention by the restaurant's staff. The fact that the appearance of interiors and exteriors of the restaurant was a source of critical incidents is one characteristic aspect of the evaluation of omotenashi consumption. It corresponds to the view that *shitsurae* (the arrangement of the environment) is important as a unique characteristic of omotenashi [13]. Additionally, the consumers who cited such empathy-type CCI-factors recognized an element of human service in customer encounter along with the hardware element in service encounter, which led to the pleasing of the other person. This is interpreted as the consumer on the host side and the restaurant/service provider having a "relationship of value co-creators" [21] regardless of whether or not the consumer is aware of it, in that they mutually demonstrate their resources in order to achieve their purpose. What was examined in this section shows that the factors in the self-assessed success of omotenashi consumption differ from the perceived factors based on which CCI-factors are recognized.

5 Discussion

The critical incidents cited as factors of the eventual self-assessed success of omotenashi consumption were classified into a total of six categories: "menu provided by the restaurant," "service provided by the restaurant," "space/appearance of the restaurant," "communication between the customers," "mutual staging by the customers," and "ambience." The critical incidents included both CCI-factors and service encounter incidents, suggesting that the restaurant's involvement plays an equally important role as the CCI in customer encounter as a factor in the self-assessed success of omotenashi consumption. More respondents cited critical incidents related to the restaurant menu than those related to the restaurant service. Therefore, in providing dining and drinking services, it is necessary to design a customer experience around a clever way to impress the customer with the "menu," which is easily remembered as a critical incident.

One important finding is that the different evaluation types of CCI-factors recognized affect those elements that are perceived as factors of self-assessed success of omotenashi consumption. Traditionally, the restaurants have recognized the importance of CCI's influence on how their services are evaluated after the service consumption by word of mouth. In fact, websites that provide customer reviews on restaurants and bars have significant influence on the success of these restaurants. On the contrary, there have been few arguments, either practical or theoretical, that the restaurants should analyze the impact of CCI in customer encounters, or during service consumption, on the evaluation of their services in order to enhance their perceived service quality. For example, by utilizing the finding of this study that those consumers who cited a staging-type CCI-factor tended to focus on the level of restaurant service as a critical incident, a strategy could be developed in order to make the restaurant better appreciated by producing a staging-type CCI-factor in customer encounters.

The service encounter studies have dealt with incidental conversations and the influence of the interaction with strangers who were present at the service encounter [9]. One theoretical contribution of this study is that it has demonstrated the importance of focusing on customer encounters in addition to service encounters as well as the effectiveness of analyzing the mutual interaction between the customers in customer encounters.

Additionally, the approach of understanding the consumption structure from the viewpoints of both service

encounters and a customer encounter is considered effective as an approach to the analysis of the patterns and characteristics of value co-creation [21].

It should be noted that this study is based on an analysis of open-response questions on the use of dining and drinking services. Therefore, more case studies on the use of other services or other cultural settings are needed and quantitatively analyzed to create a model for the future. Situations similar to omotenashi consumption might also be observed in the cultural settings of other countries. However, it should be confirmed that the people of the country understand the concept of omotenashi consumption.

References

1. Bitner (1990), "Evaluating Service Encounters: The Effects of Physical Surroundings and Employee Responses," Journal of Marketing, 54 (2), 69–82.
2. Burgess (1982), "Perspectives on gift exchange and hospitable behavior," International Journal of Hospitality Management, 1 (1), 49–57.
3. Cassee and Reuland R (1983), "Introduction," The management of hospitality. Pergamon Press Ltd, 13–22
4. Flanagan (1954), "The critical incident technique," Psychological Bulletin, 51 (4), 327–358.
5. Finsterwalder and Tuzovic (2010), "Quality in group service encounters: A theoretical exploration of the concept of a simultaneous multi-customer co-creation process," Managing Service Quality, 20 (2), 109–122.
6. M.Gojima (2007) "Omotenashi no genryu", Eichi publishing (In Japanese)
7. Gremler, Dwayne D. "The critical incident technique in service research." Journal of service research 7.1 (2004): 65–89.
8. Grove, Fisk R. P and Dorsch M. J (1998). Assessing the theatrical components of the service encounter: a cluster analysis examination. Service Industries Journal, 18(3), 116–134.
9. Harris, Baron S and Parker C. (2000), "Understanding the consumer experience: It's 'good to talk'," Journal of Marketing Management, 16(1–3), 111–127.
10. Jones (2002), "Introduction to hospitality operations: An indispensable guide to the industry," Cengage Learning EMEA, 1–20
11. K.Toya (2005), "Analysis of dissatisfaction behavior differences due to customer dissatisfaction cause", Japan marketing journal, 25(1),23–37 (In Japanese)
12. Y.Nakajima (2007) "Kakubetsuno Omotenashi Sahou", AKI shobo (In Japanese)
13. Nagao and Umemuro (2012), "Elements Constructing Omotenashi and Development of Omotenashi Evaluation Tool (Review and Survey) ", Journal of Japan Industrial Management Association, 63 (3), 126–137. (In Japanese)
14. Nicholls (2010), "New directions for customer-to-customer interaction research," Journal of Services Marketing, 24(1), 87–97.
15. K.Nishio (2007), "Kyoto hanamachino keieigaku",TOYO KEIZAI INC. (In Japanese)
16. Parker and Ward.P (2000), "An analysis of role adoptions and scripts during customer-to-customer encounters," European Journal of Marketing, 34 (3/4), 341–359.
17. Reuland, Choudry J and Fagel A (1985), "Research in the field of hospitality," International Journal of Hospitality Mangement, 4 (4), 141–146.
18. Solomon, Surprenant C., Czepiel J. A and Gutman, E. G (1985), "A role theory perspective on dyadic interactions: The service encounter, " Journal of marketing, 49(1).
19. Stauss, Bernd, and Bernhard Weinlich. "Process-oriented measurement of service quality: Applying the sequential incident technique." European Journal of Marketing 31.1 (1997): 33–55.
20. Y. Taguchi (2000) "Okoshiyasu," EIKO publishing (In Japanese)
21. Vargo, & Lusch, R. F (2008), "Service-dominant logic: continuing the evolution," Journal of the Academy of Marketing Science, 36 (1), 1–10.

Structural Equation Modeling of Purchase Funnel

Naotada Yamamoto

Abstract

Nurturing relationships with your customers is a crucial part of developing a sustainable business. This research focuses on how customer satisfaction can be improved in inter-customer relationships. We found that a structural equation analysis of some action data about consumer behaviors with three constituents of products that are supposed to ameliorate consumer gratification gives us deeper and clearer insight into the spreading process of customer satisfaction. And those three components are matching factor, purchasing factor, and customer satisfaction improvement factor. This research contributes to the fields of both consumer behavior and service science by introducing a new scheme that identifies factors in the building process of consumer satisfaction.

Keywords

Structural equation modeling • Purchase funnel • Inter-customer relationship • Sustainability parameter

1 Introduction

Let us consider the following scenario: Emma is walking on the street and sees a beautiful woman with a lovely green scarf. Then Emma determines to purchase the green scarf. Now consider another scenario that Emma, at the end, could only find gaudy color's scarf instead. In this scenario, her satisfactory level is most likely to be lower than that in the previous scenario. However, if her main determining factor on the purchase in the second scenario is scarf itself, thus commodity, rather than its color, the shopping experiences in both scenarios must be equally satisfying. If not, her satisfaction in the second scenario would be lower and she might never wear it.

Similar situations frequently arise in various products such as apparel products, furniture, food goods, and services. As illustrated in the example above, in general, it is not necessary to match what the customer demands primarily and what the customer purchases at the end, in order to gain sufficient customer satisfaction. This indicates that not only matching factor affects customer satisfaction but also customer satisfaction improvement factor. For example, the customer satisfaction increases when the customer perceives unexpectedly good reviews from their friends, i.e., post-purchase experience. Moreover, purchasing factor such as easy accessibility to products can also influence customer satisfaction. If the customer is able to reach the products they desire without any efforts, their satisfactory level tends to be higher. These three factors are independent to each other so that we can build a model to analyze how customer satisfaction varies in diverse situations.

There are two main approaches to study customer satisfaction, customer-to-firm and customer-to-customer. The customer-to-firm approach is, for example, customer relationship management, salesperson-selling behavior, and product development (e.g., [11, 26, 32, 33]), whereas the customer-to-customer approach is compatibility

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management and word-of-mouth communication (e.g., [2, 12, 23, 36]). Although the customer-to-firm approach is well developed among the several literatures, the customer-to-customer approach is relatively less developed. The most customer-to-customer approach literatures only assume verbal communications for consumer behaviors analysis and have hardly focused on nonverbal communications such that some people gain information about the product by observing what their friends or people on the street have. From the definition of word of mouth by Word-of-Mouth Marketing Association (WOMMA), which is "the act of a consumer creating and/or distributing marketing-relevant information to another consumer," the customer-to-customer approach must consider both verbal and nonverbal communications. The structural equation model in this research enables us to analyze the consumer behaviors from both communications' perspectives.

Bolton [8] and Lemon and Verhoef [21] advocate that customer satisfaction has significant implications for the economic performance of firms. Also, it is suggested that customer satisfaction has relations with firm's sustainability. The literatures about sustainability insist triple bottom line: profits, planet, and people. As mentioned before, customer satisfaction could contribute to sustainability economically and socially. For example, many traditional Japanese firms, called "SINISE," have deliberately built customer satisfaction to maintain long relationships with customers, the process that builds the strong sustainability of the firms. As for the relations between customer satisfaction and customer lifetime value, a conclusion is clarified as the general law that passed through the substantial procedure [7]. In addition to these, a lot of researches have been performed to show the importance of customer satisfaction.

Therefore, the objective of this article is to formally analyze how enterprises should construct a system ameliorating customer satisfaction through inter-customer relationships and, as a secondary purpose, why that difference of customer satisfactions occurs within the consumer satisfaction process.

In the following sections, we review the literature, introduce the setup of the main model, present the analysis and results, and extend the analysis object to accommodate a set of market features. We then report slight empirical validation of the model's key predictions and conclude with a discussion of suggestions for further research.

2 Relation to Previous Research

2.1 Customer Satisfaction and Consumer Behavior

In the motivation theory, Girard [10] finds that human desire is triangular and mimetic. He suggests that it is mimetic in that it has to do with imitation and it is triangular in that the transaction is three concerned, the source which stimulates the desire, the respondent in whom the desire is implanted, and the thing then desired. And Blackwell et al. [6] explain the two types of motivations, personal motives and social motives. In terms of social motives, the notion of retail interaction as a source of shopping motivation stems from work by Tauber [35], positing that numerous social motives help to influence shopping behavior. These motives include social interaction, reference group affiliation, and communicating with others having similar interests. And also, McClelland [24] advocates the three types of motivations, achievement motives, power motives, and affiliation motives. Especially, affiliation motives mean a person's need to feel a sense of involvement and belonging within a social group [3, 24, 25].

Related to the social motives, customer satisfaction and word-of-mouth communication have been documented in academic research. Previous research suggests that word-of-mouth is more potent than information from commercial resources because it is perceived as the most unbiased [13, 19]. Kotler [20] insists that the satisfaction of the customer is the factor that prescribes word-of-mouth communication. And Maeda and Takagi [22] show the consignor of the word-of-mouth communication strengthens brand equity by perceiving value. In order to dissect the spread of word-of-mouth communication, bass model has often been used. However, bass model cannot look into why that difference of customer satisfaction occurs within the customer satisfaction process.

2.2 Purchase Funnel

When we take into account consumer behaviors including nonverbal communication, the notion of purchase funnel has been used both in the academic world and in the practical world. Purchase funnel illustrates the theoretical customer journey toward the purchase of a product or service, and, for example, AIDA and AIDMA are well known. Mainly three kinds of study on purchase funnel have been developed: advertisement effect measurement, product amendment, and creation of new purchase funnel.

On the advertisement effect measurement, it is generally assumed that the customer response process to the advertisement is sequential and the advertisement effect toward the goal setting is measured. The intention of the product amendment is ascertaining the phase narrowing width of the funnel, widening the funnel of the final phase in the process of purchasing behavior. But the analysis technique is an almost unexplored field, and basically only a series of volume comparison of each stage is performed (see [4]). Regarding the creation of new purchase funnel, various purchase funnel models, which are derived from AIDA, are evolved to cater for the modern customer. These models are

used in marketing to guide promotional campaigns targeting different phases of the customer journey and also as a basis for customer relationship management programs and lead management campaigns.

In these three fields, almost all of the study of purchase funnel is not so much academic as practical.

2.3 Positioning

Given the researches mentioned above, I attempt to dissect customer purchase funnel by means of statistical analysis, theorizing the product itself has a role of advertisement. In other words, the spreading process is assumed to work without firm's marketing efforts. Hence, word-of-mouth communication is regarded as not only verbal communication but also nonverbal communication in this research. Besides, relations between each phases is confirmed instead of the volume comparison.

Moreover, I am seeking to introduce a new conceptual framework for catering the modern social network, referred to the digital era of consumer behavior analysis tool SIPS model. In Japan, Dentsu Inc. Open Innovation Laboratory proposed SIPS; SIPS stands for sympathize, identify, participate, and share and spread. At present, on social media such Twitter or Instagram, the level of sharing of information has been increasing steadily. In the SIPS model, empathy with the information or philosophy disseminated by a person or company serves as the initiator of consumer behavior. Through consumers' empathy and identification, the motivation for action is born, in turn leading to participation (which also includes actions without a purchase), sharing, and the beginning of diffusion. Through initial motivation, consumers look for further information using search engines or social media and take certain actions [17].

On the basis of SIPS model, it is assumed that the purchase funnel is constructed of four phases: past share (PaSh), sympathize (Sy), participate (Pa), and current share (CuSh), except identify of SIPS model in this study (following, SSPS model).

3 Approach

3.1 Hypothesis

As shown in Fig. 1, it is supposed that each product has three elements in itself: matching factor for customers, purchasing factor, and customer satisfaction improvement factor. Consumers will get interested in or sympathize with the product by matching factor, purchase it by purchasing factor, and get satisfied with it by consumer satisfaction improvement factor. In this study, it is assumed that consumers share

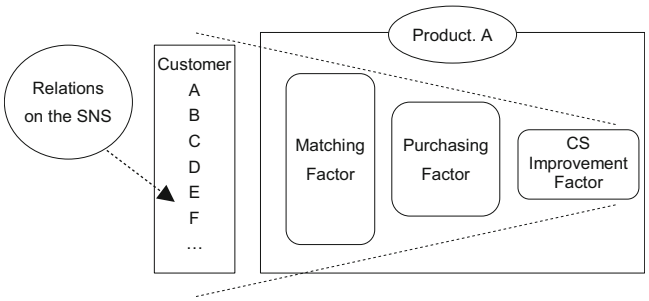

Fig. 1 Image of product elements

the information on the product by intentional word-of-mouth communication after the satisfaction.

3.2 Details

In more details, three elements of products are associated with concepts in each phase of the SSPS model. It is supposed that the matching factor is necessary for products to make Sy increase, and purchasing factor is necessary to increase Pa, and customer satisfaction improvement factor is necessary to increase CuSh.

When a product does not match the needs of customers, it belongs to niche market even if customer satisfaction is high. Then, there is a risk of demand drying up. And when purchasing factor is low, sales will not grow even if the product matches the needs of customers. In addition, when customers are not satisfied with the product, the royal customers or repeaters will not come along, and good sales will no longer last so long even if purchasing factor is high.

Furthermore, sellers cannot profit in the long term if relations between three constituents of the product are not all high. For example, firms must expend a lot of money on marketing efforts or personnel expenses to increase each factor. Therefore, the product, which has all strong correlations, can record stellar sales without additional cost.

4 Analysis and Results

4.1 Data

Japanese retail firm, named Ryohin Keikaku Co., Ltd. (MUJI), collected action data on consumer behavior on website. We use this data from Joint Association Study Group of Management Science. Action data are classified under three actions, "Want (Want)," "Have (Have)," and "Comment (Com)," and the date and time when consumer took each action from May 2013 to June 2014 are recorded. The data set for this study combines this data and "Purchase (Buy)" record data. Thus, on the online, customers can take

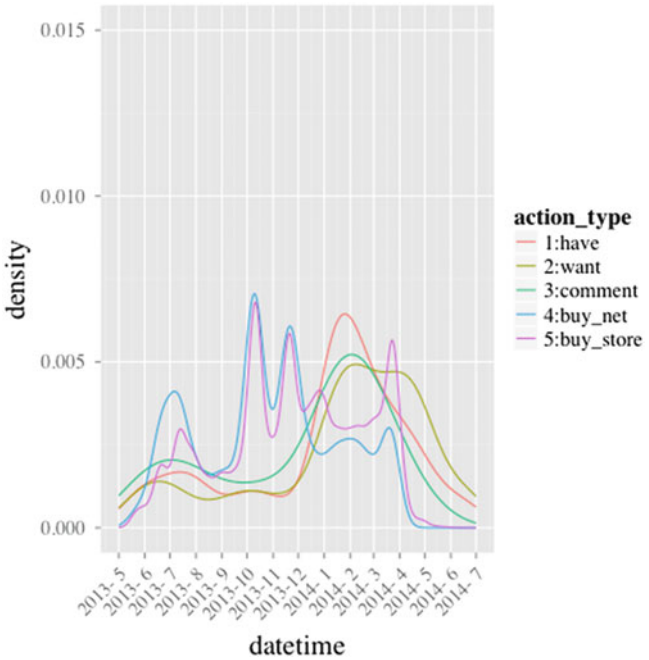

Fig. 2 Action movement of product A

four actions, Want, Have, Buy Net (BuyN), and Com, and on the offline, customers would take that four actions but only one action of Buy Store (BuyS) is collected.

Then, data set is about 36 million and the list of top 1000 products with the number of action is extracted. This is because the number of the data about action (such as Want, Have, and Com) is necessary to some extent.

In addition, actions of Want, Have, and Com on the website are regarded as the representative to consider both online and offline customers.

Figure 2 shows action movement of product A. As you can see in it, although BuyS and BuyN show slightly complicated movement, both movements form similar curves. And whereby, if online customer and offline customer behave with a same action transition period, offline actions of Want, Have, and Com should be similar to online actions.

4.2 Model Setup

In SSPS model, customers can sympathize the product which other customers share on the website at the beginning. Then, they can participate in it and last share it. Customers can take each action freely. If they get interested in the product, they want it, and if they want to buy it at the store or net, they participate in it, and if they want to share it, they share it. Each action is actually shared with other customers on website or somewhere.

Then, it is assumed that PaSh has relations with Have and Com1, Sy has a relation with Want, Pa has relations with BuyS and BuyN, and CuSh has a relation with Com2. Referred to Kotler [20] and Maeda and Takagi [22], index of CSh is explained only by word-of-mouth communication so as to analyze customer satisfaction.

The point is the period from PaSh to Sy must be within 1 day, but the periods of the others will not. Accordingly, I analyze this action data to clarify how long the customer takes to change actions for the product and find that average period from Sy to Pa is 34.5 days and average period from Pa to CuSh is 47.7 days. These action transition periods are applied to this model.

Besides, the action of Have indicates nonverbal communications, and moreover, the customer sharing the product by Have is not necessarily well satisfied with it. And also, PaSh by Want is assumed to have less influence to other customers than PaSh by Com1 and is not taken into account in this model. For example, verbal communication can be superior in expressing your feelings. Therefore, Com1 includes both the comment by purchasers and the expression of strong desire by non-purchasers.

In this analysis, I handle structural equation modeling to observe relations between these. Structural equation modeling is a statistical approach to understand social phenomenon and natural phenomenon by introducing the latent variables that cannot be observed directly and identifying the causation between the observed variable and the latent variables. Since flexible model choice is possible, I adopt it in this analysis. Given action transition periods, six observed variables are extracted: Have, Com1, Want, BuyN, BuyS, and Com2. As for latent variables, according to SSPS model, they become four: PaSh, Sy, Pa, and CuSh.

I put setting like in Eq. 1 and assume normal distribution in latent variables:

$$x_i = a_{ij} f_j + e_i \tag{1}$$

Here, x_i shows an observed variable and f_j shows a latent variable. In addition, it is assumed that the parts, which cannot be explained by the latent variable, are error and do it with independence each.

As estimation method in this analysis, maximum likelihood estimation is used. Maximum likelihood estimation decides the estimate of the parameter to maximize probability (likelihood) that data in the hand appear and is expressed in Eq. 2:

$$F_{\mathrm{ML}} = \log|\Sigma| + \mathrm{tr}\left(S\Sigma^{-1}\right) - \log|S| - p \tag{2}$$

S is a specimen covariance line calculated by data, and as for Σ, estimate of a mother covariance line led by the model, p express the number of the observed variance included in the model. *R* software is used in this analysis.

4.3 Result

First of all, one of the products in the Japanese retail firm is analyzed. Consequently, I find that all coefficients are statistically significant at the 5 % level. Figure 3 shows the path fig of product B.

As for the conformity degree index, it indicates 0.992 in CFI and 0.083 in SRMR, which is preferable. As for the path coefficient, it indicates 0.82 from PaSh to Sy, and it is suggested that Sy can be improved by widening the phase of PaSh. Confidence interval for the coefficient indicates from 0.432 to 1.200, which shows that PaSh substantially affects the improvement of Sy.

In the same way, it indicates 0.49 from Sy to Pa as for path coefficients and 0.41 from Pa to CuSh. It can be mentioned that growth of Sy improves Pa and growth of Pa increases CuSh. Also, the path coefficient from PaSh to Com1 is smaller than it from PaSh to Have, which argues PaSh is strongly expressed in Have. Hence, product B is supposed to spread to customers via nonverbal communication.

In fact, enterprises do not necessarily ameliorate three factors of each product. For instance, they can attract customers to a product whose matching factor is high and promote sales of a next product of the same kind or category whose purchasing factor is high. Accordingly, it is suggested that analyzing product groups will be more effective and analysis of product groups is performed in the following.

Consequently, I find that all coefficients are statistically significant at the 5 % level. Figure 4 shows the path fig of product group C.

As for the conformity degree index, it indicates 0.987 in CFI and 0.037 in SRMR, which is preferable. As for the path coefficient, it indicates 0.81 from PaSh to Sy, and it is suggested that Sy can be improved by widening the phase of PaSh. Confidence interval for the coefficient indicates from 0.766 to 0.860, which shows that PaSh substantially affects the improvement of Sy.

In the same way, it indicates 0.33 from Sy to Pa as for path coefficients and 0.21 from Pa to CuSh. It can be mentioned that growth of Sy improves Pa and growth of Pa increases CuSh. Also, the path coefficient from PaSh to Com1 is larger than it from PaSh to Have, which argues that PaSh is strongly expressed in Com1.

The result of each product group is summarized in Table 1.

It should be clear that rule of thumb cutoff criteria are quite arbitrary and should not be taken too seriously. Fit indices may be affected by model misspecification, small sample bias, effects of violation of normality and independence, and estimation method effects [16]. Referred to Schermelleh-Engel et al. [30], two indices were used to assess goodness of fit of the models: the CFI (good if and $0.97<CFI<1.00$, acceptable if $0.95<CFI<0.97$, and adequate if close to 0.95) and the standardized root-mean-square residual (SRMR; good if $0<$ SRMR <0.05 and acceptable if $0.05<$ SRMR <0.10). Higher number is in yellow and lower is in blue.

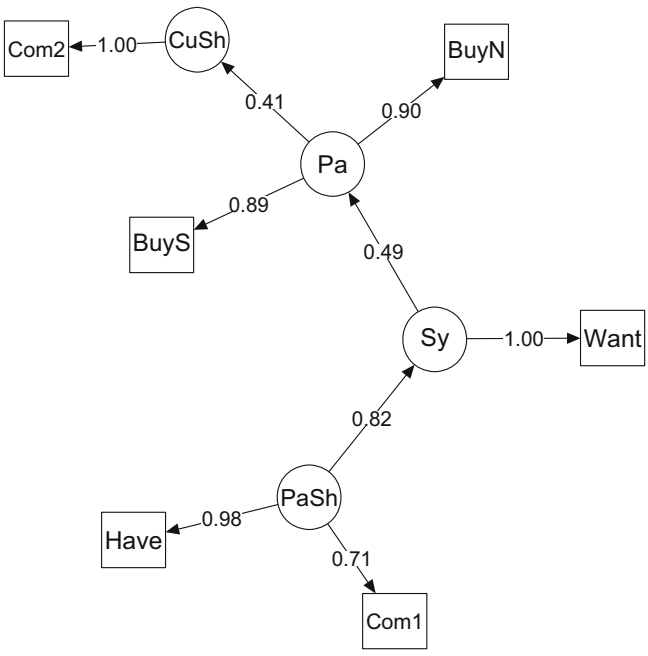

Fig. 3 Path of product B

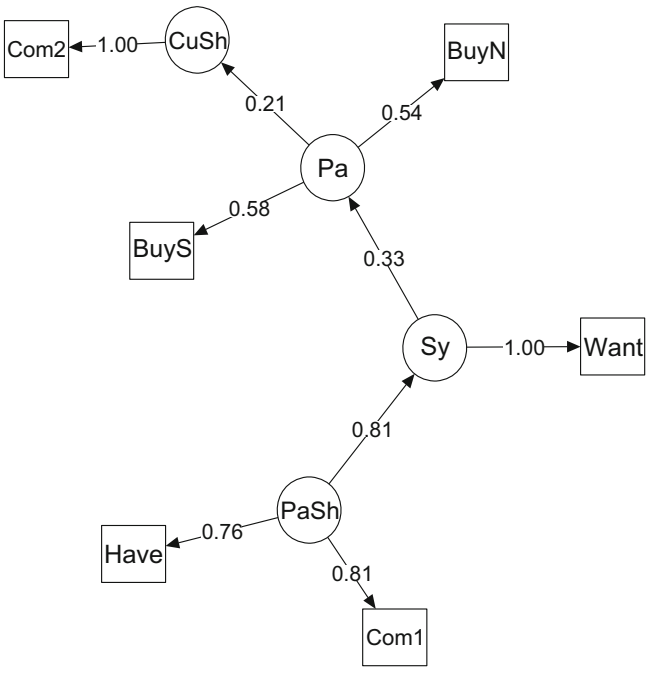

Fig. 4 Path of product group C

Table 1 Path analysis

	Sh->Sy	Sy->Pa	Pa->Sh	SUS	CFI	SRMR
A	0.32	0.16	0.05	0.0026	0.987	0.037
B	0.42	0.25	0.22	0.0231	0.952	0.069
C	0.81	0.33	0.21	0.0561	0.969	0.043
D	0.98	0.07	0.09	0.0062	0.995	0.017
E	0.60	0.30	0.27	0.0486	0.960	0.071
F	0.54	0.29	0.20	0.0313	0.946	0.060
G	0.53	0.09	0.15	0.0072	0.954	0.087
H	0.74	0.15	0.28	0.0311	0.943	0.097
I	0.79	0.19	0.28	0.0420	0.951	0.076
J	0.76	0.18	0.32	0.0438	0.976	0.042

Sustainability parameter, named SUS, is introduced to clarify product's sustainability. Sustainability parameter is calculated by the coefficient from PaSh to Sy times the coefficient from Sy to Pa times the coefficient from Pa to CuSh. In other words, sustainability parameter means the degree of ameliorating customer satisfaction through inter-customer relationships.

As a result, product group C, which has highest sustainability parameter, records best sales in this period (and probably ever). This enterprise has surely many products that have been loved for many years in product group C, and it is appropriate to this result. And product group D, which has the highest coefficient from PaSh to Sy, records comparably poor sales in this period. Thus, given this result, it is necessary for firms to make all three elements of the product group in high standards in order to improve customer satisfaction, develop the leading product group, and win customers' favor.

5 Discussion

5.1 Product Portfolio

As you can see in Table 1, product group B, C, E, and F shows the high purchasing factors. However, for the whole product group, the purchasing factors indicate slightly low. Therefore, it is necessary to ameliorate all product groups like product group C as the whole product and to improve all three factors of the product in high standards. But therefore enough time is necessary with vast cost.

To solve this issue, the balance of the product portfolio can be useful. For example, without a purchasing factor and a customer satisfaction improvement factor, it is assumed that the perception of other product groups, which is caused by drawing customers to stores and net stores, can increase sympathy for other product groups at the same time.

Analysis for whole products (top 1000 products) is performed and Fig. 5 shows the path fig. Consequently, I find that all coefficients are statistically significant at the 5 % level.

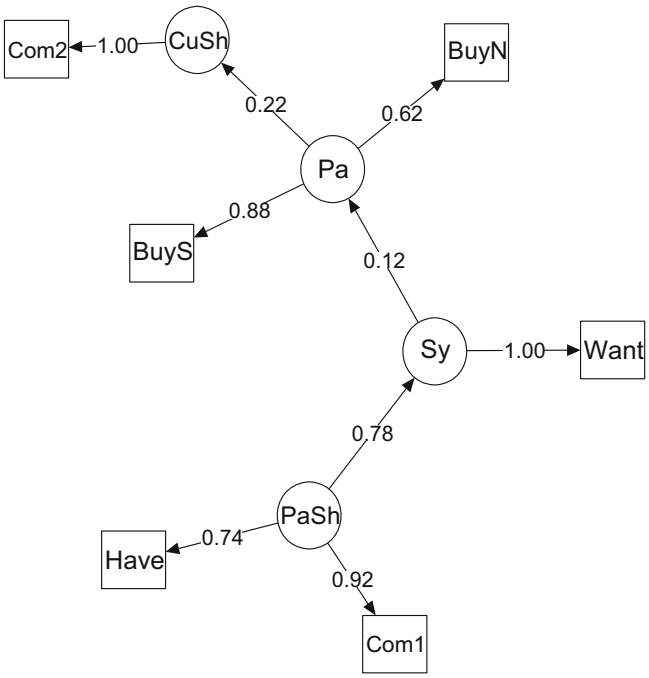

Fig. 5 Path fig of whole products

As for the conformity degree index, it indicates 0.962 in CFI and 0.066 in SRMR, which is preferable. As for the path coefficient, it indicates 0.78 from PaSh to Sy. Confidence interval for the coefficient indicates from 0.769 to 0.793, which argues that PaSh substantially affects the improvement of Sy. In the same way, it indicates 0.12 from Sy to Pa as for path coefficients and 0.22 from Pa to CuSh. Actually, this result would express this enterprise. This enterprise hardly adopts eccentric design and is famous for matching power of its products. For example, in Muji's Chairman Masao Kiuchi's explanation of the creation of the brand image quoted earlier: "By collectively selling at a single location a variety of the products that were designed according to the same taste, we could create a simple and natural environment to propose our 'Muji-based lifestyles'" ([29], page 5).

In short, it is thought that product portfolio management can be useful. It is important to make a product loved for many years, but crucial thing is being a company loved for many years. Product portfolio balance will play a vital role to "the customer satisfaction improvement."

5.2 Future Issues

Future problems greatly include three points. At first, it is necessary to coordinate a model to make conformity degree

index better. It seems that this issue can easily be solved by dividing the data depending on date and time, using any other observed variances, or investigating the content of Com. Then, more detailed empirical validation should be done. The period of this data will be not enough to illustrate sustainability. But it seems that implications are effective. Finally, more detailed analysis is necessary whether the customers become representative because website user is analyzed as representative.

6 Concluding Remarks

To conclude this research, first of all, the spread process of customer satisfaction is clarified. Second, in order to improve every customer satisfaction for sustainable management, it can be important to improve all three elements of product group. Third, analysis of each products and whole products can be useful for product management. Fourth, quantitative research about purchase funnel is performed.

In this paper, structural equation modeling of purchase funnel (SSPS model) is used to measure these three factors. It is suggested that enterprises should measure these and improve sustainability parameter to consider intra-customer relationships and customer purchasing behavior. And understanding it in more details with respect to the product enables firms to easily make more customers satisfied. It will be worthwhile for researchers in the future to study the implications of this analysis in various business contexts.

References

1. Keahey, T.A. and Eick, S.E. (2002), Visual Path Analysis, *INFOVIS '02 Proceedings of the IEEE Symposium on Information Visualization*, pp.165
2. Anderson, E.W. (1998), Customer Satisfaction and Word of Mouth, *Journal of service research*, Vol.1, 1, pp.5–17
3. Arnould, E., Price, L., and Zinkhan, G. (2002), Consumers, Boston, MA: McGraw Hill.
4. Berkowitz, D (2009), 100 Ways to Measure Social Media, *Marketer's Studio*
5. Bernard, J.J. and Simone, S. (2011), Bidding on the Buying Funnel for Sponsored Search and Keyword Advertising, *Journal of Electronic Research*, Vol.12, 1
6. Blackwell, R.D., Miniard, P.W., and Engel, J.F. (2001), *Consumer Behavior*(9th ed), Mason, OH: South-Western
7. Blattberg, R.C., Malthouse, E.C. and Neslin, S. (2009), Lifetime Value: Empirical Generalizations and Some Conceptual Questions, *Journal of Interactive Marketing*, 23, 157–168.
8. Bolton, R.N. (1998), A Dynamic Model of the Duration of the Customer's Relationship with a Continuous Service Provider: The Role of Satisfaction, *Marketing Science*, 17 (1), 45–65.
9. Clow, D. (2013), MOOCs and the Funnel of Participation, *Proceedings of the Third International Conference on Learning Analytics and Knowledge*, pp.185–189
10. Girard, R. (1961), *Mensonge romantique et vérité romanesque*, Paris, France: Editions Bernard Grasset.
11. Goff, B.G. et al. (1997), The Influence of Salesperson Selling Behaviors on Customer Satisfaction with Products, *Journal of retailing*, Vol.73, 2, pp.171–183
12. Harrison-Walker, L.J. (2001), The Measurement of Word-of-Mouth Communication and an Investigation of Service Quality and Customer Commitment as Potential Antecedents, *Journal of service research*, Vol.4, 1, pp.60–75
13. Herr, P.M., Frank,R.K., and John, K (1991), Effects of Word-of-Mouth and Product Attribute Information on Persuasion: An Accessibility-Diagnosticity Perspective, *Journal of Consumer Research*, 17 (March), 454–462.
14. Hiromitsu, M and Osamu, T (2006), The Relationship between Brand Equity and Word-of-mouth, *Japanese journal of interpersonal and social psychology*
15. Hoffman, A.J. and Bazerman, M.H. (2007), Changing practice on sustainability, *Organization and the sustainability mosaic*, pp.84–105Alan, T.K. and Stephen, G.E., 2002, Visual Path Analysis, Proceedings of the IEEE Symposium on Information Visualization
16. Hu, L. and Bentler, P. (1995), Fit indices in covariance structure analysis: Sensitivity to underparameterized model misspefication, *Psychological Methods*, Vol.3, pp.424–453
17. Isada, F. and Isada, Y. (2014), An Empirical Study of the International-Tourism Management by a Model of Consumer Behaviour, *International Journal of Business and Management*, Vol.2, No.3
18. Jeanine, M.T. and Zhang, J. (2013), (De)marketing to Manage Consumer Quality Inferences, *Journal of Marketing Research*, February, pp.55–69
19. Richins, M.L. (1983), Negative Word-of-Mouth by Dissatisfied Consumers: A Pilot Study, *Journal of Marketing*, 47 (Winter), 68–78.
20. Kotler, P. (2000), *Marketing Management Millenium Edition*, Tenth Edition, Prentice-Hall, Inc.
21. Lemon, K.N. and Verhoef, P.C. (2004), "The Theoretical Underpinnings of Customer Asset Management: A Framework and Propositions for Future Research," *Journal of the Academy of Marketing Science*, 32 (July), 271–92.
22. Maeda, H., & Takagi, O. (2006). The relationship between brand equity and word-of-mouth. Japanese journal of interpersonal and social psychology, 6, 31–38.
23. Martin, C.L. and Pranter, C.A. (1989), Compatibility Management: Customer-to-Customer Relationships in Service Environments, *Journal of Services Marketing*, Vol.3, No.3, pp.4–19
24. McClelland, D.C. (1953), *The achievement motive*, New York: Appleton-Century-Crofts, Inc.
25. McClelland, D.C. (1987), *Human motivation*, New York: Cambridge University Press.
26. Mithas, S., Krishnan, C., and Fornell, C. (2005), Why Do Customer Relationship Management Applications Affect Customer Satisfaction?, *Journal of Marketing*, Vol.69, pp.201–209
27. Murray, H.A. (1938), *Explorations in Personality*, New York: Oxford University Press.
28. Rust, R.T., Lemon, K.N., and Zeithaml, V.A. (2004), Return on Marketing Using Customer Equity to Focus Marketing Strategy, *Journal of marketing*, Vol.68, pp.109–127
29. Ryohin Keikaku Co. Ltd (2000), Company profile, http://ryohin-keikaku.jp/eng/corporate/pdf/2000_e.pdf
30. Schermelleh-Engel, K., Moosbrugger, H., and Muller, H. (2003), Evaluating the Fit of Structural Equation Models: Tests of Significance and Descriptive Goodness-of-Fit Measures, *Methods of Psychological Research Online*, Vol.8, No.2, pp.23–74

31. Sheth, J.N., Sethia, N.K., and Srinivas, S. (2011), Mindful consumption: a customer-centric approach to sustainability, *Journal of the Academy of Marketing Science*, 39, pp.21–39
32. Stahl, H.K., Matzler, K., and Hinterhuber, H.H. (2003), Linking customer lifetime value with shareholder value, *Industrial Marketing Management*, 32, pp.267–279
33. Storbacka, K., Strandvik, T., and Gronroos, C. (1994), Managing Customer Relationships for Profit: The Dynamics of Relationship Quality, *International Journal of Service Industry Management*, Vol.5, 5, pp.21–38
34. Tversky, A. (1972), Elimination by Aspects: A Theory of Choice, *Psychological Review*, 79, pp.31–48
35. Tauber, E.M. (1972), Why do people shop?, *Journal of Marketing*, 36, pp.46–59
36. Wangenheim, F.V. and Bayon, T. (2007), The chain from customer satisfaction via word-of-mouth referrals to new customer acquisition, *Journal of the Academy of Marketing Science*, 35, pp.233–249
37. Winter, D.G. (1973), *The power motive*, New York: Free Press

Part IV

Human Factors and Service Engineering

Toward Sports Training Service with the Interactive Learning Platform

Hiroyuki Okamoto, Alessandro Moro, Atsushi Yamashita, and Hajime Asama

Abstract

In recent years, the sports population has increased because of health orientation and improvement of the sports environment. We propose a platform by which leaders and learners can share the training contents with interactive training and can be feedback to leaders. The platform is intended to create the learning result jointly by leaders with the learners and leaders to update the learning contents. Through analysis of video data, the proposed solution helps learners obtain skills in a desired sport even in the absence of a real trainer.

Keywords

Computer vision • Form analysis • e-learning • VR • Sport training

1 Introduction

In recent years, world championship competition and the Olympic Games have contributed to increased popular interest in sports and people intending to practice a sport. The sporting population has increased also because of health-oriented and convenient sports environments. Nevertheless, the increased popularity of different disciplines and the increased number of learners have rendered access to professional trainers difficult in terms of time and area limits. For learners who have limited resources, because training under a leader's guidance requires a long time and because the locations are often limited, the training instruments were obtained from web sites such as YouTube and books. Such an approach usually produces limited results. Moreover, it can lead to mistakes and misunderstandings. We propose a platform by which leaders (providers) and learners (recipients) can share training contents through interactive training and can provide feedback to leaders (Fig. 1). The platform is intended to create learning results jointly by leaders with the learners and leaders to update the learning contents. The platform technology is based on robotics supported by computer vision, a database, the Internet, and a control. The platform can compare and analyze the training contents with a combination of computer graphics and a real image. The level of understanding can be improved because of the use of training using only normal text and movies. Therefore, it is possible to prevent injury or failure because of incorrect operation. The platform can be selected variously for learning opportunities and locations for running on the WEB. At the moment, we can measure the biometric during sports with a smartphone through the development of wearable sensors. Measurement data are transmitted sequentially using Bluetooth to the smartphone. Data will be saved in the smartphone or are recorded in the server on the network. The service providers have extreme difficulty in detecting user needs. Therefore, in some cases, the service supply is delayed. Consequently, a technique for constructing a network by the service media [1] has been proposed. It is also possible to understand and assess user needs early using this platform. This study was conducted to give virtual guidance to the learner using the most advanced

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communication technologies. The proposed solution facilitates skill development a desired sport, even in the absence of a real trainer, through analysis of video data.

2 Constitution

The platform comprises a dedicated application and server and advisor application. The dedicated application runs on the camera-equipped terminal. The server stores the learning contents. The service advisor application supports the analysis and content building. Sports learning is possible anywhere if it meets the conditions. Leaders and learners carry out the creation of imaging and analysis and provide contents using camera-equipped terminals. A few years ago, it was necessary to use a dedicated camera to obtain an image for sports training. Now a camera-equipped terminal can obtain all the necessary images. Recording times were longer because of the capacity increase of memory. A limit exists on the memory capacity that can be used to perform image recording to the server using streaming technology. It is also possible to perform sports learning using a video call application. Learners can learn efficiently because they can interact directly (Fig. 2). Learning by a video call application such as Skype has been conducted for learning of subjects such as English conversation. However, sports learning by video call applications requires time adjustment. That is true because it must be connected simultaneously. Sports learning can entail the difficulty of choosing from an unspecified number of leaders as one might do with English learning. Sports learning involves many subjects, unlike English learning. In addition, video learning is possible. Learners will learn to look at YouTube contents at a video created by leaders. Learners hope to be able to do sports learning anytime and anywhere. Consequently, it is necessary for learners to understand the intent of the leaders. Progress is slow or physical failure occurs if the learner makes mistakes. Because they cannot be leaders and create a dialogue, the learner must interpolate the contents that have been omitted by the leader. This interpolation can hasten the learners' progress. Terminals and servers are connected via a network at all times. Learning contents are stored on the server. Learning contents are stored in a database from such learning records and guidance contents. Learning contents can be searched by such dates. Service advisor applications are applications running on the server. Service advisor applications present the guidance content and leaders to learners from the contents of the sport to be learned (Fig. 3).

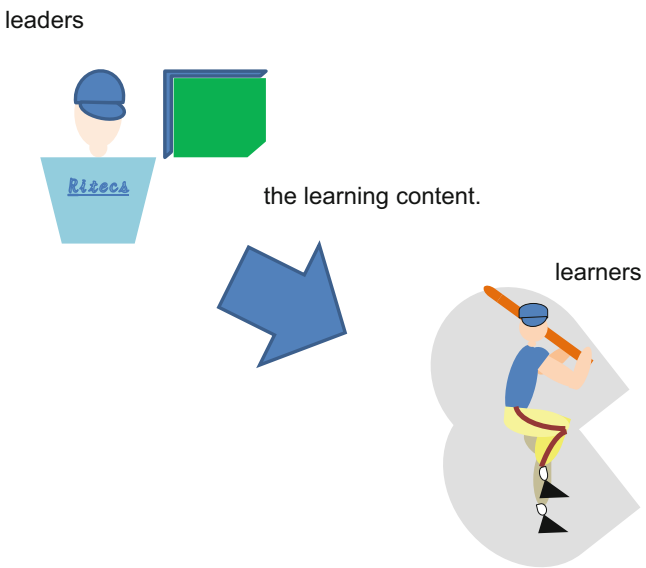

Fig. 1 Provide learning contents

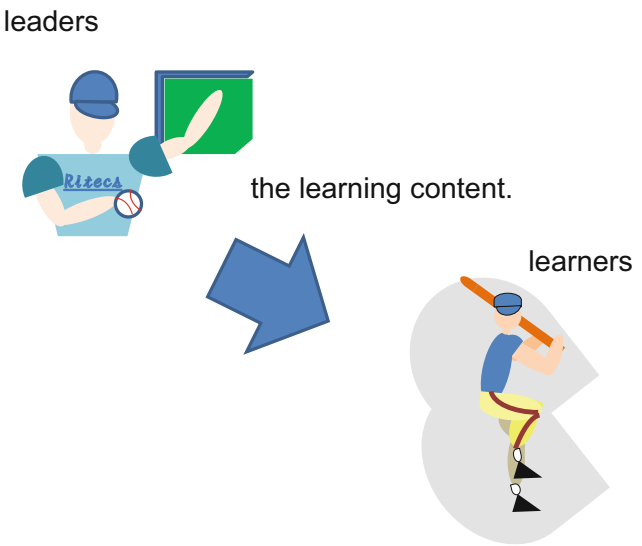

Fig. 2 Supply the content

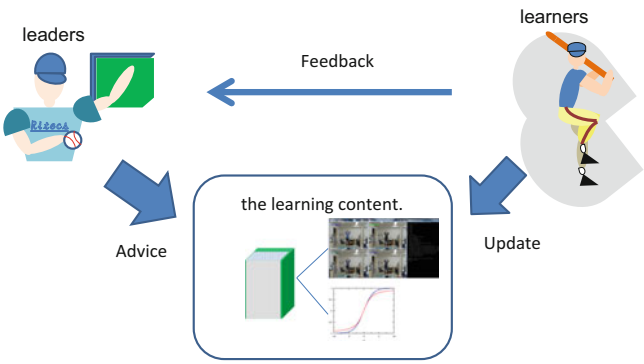

Fig. 3 Update the learning contents with the platform

3 Form Analysis

Learning by the video is believed to be effective for sports learning. This differs from the process used in the image inspection device of the production line.

It is also different from the process used to sense a suspicious individual detected by the monitoring camera. Here, we perform visualization and data of the action from the video using computer vision. We use the form image as the action video. Typically, it is often used to compare images or for multi-motion to visualize the operation image. There are many applications for visualizing the operation image by development of the camera with the terminal. The method of video comparison plays multiple images simultaneously in the display. The method of comparing the video can visually compare it to oneself and others to display the operations simultaneously. Multi-motion generates an image by sequentially updating only the video part using a motion vector. It is effective in multi-motion form analysis.

3.1 Video Comparison

Image comparison is a video to play simultaneously by adjusting the playback start timing of the plurality of images (Fig. 4). This approach shows the form and the model form of leaders on the same screen. Furthermore, it updates the learning contents by comparing the form. In 1998, the Nagano Olympics used a video of the speed skating competition [2]. It became possible to view the time difference between speed skating competitors. The following compares the form video for a squat.

3.2 Multi-motion

The method of multi-motion is a special image that is generated by the combined tension by extracting the active part in the form image. It is possible to analyze visualization continuously by an afterimage effect form. Sporting events finished the motion in a moment. Continuity of the form cannot be visualized to be played slowly with the form image. Continuously visualized form has been done with multi-motion [3] for gymnastics. Kato et al. [4] has used it for golf and baseball form analysis.

3.3 Analysis by Skeleton Model Image

Image comparison and multi-motion are analyzed with a video playback (Figs. 5 and 6). However, because there is no feature point in the video only, the learner has difficulty grasping the learning point. Recently, application of learning using the skeleton model image synthesizing a human skeleton model image using an RGB-D sensor is also presented (Figs. 7, 8, and 9). We have synthesized a skeleton model generated from the form video [5, 6].

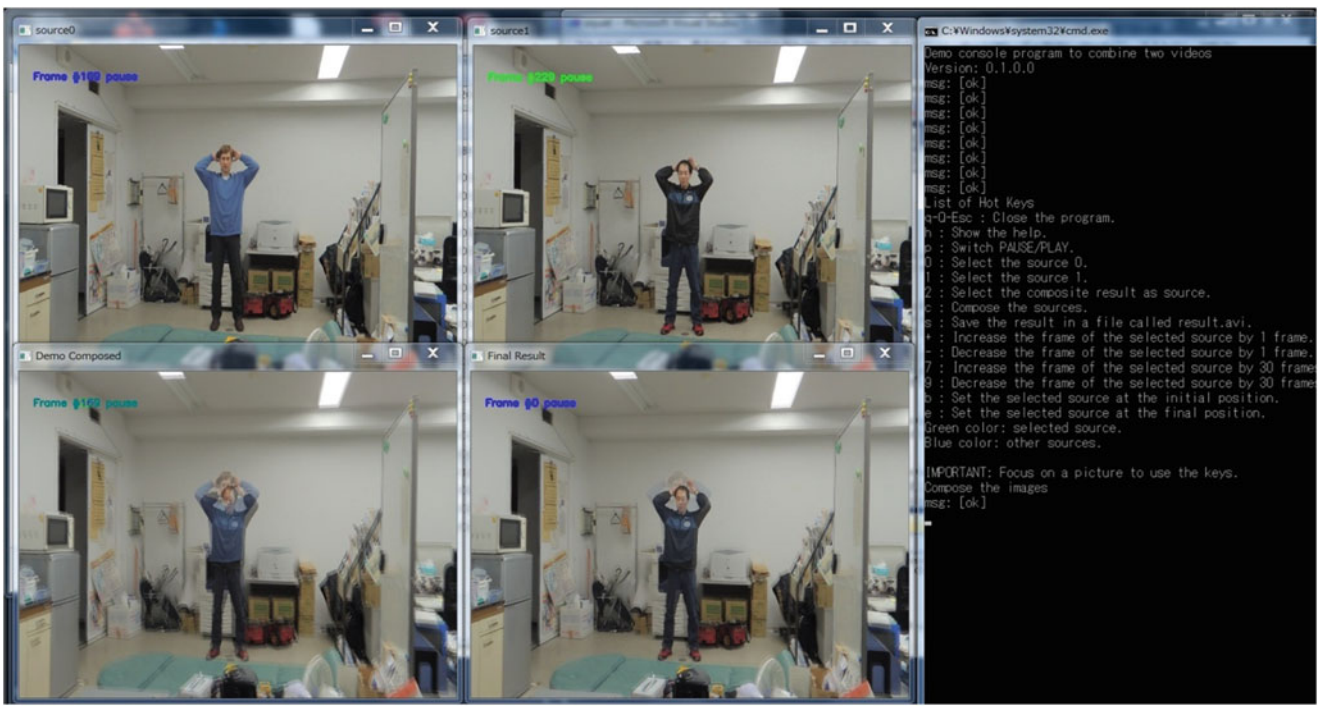

Fig. 4 Compares the form video in squat

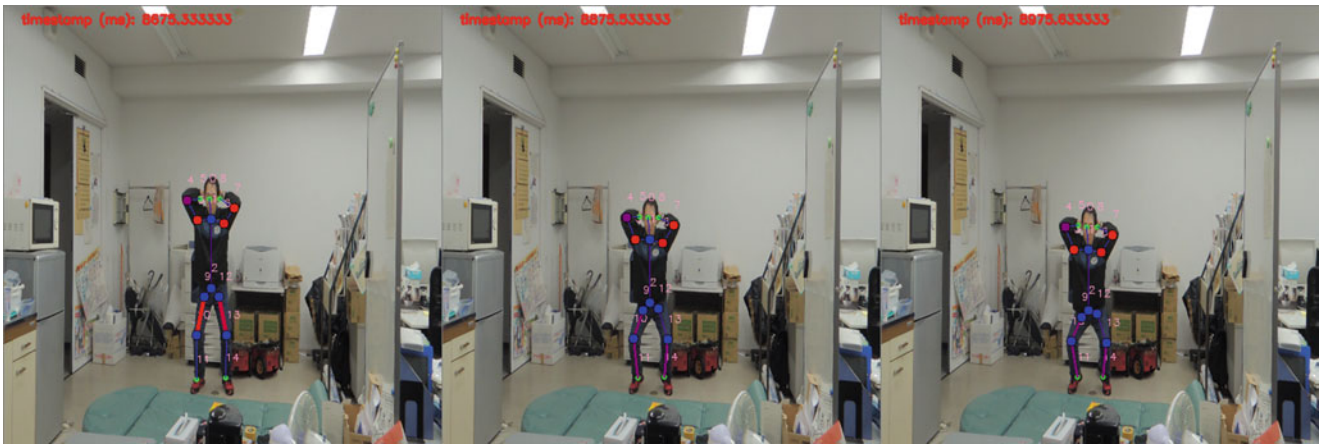

Fig. 5 Skeleton model image 1

Fig. 6 Skeleton model image 2

Fig. 7 Standing skeleton model

Fig. 8 Squatting skeleton model

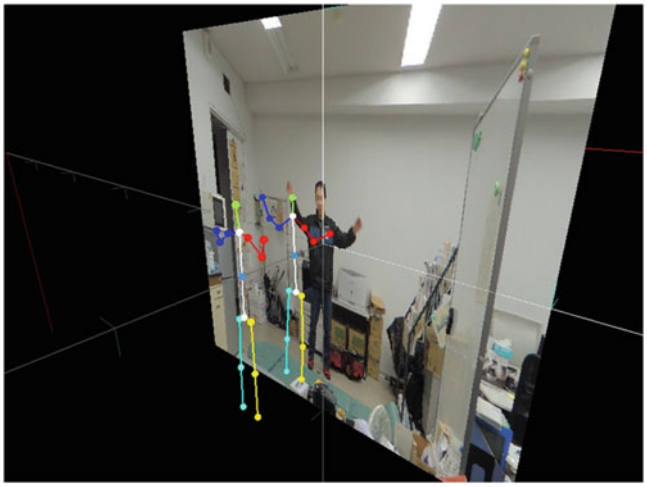

Fig. 9 Skeleton model creation

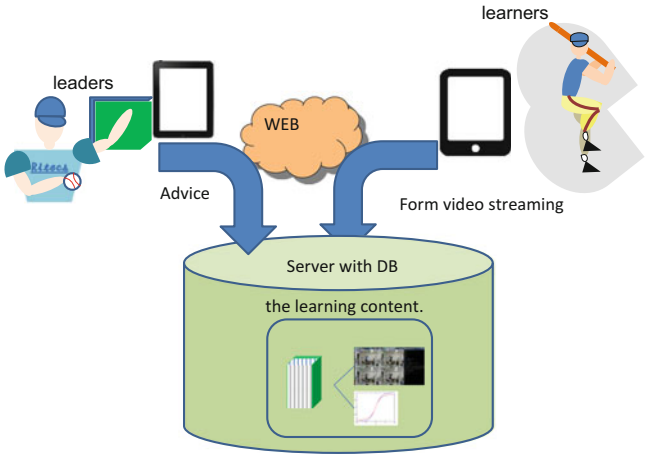

Fig. 10 Learning contents with the platform

3.4 Learning Contents

Normally, the contents of sports learning are created by leaders for an unspecified number of learners. Learners undertake learning to understand the descriptions of the leaders. In this case, leaders are satisfied with the learning contents, but learners are not satisfied unless they develop themselves. Leaders do not provide a service if the learner is not satisfied. We were able to build contents suited to the learner when the learner updates the contents using analysis results with the form image. The learner might incorporate the contents of the leaders in the learning contents if the learner is satisfied with the advice of the leaders. Furthermore, improved satisfaction created by the leader from feedback to leaders is given for built-in events in the learning content. The event includes an evaluation factor. Currently, this platform cannot measure the level of satisfaction. Evaluation of satisfaction in this platform is conducted by the evaluation factor. Learning contents are stored in the database (Fig. 10). Learning contents are being constructed to link the video and data with text that serves as a database. Databases are managed learning contents and learning histories. The platform is able to display the history list learned by the search function. Sports learning is conducted repeatedly until a satisfactory result is obtained by changing the learning method (content). Actually, this is a feedback loop. Learners not only obtain the consciousness and feeling. They can be evaluated and analyzed according to past history data. Even if I feel that a baseball pitcher is throwing in the same form, the form might be slightly different. In such cases, changing the form by physical changes or conditions, and with past and present data comparison, is important. Necessarily, returning to the previous form is not the purpose. The learning contents are updated daily. The service advisor application gives advice according to the accumulated data.

4 Conclusion

We learn by video. Leaders and learners can use the described platform to create learning contents collaboratively for sports learning. Sports learning is necessary to correspond to the learner individual contents and theory.

Theory related to various sports can be learned in books and video today. However, for the learner to be satisfied, the individual must update the learning contents by learners and leaders. Rather than build a system individually, a combination of existing products of leaders and learners is more efficient if it was learned based on the platform. Learning contents have scalability, which promotes research to improve flexibility. Currently, our platform cannot be measured for satisfaction. We expect that sports will improve through good service provided by the present platform to many children. In the future, we expect to proceed with the service advisor application of intelligence [8] and form analysis of web resources by devoting attention to research [7] conducted to elucidate satisfaction measurement.

References

1. Ueda Kanji, Asama Hajime, and Takenaka Takeshima, "Value of Artifacts and Service study," The Japan Society for Artificial Intelligence Journal 23.6 (2008): 728–735, in Japan.
2. Ishikawa Akio et al., "Characteristics of master–slave robot camera for "Virtual Competition," 1998-10-29, Institute of Image Information and Television Engineers, in Japan.
3. Yagi Nobuyuki et al., "Visualization System for Gymnast's Form and Locus: Multi-motion," Institute of Image Information and Television Engineers Journal 51.11(1997): 1881–1887, in Japan.
4. Kato Daiichiro et al. "Development of multimotion system," SICE System Integration Division Annual Conference (2002), in Japan.
5. Yang Yi, and Deva Ramanan, "Articulated human detection with flexible mixtures of parts," *Pattern Analysis and Machine Intelligence, IEEE Transactions on* 35.12 (2013): 2878–2890.

6. Brauer Jürgen, Wolfgang Hübner, and Michael Arens. "Particle swarm optimization on low dimensional pose manifolds for monocular human pose estimation," *SPIE Security+ Defence*. International Society for Optics and Photonics, 2013.
7. Asama Hajime, "Service engineering," The Japan Society for Precision Engineering Journal 75.1 (2009): 146–147.
8. Samet, H., 1990, Applications of Spatial Data Structure, Addison-Wesley, Reading, MA, in Japan

VR|ServE: A Software Toolset for Service Engineering Using Virtual Reality

Philipp Westner and Sibylle Hermann

Abstract

In service engineering a formalized process model gives the advantage that its complexity is reduced due to abstraction and could simplify the communication by specialists, e.g. business process analysts and IT specialists. At some point a more intuitively and tangible depiction of a service situation is needed. This is the case if people that may be not as versed on the theoretical side, e.g. customers, employees and decision makers, are involved in the creation or evaluation of the process. Therefore, we have developed a visualization toolset for the use with a ServCAD system. This toolset enables the user to visualize relevant parts of the process model as an interactive 3D scene. Changes are consistent on the data model, and each change on the 2D BPM view or in the 3D process scene is stored and presented simultaneously.

Keywords

Virtual reality • 3D • Service engineering • ServCAD • Data visualization

1 Introduction

System services can comprise several stand-alone services or may involve a combination of products and services. They are often provided in conjunction with other service providers. The task of the system service provider is therefore to dovetail the services of various partners/suppliers into a consistent and financially optimized value chain. The main challenges associated with developing practice-based system services are the complexity of the service, the heterogeneity of the innovation processes as well as the lack of technical support for the development process. We present our work with the focus on the development of a ServCAD system, as proposed by Shimomura et al. [1] using virtual reality (VR) technology for better communication. For a better introduction to the topic, we included some passages from our previous publication 'The Path to a Computer-Aided Design System for Services' for ISSS 2013 Proceedings [2].

1.1 Mastering Complexity via System Services

With increasing cost pressure and decreasing profit margins, it has become even more important for manufacturing companies over the past 20 years to complement their technical products with a relevant range of services. Manufacturing companies have become and are continuing to become providers of product service systems. This development is generally discussed in terms of servitization [3], service-dominant logic [4] and hybrid added value, and its significance is reflected in the steadily increasing number of relevant projects and publications (e.g. [5]).

The fact that manufacturing companies offer services is hardly new. However, what is new is the complexity of the range of services and the level of professionalism with which

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they have to be provided. Baines and Lightfoot [6] distinguish between three types of services offered by manufacturing companies: The core is made up of basic services that have direct relevance to the product itself, such as the delivery and start-up of machines, provision of spare parts, etc. The second level is made up of services that serve the system availability of a product. Regular maintenance and repairs of machines and systems, user training, condition monitoring and field services all belong to these medium-complexity services (intermediate services). The highest level comprises advanced services (customer support agreements, risk and revenue-sharing models, hiring or operating complete systems). These aim to provide the customer with a defined capacity or service availability. While the basic services complement the product, the product itself is no longer the main focus of higher-level services; they are a means to an end.

According to Barnes and Lightfoot, complex product service solutions are in demand from customers for two main reasons: they contribute towards reducing investment risks and fixed costs and allow customers to concentrate on their core business. These services offer the service providers the opportunity to make a bigger contribution towards the success of the customer's company. This is associated with the opportunity for more long-term customer relationships and a reliable flow of income for a longer period of time. However, these services also represent a higher risk. If the services cannot be provided at the quality level and speed agreed, high contractual penalties may be incurred or the complete loss of its own advance deliveries or payments. The question of mastering complexity is not only a question of success for the service provider but also sometimes a question of business survival.

1.2 Approving Heterogeneous Innovation Processes

If we assume that it is of increasing importance to companies from a wide range of industries to offer system services, the issue arises of what the suitable approaches are to developing these system services as efficiently as possible.

Sakao et al. [7] emphasize that products and services should be developed in close cooperation with, and at the same time as, the development of hybrid service bundles. Sakao et al. list two reasons for this:

1. Customer benefit is only partially derived from the functionality of the product. As a result, product functions and service activities should be defined from the start and adjusted in accordance with customer expectations.
2. Product and service components are developed by different groups of people, which means that constant negotiation is required in order to avoid any mistakes in development on either side.

We share this opinion; however, it is actually fairly rare for complex services to have to be developed from scratch in practice. It is more often the case that existing services have to be modified, be reconfigured or be supplemented by new components. This was also borne out by the company surveys we conducted. Among these companies, the starting point for the development of system services is generally successful customer projects that are later developed further into standardized and modularized services.

Innovative approaches such as service engineering do not take this into account. New first-generation service development approaches, including service engineering, aim to create an initial generic framework for the development of services. For matters of simplification, it is assumed that development projects are activities with a fixed deadline, within which time all stages must be completed from brainstorming to market launch. Re-engineering of existing services is not explicitly planned. In addition, these initial innovation approaches are largely guided by classic internal innovation paradigms [8]. However, this is not enough when it comes to system services that frequently involve customers and partners for their development and provision. This is one of the reasons why these innovation approaches are rarely used in practice.

In this regard, the participants in the ROUTIS [9] project propose a new innovation approach, round-trip service engineering [10], which will better correspond to the methods of day-to-day business practice.

The term 'round-trip engineering' originally comes from software technology and describes a development process where a combination of top-down and bottom-up processes ensures consistency between class diagrams and source codes. In forward engineering, the system to be developed is first described at a highly abstract level (modelled), gradually refined and then translated into a program code. Reverse engineering starts with the program code and extracts the diagrams from it that correspond to the current software design. With the right software support, it can be ensured that changes made on an abstract level can be followed up automatically on another. This means that it is irrelevant on which abstract level the work takes place. Both display modes are always synchronous.

This is also the basic principle behind round-trip service engineering, which also combines forward and reverse engineering in one iteration method. Changes to the service model result in changes to the test scenario or in practice. Conversely, changes to the practical aspects of the service are traced back to the model (see Fig. 1).

This means that round-trip service engineering also takes into account the fact that innovation impulses not only come

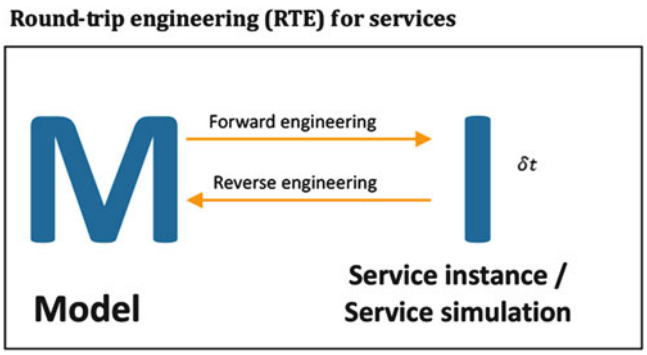

Fig. 1 Principle of round-trip engineering for services (Source: University of Leipzig)

from the system service provider but also from customers and partners. Open service innovation [11] or lead-user approaches [12] can thus be integrated seamlessly.

1.3 Using More Powerful Tools

The classic service engineering approach distinguishes five different stages [13]: brainstorming and idea analysis, analysis of the market and company requirements, development of the service concept (product model, process model, resource model, marketing concept), service implementation and market launch (test, roll-out, start-up monitoring). There are already methods available for all these phases, which have been taken from various specialist disciplines (marketing, engineering, design, user experience design, etc.). These include the Business Model Canvas to describe business models, service blueprinting to visualize processes and customer touch points, service experience mapping or service FMEA to determine relevant quality aspects, etc. These generally consist of 'paper and pencil' solutions or proprietary software tools. This means that the results cannot be processed automatically but always need to be documented manually and prepared for processing. This is a major contrast to the situation in product development, where most analogue tools were replaced years ago via digital solutions (CAD, simulation tools, rapid prototyping tools, etc.). It therefore makes sense to try to develop similar tools for service development.

2 Related Work

Initial ideas and a prototype solution for a computer-aided design system for services (ServCAD) were presented by Arai and Shimomura in 2004 [1]. The aim of the Arai and Shimomura research group is to create a tool that can be used to increase the value (customer benefit) of artefacts and also reduce the impact on the environment at the same time. According to the authors, the aim of service engineering is to create service product systems that provide the optimum relationship between product functions and service activities.

Arai and Shimomura define services as activities that change the status of the recipient. This change is created by the content of the service (material, energy, information) and the service channel by which the content is transferred, strengthened and/or controlled. In this system, artefacts (products) can be content or service channels. The authors argue that services can thus be designed in a similar way to artefacts. Like artefacts, they also have their own functions, processes and statuses.

The starting point for the ServCAD solution proposed by Arai and Shimomura is a service model that is based on these concepts. In its original form, it includes three components: the flow model, the view model and the scope model. The flow model describes the sequence of content and channels that links the service provider (potentially via other persons in the value chain) with the receiver of the service. The view model defines the changes to the content and channels that produce a change in a given state parameter for the receiver (receiver state parameter, RSP), i.e. how a result can be achieved that leads to customer satisfaction. Because the value of a service can have various aspects, the service model consists of various view models. These are clearly summarized in the scope model. The scope model therefore provides information about changes to all relevant receiver state parameters.

One major advantage of a ServCAD system is that the development process develops, visualizes, selects and optimizes design variations with little effort. The depiction of processes plays a major role in this regard. Experience regarding various service engineering projects shows that formal process models are extremely complex and intricate. Creating formal process models thus requires a high degree of imagination, concentration and modelling expertise. If customers, employees or decision makers are to be integrated into the service development at early stages, clearer visualization methods are required. In addition, process models are not suitable for depicting customer interactions. Process models such as the advanced service blueprints described above only show one particular type of customer interaction as an outcome. They do not provide information about how the customer interaction should look in detail. In addition, pure process modelling also does not take into account the fact that customer interaction process can be greatly influenced by the environment in which the service activity takes place [14]. Available space, noise, odours, lighting and furnishing all play a major role in human behaviour and should be taken into account when

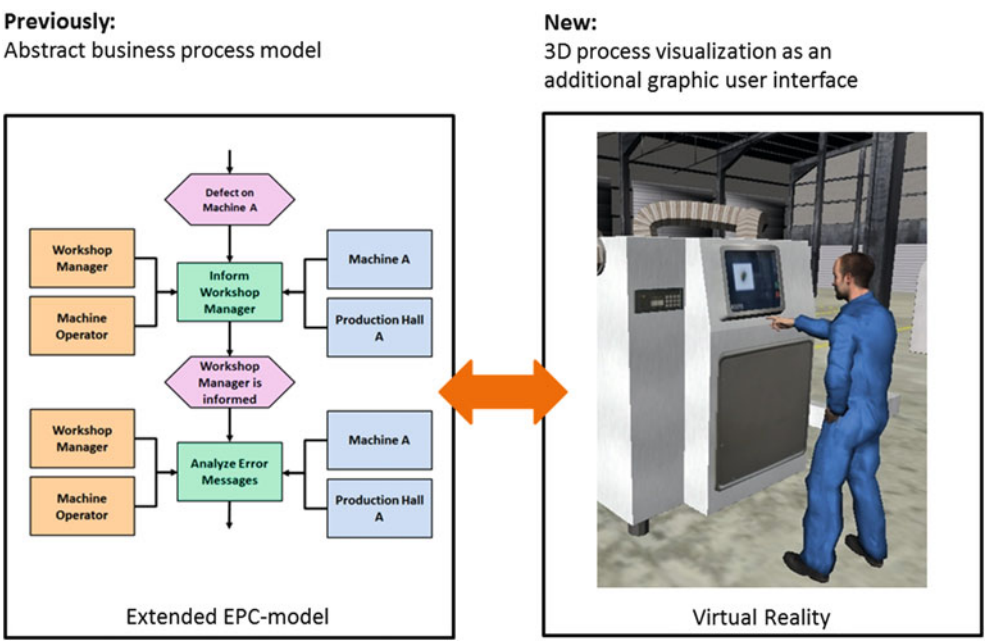

Fig. 2 Designing the 2D/3D modelling tool

designing the service. ROUTIS therefore takes the system described above one step further. As the central element of a CAD system for service development, ROUTIS aims to develop a solution that supplements the abstract process models with an additional graphical user interface.

Our approach is different from the one described in the paper by Brown and Recker [15]. Their 3D representation also included a BPM in a spatial relation to the virtual world. Our objective was more a virtual training or teaching situation as described in Aust et al. [16]. In the paper 'Intelligent Virtual Environment for Process Training' from Wasfy et al. [17], there is also a training scenario described in which they used virtual worlds to give the user a better insight to the complex engineering system controls. They based their tool on a knowledge base and a set of rules instead of using a process graph from BPM as base of their system.

3 Development Process

3.1 Overview

Formalized process models have the advantage that they can reduce complexity through abstraction and can simplify communication by specialists (business process analysts, IT specialists). 3D visualizations, however, present an intuitively comprehensible and tangible depiction of service situations and processes for people who may not be as well versed in the theory side (customers, employees, decision makers). The ROUTIS project therefore aims to develop a visualization tool as the core of a ServCAD system, which will enable a straightforward switchover between both forms of visualization (see Fig. 2).

The project investigated the feasibility of interconnecting the 2D and 3D process visualization based on the same data model and, using the results of this, will establish what research and development work is necessary in order to create a comprehensive ServCAD solution. One integral part of this is our VR|ServE prototype which enables us to evaluate the basic concepts and will give us a clear view towards where we should focus our research. The following chapters show the development and the results we identified.

3.2 Use Case

To get a clear understanding of all the parts involved in a service event, we have chosen a use case from our field of industrial engineering. As a first step, we textually described a machine maintenance use case step by step. A quick abstract of the use case:

> A malfunctioning machine is described. The worker discovers the error. He informs the manager who orders an external specialist for repair. In parallel the internal electrician is ordered to take the machine offline. The repair is carried out. The repair is reviewed and the electrician reconnects the machine.

From the detailed use case text, a storyboard for the VR software (Fig. 3) and an event-driven process chain (EPC [18]) (Fig. 4) were developed.

Based on those drafts, we were able to define the data model, which data we have to exchange and the requirements for the process modelling and the VR

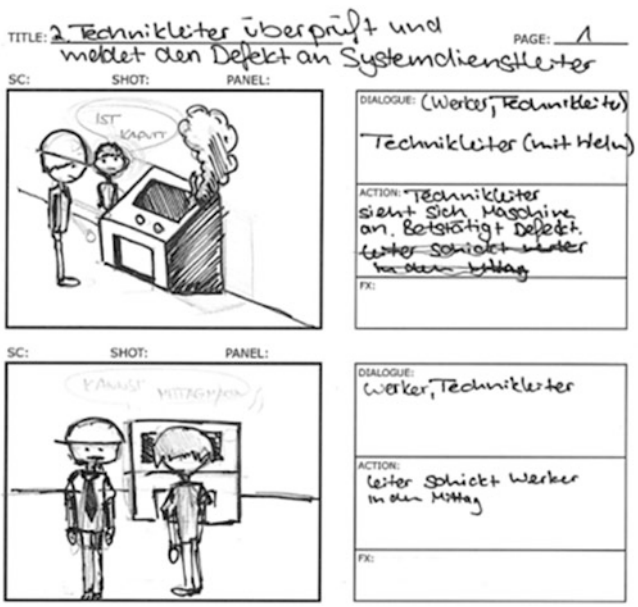

Fig. 3 Storyboard for 3D representation from description

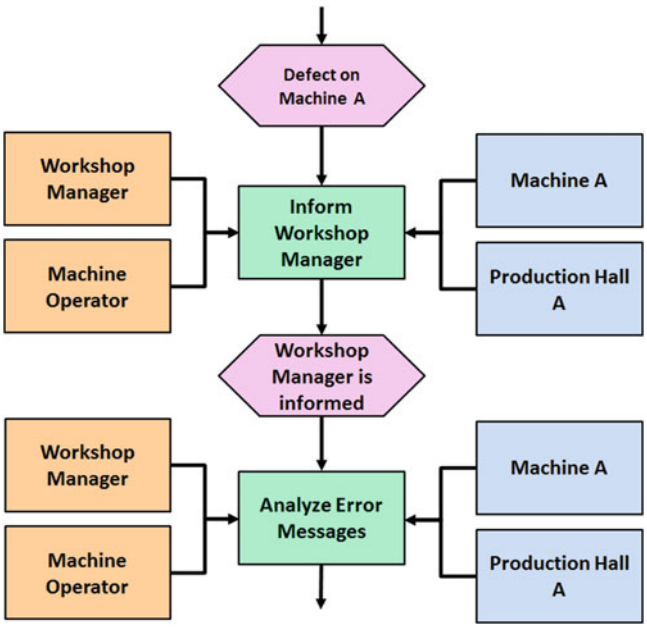

Fig. 4 EPC from description

frontends. Also we were able to deduce the necessary graphical representation of roles, processes and events.

3.3 Virtual Reality Software

All this functionality was integrated in our VR software VRfx [19] which already provides the user the ability to configure and use the software to be used on large immersive display systems (e.g. immersive 3D systems [20]) or on a simple 2D desktop computer display. With VRfx the user is

Fig. 5 VR|ServE toolkit model

able to navigate the displayed 3D scenario, so to take any viewpoint in the currently displayed process step, e.g. to verify the repair process from a different angle (Fig. 5).

For first testing purposes, a simple click through VR scenario was implemented. From this scenario we could extrapolate all the necessary information (e.g. position of the 3D representations) which is normally not included in a standard event-driven process model.

We planned our toolkit as a distributed system (Fig. 6). As a foundation we focused on using common web technologies. Similar to a web browser, we decided to use the statelessness principle for the VR viewer. For communication we implemented simple representational state transfer (REST [21]) calls which exchanged the required data as Java Script Object Notation (JSON [22]).

We also added a dialog system. It is used to display, via speech bubbles or head-up display, text representing a communication sequence between the human 3D representations (Fig. 7). Furthermore this was also extended to human-machine communication by displaying messages on the virtual display of a machine 3D representation. Also other process relevant texts or icons could be displayed at the corresponding object or in a head-up information display on screen, e.g. description of the current process step.

3.4 Process Modelling Software

To model the business process, we took a state-of-the-art process modelling tool [23] (Fig. 8) that already provided a REST compliant API for data exchange. With this tool the roles, events and process are designed and stored. With the API it is possible to exchange data in the JSON format.

During the development process, it turned out that some features that our VR software required could not be directly implemented on this productive platform system. One of the requirements we found out was that integrating a data input (e.g. communication dialog texts) or an accessible storage for our VR data. Also the performance of receiving and sending process data real time could not be realized with

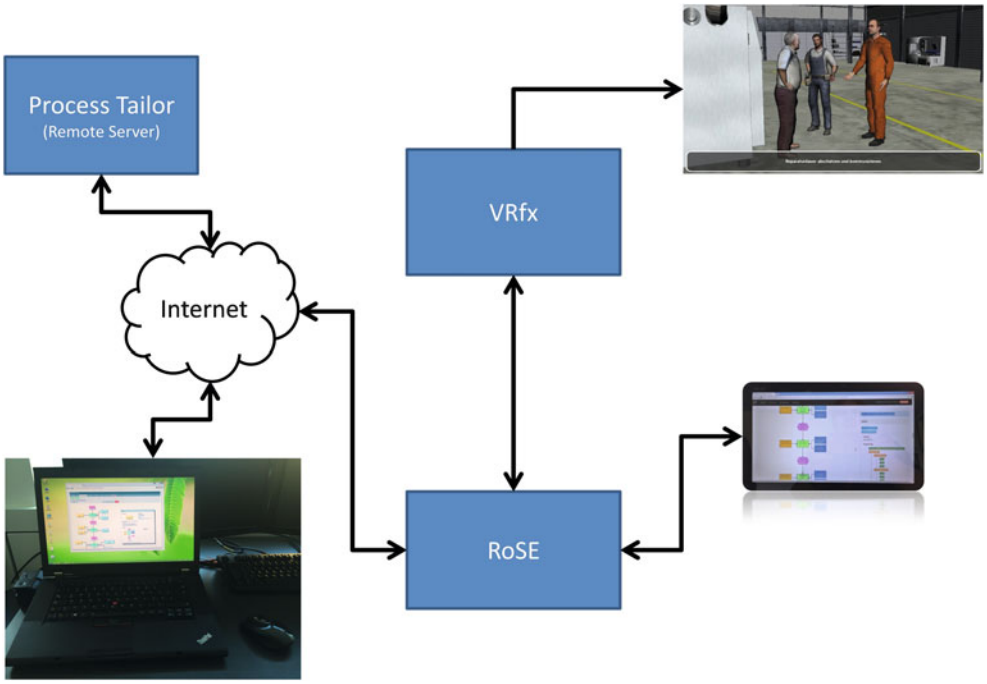

Fig. 6 3D representation of a process step

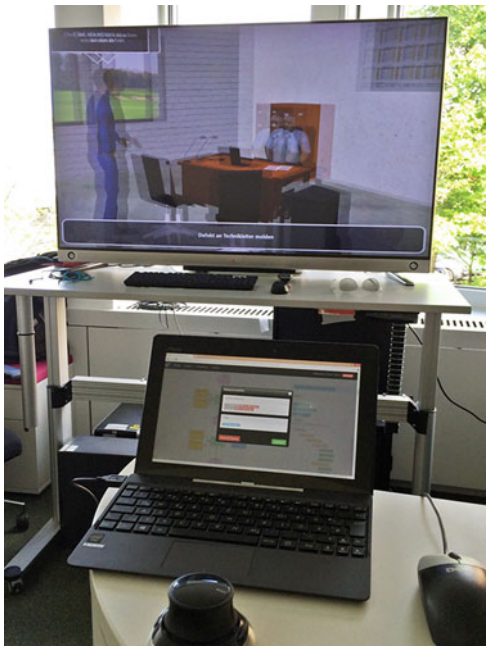

Fig. 7 Set-up using a 3DTV for output and Tablet PC for dialog input

the available API. Because the software is an online productive software, API changes could not be realized for our research prototype, and therefore we developed a middleware to compensate that.

3.5 Middleware

As mentioned in the previous section, most business process software enables the user generate and edit an event-driven process chain (EPC) graph but misses the feature of execution or simulation. There was also the requirement for an interface for easy process navigation (e.g. select current process step to visualize) or text input for our dialog system.

This was realized with this middleware, which requested data from the process modelling software and presents the content as an interactive 2D web page. It features process navigation by clicking on process steps and editing abilities via context menus, e.g. for process description text changes (Fig. 9). We also implemented the input of the human-human or human-machine dialog text using simple web forms displayed in context to the process node.

The main feature in this middleware is to keep track of changes in the process model and the VR software and synchronization with the model. If necessary it generates events to trigger updates of all the involved modules. All the data, excluding the current simulation related data, is synchronized and stored in the process modelling software. By filtering and selecting the raw process data, it was possible to supply the VR software with reduced necessary data required for runtime.

4 Results

With the VR|ServE toolkit, we showed a working process modeller with VR visualization. We also identified the necessary data and in which scale and performance they are required to enable an interactive 3D scenario visualization. Through the direct data interchange between model, simulation and visualization, the support of the round-trip engineering principle is realized.

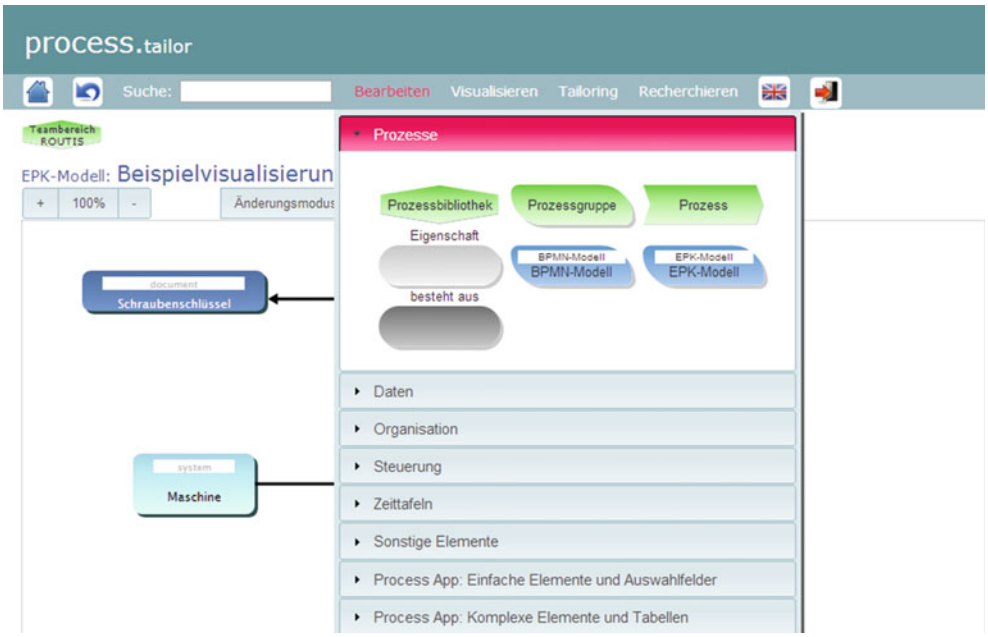

Fig. 8 Process tailor (Source: Scheer Process Tailor Screenshot)

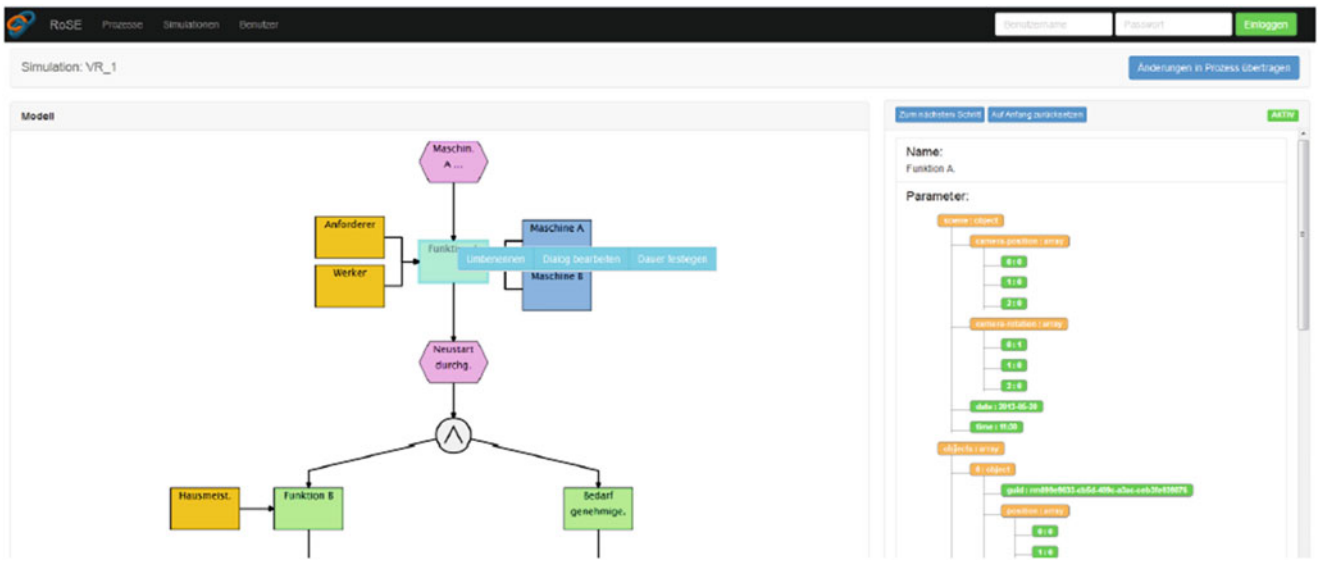

Fig. 9 Routis Simulation Engine GUI (RoSE)

For our first prototypes, we developed a 3D object library with:

- 17 objects of type system (e.g. machine, shop floor)
- 7 objects of type role (e.g. manager, engineer, repairperson)

Based on the process model, we generated 38 3D scenes corresponding to each process step in the EPC graph.

To use 3D representations from an EPC graph, they have to be spatially placed in the virtual world. This information is usually not included in a standard EPK model. For some objects (e.g. shop floor), this has been realized by setting a default value throughout the process. For the 3D representation of a role (virtual human model), setting position was one parameter, but also the gesture, pose and direction have to be set. This had to be dynamically updated during stepping through the simulation.

The storage of these parameters was realized as extra parameters/resources in the EPC nodes. Some of the parameters would not fit cleanly into the EPC model; therefore, they were realized as additional parameters attached to the nodes. For example, the dialog texts are placed into the process node for storage. Although the VR software could query all information from the process model, some quick access functions had to be implemented due to the large amount of data required the additional component of a middleware.

5 Conclusion

We have developed a toolkit consisting of the three above-mentioned modules and a method to apply them successfully to a service engineering process. Although we made a big progress with our first prototypes of a VR|ServE, there is still a lot of potential. A large part in creating a visualization model is the placement of the 3D objects in the virtual world, which is currently done manually.

In the next step, we planned to provide an easy user interface or implement automatic placement by using semantic object information (e.g. if a worker is applied to the process model, the 3D representation selects a correct initial position in front of the machine).

Another part is creating a collection of 3D models from which the user can choose which 3D representation best fits their current process design. Also the current process steps are displayed using static 3D models. To clarify the intension of an action, some of the events could be animated (e.g. a technician walks to the machine and interacts with it).

As mentioned above EPC is on the one hand very easy to understand, and on the other hand, it is very limited to express complex processes and integrate metadata as part of the process graph. Therefore, our target will be to switch the modelling protocol to BPMN and select a better, more flexible and performant process modelling tool and also to eliminate the middleware component.

Throughout the evaluation cycles, we collected a lot of ideas for the reuse of the finally modelled process, e.g. shop floor training or interactive repair manual. We also had many requests from the industry to integrate or simulate machine states, information input and output and resource planning, which we will include in our research in the next stage.

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References

1. Hara, T.; Arai, T.; Shimomura, Y.; Sakao, T. (2009). Service CAD system to integrate product and human activity for total value. CIRP Journal of Manufacturing Science and Technology (l), 267–271.
2. Meyer, K.; Thieme, M. (2013). The path to a computer-aided design system for services, ISSS 2013 Proceedings. 117–126.
3. Van der Merwe, S.; Rada, J. (1988). Servitization of business: Adding value by adding services. European Management Journal, 6(4), 314–324. #
4. Vargo, S. L., & Lusch, R. F. (2004). Evolving to a New Dominant Logic for Marketing. Journal of Marketing, 68(1), 1–17. von Hippel, Eric (1986): Lead Users. A Source of novel product concepts, in: Management Science, Vol. 32, pp. 791–805.
5. Korte, S., Grimm, V., Rijkers-Defasne, S., & Zweck, A. (2012). Hybride Wertschöpfung. Bewertung des Förderschwerpunkts.
6. Baines, T., & Lightfoot, H. (2013). Made to Serve: How manufacturers can compete through servitization and product service systems. Wiley.
7. Sakao, T., Shimomura, Y., Sundin, E., & Comstock, M. (2009). Modeling design objects in CAD system for Service/Product Engineering. Computer-Aided Design, 41(3), 197–213. Elsevier.
8. Meyer, K., & Böttcher, M. (2011). Entwicklungspfad Service Engineering 2.0 – Neue Perspektiven für die Dienstleistungsentwicklung. Leipzig: Universität Leipzig.
9. ROUTIS, (2015), http://www.routis.de/
10. Meyer, K.; Thieme, M. (2013). Theory and Practice for System Services Providers in Complex Value and Service Systems, ISSS 2013 Proceedings. 127–135.
11. Chesbrough, H. (2010). Open Services Innovation: Rethinking Your Business to Grow and Compete in a New Era. Jossey-Bass.
12. Oliveira, P., & Hippel, E. Von. (2010). Users as Service Innovators: The Case of Banking Services Users as Service Innovators: The Case of Banking Services. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1460751
13. Meiren, T., & Barth, T. (2002). Service Engineering in Unternehmen umsetzen. Leitfaden für die Entwicklung von Dienstleistungen. Stuttgart: Fraunhofer IRB Verlag.
14. Bittner, M. J. (1992). Servicescapes: The Impact of Physical Surroundings on Customers and Employees. Journal of Marketing, 56 (2), 57–51.
15. Brown, Ross; Recker, Jan; West, Stephen (2011): Using virtual worlds for collaborative business process modeling. In: Business process management journal 17 (3), S. 546–564.
16. M. Aust and K. Pöhland, "Sicheres Arbeiten trainieren – in der Virtuellen Realität," Technische Sicherheit, vol. 3, no. 10, pp. 29–32, 2013.
17. Wasfy, A.; Wasfy, T.; Noor, A., Intelligent virtual environment for process training, Advances in Engineering Software 35 (2004), 337–355
18. Scheer, Prof. Dr. A.-W. (1992). Veröffentlichungen des Instituts für Wirtschaftsinformatik, Heft 89, Semantische Prozeßmodellierung auf der Grundlage "Ereignisgesteuerter Prozeßketten (EPK)" Retrieved from http://www.iwi.uni-sb.de/iwi-hefte/heft089.pdf
19. M. Bues, G. Wenzel, M. Dangelmaier, and R. Blach, "VRfx: A user friendly tool for the creation of photorealistic virtual environments," in Universal access in human-computer interaction. 4th International Conference on Universal Access in Human-Computer Interaction, UAHCI 2007. Vol.2: Ambient interaction, Berlin: Springer, 2007, pp. 624–632.
20. Cruz-Neira, Carolina; Sandin, Daniel J.; DeFanti, Thomas A.; Kenyon, Robert V.; Hart, John C. (1992): The CAVE: audio visual experience automatic virtual environment. In: Commun. ACM 35 (6), S. 64–72. DOI: 10.1145/129888.129892.
21. ECMA International (2013). Standard ECMA-404: The JSON Data Interchange Format. Retrieved from http://www.ecma-international.org/publications/files/ECMA-ST/ECMA-404.pdf
22. Webber, J.; Parastatidis S.; Robinson, I. (2010). REST in Practice. O'Reilly Media Inc.
23. Scheer Process Tailor, Software, http://scheer-management.com/scheer-process-tailor/?lang=en

Productivity Improvement and Stress Reduction by Showing Information to a Surveillance Worker

Mitsunari Uozumi, Kouichi Yamada, Shuto Murai, Hajime Asama, and Kaoru Takakusaki

Abstract

System surveillance is a function required for continuous operation of a system which consists of various apparatus and networks. Many service providers try to raise their productivity. Their methods show some information to a surveillance worker after the alarm occurs. As another method of the rationalization, a surveillance system shows some information to the worker on the waiting time. The simulated environment of surveillance has been built. There are three kinds of screens that are shown to the subject on waiting state. Passive case test uses passive waiting screen that displays no information. Directed case test uses directed waiting screen that displays operation method. Active case test uses active waiting screen that displays list of surveillance objects and can be scrolled by subject. Subjects' stress are performed by R-R interval. By comparing 12 subjects, it was confirmed that they are working efficiently in the test which display some information, and active case test that encourages voluntary browsing allows subjects to relax. It is an effective method of a productivity improvement and stress reduction to display the information that encourage voluntary browsing on waiting time.

Keywords

Surveillance service • Service engineering • Human interface

1 Introduction

System surveillance is a function required for continuous operation of a system which consists of various apparatus and networks. These system components break and deteriorate with age, etc.

Surveillance system detects these abnormalities, and the surveillance worker performs predetermined disposal for returning to normal (Fig. 1).

The entrepreneur who provides service may maintain a system at low cost. So it is not rare to contract out surveillance to a service provider. The entrepreneur who offers surveillance as a service has the equipment which performs the service effectively and trains workers who handle the system and carry out the surveillance 24/7 [1]. Entrepreneurs of surveillance service are advancing rationalization of surveillance business. They increase their productivity and offer a competitive charge [2, 3].

Their methods show some information to workers after the alarm occurs. This information helps the worker to dispose problem [4]. Software products for the purpose of monitoring system provide such functionality [5, 6].

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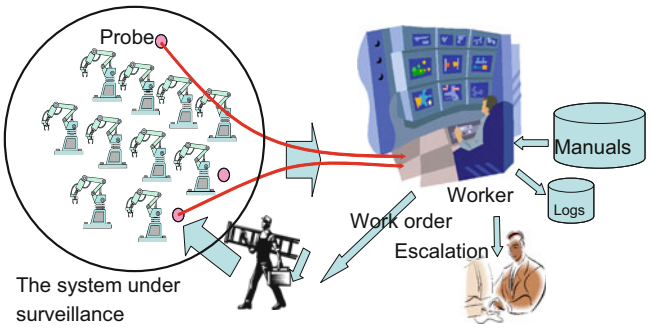


Fig. 1 System surveillance

However, these products are not inexpensive; these are necessary to organize and manage object information. By the appropriate information, these software will reduce the disposal time of failure.

As another method of the rationalization, it can be considered that a surveillance system shows some information to workers on their waiting time. Tamura et al. have reported that activeness positively affects cognitive performance [7]. Bechara et al. have reported that emotion can affect the decision-making [8].

In monitoring work, waiting time will always occur. Presenting information on the waiting time can be easily realized than replacing software for monitoring.

In the surveillance operation, it can be considered that the productivity can be changed by controlling the state when the worker receives an alarm. Using the information shown, the disposal time of workers is shortened by doing active work [9].

However, if workers' stress are increased by presenting the information, it becomes an obstacle to continuous operation.

The simulated environment of surveillance has been built and the results of 12 subjects are evaluated. This study evaluates the difference in productivity and stress of the work by way of the use of the waiting time. This will reveal the appropriate usage of waiting time.

2 Productivity Improvement Using Waiting Time of the Worker

2.1 Surveillance Worker Model

A surveillance worker's work consists of the following three states:

- The worker waits for the alarm.
- The worker recognizes the alarm.
- The worker disposes of the alarm.

A worker changes these states in order (Fig. 2).

In the waiting state, a worker waits for a change of display in the screen. In the recognizing state, a worker notices a change of display in the screen and starts to dispose of the alarm. In the disposing state, a worker deals with the alarm according to the instructions stated in the manual and completes the disposal.

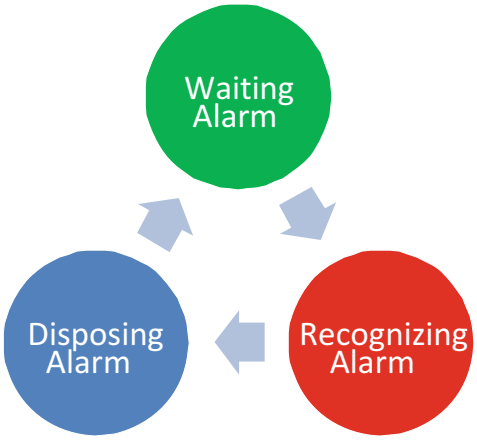


Fig. 2 Surveillance worker model

2.2 Stimuli in the Waiting Time

There are three kinds of stimuli that are shown to the worker on waiting state and are as follows:

- Passive case uses passive waiting screen (A).
- Directed case uses directed waiting screen (B).
- Active case uses active waiting screen (C)

1. Passive waiting screen (A):
   No additional information is shown on this screen until an alarm is generated. The generated alarm is displayed on the upper row of the screen. After the display of an alarm is recognized, a worker will click the button on the screen for disposal. Figure 3 shows an example of the screen being displayed before an alarm will be generated.
2. Directed waiting screen (B):
   Explanation of the operation method is shown as the information on this screen until an alarm is generated. The generated alarm is displayed on the upper row of the screen. After the display of an alarm is recognized, a worker will click the button on the screen for disposal. Figure 4 shows an example of the screen being displayed before an alarm will be generated.
3. Active waiting screen (C):
   A list for surveillance is always shown in the lower part of the screen. While waiting for an alarm, a worker can scroll this list or can sort a list by items, such as apparatus ID or hours of use. After the display of an alarm is

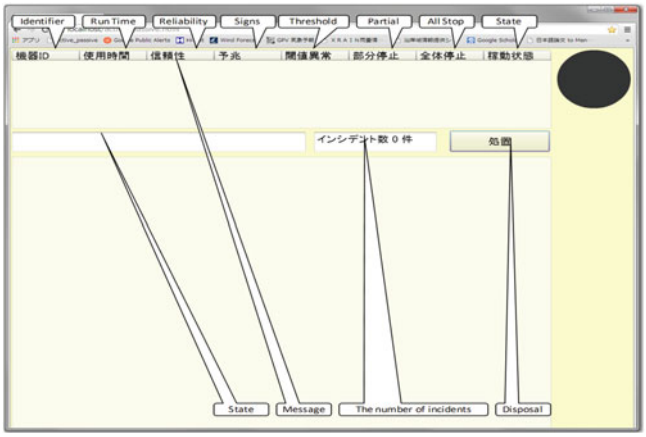


Fig. 3 Passive waiting screen (A)

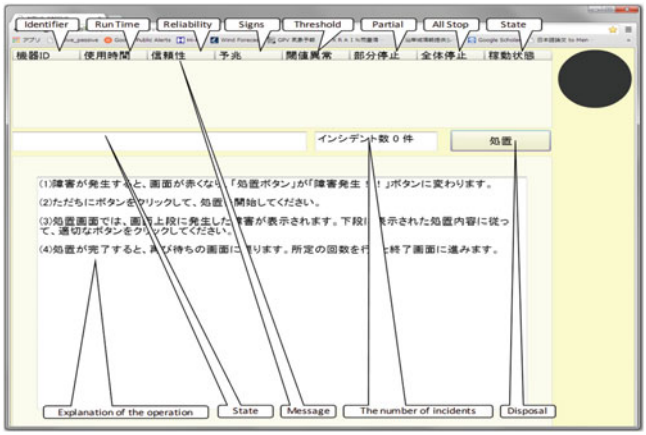


Fig. 4 Directed waiting screen (B)

recognized, a worker will click the button on the screen for disposal. Figure 5 shows an example of the screen being displayed before an alarm will be generated.

3 Experiments with Simulated Environment

3.1 Simulated Environment of Surveillance System

The simulated environment of the surveillance system using a computer has been built (Fig. 6).

A subject waits for a change of alarm by viewing a computer screen.

Alarms are generated randomly and the generating interval average is 25 s. The generated alarm will enable the display of a message on the screen which the subject is looking at. In each test, the subject disposes 20 alarms.

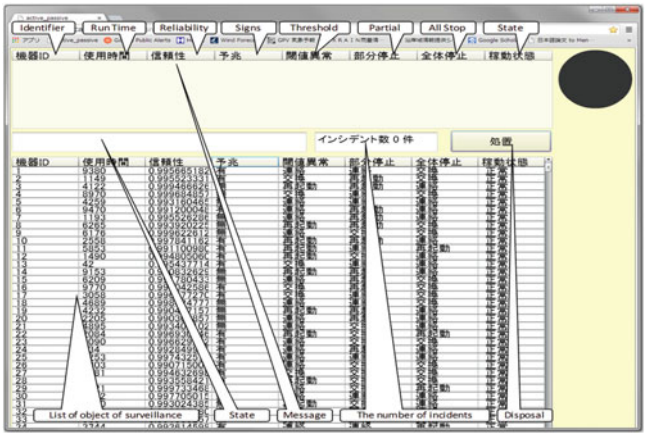


Fig. 5 Active waiting screen (C)

3.2 Method of Measurement

To accurately record the screen transition and mouse operation, the following methods are used:

1. Screen Transition

In all the used screens, the circle is displayed on the upper right (Figs. 3, 4, and 5). The luminosity of this circle is different by changes of a screen.

The difference in the luminosity of this circle is measuring using the phototransistor. A measuring result is shown in Fig. 7. The upper row of Fig. 7 is a measurement value of luminosity. It can check changes with screen transition.

2. Mouse Operation

The potential difference between the terminals of the microswitch of the mouse which a subject operates is measured. If a subject pushes a mouse, since a microswitch short-circuits, potential difference will be 0 v. The lower row of Fig. 7 is a measurement value of potential difference. The timing which pushed the mouse and the released timing are recorded.

The time axis of this record is in agreement with the record of the physiology measurement shown in Fig. 6, and a subject's operation and a physiological state can be compared in the unit for 1/1000 s.

As shown in Fig. 7, the period until the alarm is generated and the luminosity of a screen changes is defined as working hours (WORK).

The time from the alarm of the process is completed until the occurrence of the next alarm is waiting time (WAIT).

The time from the end of the test until the next start of the test is idle time (IDLE).

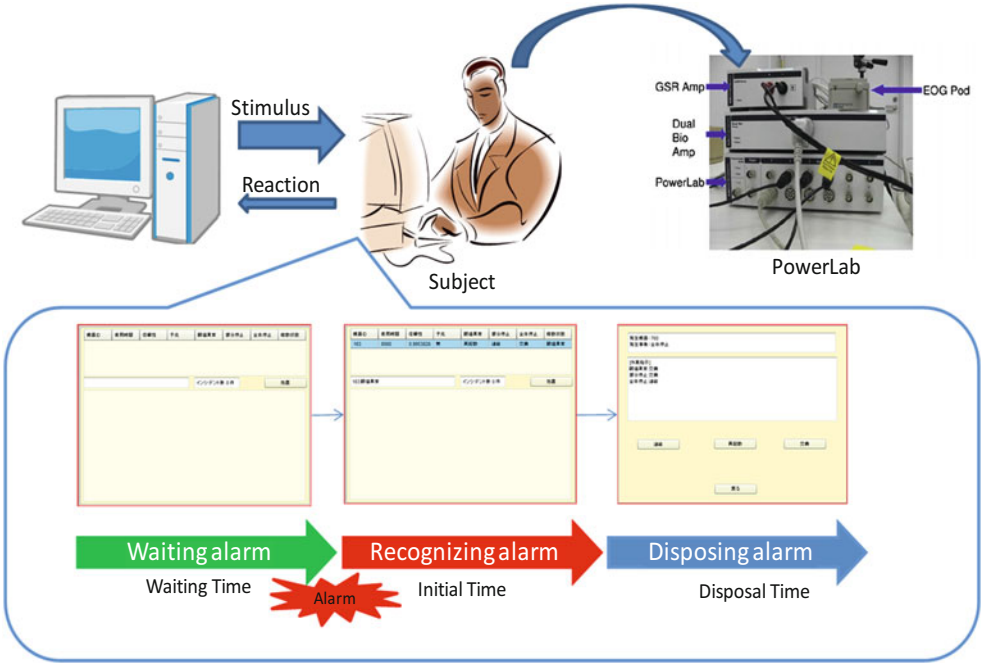


Fig. 6 Simulated environment

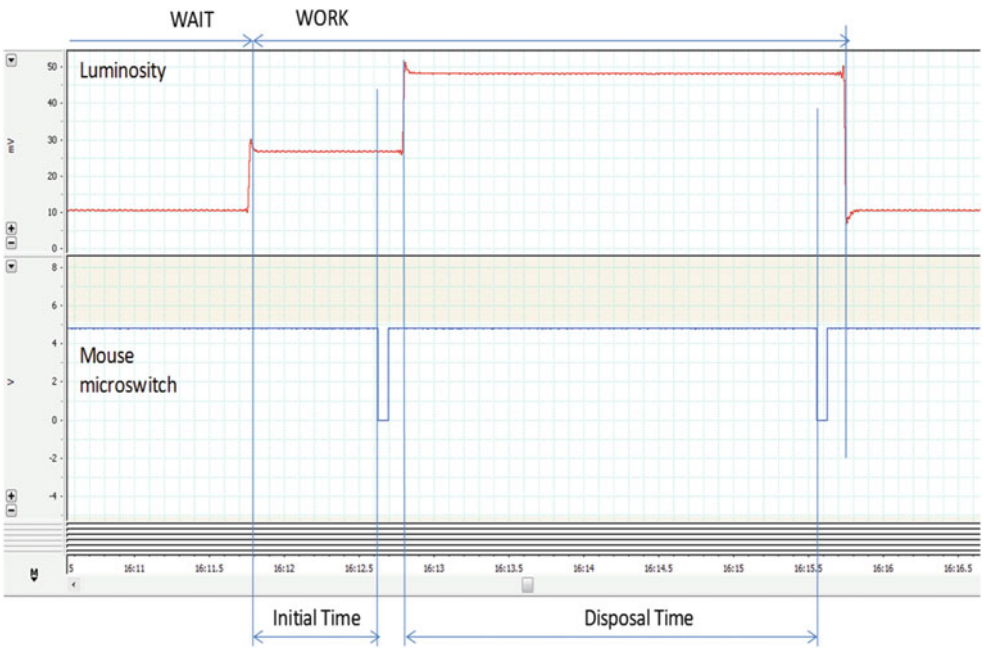


Fig. 7 Example of measurement data

After the screen of the alarm is displayed, the period until a mouse is pushed is defined as a subject's initial time.

After a disposal screen is displayed, the period until a mouse is pushed is defined as disposal time.

For evaluation of the difference of each case in physiological reactions, physiology measuring device is used. In order to evaluate mental tension, electrocardiogram (ECG) is used.

4 Experimental Results and Discussion

4.1 Subjects

In this simulated environment, measurement using 12 subjects was performed. Subjects are seven employees of corporate laboratory and five graduate students. There are

11 men and 1 woman aged 23–54 years old (average = 32.6, SD = 10.3).

In many surveillance environments, generation structure is broad. This group of subjects is close to this.

4.2 Reaction Time of the Subjects

The total of a measuring result is shown in Fig. 8 as a scatter diagram. A horizontal axis is the initial time and a vertical axis is the disposal time. The average of a subject's initial shock time and disposal time is computed for every test.

The passive-type test is set to A. The directed-type test is set to B. The active-type test is set to C.

About disposal time, it can be read that it is about the tendency of A > B > C.

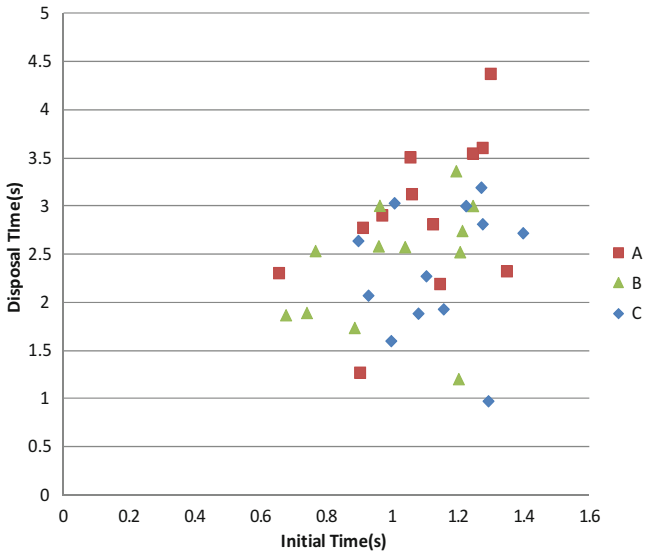


Fig. 8 Reaction time of the subjects

The difference in a remarkable tendency cannot be read about disposal time.

4.3 Evaluation to Initial Time

The average of each subject's initial time is shown in Fig. 9. The bar graph shows the average value of the passive type (A), the directed type (B), and the active type (C).

The average value of the passive type (A), the directed type (B), and the active type (C) is estimated by the *T*-test. The asterisk shows the item a significant difference ($p < 0.05$) is accepted.

All subjects' average initial time of each type is 1.08 s (SD = 0.33), 1.01 s (SD = 0.48), and 1.14 s (SD = 0.45).

Significant differences ($p < 0.05$) are accepted between the passive type (A) and the directed type (B) and between the passive type (B) and the directed type (C). But there are only little differences (from 5.6 % to 6.5 %) in these average times.

In initial time, it can be said that there is no big difference between the passive type (A), the directed type (B), and the active type (C).

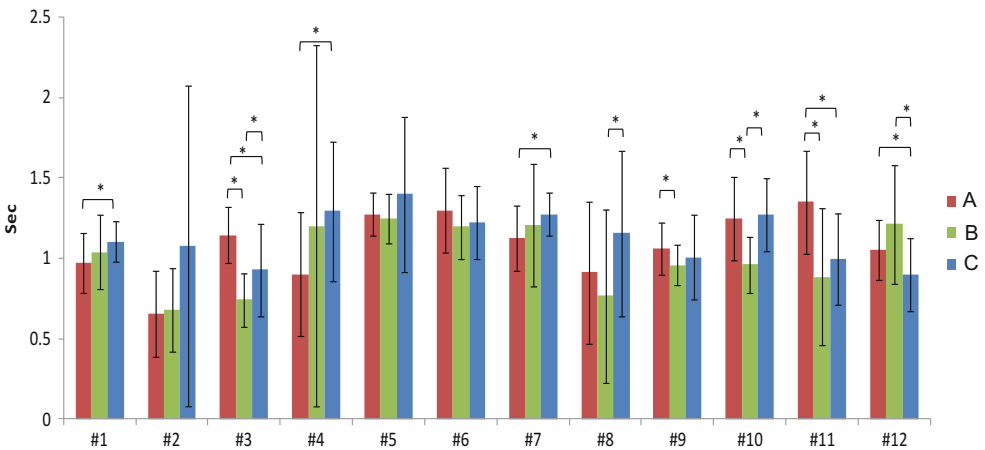
4.4 Evaluation to Disposal Time

The average of each subject's disposal time is similarly shown in Fig. 10. It can be said that the directed type (B) and the active type (C) of disposal time are shorter to the passive type (A) in 11 subjects among 12 subjects. Moreover, in eight subjects, it can be said that the active type (C) has an effect of a disposal time.

All subjects' average disposal time of each type is 2.90 s (SD = 0.95), 2.42 s (SD = 0.78), and 2.35 s (SD = 0.81).

In disposal time, significant differences ($p < 0.05$) are accepted between the passive type (A) and the directed type (B) and between the passive type (A) and the active type (C).

Fig. 9 Initial time



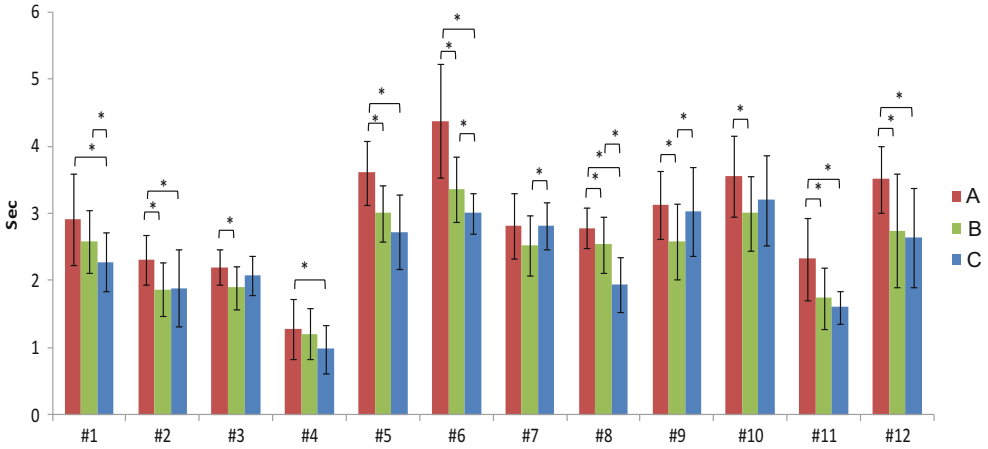


Fig. 10 Disposal time

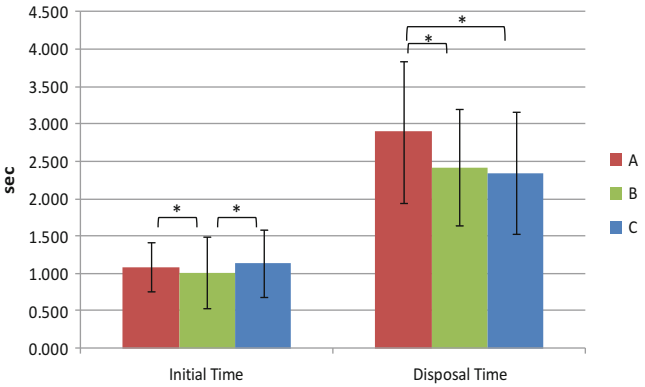


Fig. 11 Average of 12 subjects

4.5 Evaluation to Productivity

The rate of the time savings in the directed type (B) and the active type (C) is computed on the basis of the passive type (A). A maximum of 25–35 % of shortening effect is seen in initial time. However, the difference is minute on the average.

An average of 16.4 % of shortening effect on the directed type (B) and average of 19.0 % of shortening effect on the active type (C) are seen in disposal time (Fig. 11). Improvement of the productivity by time saving is accepted.

In a real system, alarms that occur randomly are queued by the system and processed sequentially by the worker.

The alarm density is λ. The time from the alarm is occurred until the end of processing is Tq. And Tq is the average service time.The processing time (initial time + disposal time) is Ts. In the queueing model, the relationship between Tq and Ts can be represented by the following formula:

$$Tq = \frac{Ts}{1 - Ts * \lambda} \quad (1)$$

Table 1 Ts in each type

	A	B	C
Initial time	1.08 s	1.01 s	1.13 s
Disposal time	2.90 s	2.42 s	2.35 s
Ts	3.98 s	3.43 s	3.48 s

Using Ts in each type (Table 1), Tq can be calculated by this formula (Fig. 12). This result shows an example of an indicator of the service management.

To keep average service time under 10 s, 0.2 alarm/s is a limit alarm density in the passive type (A). But in the directed type (B) and the active type (C), 0.24 alarm/s is a limit alarm density.

In the passive type (A), it takes time of average 89 s to process 0.24 alarm/s alarm density.

Differences of processing time are from 12.5 % to 13.9 %.

The manager calculates the number of workers required for the operation by using the performance of the worker as a base value.

Improvement of worker's performance is to reduce the number of required workers and to improve the productivity.

4.6 Evaluation to Stress

In addition to the reaction time of the subject, the measurement of the electrocardiogram has been performed.

RMSSDs (root mean squared successive differences) and SDNN (standard deviation of the N-N(R-R) interval) [10], SDNN/RMSSD [11], are calculated using the R-R interval obtained from the electrocardiogram.

In RMSSD, it is considered that there is a correlation PNS (parasympathetic nervous system). In SDNN/RMSSD, it is considered that there is a correlation SNS (sympathetic nervous system).

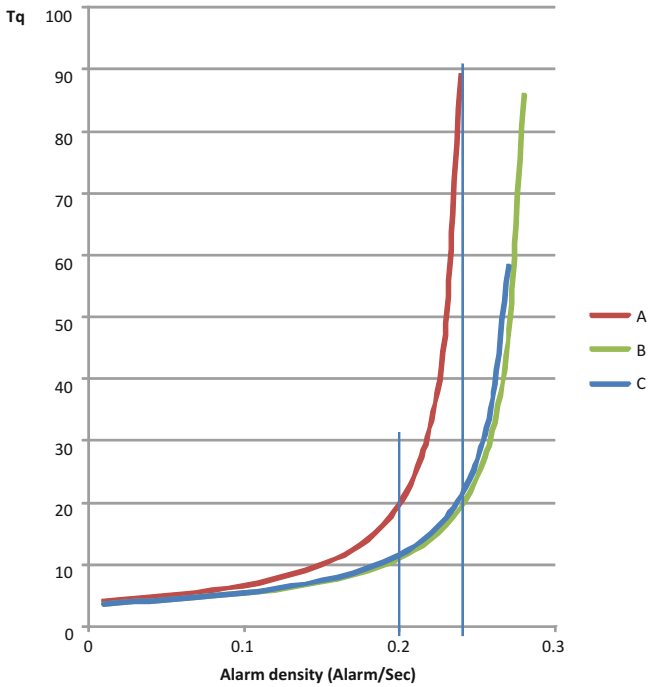


Fig. 12 Average service time

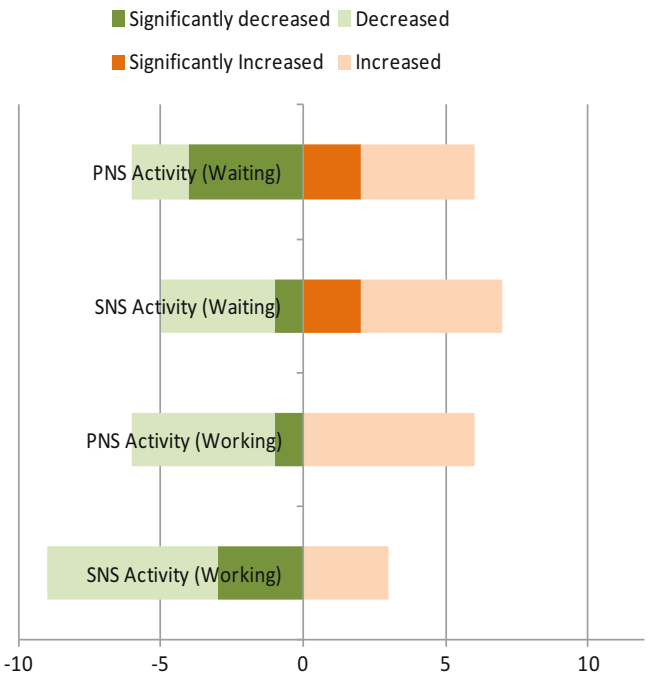


Fig. 13 Comparison of passive and directed type

Evaluation is carried out as there are correlations between RMSSD and PNS and between SDNN/RMSSD and SNS.

The time until the occurrence of the alarm is a waiting section. The time until the completion of the procedure from the alarm is a work section.

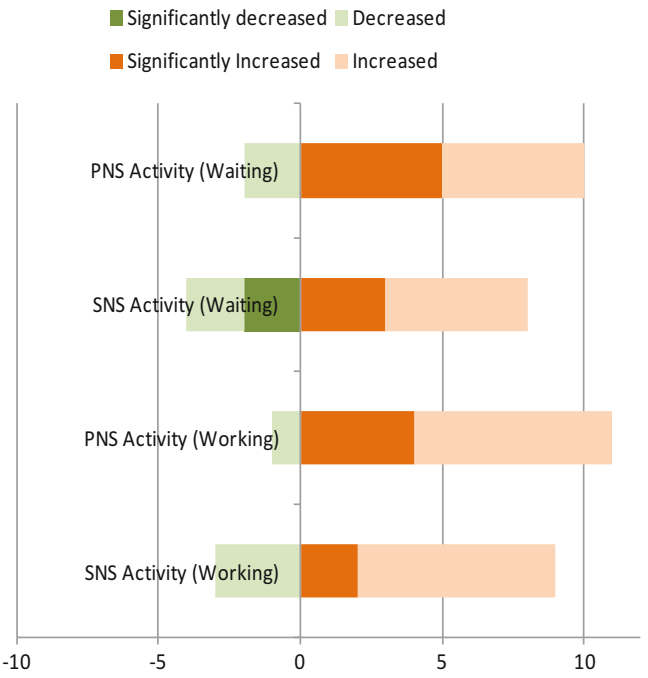


Fig. 14 Comparison of passive and active type

Figures 13 and 14 show the results of the comparison of the passive type (A) and the directed type (B) and the passive type (A) and the active type (C).

These graphs show the number of subject PNS or SNS increases/decreases, and the number of subjects shows a significant difference in *T*-test.

In the directed type (B), the activities of the PNS have become sluggish on waiting time. This type only shows the method of operation to subjects on waiting time. But, this information is a stress to the subject. In the active type (C), the activities of the PNS have become active on waiting time. Voluntary browsing makes the subject relax.

On working time, the activities of the SNS have become sluggish in the directed type (B). In the active type (C), the activities of the SNS have become active. While work is the same between the directed type (B) and the active type (C), it is shown that the work has been more an active task in the active type (C).

5 Conclusion

As methods of the rationalization, it can be considered that a surveillance system shows some information to workers on their waiting time.

In simulated environment, shortening of 16.4–19.0 % of processing time was obtained by displaying information on waiting time to workers.

An effect is acquired also by a simple method like a directed type. Therefore, it is thought that this method is applicable to general work with a worker's waiting time.

When presenting information to the worker of the waiting time, the worker's productivity improved. However, in the manner of presentation of information, workers' stress are shown to be a different trend by experimental results.

The directed type only shows the method of operation to subjects on waiting time. But, this information is a stress to the subject.

The active type shows that voluntary browsing makes the subject relax.

The surveillance system was assumed in this paper. However, this method can apply also to the work in a factory or a call center.

References

1. Integrated Control Center Website. http://www.mind.ad.jp/service/icc/ (Japanese)
2. Ogata, H., 2010, Cloud-oriented data center platform, NEC Tech. J., 5 (2):74–78
3. Ito, H., 2011, Operation efficiency improvement for IT infrastructure thought automation technology, FUJITSU Sci. J., 62 (3): 300–304
4. Otsuki, M., 2009, Study of Service Operation under Unattended ICT System, UNISYS TECHNOLOGY REVIEW, 100:53–64 (Japanese)
5. IT Service Desk and Help Desk Software, Service Manager. http://www8.hp.com/us/en/software-solutions/service-manager-service-desk/index.html
6. IBM Optimizing IT and Service Management http://www-01.ibm.com/software/tivoli/optimizing-itsm/operations-management/
7. Tamura, Y., et al., 2013, Activeness Improves Cognitive Performance in Human-Machine Interaction, Journal of Advanced Computational Intelligence and Intelligent Informatics, 17 (3):425–432
8. Bechara, A., et al., 2005, The somatic marker hypothesis: A neural theory of economic decision, Games and Economic Behavior, 52: 336–372
9. Uozumi, M., et al., 2012, Automation of supervisory service and examination of the subject of operation, SICE2012, 903–908
10. The Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996, Heart Rate Variability: Standards of measurement, physiological interpretation, and clinical use, European Heart Journal, 17
11. J. J. Sollers III, et al., 2007, Comparison of the Ratio of the Standard Deviation of the R-R Interval and the Root Mean Squared Successive Differences (SD/rMSSD) to the Low Frequency-to-High Frequency (LF/HF) Ratio in a Patient Population and Normal Healthy Controls, Biomedical Sciences Instrumentation, 43

Skill Evaluation and Education Services for Bed-Care Nursing with Sliding Sheet with Regression Analysis

Wen Wen, Xiaorui Qiao, Koshiro Yanai, Junki Nakagawa, Junko Yasuda, Atsushi Yamashita, and Hajime Asama

Abstract

Sliding sheet is a tool for changing positions and postures of bedridden patients. In the present study, in order to provide education service of sliding sheet, we examined skill points during the pulling movement of sliding sheet with regression analysis. Further, we proposed an automatic education system with Kinect camera basing on the results of the analysis. In the regression analysis, according to prior research, we included bending angle of waist, opening angle of legs, and angle of arm flex as three independent variables and moment of lumbar extension as a dependent variable. According to the results of regression analysis, we found that in order to minimize the load of lumbar during the pulling motion, participant should bend their body close to the bed, spread their legs widely to lower their center of gravity, and straighten their arms to the bed. Furthermore, basing on the results of our analysis, we proposed an evaluation service with Kinect camera, overlaying recommended posture on picture of learners' body and giving evaluations on the load of their lumbar to the learners. We believe that our education service will be useful for the spread of sliding sheet.

Keywords

Skill extraction • Nursing • Skill evaluation • Sliding sheet • Regression analysis • Education

1 Introduction

Nursing care is important for the present aging society. However, occupational diseases of care workers became serious problems during the recent years and greatly impaired the quality of nursing service. Low back pain is one of the commonest diseases among nursing personnel. It is usually caused by heavy physical work, such as moving and lifting bedridden patients [1, 2]. In order to reduce low back pain of nursing personnel, lifting machines and nursing tools which reduce the physical labor of moving or lifting patients have been developed and widely used in some countries, such as Australia, in which nursing service is highly developed [3].

Sliding sheet is one of such tools that help to change the position of patients. Sliding sheet is made by nylon and has low frictional resistance. When changing the position of a patient on bed, a sliding sheet is folded into two layers and laid between the bed and patient. Then, the nurse holds the upper layer of the sheet, pulling it toward her or his own body (Fig. 1). The patient's body will move together with the upper layer of the sheet (toward the nurse's body). Because the sliding sheet is easy to slide, nurse can move a patient with less strength, relative with the condition in which nurse directly holds the body of the patient. Also, a patient would feel more comfortable lying on a sheet, relative to being held

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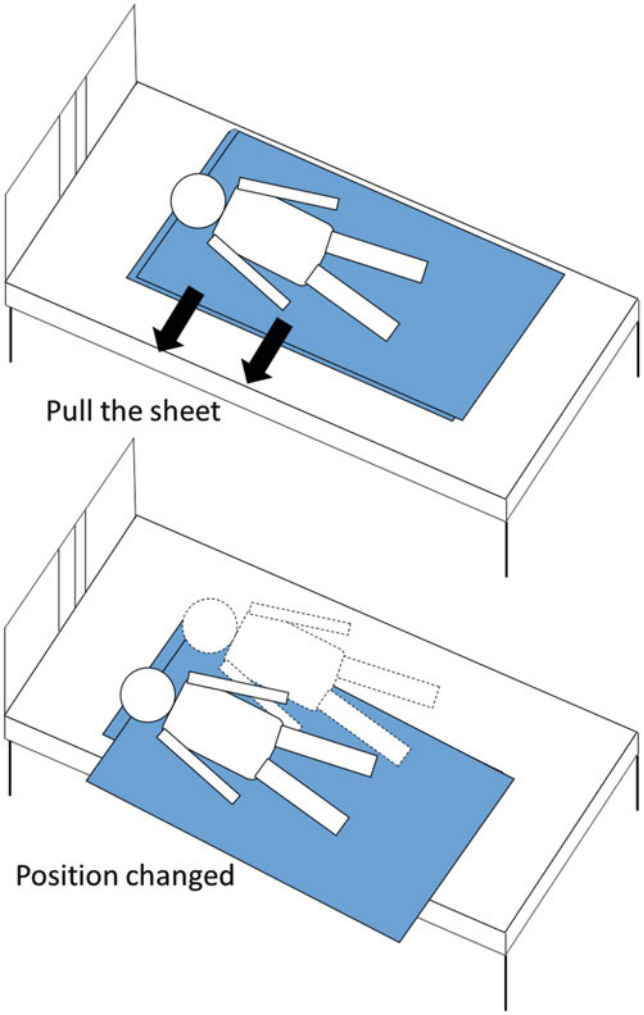

Fig. 1 An example of how to use the sliding sheet

Fig. 2 The motion of the expert when pulling the sliding sheet [4]

by a nurse. In conclusion, sliding sheet is cheap but can significantly reduce the physical load of nurses; therefore, it is greatly worth to be introduced to both hospitals and families. However, although the physical strength is much less to move a patient with the sliding sheet relative to the condition of moving a patient directly, it still brings loads to lumbar during repetition of this motion and involves the risk of low back pain. In order to maximize the effect of the sliding sheet, it is necessary to extract the proper skill points in this motion and teach the skills to the users.

A previous study suggested several skill points which are important for reducing the load of lumbar significantly in this pulling motion [4]. Nakagawa and colleagues interviewed an expert about the skill of sliding sheet and compared the motions between novel learners and the expert. They concluded that there are three skill points in this motion: refer to postures of trunk, legs and arms. Specifically, when pulling a sliding sheet, users should keep their trunks standing up (no bending), spread their legs to shift their weight during the motion, and put their arm as close to the trunk as possible. The authors also taught these skill points to an inexperienced user and found that the load of lumbar was reduced after carrying out the three skill points. However, in their study, the three skill points were extracted verbally and visually; therefore, the quantitative contribution of each skill point is unknown. Furthermore, there was also inconsistency between the expert's instruction and her actual motion. Specifically, she told that users should keep their trunk standing straightly up, but actually she did bend her trunk during the motion (Fig. 2). In addition, learners might have difficulty in the comprehension of the three skill points by only verbal instruction.

In the present study, we examined the attribution of the three skill points on the reduction of load of lumbar with regression analysis. Regression analysis is a statistical method for estimating the relationship between several independent variables and a dependent variable. Here we used the angle of lumbar extension (i.e., the bending angle of waist), the opening angle of legs and the angle of arm flex as the three independent variables (Fig. 3). The three variables represent the three skill points of the trunk, legs, and arms in Nakagawa et al. (2014)'s study, respectively. Furthermore, we calculated the moment of lumbar extension with a 3D kinematics model as the dependent variable. The lumbar spinal moments have been reported to be accompanying with low back pain [5] and increase the risk of low back pain in normal people [6]. Correct pulling motion of the sliding sheet should minimize the moment on lumbar. According to the regression analysis, the attribution of each skill point on the moment of lumbar will be quantitatively clarified. Therefore, when teaching new users to use the sliding sheet, both teachers and learners would understand how each skill point attributes to the motion and which one takes priority. Moreover, according to the

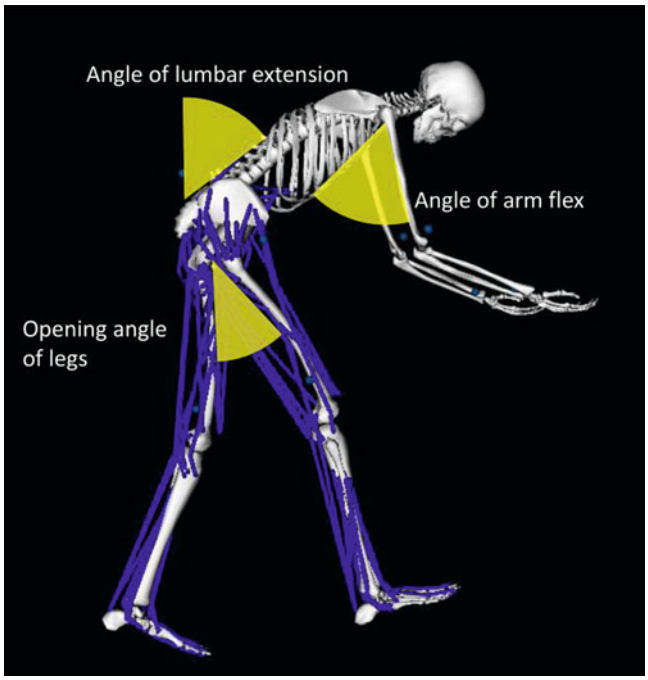

Fig. 3 The three independent variables in the regression analysis

analysis, it is possible to estimate the load on lumbar with one's posture during the motion. As an application of our analysis, we proposed an education service with a Kinect camera, in which recommended posture is overlaid on the picture of the learner, and estimation of load on learner's lumbar is given after the pulling motion. We believe that our service will be useful for the education and promotion of the sliding sheet.

2 Skill Extraction

In the present study, we followed Nakagawa et al.'s suggestion [4] and focused on the three angles of the body: the angle of lumbar extension, the opening angle of legs, and the angle of arm flex. Nakagawa et al. suggested that the angle of lumbar extension and arm flex should be kept nearly 0° and the opening angle of legs should be kept widely during the pulling motion. We asked an inexperienced learner to pull the sliding sheet with different postures. We measured the motions with a motion capture system and measured reaction forces with force sensors. After the measurements, we calculated the moments of lumbar extension during the motions with a 3D kinematics model. At last, we conducted a regression analysis.

2.1 Participant

An inexperienced female user (weight = 51 kg, height = 155 cm, age = 32) participated in the experience. The experiment was conducted with the approval of the ethics committee of the Faculty of Engineering at the University of Tokyo.

2.2 Equipment

A 48-kg mannequin with movable joints was used in the experiment as a bedridden "patient". The mannequin was laid on a bed of 74 cm in height. The bed was the same as the one used in nursing care. A sliding sheet was folded into two layers and laid between the mannequin and the bed. The motion of the participant was measured by eight cameras (HMK-200RT) of a motion capture system (Motion Analysis, MAC3D). The sampling rate was 200 Hz. Markers were attached to the shoulders, elbows, hands, lumbar, hips, and knees of the participant (11 markers in total). The reaction forces were measured by five reaction sensors (Nitta Corp.) in a sampling rate of 64 Hz.

2.3 Procedure

Before the experiment, the participant received a brief description of the sliding sheet, watched videos of an expert using this tool, and did several trials of practice. The participant was told to pull the sheet as carefully and slowly as possible, to make sure that the "patient" will not feel uncomfortable. Furthermore, the participant was instructed to change the angle of lumbar extension, the opening angle of legs and the angle of arm flex as much as possible between trials (in possible range). During each trial, the sheet was pulled about 30 cm toward the participants (i.e., the "patient" was moved 30 cm laterally) in about 5 s. The measurement of each trial lasted for 10 s, including about 1 s and 4 s before and after the motion, respectively. The participant conducted 30 trials in total.

2.4 Results

The average moment of lumbar extension of each trial was calculated with OpenSim (Sun Microsystems Inc., version 3.2) from the 3D motion data and reaction forces of each foot. Two trials were excluded because of technical problem. Therefore, data from 28 trials was analyzed. The average moment of lumbar extension was ranged from 71.1 to 165.9 Nm ($M = 121.9$ Nm, $SD = 27.0$ Nm). The angle of lumbar extension ranged from 45.4 to 89.9° ($M = 67.6°$, $SD = 13.3°$). The opening angle of legs ranged from 18.2 to 68.1° ($M = 40.6°$, $SD = 15.3°$). The angle of arm flex ranged from 32.6 to 71.6° ($M = 52.8°$, $SD = 11.3°$).

The results of the regression analysis are shown in Table 1. The regression predicted the data well (F

Table 1 The results of the regression analysis

	β
Angle of lumbar extension	−0.85**
Opening angle of legs	−0.89**
Angle of arm flex	−0.58**
R^2	0.39

Note: $^{**}p < 0.01$

$(3, 24) = 5.13$, $p < 0.01$), and all the three independent variables significantly attributed to the dependent variable. The parameter βs represents the quantitative attribution of each independent variable on the dependent variable, and the p-values represent whether these contributions are significant. According to the result of the analysis, in order to reduce moment of lumbar extension, people should increase all the three angles.

2.5 Discussion

In the present study, we aimed to examine the relationship between posture and load of lumbar during the pulling motion of sliding sheet. To do this, we conducted a regression analysis, including three independent variables which describe the user's posture and reflect the three skill points suggested by a previous study. The dependent variable was the moment of lumbar extension, which reflects the load on lumbar and should be minimized during the sheet pulling motion. According to the results of the regression analysis, we found that all the three body angles significantly attributed to the lumbar extension moment negatively. Specifically, in order to reduce the load of lumbar, all the three angles should be magnified. We discuss the relationship between three independent variables and the load of lumbar, respectively, as follows.

First, for the angle of lumbar extension, we surprisingly found an opposite result with the prior study. In Nakagawa et al.'s study, the authors reported that the expert told learners to keep their trunk straight up and not bend down during the pulling motion [4]. However, according to our regression analysis, the angle of lumbar extension (equals to the extent of bending) attributed negatively to the moment of lumbar extension. That is, to reduce the moment of lumbar extension, users should bend their lumbar down. We suggest that the expert might have given a wrong instruction. Because according to our measurement, fewer bending did induce more moment of lumbar extension. Actually, after reviewing the videos of three experts (including the expert in [4]) using the sliding sheet, we found that all of them bended forward during the pulling motion, to make their body close to the bed. We suggest that during a lifting motion, bending of lumbar might increase the load on it. But during a pulling motion, bending probably does not increase the load of lumbar. By contrast, it might help people to produce more physical strength and reduce the load on lumbar if they could keep their body close to the pulling object.

Nakagawa et al. also suggested that the variation of lumbar extension might be critical to reduce load of lumbar [7]. That is, a learner should keep their lumbar extension unchanged, either standing up or bending down. However, the lumbar extension moments did not correlate with the standard deviation significantly ($r = 0.34$, *n.s.*). Actually, the participant did not alter her lumbar extension drastically, since it is unnatural in such pulling motion (the standard deviation of lumbar extension ranged from 0.01 to 16.88°, with an average of 3.44°).

Second, the opening angle of the legs also negatively attributed to the load of lumbar, and it was the strongest factor to reduce the load of lumbar. People should spread their legs as much as possible to reduce the load on lumbar during the pulling motion. This is consistent to the previous study, which suggested that people should lower their body, spread legs, and shift their weight during the motion [4]. Moreover, spreading legs also helps to make the body closer to the bed and therefore might help to produce more physical strength during the pulling motion.

At last, we found that the larger angle of arm flex reduced the load of lumbar. However, the attribution of this factor was relatively smaller than the former two. The previous study suggested that people should keep their arms as close to the body as possible [4]. We suggest that keeping arms close to body might not reduce the load on lumbar, but probably helps to produce more strength relative to the condition of just using muscles of arms. In summary, there probably are merits if people keep their arms close to body, but it might slightly increase the load of lumbar during the pulling motion.

3 Skill Evaluation

3.1 Verification of the Analysis

According to the results of the regression analysis, we acquired a formulation as follows, which gives prediction of lumbar extension moment from one's posture (i.e., the three angles shown in Fig. 3). Y (in lower case) represents the load of lumbar, and x_1, x_2, and x_3 represent the angle of lumbar extension, the opening angle of legs, and the angle of arm flex, respectively:

$$y = -1.72 \times x_1 - 1.58 \times x_2 - 1.38 \times x_3 + 374.94$$

However, there is doubt whether it is able to predict the load on lumbar for other people. We believe it is true, because healthy adults generally have common kinematical

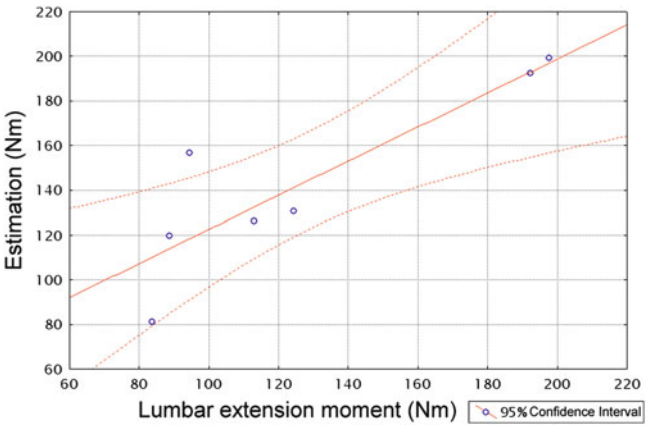

Fig. 4 The scatter plot of participant's lumbar extension moments and estimated moments

features in basic motions, such as standing, walking, pulling, and pushing. We also conducted another experiment, using the same procedure described above, to examine whether the estimation of lumbar load matches the actual load from another individual. We asked another inexperienced user (female, weight = 50 kg, height = 158 cm, age = 26) to pull a sliding sheet and calculated the moments of lumbar extension from 20 trials. Because of technical problem, only seven trials were analyzed. The estimated values and measured values are plotted in Fig. 4. The estimations well matched the actual loads ($r = 0.87$, $p < 0.05$). In conclusion, our results of regression analysis are able to correctly estimate the extent of load on lumbar from one's posture during the pulling sheet motion. Therefore, it is possible to use a simple 3D motion device to estimate the quality of a pulling motion.

3.2 Skill Education and Evaluation System

As an application of our study, we developed a system with Kinect camera (Microsoft) to give visual instruction of the skill points and quantitative evaluation of lumbar load during the pulling sheet motion. Kinect camera is a device which measures 3D motion of human. The cost of introduction of a system with Kinect is much lower than a system with motion capture and force sensors. Therefore, it is feasible for hospitals and nursing schools to introduce such system to teach their nurses and students the correct motion of using sliding sheet [8].

In our system, the Kinect camera was connected to a computer with Windows 7. After sheet pulling motion being recognized by Kinect, the three angles showed in Fig. 3 were calculated from skeleton positions. User's skeleton and recommended skeleton were overlaid on the RGB video during the pulling motion of sliding sheet (Fig. 5).

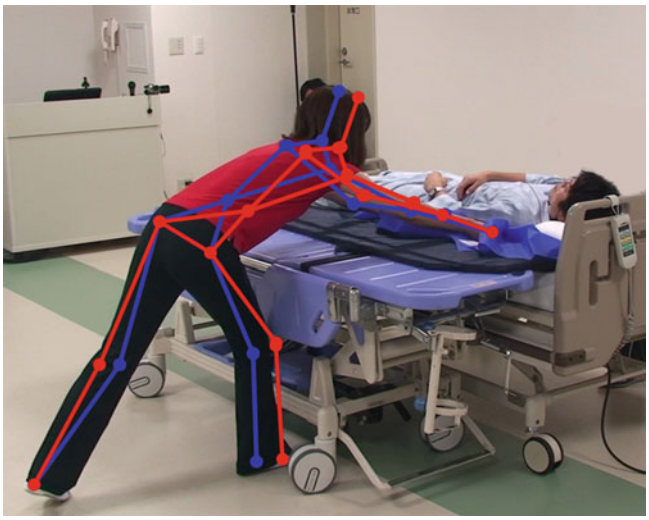

Fig. 5 An example of visual instruction of recommended pose during the sheet pulling motion

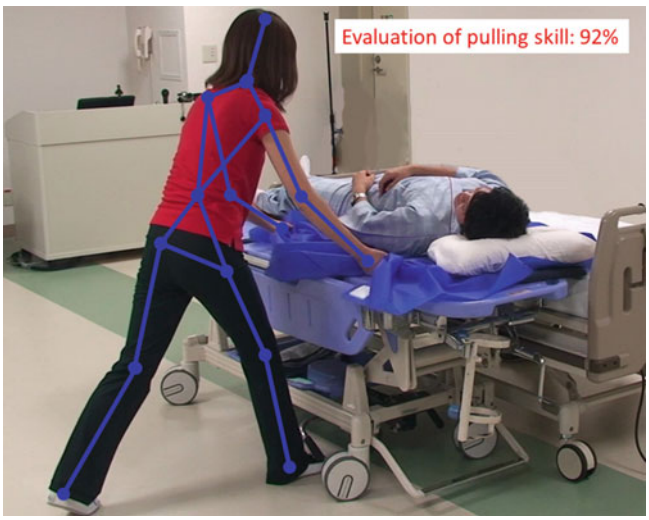

Fig. 6 An example of evaluation of pulling skill after completing the motion

Recommended posture was represented in red skeleton, and leaner's actual posture was represented in blue skeleton. Furthermore, after completing a pulling motion, the system estimated the load of lumbar from the three body angles and showed a percentage which described the quality of the motion on the screen (Fig. 6).

In the skeleton recommended pose during sheet pulling, coordinates of hip joints were duplicated from learner's pose, and the rest coordinates of joints were modified from the actual pose. For the torso and shoulder joints, coordinates were modified to increase the angle of lumbar extension by 10 % without exceeding 90°. For the elbow and hand joints, coordinates were modified to match the modified position of

shoulder joints and original position of hand joints and maximize the angle of arm flex. For the knee and foot joints, coordinates were modified to increase the opening angle of legs by 20 % without exceeding 90°.

To present the evaluation of sheet pulling skill after completing the motion, average values of angle of lumbar extension, angle of arm flex, and opening angle of legs were measured by Kinect. Then moment of lumbar extension was estimated with the regression formulation that was acquired in the regression analysis (Sect. 3.1). To give a valuation of sheet pulling skill in percentage, lumbar extension moments in "perfect" motion and "worst" motion were set to 50 Nm and 200 Nm, respectively. The percentage was calculated from the estimated moment to describe how close it reaches to the perfect motion. In summary, our education service was able to give visual instruction of skill points during real-time movement and give approximate estimation of one's pulling motion with the posture information. Our system is easy for learners to improve their sheet pulling skills, and it is also suitable for e-learning.

4 Conclusion

In the present study, we examined the relationship between the body postures and the load of lumbar when one was pulling a sliding sheet. Sliding sheet is a useful tool to reduce the necessary strength to move a bedridden patient, and proper motion should minimize the load of lumbar. A previous study proposed three skill points of posture—refer to the trunk, legs, and arms—during the pulling motion via interview and comparisons between expert and naïve people [4]. However, the quantitative attribution and the authorities of these skill points were unclear.

In the present study, we followed the suggestion of prior studies and focused on the three body parts. The three independent variables in the regression analysis were angle of lumbar extension, opening angle of legs, and angle of arm flex. The dependent variable was moment of lumbar extension, which was calculated from a 3D kinematics model. According to our regression analysis, we found that all the three angles of body negatively attributed to the load of lumbar. Specifically, in order to reduce the load of lumbar during the pulling sheet motion, people should bend their body close to the bed, spread their legs widely to lower their center of gravity, and straighten their arms to the bed. The skill points of trunk and arms were inconsistent with Nakagawa et al.'s study. After reviewing the motions of experts, we found that experts actually did the same motion as our analysis suggested, instead of what the expert verbally described. In conclusion, we suggest that bending one's body toward the bed will not increase the load of lumbar during the pulling motion, but will help to produce more strength to pull. And spreading one's legs will help to fix one's center of gravity, produce more power, and reduce the load of lumbar. At last, although straightening one's arms slightly attributed to the reduction of load of lumbar, it might impair the strength of pulling. Therefore, as a strategy, keeping arms close to the trunk might bring merits (i.e., more strength) along with slight increment of load of lumbar. In summary, according to our analysis, we suggest that the previous suggested skill points should be reconsidered carefully, because experts might tell differently from what they actually act.

Furthermore, we verified the results of our regression analysis on another participant and found that the results were effective in estimating the extent of load of lumbar from one's posture during the pulling motion. As an application of our results, we developed a system using the Kinect camera, which can measure the 3D motion of human with a low cost. The system gives real-time visual recommendation of ideal posture to minimum load of lumbar during the sheet pulling motion (Fig. 5). Moreover, after completing the sheet pulling motion, our system gives a quantitative valuation of leaner's motion to estimate the moment of lumbar extension during the motion. The design of our system was based on the results of the regression analysis. We believe our system is useful for learners to recognize the quality of their motion and helps them to improve it.

At last, the regression analysis in the present study was based on a small sample size. Therefore, the individual differences of physique (e.g., weight, height, muscle strength) were not considered. The appropriate skill points might change between people with different body sizes. This issue is worth to examine carefully in the future study.

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References

1. The Policy and Strategic Projects Division Victorian Government Department of Human Services, 2002, Victorian Nurses Back Injury Prevention Project Evaluation Report 2002.
2. Engkvist, I.L., Kjellberg, A., Hjelm, E. W., Hagberg, M., Menckel, E., Ekenvall, L., 2001, Back Injuries Among Nursing Personnel – Identification of Work Conditions with Cluster Analysis, Safety Science, 37:1–18.
3. Engkvist I.L., 2006, Evaluation of an Intervention Comprising a No Lifting Policy in Australian Hospitals, Applied Ergonomics, 37: 141–148.
4. Nakagawa, J., An, Q., Ishikawa, Y., Yanai, K., Wen, W., Yamakawa, H., Yasuda, H., Yamashita, A., Asama, H., 2014, Extraction and Evaluation of Proficiency in Bed Care Motion for Education Service of Nursing Skill, Proceedings of the 2nd International Conference on Serviceology (ICServ2014), pp.91–96.
5. Wilson, D.J., Hickey, K.M., Gorham, J.L., Childers, M.K., 1997, Lumbar Spinal Moments in Chronic Back Pain Patients During

Supported Lifting: A Dynamic Analysis, Archives of Physical Medicine and Rehabilitation, 78: 967–972.
6. Callaghan, J.P., Cunning, J.L., McGill, S.M., 1998, The Relationship Between Lumbar Spine Load and Muscle Activity During Extensor Exercises, Physical Therapy, 78: 8–18.
7. Nakagawa, J., An, Q., Ishikawa, Y., Yanai, K., Yasuda, H., Wen, W., Yamakawa, H., Yamashita, A., Asama, H., 2014, Prioritization of skill points in nursing movements with sheet for education service, the 32th Annual Meeting of the Robotics Society of Japan.
8. Huang, Z., Nagata, A., Kanai-Pak, M., Maeda, J., Kitajima, Y., Nakamura, M., Aida, K., Kuwahara, N., Ogata, T., Ota, J., 2014, Automatic Evaluation of Trainee Nurses' Patient Transfer Skills Using Multiple Kinect Sensors, IEICE Transactions on Information and Systems, 97: 107–118.

Kizkey Is the Key to a Better Care Service

Ryoko Fukuda, Atsushi Shinjo, Masahiro Kudo, Yutaro Ono, and Jun Murai

Abstract

Evaluation of the quality of nursing care is vital, but customer or outcome evaluation is difficult. In this study, the word *Kizkey*, from the Japanese *kizuki*, is used to describe caregivers' awareness of the condition of care recipients. The study focused on *Kizkey* as the key to better nursing care and used it to evaluate the quality of nursing care. Field study data showed differences in *Kizkey* between skilled caregivers and novices. There was an association between these and the quality of care provided. Based on these findings, it is suggested that a new method for evaluating the quality of nursing care services could be developed.

Keywords

Nursing care • Awareness • Skilled • Novice • *Kizkey*

1 Introduction

In Japan, the need for nursing care services is growing as the population ages rapidly. However, the number of caregivers is far smaller than that needed, with the shortage expected to reach 300,000 by 2025 [1]. To overcome this shortfall, effective recruitment and training of new caregivers is required. This, however, is not easy, and the possible decline in service quality is worrying.

Traditionally, older people in Japan have been cared for by female family members. Older adults requiring further support received nursing care provided by the government. The proportion of the population that is over 65 years old has grown so rapidly that demand for nursing care has outstripped supply. The proportion of younger people available to provide care has decreased, and at the same time, more women are working, and attitudes towards family responsibilities have changed. This has resulted in widely held perceptions that the traditional system of informal caregiving is inadequate. The social security fund has also faced a financial crisis. Against this background, the Japanese public nursing care insurance programme, Long-Term Care Insurance (LTCI), started in 2000 [2].

When nursing care was government provided, care recipients were often given no choice of service provider. To satisfy demand, priority was given to increasing the quantity of nursing care, and in the process, quality suffered. So-called large group care was widely provided, and many efforts were made to increase efficiency in care provision. Care recipients shared bedrooms, meals were provided in large dining halls at fixed times, and assistance with bathing became like an assembly line operation. Nursing care was provided based on caregivers', rather than recipients', convenience [3].

Since implementation of LTCI, nursing care has been provided through contracts between care recipients and caregivers, and recipients can select their own service providers

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[3]. Nursing care is therefore now regarded as a "service" and its quality is assessed. Earlier forms of nursing care, such as large group care, were criticised as disregarding human dignity. At the same time, a new type of individualised nursing care provided in small nursing care facilities showed positive effects on both care recipients and caregivers [4]. Together, these led to reconsideration of large group care and the introduction of so-called individual care [5]. Here, service provision and scheduling are planned to meet care recipients' wants and needs. The quality of care is prioritised over the quantity. Individual care is often implemented in the form of "unit care" in Japan [6]. One unit typically consists of ten care recipients and several caregivers. All the care recipients have individual bedrooms and share a living room within the unit. Caregivers provide individual care within their own unit.

It is clear that nursing care has changed its positioning from family support and provision by government to a service. It is therefore important that nursing care not only satisfies the level of demand but also reaches a certain level of quality.

2 Nursing Care Services and *Kizkey*

2.1 Nursing Care Examined Using Service Science

Management and marketing of services are important in providing a better service, and various models are proposed. Service-dominant (S-D) logic, for example, focuses on intangible resources, the cocreation of value and relationships [7, 8]. It is totally different from the conventional goods-dominant (G-D) logic, which focuses on tangible resources, embedded value and transactions. In S-D logic, service is regarded as the application of competences, such as knowledge and skills, by one party for the benefit of another. Value was conventionally determined by the producer and defined in terms of "value in exchange". In S-D logic, however, value is determined by the beneficiary (e.g. customer) on the basis of "value in use". In the keynote speech at the third International Conference on Serviceology (ICServ2015), Vargo pointed out that transactions have changed from B2C to B2B, and will soon be seen as A2A, where all actors are producers and consumers [9]. Fujikawa noted at the same event that the transaction flow has also changed: from one way, producer to customer, in G-D logic, through bidirectional between producer and customer in S-D logic, and two- or multisided cocreation of value in the multisided platform, which is expected to develop over time [10]. Cocreation of value is regarded as an important factor in current service science.

Nursing care can also be regarded as the cocreation of value by care recipients and caregivers, but has some significant differences from other service domains. The first is the continuity of service provision. In a long-term care facility, nursing care is provided continuously, 24 h a day, every day, to meet all the daily care needs of the recipients, who may be in very different states of health. The aim of nursing care is to make the recipient comfortable and to keep their condition at least stable. The second difference is that many care recipients have communication difficulties as a result of conditions such as dementia and so are unable to express their views clearly. This means that they cannot explain their expectations or provide direct feedback.

Such differences make value cocreation in nursing care more difficult. Out of ten foundational premises (FPs) of S-D logic, two in particular are affected: FP6 "the customer is always a co-creator of value" and FP10 "value is always uniquely and phenomenologically determined by the beneficiary" [8]. If, however, the aim or value of nursing care is that individual care recipients "are observed" to be quiet and comfortable, the process of value cocreation can be described based on the awareness of caregivers. The expectations of care recipients as customers will be grasped by caregivers through observation. Feedback from care recipients as a result of value cocreation is obtained in the same way. Being aware of the condition and needs of recipients is important for maintaining and improving their situation and requires careful observation. The effect of the care is also confirmed by observation of the recipient.

As the provision of good nursing care is highly dependent on observation by caregivers, their awareness is regarded as key.

2.2 Difficulties in Evaluating the Quality of Nursing Care Services

There is no clear definition of quality of nursing care, or a common method to evaluate it, although evaluation of quality of service is used to control and improve the service in most service sectors. Establishing a common method to evaluate the quality of nursing care services would allow individual caregivers' ability and effort to be properly assessed. Such a system might also encourage the introduction of systematically designed job training, which would accelerate the career development of caregivers. These improvements would help make this challenging job more attractive to new, potential caregivers. Effective evaluation would also be reflected in caregivers' salaries, further motivating them to offer high-quality nursing care. All this would, of course, lead to better care for care recipients.

Customer evaluation and analysis of the relationship between service input and outcome enable providers to understand and solve problems. However, this is more difficult in nursing care than in other service sectors for several reasons.

The first reason is communication difficulties, as discussed in Sect. 2.1. This means that care recipients cannot provide customer feedback directly. Instead, family members or a guardian may evaluate the quality of nursing care, but this is evaluation by proxy and cannot replace evaluation by care recipients themselves.

The second reason is that service outcomes are difficult to observe. There may be no improvement in the condition of a care recipient because of their age. As bodily functions decline with age, the effect of the nursing care is frequently observed as slowing down the decline or helping to maintain function, rather than as improvement. It can also take a long time to confirm the effect of nursing care. This makes it difficult to evaluate the outcome of the care provided.

Conventional evaluation of nursing care therefore frequently does not examine quality. Instead, examples include evaluation of facilities and self-evaluation by caregivers about the services offered [11].

Another approach to evaluating nursing care is through observation of care recipients (and caregivers in some cases) by other people. This approach is typically used to verify the effect of a new caregiving method such as a support tool. An example of this includes Dementia Care Mapping (DCM). Here, "mappers" record the behaviour of care recipients during a 6-h observation period, using 24 category codes describing the level of wellbeing of the person concerned [12, 13]. Such methods describe the condition of care recipients empirically and thus provide better evaluation of nursing care quality.

Although DCM is a good evaluation method, it is difficult to apply because at present there are few trained mappers. Another possible problem with DCM is that some caregivers may dislike outside observers evaluating their work.

2.3 *Kizkey* for Good Nursing Care Service

What actually constitutes good nursing care? Based on other service domains, one possible definition is an individualised, appropriate, well-timed service. This is consistent with the idea of person-centred care [14]. In unit care, each caregiver provides this type of care to several recipients.

As we have said, providing good quality care and checking its effect require awareness of the recipient's needs and condition. Awareness can therefore be used as an index of quality of nursing care.

Kizuki is the Japanese word for awareness and is frequently cited as a key factor for improvement in Japan. There are many examples of improvement by promoting *kizuki* in various domains (e.g. [15–17]). It seems likely that *kizuki* is also key to a better nursing care service. We therefore focused on the *kizuki* of caregivers, coining the term *Kizkey* for this concept. Caregivers' *Kizkey* is implicit and used by each person at the time the service is provided. If *Kizkey* becomes explicit, accumulated *Kizkey* can be discussed afterwards and shared with other caregivers. Sharing information about care recipients is especially important in unit care to ensure that consistent nursing care is provided. Comparison of *Kizkey* performance can help caregivers to understand their own *Kizkey* characteristics and differences from other caregivers. This can accelerate skill development, especially when skilled caregivers share information with novices. Such progress can be confirmed by comparing previous and current *Kizkey* performance.

2.4 Definition of *Kizkey* Data in This Study

The formulation of *Kizkey* data relied on concepts adapted from DCM. DCM uses 24 behaviour category codes. Through a pilot study and discussion with skilled caregivers who participated, these behaviour category codes were revised, and 13 behaviour category codes were defined. The caregivers noted that caregivers' viewpoint during observation, approach to care recipients and whether insight was gained from observation differed according to skill level. Four category codes for viewpoint, three for approach and one for insight were therefore added. The final category codes are shown in Table 1. Each piece of *Kizkey* data includes time, name of caregiver, name of care recipient, location, category code and rating. The condition of a care recipient was rated using a 5-point scale of "very good", "good", "usual", "poor" and "very poor".

Table 1 Category codes of *Kizkey* data

Category	Explanation		Category codes
Behaviour	Which behaviour of a care recipient was observed	Basic behaviour	Being cared for, eating, bathing, toileting, sleeping, walking, wheelchair, dressing and grooming
		Social behaviour	Media, communication, labour, amusement, monologue
Viewpoint	What the caregiver focused on when observing a care recipient		Expression, movement and posture, voice, vitality
Approach	How to approach to a care recipient, to understand their condition		Whether care recipients were spoken to or touched or their memory triggered in some way
Insight	Whether insight was gained from observation		Insight

2.5 *Kizkey* System

To record, analyse and feedback the *Kizkey* data, a new system was developed. Smartphones were selected for recording data, because caregivers can carry them while working. Each caregiver logged into the *Kizkey* application at the beginning of the job and carried the smartphone while working. Whenever the caregiver became aware of a care recipient's condition, they recorded *Kizkey* data by selecting the name of the recipient, the location of the observation, the category code(s) and rating for each one. The recording procedure was sequential in the early version, but was later revised in response to caregivers' requests to make it more flexible, so that more than one category code could be recorded at any one time.

The recorded *Kizkey* data are fed back to the caregivers using a tablet computer. As the time of writing, *Kizkey* data for given periods (weekly or monthly) are summarised using Microsoft Excel. Comparison of data between caregivers helps each person to understand their own *Kizkey* characteristics. Comparison data between care recipients are used in reviewing the provision of nursing care. The *Kizkey* system is also characterised by a self-learning function.

In this paper, the effectiveness of *Kizkey* data for evaluating the quality of nursing care was examined through a field study.

3 Method

The field study has been ongoing in two nursing homes in Tottori Prefecture, Japan, since June 2013. This paper presents data from one of the nursing homes, for a period between June 2013 and March 2014.

3.1 Participants

A total of 69 caregivers recorded *Kizkey* data using the dedicated system, for 97 care recipients at a nursing home in Yonago. This nursing home provides unit care. Each unit consists of 5–6 caregivers and 9–12 care recipients. Seven of the eight units participated.

3.2 Procedure

During each 8-h work shift, each caregiver carried a smartphone with the *Kizkey* application. They were instructed to record their *Kizkey* as much as possible, whenever they became aware of the condition of one or more care recipients. If real-time recording was impossible for some reason, they were able to record the data afterwards.

To view the *Kizkey* data, a tablet computer was provided to each unit. The recorded *Kizkey* data were summarised and provided weekly for each unit so that caregivers could review their *Kizkey* data at any time. Caregivers also reviewed the *Kizkey* data during the unit's monthly meetings and used it to assess whether changes were required to the nursing care provision.

3.3 Data Analysis

Kizkey data were divided into daytime (0700–2200) and night-time (2200–0700) data, because the two periods are covered by different work shifts and the nursing care provided is quite different. During the day, all caregivers provide all possible types of nursing care to the care recipients in their own unit. At night, one caregiver looks after two units: their own and another. The main requirements for nursing care at night are assistance with toileting and position changes and checking on sleep state.

Although the recorded *Kizkey* data were rich in information, this paper focuses on category code as the first step of the analysis. The number of recorded pieces of *Kizkey* data was counted for each category code and each combination of caregiver and recipient on a day-to-day basis. If the number of pieces of data recorded by one caregiver was fewer than five in a day, the data were excluded from the analysis.

4 Results

4.1 Overview of Recorded *Kizkey* Data

Over 9 months, a total of 157,057 pieces of *Kizkey* data were recorded. The average number of pieces of data recorded each month during the day and at night is shown in Figs. 1 and 2. During the day, expression was the most frequently

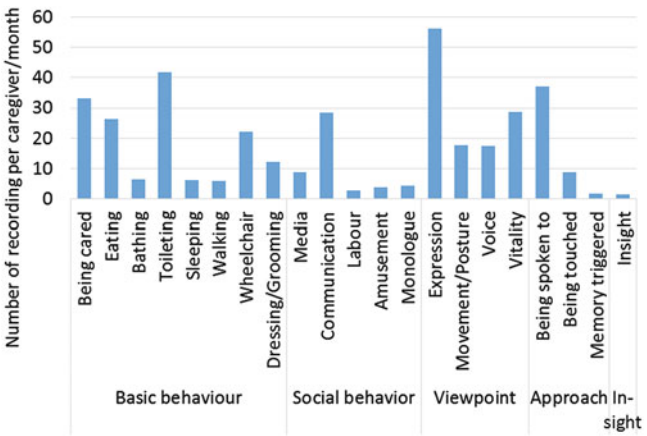

Fig. 1 Number of pieces of *Kizkey* data recorded during the daytime

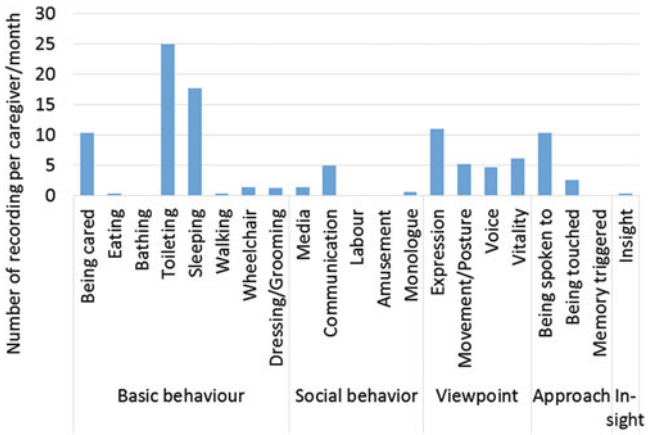

Fig. 2 Number of pieces of *Kizkey* data recorded at night

recorded category code, followed by being spoken to, toileting, being cared for, communication, vitality and eating. At night, toileting was the most frequently recorded category code, followed by sleeping. The difference in recording basic behaviour codes seems to be related to the frequency of each behaviour. Toileting occurs several times per day, whereas eating is three times per day and bathing is twice per week. For social behaviour codes, communication is frequently triggered by the approach of caregivers and is therefore the most frequently recorded. The four viewpoint codes were frequently recorded in combination with other behaviour codes. The category code for caregivers speaking to care recipients was also frequently recorded, as caregivers tend to speak to recipients as they start to provide care, not only to assess the condition of the recipient but also to let them know that care will be provided.

4.2 Difference Between Care Recipients Whose Condition Worsened and Those Whose Condition Improved or Was Maintained

To establish the most important category codes to maintain or improve care recipients' condition, *Kizkey* data were compared between care recipients whose condition worsened and those whose condition improved or was maintained. For this analysis, three units were selected, as *Kizkey* data were continuously recorded throughout the period.

Care recipients were divided into two groups depending on changes in their ability to eat independently, independence of toileting and skin condition. The degree of independence in eating was checked every 6 months. The independence of toileting was calculated based on day-to-day notes about care provided. Skin condition was determined by whether the care recipient's skin had become excoriated. *Kizkey* data were compared between two groups within each unit.

Table 2 Observed significant differences in the number of recorded *Kizkey* data between care recipients whose condition worsened and those whose condition improved or was maintained

Comparison of condition	Category code	Unit		
		E	F	G
Eating	Being cared for	X		X
	Eating	X	X	X
	Toileting	X		X
	Communication	X	X	X
	Being spoken to	X	X	X
	Being touched	X		X
Toileting	Eating		X	X
	Toileting	X	X	X
	Sleeping	X	X	
	Wheelchair		X	X
	Dressing/grooming		X	X
	Communication		X	X
	Being spoken to		X	X
	Being touched	X	X	

The results showed different patterns among units. Category codes with significant differences between the two groups in two or more units are shown in Table 2. For skin condition, no category code showed significant differences for two or more units. Significant differences were observed in eating, communication, being spoken to and toileting in all three units. All these category codes are strongly related to the activity that was used for the comparison. As care recipients eat, caregivers encourage them by speaking to them and helping them enjoy eating through communication.

It was interesting that the number of pieces of *Kizkey* data was not always larger for care recipients whose condition improved or was maintained than it was for those whose condition worsened. Unit G showed considerably different results from the others. Some category codes showed significant differences between two units (shown in Table 2) or for only one unit (not shown). It is assumed that this depends on differences in the types of care recipients and differing policies in each unit. The category codes shown in Table 2 do, however, seem to be important for maintaining or improving the condition of care recipients.

4.3 Model of Good Nursing Care Service and the Definition of "Depth" and "Breadth" of *Kizkey*

Before carrying out analysis of the differences between skilled and other caregivers, a model of the process of good nursing care service was built (Fig. 3). The model consists of three

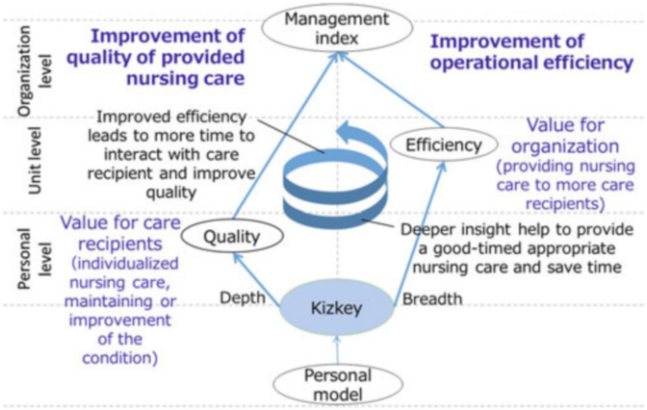

Fig. 3 Model of good nursing care services

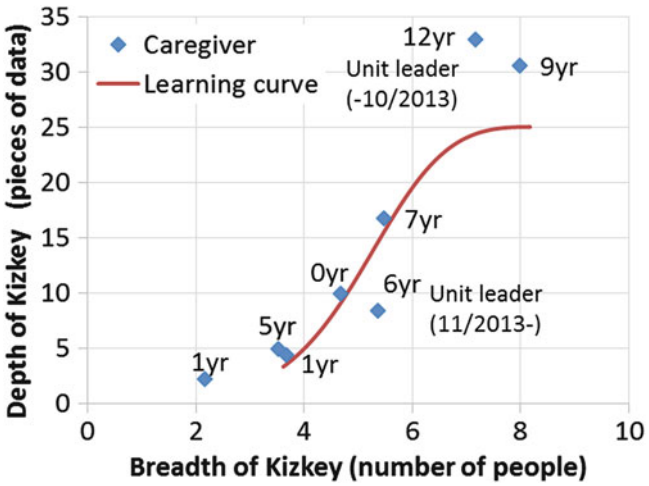

Fig. 4 Difference between caregivers based on the depth and breadth of *Kizkey* (number of years means years of experience)

levels. The personal level covers how a caregiver provides appropriate nursing care to an individual. This is related to quality of nursing care and the "depth" of *Kizkey* may play an important role. The unit level covers how a caregiver provides nursing care to a number of care recipients within the unit. This is related to efficiency and possibly to "breadth" of *Kizkey*. Efficiency is improved when the quality of nursing care is improved. In other words, a well-timed and appropriate nursing intervention based on deep insight requires less time, so nursing care can be provided to more care recipients. Likewise, the quality of nursing care is improved when efficiency is improved. If necessary tasks, especially peripheral ones not directly involving care recipients, such as writing care reports, cleaning or laundry, are completed in a shorter time, caregivers have more time to interact with care recipients. Efforts on both personal and unit level affect management index on the organization level.

To define the "depth" of *Kizkey*, category codes were divided into two groups based on the nursing care process, which consists of observation of a care recipient without interaction and then interaction with them based on the observation. Some *Kizkey* category codes relate mainly to observation and therefore are described as "passive *Kizkey*", including media, labour, leisure, monologue, expression, movement/posture, voice, vitality and insight. The other category codes are assumed to be relevant during interaction with care recipients and therefore are "active *Kizkey*", being cared for, eating, bathing, toileting, sleeping, walking, wheelchair, dressing/grooming and communication, and how the caregiver approached the recipient, speaking, touching or triggering memory in some way.

On the assumption that interaction is triggered by observation, passive *Kizkey* items were used to create an index of "depth" of *Kizkey*. Passive *Kizkey* items that are highly correlated with active ones were regarded as important and more heavily weighted in the analysis. Based on the partial correlation coefficient between individual active and passive *Kizkey* items, three passive *Kizkey* items were extracted as important. These were also related to active Kizkey items that were important for maintaining or improving the condition of care recipients (see Sect. 4.2). Depth of *Kizkey* was therefore defined as the average number of pieces of these passive *Kizkey* data recorded by each caregiver each day.

Breadth of *Kizkey* also focused on passive *Kizkey* items. It was defined as the average number of care recipients for whom passive *Kizkey* items were recorded by each caregiver each day.

4.4 Difference Between Skilled and Other Caregivers

Based on depth and breadth of *Kizkey*, differences between skilled and other caregivers were examined within each unit. It was assumed that both depth and breadth of *Kizkey* increase as caregivers become more skilled in providing nursing care. An example of the results is shown in Fig. 4. The depth and breadth of *Kizkey* of a former unit leader with 12 years' experience or caregiver with 9 years' experience were higher than those for other caregivers. The difference in experience seems to be related to the depth and breadth of *Kizkey*.

Another example is shown in Fig. 5. This shows the change in depth and breadth of *Kizkey* for a novice caregiver in her first year of work. Both depth and breadth increased with experience and the change was far greater than in other novices. This caregiver improved her skills more quickly than others who started their careers at the same time, and

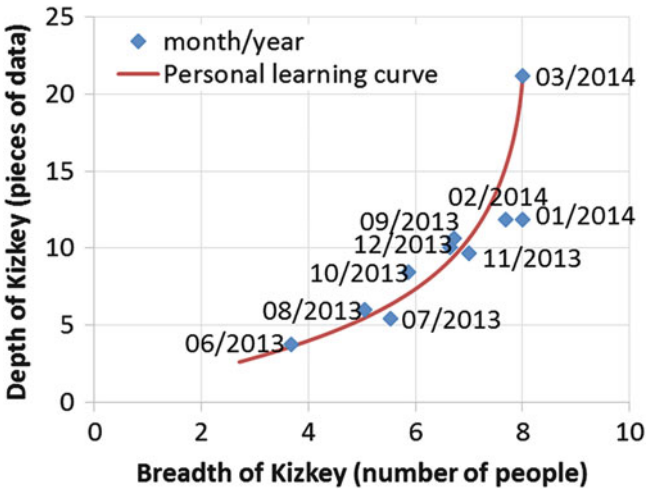

Fig. 5 Change in the depth and breadth of *Kizkey* of a novice caregiver during her first year

she is now a sub-leader in the unit. The *Kizkey* data illustrate her progress.

5 Discussion

5.1 Relationship Between *Kizkey* Data and Condition of Care Recipients

This study examined the effectiveness of *Kizkey* data in evaluating the quality of nursing care. The first step was to determine the difference in *Kizkey* data between care recipients whose condition worsened and those whose condition improved or was maintained. The results showed differences in some category codes of the *Kizkey* data, so it is therefore likely that the *Kizkey* data were related to the changes in the condition of care recipients.

The differences between care recipient groups varied by unit. In Units E and F, more pieces of *Kizkey* data were recorded for those care recipients whose conditions improved or were maintained. This suggests that more active *Kizkey* contributed to maintaining or improving the care recipients' condition. In Unit G, however, more *Kizkey* data were recorded for those whose condition worsened. It was found that these patients actually required particular attention because they became quite ill. One died during the study period and another 2 months later. The differences between Unit G and the other units probably reflected these differences between patients.

It is important to note that the differences in care recipients' condition were reflected in differences in the active *Kizkey* data. Further analysis of other units' *Kizkey* data or new data should develop understanding of the meaning of these patterns.

5.2 Relationship Between *Kizkey* Data and Skill Level of Caregivers

The second step in examining the effectiveness of the *Kizkey* data was to determine the differences between skilled and other caregivers. This was done by using the model of good nursing care service and the indices for "depth" and "breadth" of *Kizkey*.

The results showed that there were differences that depended on the skill level of caregivers. Indices of depth and breadth of *Kizkey* were higher in skilled caregivers with more experience than in others. The data also showed that level of experience was not directly related to the skill level implied by the depth and breadth of *Kizkey*. This *Kizkey*-implied skill level was, however, consistent with the views of the managers of the nursing home and suggests that the skill level of caregivers could be assessed using *Kizkey* data.

Changes in the depth and breadth of *Kizkey* data of individual caregivers over time also revealed the effectiveness of such data for evaluating the skill level of caregivers. The novice caregiver shown in Fig. 5 improved her skills more quickly than other novices, and she is now a sub-leader of the unit. The depth and breadth of her *Kizkey* data increased month by month until it approached those of skilled caregivers, reflecting her increased nursing skills.

Using *Kizkey* data to evaluate the skill level of caregivers may support changes in the pay system for Japanese nursing care, away from a system based on seniority towards a more merit-based system.

5.3 Use of *Kizkey* Data by Caregivers

In this field study, the *Kizkey* data were fed back to the caregivers. The data were summarised in two ways: by care recipient and by caregiver. The former were used at the unit's monthly meetings to (re)consider the provision of nursing care to individuals. If caregivers struggled to grasp the needs of a certain care recipient (typically a new client), they focused on the data for that person to identify characteristics and reflect them in the nursing care provided. If comparisons between care recipients showed imbalances in *Kizkey* performance, caregivers tried to remedy the imbalance. The effect of any changes in care provision was also discussed using the *Kizkey* data.

Caregiver data help caregivers to understand their own characteristics and awareness during nursing care. At this time, these data are used less frequently than recipient-related data. The next step is to find a way to provide more effective feedback and use of each caregiver's data because this could help caregivers to improve their nursing skills.

6 Conclusion

This study focused on caregivers' *Kizkey*, or awareness of care recipients' condition, as the key to improving nursing care services. It examined the effectiveness of *Kizkey* in evaluating the quality of nursing care through a field study. Although *Kizkey* data are subjective, collective analysis of accumulated *Kizkey* data enabled them to be treated as objective data, identifying particular features. The results showed that differences in *Kizkey* data depended on both the condition of care recipients and the skill level of caregivers. *Kizkey* data could therefore provide a route to better evaluate nursing care quality.

Caregivers also used their *Kizkey* data to improve the quality of care provided. Through the recording of *Kizkey* data, caregivers gained more and wider insights into care recipients. Discussion and sharing of feedback data also helped caregivers to develop a deeper understanding of care recipients. *Kizkey* data therefore contribute to the cocreation of value by care recipients and caregivers.

Following further data analysis and discussion, a new method for evaluating the quality of services, including nursing care, will be proposed in the near future.

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References

1. http://digital.asahi.com/articles/DA3S11600814.html, retrieved on 25 February 2015
2. Matsuda, S. and Yamamoto, M., 2001, Long-term care insurance and integrated care for the aged in Japan, International Journal of Integrated Care, 1: 1–11.
3. Tanaka, S. and Tochimoto, I. (eds.), 2011, Long-Term Care Innovation, Dai-ichi Hoki, Tokyo
4. Muraoka, M., Kitajima, E. and Honna, Y., 2003, Transition of institutional formation and the principle of nursing in elderly welfare – From a large group care to a small group care –, Tokai University The School of Health Sciences bulletin, 9: 89–95.
5. Ueno, C., 2011, Care no shakaigaku (*Sociology of Care*), Ohta Publishing, Tokyo
6. Koreisha Kaigo Kenkyukai (*Elderly Care Committee*), 2003, Long-Term Care in 2015, http://www.mhlw.go.jp/topics/kaigo/kentou/15kourei/3.html, retrieved on 13 March 2015
7. Vargo, S. L., Lusch, R. F., 2004, Evolving to a new dominant logic for marketing, Journal of Marketing, 68: 1–17.
8. Vargo, S. L., Maglio, P. P. and Akaka, M. A., 2008, On value and value co-creation: A service systems and service logic perspective, European Management Journal, 26: 145–152.
9. Vargo, S. L., 2015, Service-Dominant Logic, Keynote speech presented at the 3rd international conference on Serviceology (ICServ 2015), San Jose, CA.
10. Fujikawa, Y., 2015, Keynote speech presented at the 3rd international conference on Serviceology (ICServ 2015), San Jose, CA.
11. Suga, Y., 2003, Development of a scale for user satisfaction with home help services: A step towards the development of the Satisfaction with Home help Scale (SHS), Japanese Journal of Gerontology, 25(3): 325–338.
12. Brooker, D., 2005, Dementia Care Mapping: A Review of the Research Literature, The Gerontologist, 45 (Special Issue 1): 11–18.
13. Suzuki, M., Mizuno, Y., Brooker, D., Sumigaki, C., Sakamoto, R., Uchida, A., Greiner, C., Ooshiro, H. and Kanamori, M., 2008, Dementia Care Mapping – Japanese version (DCM-J) as a research evaluation method for measuring quality of life among elderly patients with dementia: reliability and validity of Well-being and Ill-being value, Nihon Ronen Igakkai Zasshi, 45(1): 68–76.
14. Brooker, D., 2007, Person-centred dementia care: making services better, Jessica Kingsley Publications, UK.
15. Saito, K., Okade, Y. and Miki, H., 2011, Effectiveness of Self Observation and Improvement of Awareness on Movement in Senior High School Apparatus Gymnastics Class, Japanese Journal of Sport Education Studies, 30(2): 27–37.
16. Okugawa, K., Higashi, S. and Ninomiya, K., 2011, A Practical Maturity Model Giving the Awareness, Journal of Society of Project Management, 13(6): 13–18.
17. Katsukura, R., Ito, Y., Nedate, K. and Kanetsuki, M., 2009, Mindfulness Training and Depressive Tendencies in College Students: Mediating Effects of Metacognitive Awareness, Japanese Journal of Behavior Therapy, 35(1): 41–52.

Role of Servicing Activity Visualization in Quality Control Circle

Takashi Okuma, Tomohiro Fukuhara, Ryosuke Ichikari, Ching-Tzun Chang, Luis Carlos Manrique Ruiz, Takeshi Shinmura, and Takeshi Kurata

Abstract

This paper describes roles of servicing activity visualization in quality control (QC) circle based on a field study. The field study was conducted in order to investigate how human behavior sensing and visualization technologies support QC circle activities conducted by waitresses. We conducted the field study at a Japanese cuisine restaurant, "Ganko Shinjuku Yamano Aiko-tei," located in Tokyo just after it launched. Positions and directions of the waitresses were measured in order to grasp the conditions objectively. The visualized position data was shown to QC circle members. They discussed what they should improve preferentially based on the visualized position. In the visualization, the map of the restaurant was divided into small grids, and accumulated stay time in each grid area was visualized by color and overlaid on the map. From this visualization result, they recognize that they stayed relatively longer on backyards than dining area. Then, they inferred the cause themselves. This visualization result is used not only in this discussion but also used for explanation of their QC themes to inexperienced waitresses. About 1 month since the opening of the restaurant, the second measurement had been conducted in order to confirm the result of their QC activities. The comparison results of the measured positions and sales data were shown to QC circle members. They evaluated the result of their own activities. In the meeting, we conducted the inquiring survey about roles on which human activity sensing and visualization play in QC circle activities. The visualized results show that they stayed longer time in dining area during the second measurement term than the first term. QC circle members pointed out that the visualized result had them be able to lead inexperienced waitresses to tackle problems calmly and set priorities on their problems to be tackled. This comment is important because it implicates potential ability of servicing activity visualization.

Keywords

CSQCC • Human activity visualization • Human activity sensing • Service engineering

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1 Introduction

Behavior of service-providing people is an important factor affecting customer satisfaction through the customers' experience in shops and facilities that provide services. In the field of our collaborator, the Japanese cuisine restaurants, various actions in service process, such as seating, taking orders, cooking, and serving, affect customers' impression

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through the timing of serving and communication. Comfortable dining experience consists of the impressions that they gave and leads to customers' satisfaction.

We have been developing human behavior sensing technologies that can record human activities relatively long term automatically. The sensing technology can be used for quantifying human activities. For understanding the current situation and finding problems to be solved, analysis of service process data including human behavior data and business data such as sales and order history is useful. We have proposed a framework named CSQCC (computer supported quality control circle) that is QC circle activity using such kind of data analysis for improvement of a service process and an environment and have been verifying its effects through field studies [1–3].

This paper describes the most recent field study on the CSQCC and discusses roles of visualization of serving activities based on interview comments from QC members in the field study.

2 Rerated Study

Various methods for measuring worker's activity such as time study and work sampling have been developed and used in the field of industrial engineering. These methods were applied to some service fields such as hospital and nursing home for elderly. In addition to these, business ethnography, which originated from social anthropology, has been attracting attention as a method for analyzing human activity. These methods can make high-quality records based on recognition ability of human for short term. However, practically, it is difficult to make high-quality dense records for long term. In addition, in some environment in which atmosphere is important such as exclusive restaurants, people in charge of recording worker's activity may affect customers' experience and serving staff activities.

Tsuji et al. proposed "business microscope," that is, a technology for measuring and analyzing human activities in the workplace. It mainly focuses on communication among people in workplace and is useful for improving cooperation aspect of working process. However, in some case such as improving service process and environment of service field, more direct behavior data such as log of position and direction of human body are important so that a different measurement method is required.

3 CSQCC

A framework named CSQCC is for quality control circles to use human activity data recorded by sensing technologies. In CSQCC, behavior of QC members is measured and used for analyzing working process and environment. Human behavior data is combined with "result" data such as order history recorded by ordering system and sales data from POS system for the analysis [1–3]. Various component technologies, such as human indoor positioning, measurement operation support for QC members, and visualization to clue QC members, are used for CSQCC (Fig. 1). This section describes each technology used in the most recent field study.

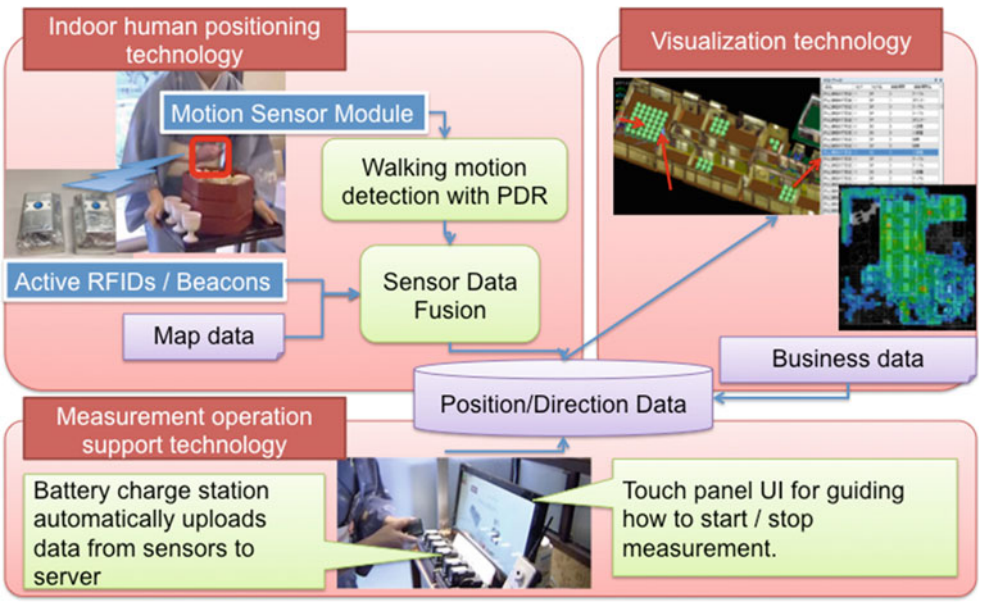

Fig. 1 Component technologies used in CSQCC

3.1 Sensing Technologies

In our field study, we have to use human positioning technology that can be used in indoor environment. We use PDR (pedestrian dead reckoning) [4] method that has been developed for indoor navigation system. PDR system robustly detects human walking motion using accelerometers, gyroscopes, magnetic compasses, and barometers, accumulates detected walking velocity to measure the position, and records position and body direction of human with time stamp. This method works robustly and continuously very well. However, it is very difficult for PDR systems to avoid accumulation error. In addition, many irregular body motions occur during providing service so that there exist some situations in which PDR system cannot provide sufficient performance. In order to reduce measurement errors because of these factors, active RFIDs were set in the environment and received ID and time stamp was recorded when the sensor module receives the radio wave from the RFIDs. In order to be used for anchor point measurement accurately, all active RFIDs were wrapped by aluminum foil to narrow the area where the radio wave can be received. Then, sensor data fusion method [5] was applied for estimating probability density distribution of position and body direction using PDR, active RFIDs, and the floor map information, and the representative values of the distribution were visualized and used in QC activities.

3.2 Measurement Operation Supporting Technology

Sensor modules that we have developed are able to record only sensor data with time stamp from start to end of measurement, so we have to manage who used which sensor module device from when until when. In order to conduct long-term measurement, measurement operation supporting software was developed and installed to a PC with touch panel display for making measurement operation easier for QC members. User interface design of the software imitates that of attendance management system and has function that illustrates how to attach and detach the sensor module, start and end sensing.

3.3 Visualization

In order to make the recorded information easy to understand, we have been developing software that visualize the recorded position and body direction of each person at each time on 3D computer graphics model of the service field. This software is also able to visualize business data such as order history with the position data at the same time in order to give some clue for making estimation of the situation easier. In addition, we implemented new function that sums up stay time at each place for each condition and visualizes like a heat map using the color shown in Fig. 3 for the most recent field study.

4 Field Study

The field study was conducted in order to investigate how human behavior sensing and visualization technologies support QC circle activities conducted by waitresses.

4.1 Place and Term

We conducted the field study at a Japanese cuisine restaurant, “Ganko Shinjuku Yamano Aiko-tei” located in Tokyo (Fig. 2). Our field study had been conducted from October to

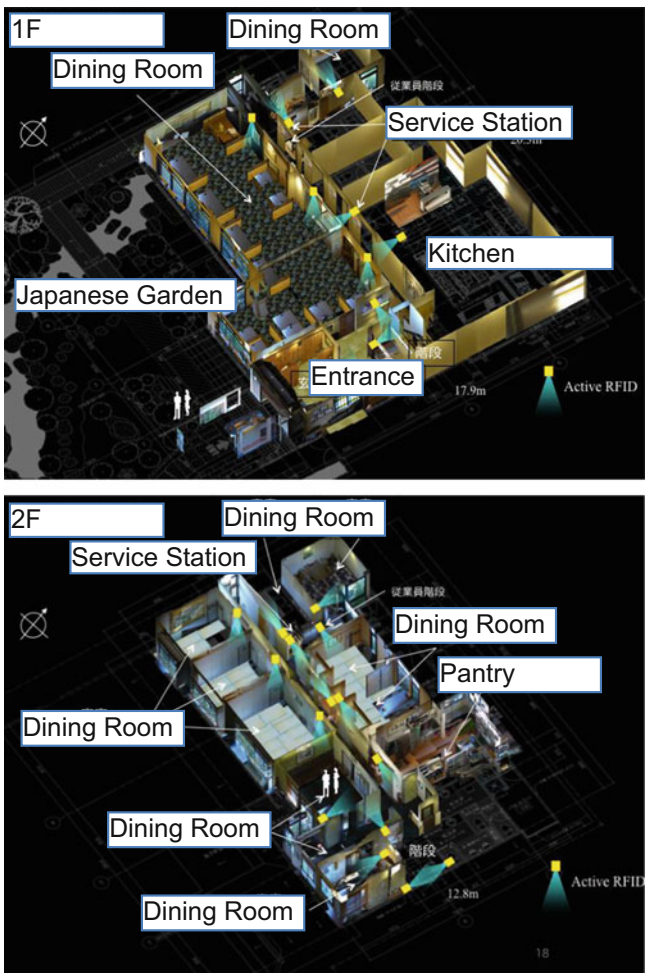

Fig. 2 3D environment model of the Ganko Shinjuku Yamano Aiko-tei

December in 2014. It was just after the restaurant was launched on 10 October 2014.

Because we have limited number of sensor modules, we need to decide prior to measurement targets. Therefore, we selected waitresses as measurement targets the same as field studies that have been conducted before. The reason is that behavior of waitresses often affects customers' experiences both direct and indirect because they share the space with customers during their work.

4.2 Process of the Field Study

Positions and directions of the waitresses were measured in order to grasp the conditions objectively from 15 to 27 October (13 days).

The visualized position data such as the upper side in Fig. 3 was shown to QC circle members. They discussed what they should improve preferentially based on the visualized position. In the visualization, the map of the restaurant was divided into small grids, and accumulated stay time in each grid area was visualized by color and overlaid on the map. Red indicates that the accumulated time of corresponding area was relatively long, and blue indicates that it was short. From this visualization result, they recognize that they stayed relatively longer on backyards than dining area. Then, they inferred the cause themselves. It was easy for QC members to estimate that many factors are caused by behavior of inexperienced waitresses. So they categorized these factors using their experience as the following:

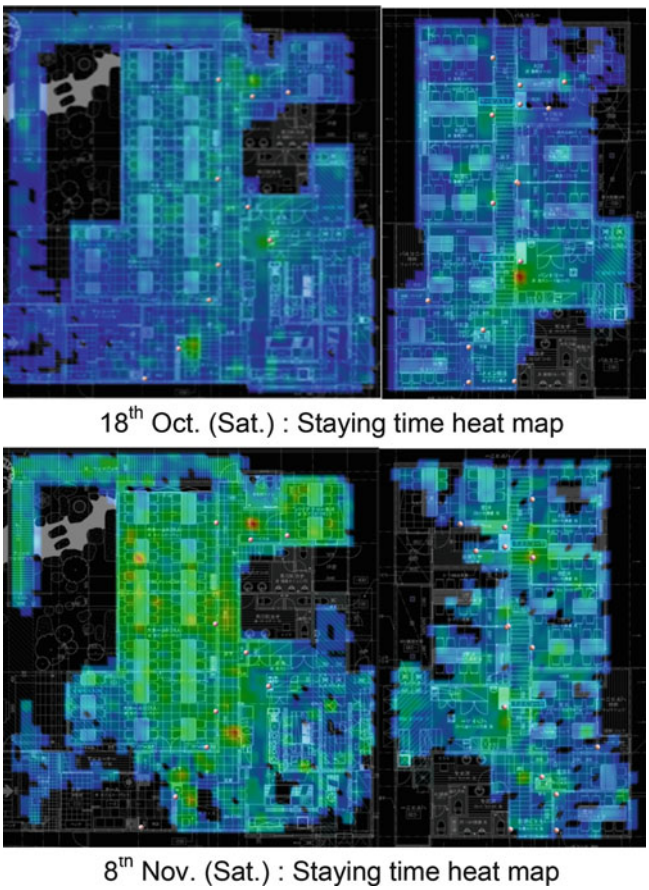

Fig. 3 Comparison of staying time using heat map visualization (*left side*, first floor; *right side*, second floor)

- Inexperienced waitresses did not get used to use handy terminal device for order input. It was difficult for them to remember the operation of the device.
- They took long time to prepare dinner party because they did not remember all menus. There were some cases that all required items were not complete because the preparation was insufficient.
- Staying time of waitresses in pantry tended to be long because the pantry was crowded. Dishes and the order slip printer were placed on inconvenient position.

The QC members set QC theme on the increase of time for attending customers and agreed to take measures to solve each problem. This visualization result is used not only in this discussion but also used for the explanation of their QC themes to inexperienced waitresses later.

About 1 month passed from the opening of the restaurant, from 7 to 20 November (14 days), the second measurement had been conducted in order to confirm the result of their QC activities.

On 25 November, the comparison results of the measured positions and sales data were shown to QC circle members. They evaluated the result of their own activities. In the meeting, we conducted the inquiring survey about roles on which human activity sensing and visualization play in QC circle activities.

4.3 Result and Discussion

4.3.1 QC Circle Activities

The QC circle members reported that they conducted the following concrete activities:

- Additional instructions using new documents that were easy to understand at a glance (illustrated dish placement for each menu; how to use the handy terminal device; topics about facilities, cuisine, and recommended menu to be explained; tips on how to be watchful of details; and so on)

- Change of item layouts for solving crowded pantry.
- Appropriate role allotment (careful observation and direction by controller, actual operation, and attendance by normal waitresses)

4.3.2 Result 1: Net Attending Time

Figure 3 shows a visualization result of accumulated time for all participants for each measurement term. In order to compare results of similar condition, data of 2 days, when it was the same day of the week, are visualized. It shows that participants of measurement stayed longer time in dining area during the second measurement term than the first term. The tendency was clearer on the first floor that has a large dining room than the second floor that has small rooms.

"The net attending time," which is defined as the time length of staying in dining area when customers are there, increased 13 % on average (Fig. 4, *U*-test, *p-value* = 0.01716 <0.05). The actual increased time is almost equivalent to three times of average attending time. The QC members evaluated it as good results of their activities such as instructions using new documents and layout change.

Figure 5 shows change of the net attending time. This result indicates two things:

1. Dispersion of average net attending time of all participants between each time slot tends to be leveled.
2. At the same time, dispersion of the net attending time for each participant for each time slot tends to be increased.

The QC members estimated that the reason why (1) occurred is due to the change of the waitresses' attitude for attending from passive to active. They used to attend customers only when they are called from customers, but later, they became to attend customers actively. That is because of mental leeway generated by the additional training. The reason why (2) occurred might be based on the role allotment.

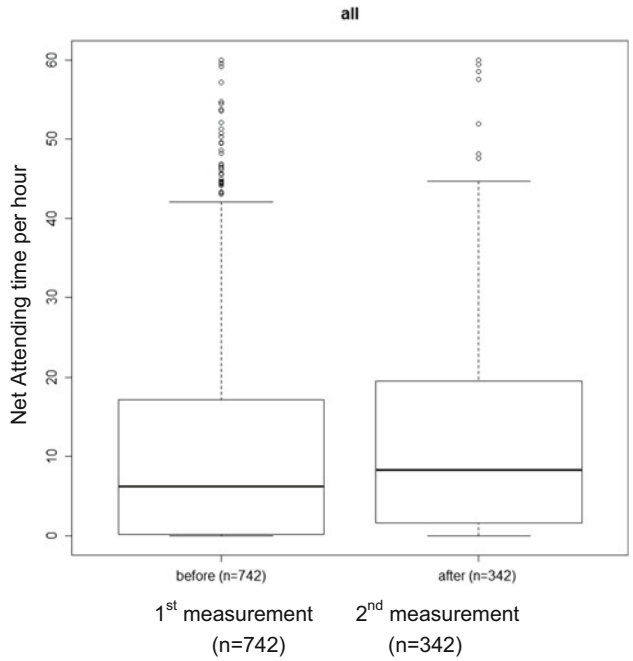

Fig. 4 Comparison of net attending time

4.3.3 Result 2: Walking Distance

Walking distance per hour for each person also increased about 13 %, just the same as the net attending time (Fig. 6,

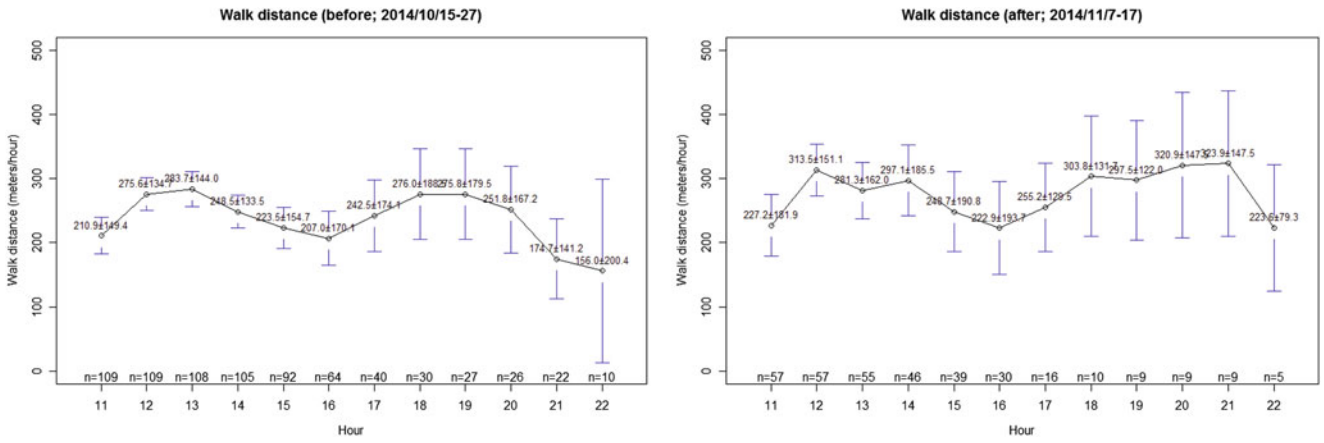

Fig. 5 The net attending time for each time slot (*left*, first term; *right*, second term)

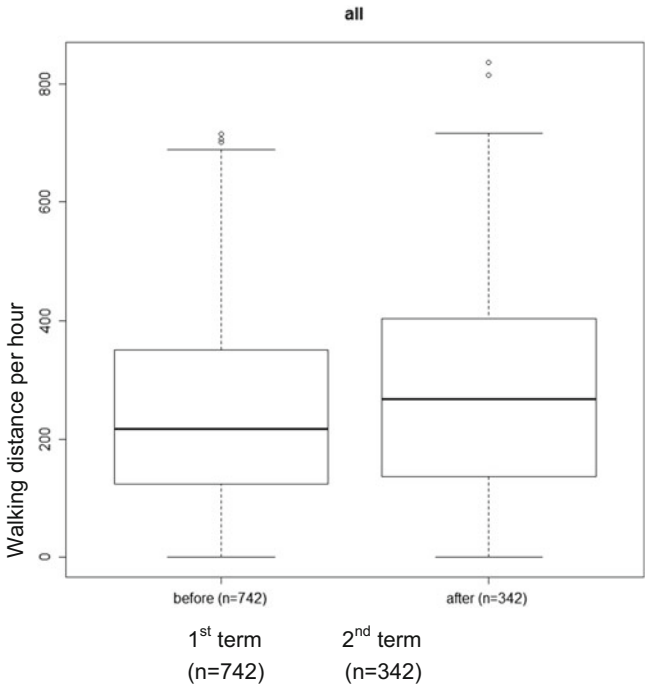

Fig. 6 Comparison of walking distance

U-test, *p-value* = 0.00767 <0.01). The actual difference of the length was about 30 m per hour. The QC circle members estimated the reason why their walking distance was increased as follows: their skills for attending and observing customers are improved so that they were able to walk around dinning area for observing customers. They received the result as positive thing and didn't think that working load had increased.

4.3.4 Result 3: Number of (Additional) Orders

There are no statistical significant difference between the number of orders and additional orders per person of the first term and that of the second term. Figures 7 and 8 show change of the number of orders and additional orders for each time slot. We can figure out the following from these graphs:

1. The peak of the number of orders in dinnertime shifted from between 18:00 and 19:00 to between 17:00 and 18:00. The QC members estimated some reasons. One of the reasons was estimated as inexperienced waitresses were getting used to the handy terminal device to input orders.
2. The number of orders is increased between 20:00 and 21:00. The QC members estimated that the reason is the net attending time increased in this time slot as shown in Fig. 5.

4.4 Discussion About the Role of Visualization in CSQCC

The QC members reported that they got used to be measured in CSQCC during long measurement term and didn't care so much. Therefore, if the CSQCC can get better results, the main factors of the reason are caused by the difference of QC themes and motivation affected by seeing visualization result of the measurement.

The heat map visualizations were evaluated as easy to understand and grasp the whole tendency. Actually, the QC members were able to grasp quickly that the net attending time was relatively shorter compared to the length of staying time in the backyard. At least, the fact that one of the QC members expressed "I would like to see the color of the dining area changes from blue to red in this heat map" indicates that the visualization helped her recognize problems at that time.

In addition, when they visualized each trajectory, they remember concrete episodes. It helped them to figure out more concrete problems.

As mentioned before, the visualization software was used in the meeting that only the staff of the restaurant attended. They reported that the effects of using visualization tool in QC circle activities are as follows:

- The QC members could share the problems calmly with inexperienced waitresses, and they were able to lead inexperienced waitresses to tackle problems without pointing out problems of each person.
- It helped them make priority of the themes of QC activities for solving the problems.

These reports suggest the kind of possibility that the measured data visualization improves QC activities.

In addition, one of the managers pointed out the restaurant started up quicker than the usual restaurant. Figure 9 shows normalized labor productivities from the second month to the fourth month of similar type of restaurants in Ganko foodservice chain. The graph shows the labor productivity of the Ganko Shinjuku Yamano Aiko-tei increased quicker than other restaurants.

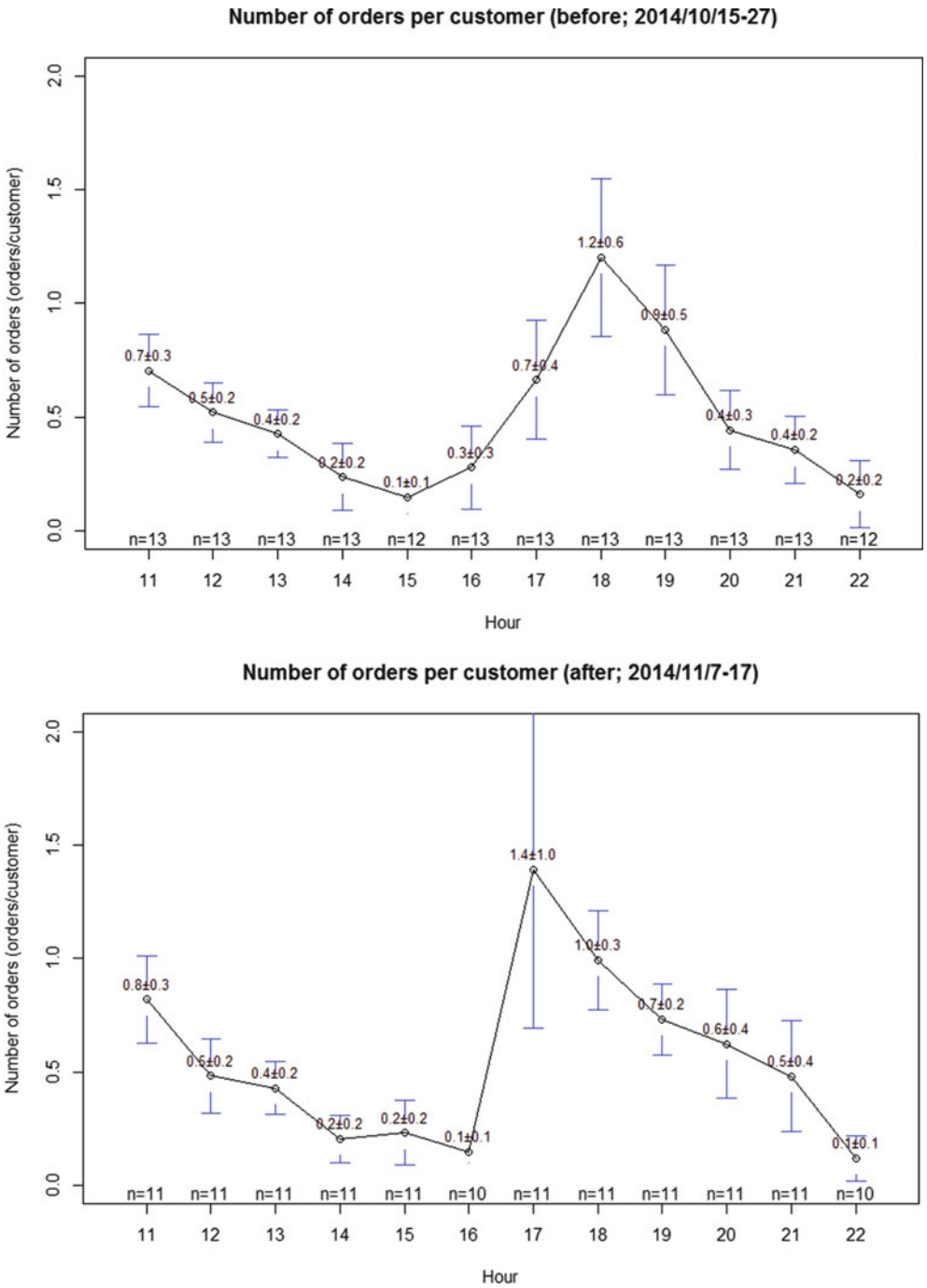

Fig. 7 Comparison of the number of orders for each time slot (*upper*, first term; *lower*, second term)

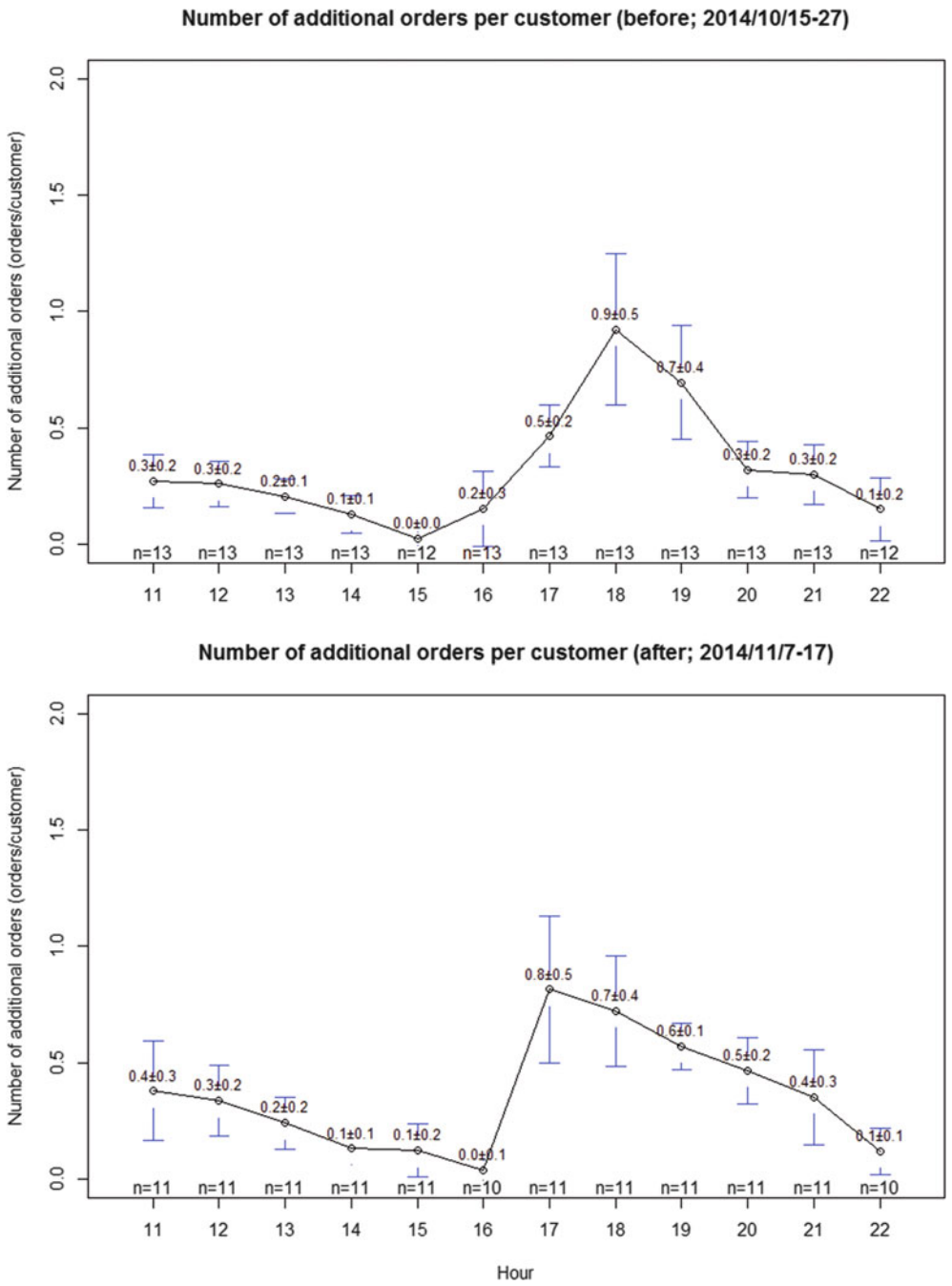

Fig. 8 Comparison of the number of additional orders for each time slot (*upper*, first term; *lower*, second term)

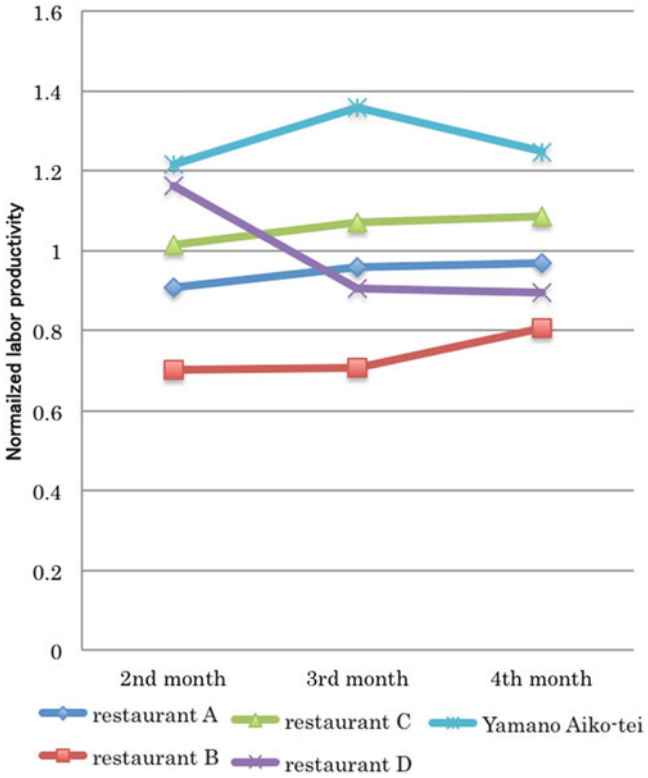

Fig. 9 Comparison of labor productivity (rates to average of the five restaurants)

5 Conclusion

We tried to verify whether servicing activity visualization is able to give some positive effect in QC circle activity through the field study in the restaurant just launched. The visualization results were evaluated as useful to share problems among QC circle members and to set priorities on the problems. In addition, we could observe management of the restaurants got stable earlier than usual restaurants. It indicates a possibility the CSQCC is also useful to quick start.

References

1. Ueoka, R., Shinmura, T., Tenmoku, R., Okuma, T., and Kurata, T.: "Introduction of Computer Supported Quality Control Circle in a Japanese Cuisine Restaurant", Proceedings of 4th International Conference on Applied Human Factors and Ergonomics (AHFE), pp.6632–6641, 2012.
2. Tomohiro Fukuhara, Ryuhei Tenmoku, Takashi Okuma, Reiko Ueoka, Masanori Takehara, Takeshi Kurata: "Improving Service Processes based on Visualization of Human-behavior and POS data: a Case Study in a Japanese Restaurant," Proceedings of the 1st international conference on Serviceology, Tokyo Waterfront, Japan, pp.1–8, 2013.
3. Tomohiro Fukuhara, Ryuhei Tenmoku, Reiko Ueoka, Takashi Okuma, Takeshi Kurata: "Estimating skills of waiting staff of a restaurant based on behavior sensing and POS data analysis: A case study in a Japanese cuisine restaurant," Proceedings of the 5th International Conference on Applied Human Factors and Ergonomics (AHFE2014), pp.4287–4299, 2014.
4. Masakatsu Kourogi, Nobuchika Sakata, Takashi Okuma, and Takeshi Kurata: "Indoor/Outdoor Pedestrian Navigation with an Embedded GPS/RFID/Self-contained Sensor System", In Proc. 16th International Conference on Artificial Reality and Telexistence (ICAT2006), pp.1310–1321, 2006.
5. Tomoya Ishikawa, Masakatsu Kourogi and Takeshi Kurata: "Economic and Synergistic Pedestrian Tracking System with Service Cooperation for Indoor Environments", International Journal of Organizational and Collective Intelligence, Vol.2, No.1 pp.1–20, 2011.

Physiological Detection of Satisfaction for Services by Body Motion Wave Revealing Unconscious Responses Reflecting Activities of Autonomic Nervous Systems

Hiroaki Okawai and Mitsuru Takashima

Abstract

For suppliers it is a significant theme to know how much their services satisfied customers. Questionnaire survey is often adopted; however, the reply from customers is not always accurate. This paper describes a detecting method of a more accurate reply by entrusting the reply for the services to unconscious responses reflecting activities of autonomic nervous system during sleep. Such experiment was performed on the idea that there is some relationship between satisfaction and conditions of both mental and physical activities. As a result, the unconscious responses of phenomena of respiration and pulse through nights showed satisfaction instead of conscious responses.

Keywords

Satisfaction • Body motion wave (BMW) • Autonomic nervous system • Unconscious response

1 Introduction

In daily life we accept various services such as articles, information, etc. The suppliers of them usually want to know how much degree the services satisfied customers. Though questionnaire survey, for example, is often adopted, the customer's reply to the service is usually distorted by some reasons, i.e., it is neither accurate nor honest.

Therefore, the question here is if it is possible for suppliers to know the degree of satisfaction turning out accurate and/or honest reply to the services. If possible, they would make better services by considering the honest reply.

To resolve such problems, Okawai et al. [1–3] have suggested a method to entrust the reply to unconscious responses through signs of vital activities, for example, rates of respiration and pulse, reflecting activities of autonomic nervous system during sleep.

In the series of these studies, healing music and aroma have been adopted to demonstrate the method to be adequate. The reason why the findings obtained through the above method, i.e., the findings of such unconscious responses reflecting activities of autonomic nervous system, should mean the degree of satisfaction is because music or aroma to heal humans mentally and physically is already approved by some other way throughout the world as adopted in music therapy or aromatherapy.

At the present study, the phenomena of relaxation detected by the above measurement method were further investigated by fluctuation of instantaneous pulse rate implying more of information of the relaxed.

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2 Method for Taking Data of Unconscious Responses

2.1 Human System at the Viewpoint of Input/Output

In general idea, a system has a mechanism to produce an output modulated by its characteristics for an input. This idea was applied to the following human system [1–3]. A human is an elaborate system having two functions of mental and physical activities as shown in a schematic model in Fig. 1. Therefore, the human receives a stimulus, i.e., input of service, intentionally or unintentionally through human's own various biological sensors to put one or both sides of above functions into action as output of response. For the output, Fig. 1 suggests a mechanism of resulting a conscious response and an unconscious response for an input of a service. Here, article, information, energy, and labor were listed, for example, for input. Listening, reading, watching, buying, and receiving something in conscious state are examples of input stimuli.

The output through language or conscious motion, for example, is a conscious response. For the former, such as talking, writing, or painting corresponds to the former, while motions due to motor function, such as walking, does to the latter.

On the other hand, the variation in physical condition is an unconscious response to express by vital activity, sensitivity, and unconscious motion.

Here, the flow to conscious response is as follows. A biological signal, produced due to sensing stimuli at channel 1 (circled 1), flows into channels 2 and 3 to activate mental activity and physical activity, respectively.

Then, these mental and physical activities interact through channel 4. Mental activity, such as satisfaction or emotion, probably makes physical activity better. Also good physical activity will make mental activity better.

Thus, the mental activity will reply to the service by satisfying for a conscious response through channels 5 and 6. However, there would be a possibility to reply to the apparent satisfaction, because a signal of mental activity was sometimes distorted by reasons or consideration, etc., as shown in the bracket between channels 5 and 6. Thus, the reply in such a way is not always accurate. In addition, the mental activity does not always have a clear idea of satisfaction or not. Also, for stimuli such as lower variations of temperature or background music during the unconscious state, a signal does not pass through channel 2.

On the contrary, there are two lines in the physical activity as a physical condition to express an unconscious response. The one is direct channel 3 and the other is channel 4 via a mental activity. The signals from such two pass ways are combined and then sent by channel 7 for output. This output, an unconscious response such as vital activities, sensitivities, unconscious motions, etc., should be an honest answer because it was not distorted by above reasons, etc.

Physical condition generating unconscious response as shown in Fig. 1 was determined by a factor of condition c. This factor c was simply determined here by $c = hs$, where h is a factor of health and s is a factor of surroundings or service. For the less amount of variation, it can be simply expressed by

$$c + \mathrm{d}c = (h + \mathrm{d}h)(s + \mathrm{d}s) = (1 + \mathrm{d}h)(1 + \mathrm{d}s), \quad (\mathrm{d}: \text{ delta})$$
$$\mathrm{d}c = \mathrm{d}h + \mathrm{d}s.$$

As some variation of surroundings or service ds is input under a state in health maintained, i.e., dh = 0, the output will mainly occur as dc = ds. If c varied with no sensitive input, the fraction of health condition, dh, must have changed.

Daily life is roughly classified into two situations of in awake and in sleep as shown in Fig. 2. In the former, mental activities produced in the cerebrum will generate a conscious response. On the contrary, in the latter, because of unconscious state, autonomic nervous system activity is superior so that physical activities will generate an unconscious response. This is why the answer is put into unconscious response.

Then, service input can be classified into three types as shown also in Fig. 2. Articles and food are examples of type I having channels 2 and 3. Information is an example input of type II not having channel 3. Unconscious responses would be accumulated in the body and, therefore, would appear during sleep. Then we are in an unconscious state; therefore, the output through several hours is free from reason,

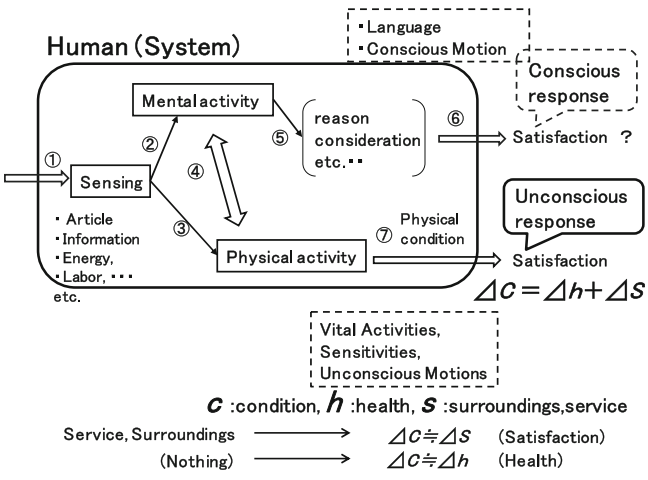

Fig. 1 Hypothetic model revealing flow of a service for a human system from sensing to response [2]

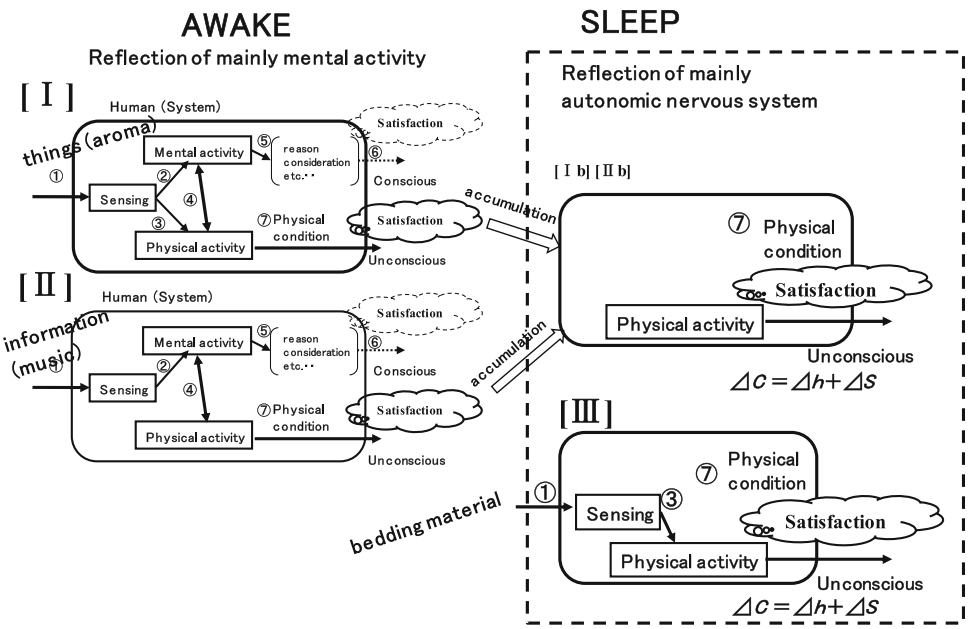

Fig. 2 Hypothetic model revealing three types of service flows: I, II, and III [2]

consideration, etc. Some bedding materials, input to human system without awareness during sleep, are examples of type III having neither channels 2 nor 4.

At the present study, vital activities during sleep has been adopted and studied. Now, it is obvious that the mind does not answer; however, the vital activities express unconscious responses free from reason, etc.

2.2 Instrumentation

It is understood that both respiration and pulse during sleep are controlled by autonomic nervous system and the rates of those become less [4, 5].

In order to investigate more of such findings, as shown in Fig. 3, the measurement system to detect the vital activities during natural sleep was developed [6]. A pressure sensor, named "dynamic air pressure sensor" (M.I. Lab), was adopted in order to fabricate a non-restraint measurement system. In principle, it was set on a bed to detect dynamic air pressure arises between the sensor and a subject's body at lying. The pressure variation detected with the sensor was converted to electric signals, "body motion wave" as mentioned later, sampled at the rate 400 Hz and 16 bit and stored in a personal computer.

The signal was processed with Chart v4.2.2 (AD Instrument) and programmable software VEE Pro ver6.0 (Agilent Technologies).

It is understood that the vital activities, such as respiration or pulse etc, occur independently, as unconscious responses are free from rational mind [7, 8]. The reproducibility of this system was already confirmed [1, 2].

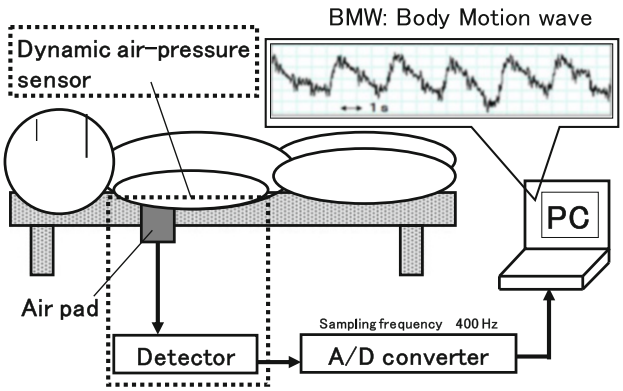

Fig. 3 Measurement system to detect body motion wave (BMW) having components of respiration-origin BMW (R-BMW) and pulse-origin BMW (P-BMW)

2.3 Body Motion Wave

As reported by Okawai et al. [1–3, 7, 8], in the subject's body during sleep, some continuous motions are generated resulting in respiration and pulse, so the motions can be detected as pressure waves named "body motion wave (BMW)," "respiration-origin BMW(R-BMW)," and "pulse-origin BMW (P-BMW)." In addition, during sleep, some frequent extra motions are generated resulting in unconscious actions, etc., and these can be detected as pressure waves also.

For these extra waves, approximately two types of waves appear. The one was named Tremble-origin BMW (T-BMW) having a small magnitude and short duration of wave due to a slight action of a portion of a body. The other was named Action-origin BMW (A-BMW) having a large

magnitude and wide duration of wave. Accuracy of the present method for detecting rates of respiration and pulse was already confirmed by comparing with the data taken from a thermistor and an electrocardiogram [6].

Thus, the present method adopting a nonadhesive, dynamic sensor realized the following merits: (1) it can be utilized to daily life because of no need of any medical stuff; (2) it takes data through an entire period in a bed even if a subject goes to the bathroom during night; (3) it takes data of pulse, respiration, and action simultaneously; and therefore (4) it secures subject's privacy because of neither a video camera nor a microphone used.

3 Experiment

Consecutive four weekdays were set to perform one set of experiment. At the first and second days for normal days as usual, physical reproducibility for a subject was checked and then at third and fourth days for receiving service days, i.e., stimulated days. At the present study, three types of stimuli of (a) aroma, (b) healing music, and (c) beddings including carbon fiber were adopted for the service of healing, relaxing, or improving circumstances:

(a) For aroma, subjects who do not use aroma in daily living were selected. Any aroma each subject liked by himself/herself among more than 20 kinds of aroma oils was diffused in the room before going to bed by 1–2 h (hours). The aroma was available for approximately 2–3 h after going to bed (type I in Fig. 2).
(b) For healing music, subjects who do not listen to healing music in daily living were selected. The subject listened to a music chosen by himself/herself for approximately 30 min (minutes) to 1 h between 2 h and 0.5 h before going to bed (type II in Fig. 2).
(c) For bedding material, two types of quilt materials, A and B, trially producted through different process though the same carbon fibers, were tried to be measured (type III in Fig. 2).

In principle, the experiment was carried out for consecutive four weekdays of the former 2 days for normal (usual day) and the latter 2 days for trials.

Holidays were excluded because of mental or physical variations. Also any subject having an event or an unusual condition as a result of some kind of mental or physical situation were excluded. For this reason, experiment (c) was carried out only for material A and material B to be completed in 4 days.

4 Result

As for aroma stimuli, example transitions for a subject of pulse rate in the upper and of respiration rate in the lower through one night were shown in Fig. 4. The two on the left are for the normal, i.e., no particular stimulus for the first and second nights, and then the two on the right are for aroma.

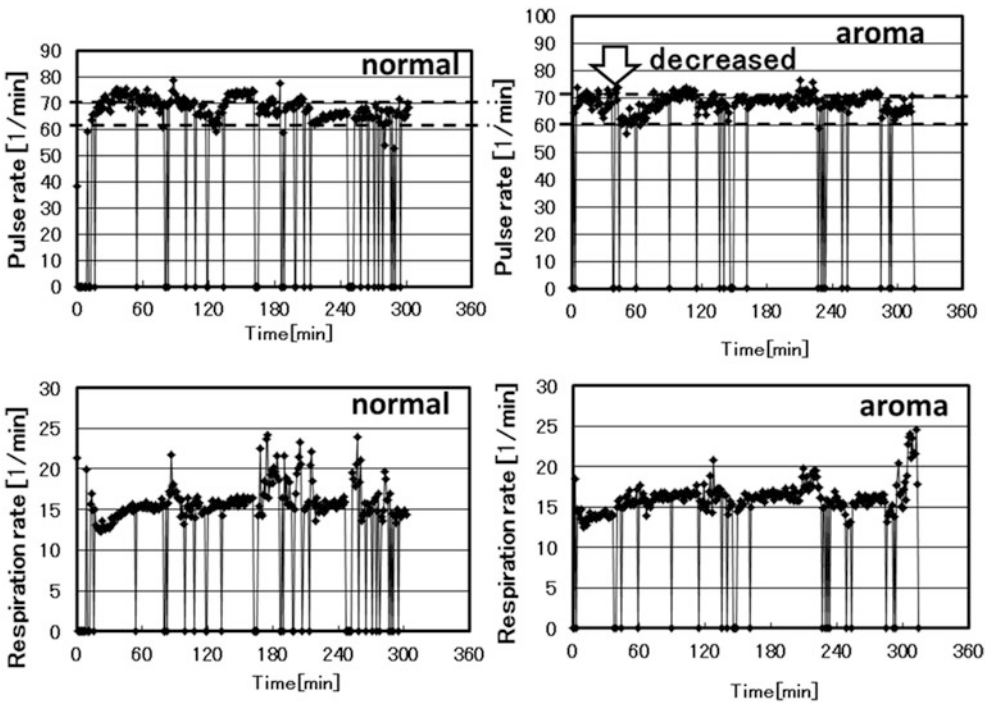

Fig. 4 Rates of pulse, *upper*, and respiration, *lower*, during sleep through a night. The *left* shows "normal," i.e., with no particular service (stimulus), while the *right* shows "aroma" stimulus as a service

Pulse rate decreased especially in 1 h, while respiration rate did not decrease in three of three subjects. Dashed lines at approximately 60 and 70 in pulse rate traces show a certain mark to compare levels. Vertical bars reaching to zero show body actions to disturb counting rates of pulse and respiration, on the contrary, to give further information of sleep state. However, this information will not be discussed here.

For the music stimuli, as shown in Fig. 5, pulse rate decreased considerably by approximately 10, while respiration rate did not vary so much. Arrows n_1 to n_3 and m_1 to m_3 will be discussed later.

In Fig. 6, pulse rate for carbon A showed lower value of approximately 50–60 than that of carbon B of 55–70, for example. While respiration rate for carbon A showed less

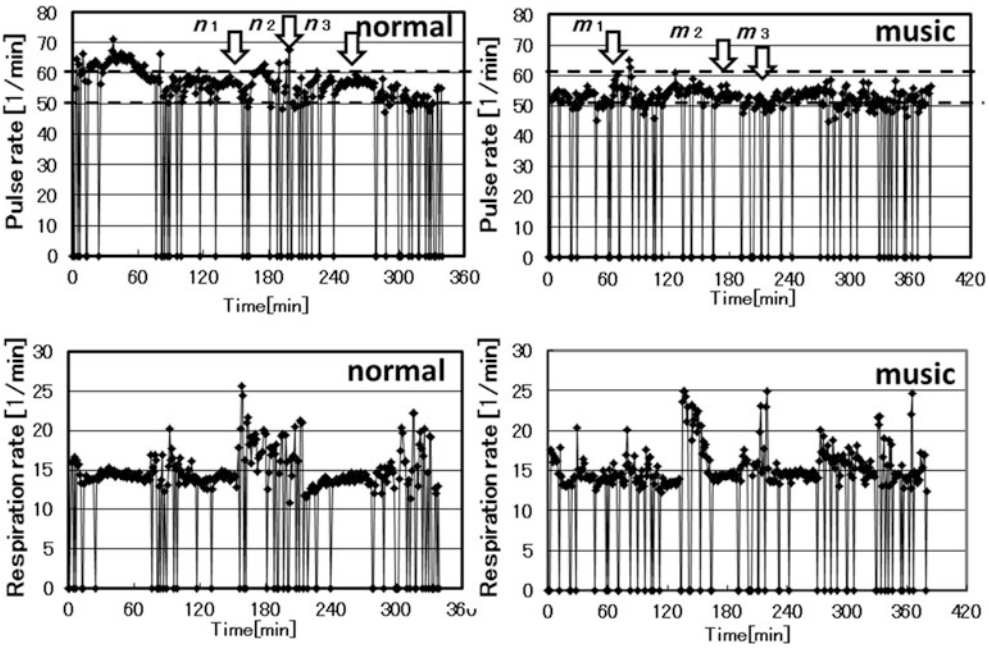

Fig. 5 Rates of pulse, *upper*, and respiration, *lower*, during sleep through a night. The *left* shows "normal," i.e., with no particular service (stimulus), while the *right* shows "music" stimulus as a service

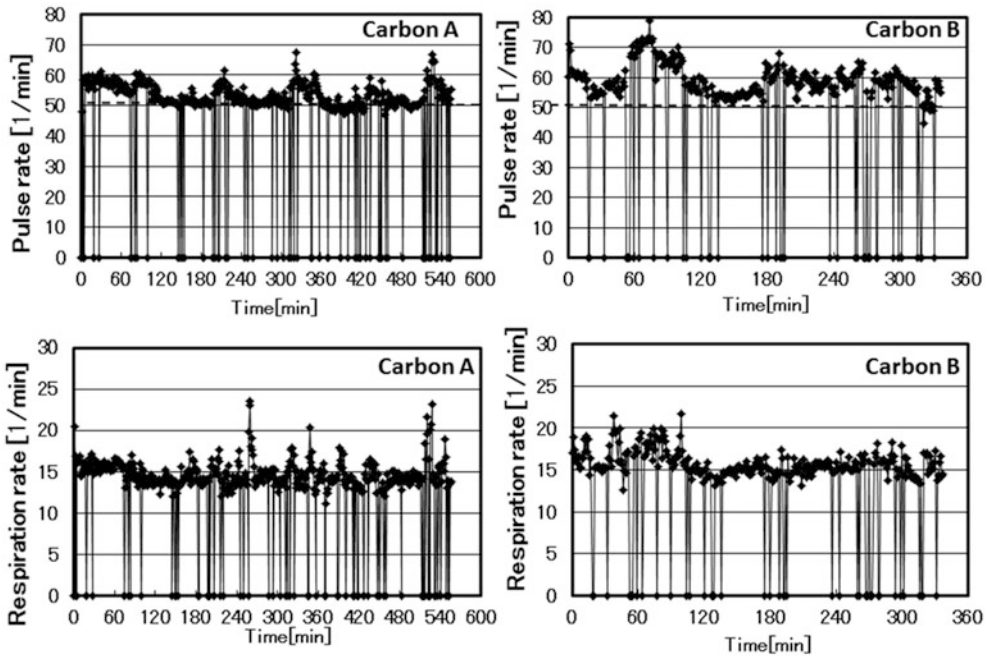

Fig. 6 Rates of pulse, *upper*, and respiration, *lower*, during sleep through a night. The *left* shows carbon fiber material *A* while the *right* shows *B*

value than approximately 15, on the contrary, that for carbon B showed larger value than 15. Such tendency was shown in three of four subjects at age 21–25.

5 Discussion

The decrease in the rates of pulse and respiration, especially pulse, during sleep when a subject received stimuli of aroma or healing music was reported [1–3]. The same tendencies were shown in Figs. 4 and 5; thus, the response of decrease was confirmed also here. As aroma and healing music are recognized internationally to be a relaxation method, the physiological detection method using BMW (BMW method) at the present study agreed fundamentally with the understanding that pulse rate and respiration rate decrease by relaxation [4, 5].

For this reason, it is clear that the satisfaction a subject felt through mental and physical activities at awake state due to a stimulus by aroma or music for relaxation was accumulated in the body physiologically. Thus, physical data was successfully detected by BMW method during sleep, i.e., at the condition that activities of parasympathetic nerves became relatively dominant compared with that of normal days in principle.

Next, at the present study, the third type for a process of input of stimuli/service to output of response suggested in Fig. 2 was tried by means of examples of carbon material, as shown in Fig. 6. As a result, carbon A resulted in decrease in both rates of pulse and respiration. This would be relaxation effects.

The reason why carbon A resulted in relaxation is the data, obtained through other experiment for the carbon fiber materials A and B tried separately, produced some decrease in both rates, especially pulse rate to subjects though with some difference between person to person including no effect. Then, at the present study to confirm the difference between two materials A and B within the limit of four consecutive weekdays, i.e., no normal data taken, it was found that material A has effected a subject to be relaxed more clearly. In addition, it is noted that a subject surely answered satisfaction through unconscious response without mental activity process as shown by type III in Fig. 2. In fact, the carbon material neither smelled like aroma nor gave different hardness, i.e., the subject was mentally not aware of carbon.

For this reason, an idea that all of the three types of services to relax a human as shown in Fig. 2 made the subject relaxed though some detailed mechanism was still unknown. Thus, usefulness or accuracy of the BMW method was demonstrated.

Here, in order to investigate more of mechanisms resulting in the relaxation effect, detailed transit of "instantaneous pulse rate" was studied, because minute pulse rate is only an average value of those during 1 min to mask detailed variation.

Figures 7 and 8 show examples of instantaneous pulse rate extracted from the data for the normal and music in Fig. 5 by paying attention to three 5 min portions, respectively. As a result at first, as shown in Fig. 7, portions n_1 and n_3 at approximately middle level through one night had fluctuations with a magnitude of less than approximately 10, while n_2 at larger level had that of 20–40.

In the second, in Fig. 8, portion m_2 at the middle level through one night had fluctuations with a magnitude of less than approximately 10. On the contrary, m_1 at the largest level of 60 in minute rate had large magnitude fluctuation in the range 10–30, and also m_3 at the least level of 50 in minute rate had large magnitude ones of 20.

Though such investigation is still on progress, the fluctuation known from instantaneous pulse rate implies that pulse rate range can be classified into three:

*R*a: large magnitude in fluctuation of instantaneous pulse rate at higher minute pulse rate level
*R*b: less magnitude in fluctuation of instantaneous pulse rate at a certain range in minute pulse rate
*R*c: large magnitude in fluctuation of instantaneous pulse rate at lower minute pulse rate level

Such a specific minute pulse rate range *R*b implies optimum range for calm state of sleep. In this range, a heart beats at relatively ease. However, minute pulse rate increases up to the range *R*a and then decreases to the range *R*c also, due to some unknown physiological reasons.

Once the minute pulse rate becomes larger up to the range *R*a, the heart makes an effort to reduce the minute pulse rate by raising large magnitude of fluctuation in consecutive beats, i.e., instantaneous pulse rate in order not to increase anymore. On the contrary, once the minute pulse rate enteres the range *R*c, the heart must make an effort to return to an appropriate in the range *R*b by raising large magnitude of fluctuation in instantaneous pulse so as not to remain at lower rate or decrease any further.

As a result, it is considered that the relaxation effect, as demonstrated by decrease in minute pulse rate, is shaped by the shift of the range *R*b toward less. Therefore, the relaxation effect will be confirmed by variation, or shift, of the ranges *R*a, *R*b, and *R*c and by the shift of position occurring large magnitude of fluctuation in instantaneous pulse rate axis as well as minute rate.

Then, at the present study, authors suggested specific terms for the range *R*b mentioned above as Minute optimum Pulse rate Range for Sleep (moPR-S).

In addition, from this viewpoint, further study would suggest the magnitude range of fluctuation as Instantaneous optimum Pulse rate Range for Sleep (ioPR-S).

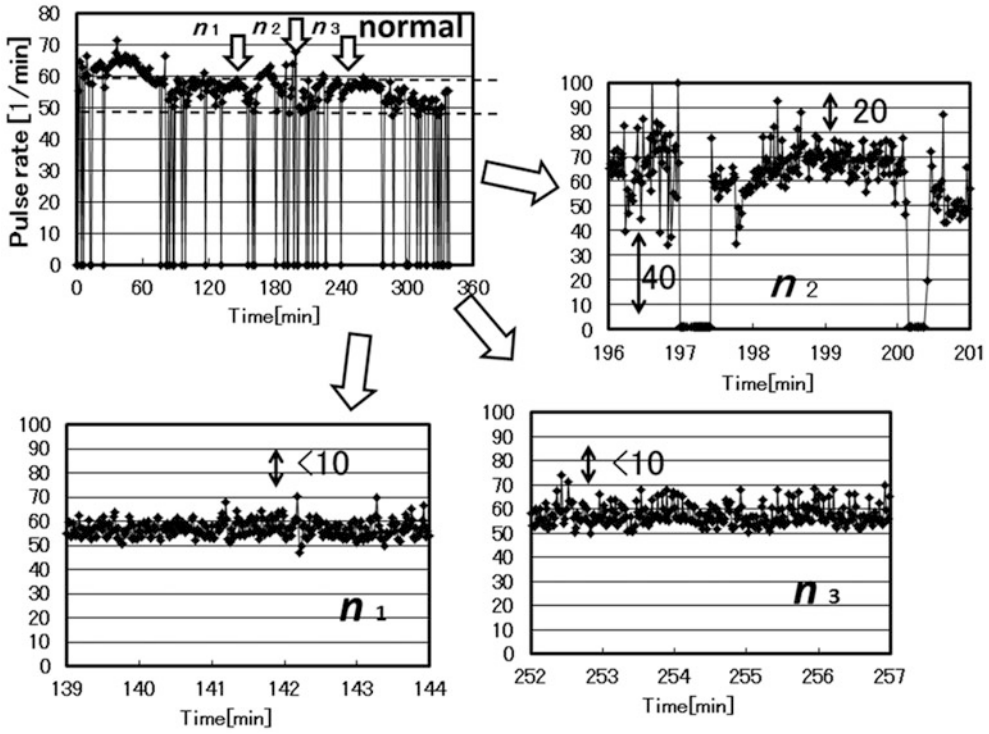

Fig. 7 Variation of the instantaneous pulse rate for 5 min duration enlarging portions n_1, n_2, and n_3 in the *left upper* trace in Fig. 5 (normal)

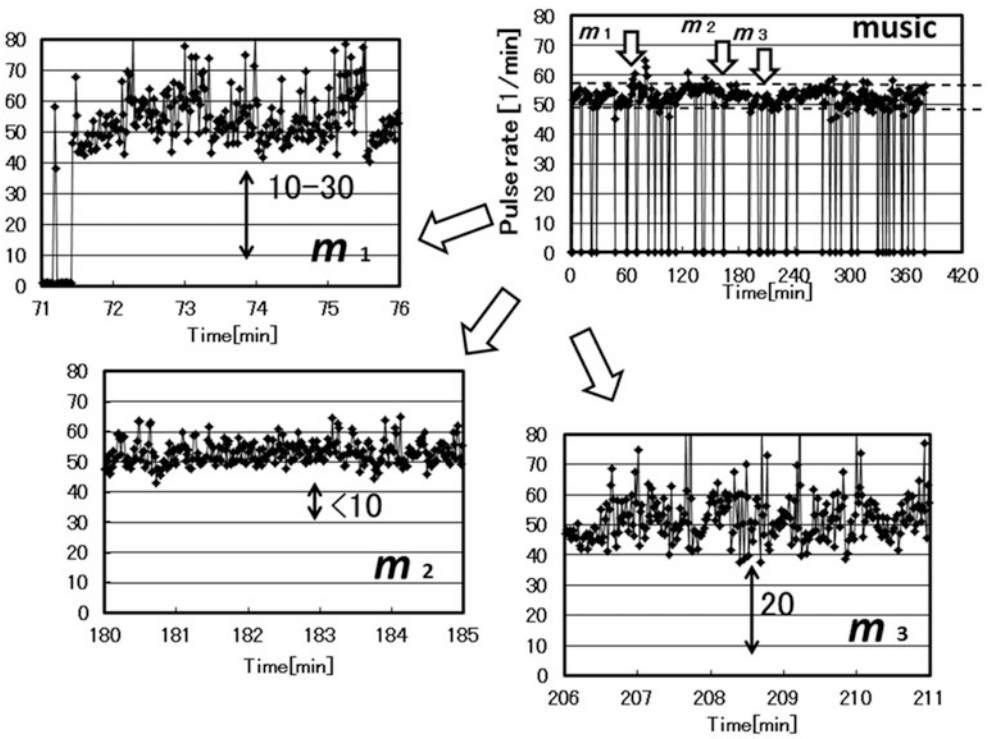

Fig. 8 Variation of the instantaneous pulse rate for 5 min duration enlarging portions m_1, m_2, and m_3 in the *right upper* trace in Fig. 5 (music)

From the discussion here, the range moPR-S can be determined by approximately 51–60 for the normal, i.e., non-stimulus as shown in Fig. 7, while by approximately 48–57 for the stimulus as shown in Fig. 8 as traced by dashed lines in the figures.

In the experiment at the present study, aroma, music, and bedding material of carbon were tried. Each supplier intentionally supplied for the first and the second industrial products, while the customer, i.e., subject here intentionally chose in awake state. The subject intentionally showed satisfaction by conscious response of choosing aroma oil or music he/she liked and then replied by unconscious response of varying physical conditions during sleep.

For the third, though the supplier, i.e., a corresponding author, intentionally supplied for the trial product, the subject did not know what it was and accepted the service non-intentionally. However, the subject replied to the service through unconscious response during sleep.

Thus, the BMW method using unconscious response on the basis for the flow of service input to satisfaction output was demonstrated to be practical. Here, it was also found that the supplier's or customer's intention does not always need to follow the service flow, or rather, the intention sometimes distorts honest information.

6 Conclusions

Autonomic nervous system answered satisfaction to services for a subject to be relaxed in a conscious state, by unconscious responses, i.e., nonverbal communication, by varying rates of pulse and respiration during sleep through the process of accumulating information. In addition, the system did the same even though a subject did not know receiving services. The unconscious responses studied at the present study are as follows: (1) decrease in above two rates; (2) variation, or shift, of the ranges *R*a, *R*b, and *R*c in pulse rate axis; and (3) shift of position of occurring large magnitude of fluctuation in pulse rate axis.

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References

1. Okawai H., Ichisawa S., Numata K., 2011, Detection of influence of stimuli or services on the physical condition and satisfaction with unconscious response reflecting activities of autonomic nervous system, N.A.Abu Osman et al. (Eds.), BIOMED2011, IFMBE Proceedings 35, Kuala Lumpur, MALAYSIA, 20–23 June: 420–423.
2. Okawai H, Kato K, Baya D, 2012, Entrusting the reply of satisfaction or physical condition for services to unconscious responses reflecting activities of autonomic nervous system, 4th International Conference on Applied Human Factors and Ergonomics, AHFE2012, San Francisco, 21–25 July: 911–920.
3. Okawai H, Yajima T, Wada J, Takashima M, 2014, Detection of Satisfaction for the Services by Body Motion Wave Revealing Unconscious Responses Reflecting Activities of Autonomic Nervous System, Ahram T, Karwowski W, Marek T (Eds.), Proceedings of the 5th International Conference on Applied Human Factors and Ergonomics AHFE 2014, Krakow, Poland, 19–23 July:4297–4286.
4. Hori T, 2008, Sleep psychology, Kitaoji Shobou, Kyoto, Japan (in Japanese)
5. Kaniusas E, 2012, Sleep, Biomedical signals and Sensors1, Springer, 270–282.
6. Kuno H, Takashima M, Okawai H, 2004, Measurement of Respiration, heart beat and body movement on a bed using dynamic air-pressure sensor, IEEJ Trans. EIS.vol.124, No.4, 935–940 (in Japanese).
7. Okawai H, Yajima T, Imamatsu T, 2012, Transition of Rates of Respiration and Pulse, and Sleeping Posture During Night Detected by Body Motion Wave, IEEE international Conference on Biomedical Engineering and Sciences, Langkawi, MALAYSIA, 17–19 December:129–133.
8. Okawai H, Yajima T, Imamatsu T, Wada J, 2013, Sophisticated Rate Control of Respiration and Pulse during Sleep Studied by Body Motion Wave. L.M. Roa Romero (eds.), XIII Mediterranean Conference on Medical and Biological Engineering and Computing 2013, IFMBE Proceedings 41, MEDICON 2013, 25–28 September, Seville, Spain: 1895–1898.

The Effects of Waiting Time, Length of Stay, and Hospital Remodeling on the Structure of Patient Satisfaction

Masumi Okuda, Akira Yasuda, and Shusaku Tsumoto

Abstract

Patient surveys at a Japan hospital were analyzed using distance to explore changes in similarities among care services, by waiting time, length of stay, and hospital remodeling. In an outpatient survey, the overall rating moved from a general interpersonal skill cluster to a personalized care cluster as waiting time became longer. In an inpatient survey, the three clusters of environment, interpersonal skills, and technical skills were consolidated into environment and the other one as length of stay became longer. After hospital remodeling, overall rating moved to a different cluster. Analysis using distance has the potential to explore the hidden structure of patient satisfaction.

Keywords

The structure of patient satisfaction • Waiting time • Length of stay • Hospital remodeling • Clustering

1 Introduction

As patient-centered care has been gaining strong support from both health-care providers and consumers, patient satisfaction is considered to be a key component of quality of medical care. Many studies have used a predictive model to assess the impact of various hospital services on overall assessment of hospital performance and the willingness to recommend a hospital. Two elements of performance of medical practitioners identified by Donabedian are technical performance and interpersonal performance [1]. Interpersonal skills have been reported as a major determinant of patient satisfaction for both inpatients and outpatients [2].

To focus on the determinants, however, carries the risk of understating the non-determinants. For example, while quietness is the least appreciated hospital performance, as compared to overall rating and other services such as communication with doctors and nurses [3], studies on reducing noise have rarely been reported [4]. On the other hand, analysis using distance as a data mining technique aims to produce insight and understanding of the structure of the data, and no single variable is central [5] and can be applied to categorical data [6–8]. Clustering, an example of data mining technique, is used in the areas of marketing, biology, finance, archeology, and medicine [5].

Studies on patient satisfaction by analysis using distance have been reported recently, although they are still few in number [9–13]. Cluster analysis can be applied to clustering observations or variables or to both observations and variables simultaneously [19]. Some studies have used the method to find groups among patients with respect to their sociodemographic characteristics and assessment of hospital services [9–10]. Other studies have used the method to find similarities among hospital services [11–13], which is the structure of patient satisfaction. One study found that hospitals in the USA with different survey response sizes had different

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structures of patient satisfaction. For hospitals with smaller response sizes, communication with nurses and doctors formed a different cluster from other hospital services such as pain management and overall rating, while at hospitals with larger response sizes, these were included in the same cluster [13].

To investigate the impact of waiting time on patient satisfaction with a quantitative approach, many studies have used correlation, multiple linear regression, and logistic regression with similar results of negative association of longer waiting time [14–17]. However, in Japan the reported results are mixed [18–20]. Length of stay was examined with similar methods and was found to have little association between length of stay and patient satisfaction [21–23] with some exceptions [24, 25]. Studies on the effects of a newly built hospital reported improved patient satisfaction using a descriptive method and mean differences [26, 27].

2 Objectives

To explore the effects of waiting time, length of stay, and hospital remodeling on the internal structure of patient satisfaction by waiting time, length of stay, and hospital remodeling in Japan.

3 Methods

3.1 Patient Survey

The results of patient satisfaction surveys conducted at an emergency hospital in a suburban city in Japan for 1 week for the years 2010 through 2012 were used for the analysis. The hospital with 645 beds, cardiac surgery department, and intensive care unit had been under on-site hospital remodeling since 2007 and saw the completion of its ward remodeling in 2010 and the final completion in 2012. The hospital remodeling improved its reception system and flow line. As each outpatient clinic examination room was now staffed by a medical clerk who assisted doctors with medical records, doctors were able to spend more time talking to patients. OECD has reported Japan's average length of hospital stay as 17.5 days, longer than other countries: the USA, 4.8; the UK, 7.0; and Germany, 9.2 [28], principally due to the hospital tradition of providing long-term care to the elderly and to a shortage of long-term care facilities and nursing homes [29].

The questionnaire was handed out to outpatients at reception and to inpatients in their rooms by a clerk. Inpatients to be given the questionnaire were first identified by a head nurse based on their health status.

The survey asked three social demographic items: sex, age, and waiting time for outpatients and length of stay for inpatients. Waiting time was a four-choice question: "less than 30 minutes," "between 30 minutes and 59 minutes," "between 60 minutes and 89 minutes," and "90 minutes and over." Hospitalization period was also a four-choice question: "no more than 6 days," "between 7 days and 13 days," "between 14 days and less than one month," and "one month and over." Length of stay was modified in 2012 to "no more than 7 days," "between 8 days and 14 days," "between 15 days and less than one month," and "one month and over."

Table 1 shows the survey items of outpatient satisfaction. The outpatient surveys in 2010 and 2011 used 13 measures: technical skills (three items), interpersonal skills (seven items), privacy protection, environment (clarity of information), and overall rating. In 2012 the survey items were modified and increased to 15 items. Doctor's technical skills were differentiated from the other staff. Interpersonal skills were reduced from seven items to four. The assessment of waiting room and examination room was added to environmental items. Willingness to recommend the hospital and willingness to reconsult were added to overall rating. Table 2 shows the inpatient survey items. The inpatient survey in 2010 and 2011 used 15 measures including food and

Table 1 Outpatient survey items with regard to hospital service

Domain	Years 2010–2011 (13 items)	Year 2012 (items revised, 15 items)
Technical skills	Examination and treatment	Examination and treatment by doctor
		Examination and treatment by the other staff
	Explanation by staff	Explanation by doctor
		Explanation by the other staff
	Answer from staff when asked	–
Interpersonal skills	Staff appearance	–
	Greeting from staff	–
	Communication with a smile	–
	Staff responsiveness	Staff responsiveness
	Listening	Listening
	Approach from staff	Approach from staff
	Courteousness	Language use
Privacy protection	Privacy protection	Privacy protection
Environment	Clarity of information signage	Clarity of information signage
	–	Environment of waiting room
	–	Environment of examination room
Overall assessment	Overall rating	Overall rating
	–	Willingness to recommend hospital to others
	–	Willingness to reconsult

Table 2 Inpatient survey items with regard to hospital service

Domain	Years 2010–2011 (15 items)	Year 2012 (items revised, 17 items)
Technical skills	Examination and treatment	Examination and treatment by doctor
		Examination and caring by nurse
		Caring by the other staff
	Explanation by staff	Explanation by doctor
		Explanation by nurse
		Explanation by the other staff
	Answer from staff when asked	–
Interpersonal skills	Staff appearance	–
	Greeting from staff	–
	Communication with a smile	–
	Staff responsiveness	–
	Approach from staff	–
	Courteousness	–
	Listening	Listening
	–	Language use
Privacy protection	Privacy protection	Privacy protection
Environment	Clarity of information signage	Clarity of information signage
	Environment	Cleanliness of room
		Comfortableness of room
	Food	Food menu
		Food taste
Overall assessment	Overall rating	Overall rating
		Willingness to recommend hospital to others
		Willingness to reconsult

environment in addition to the outpatient survey items. The modified 2012 inpatient survey consisted of 17 measures. Technical skills were divided into three parts, by doctor, by nurse, and by the other staff because nurses play a larger role in the ward. Interpersonal skills were reduced to two items. Cleanliness and comfortableness of room were added to the environmental item. Overall assessment was increased to three items.

Each question used a 5-point Likert scale ranging from "very satisfied/good" to "not satisfied/not good at all."

3.2 Analysis

Descriptive statistics were performed on social demographics. Analysis using distance, clustering by Ward's method, correspondence analysis, and multidimensional scaling (MDS) were mainly performed to identify groups among items. First, to explore the relation between satisfaction rating and waiting time and between satisfaction rating and length of stay, "unsatisfied/not satisfied" and "very unsatisfied/not satisfied at all" were integrated due to their small numbers. Second, correspondence analysis was performed to reclassify satisfaction rating, waiting time, and length of stay by the integrated "overall rating" [11]. Third, correspondence analysis, clustering, and MDS were performed to study the change of the structure of patient satisfaction by waiting time and length of stay for the 2010 patient survey and for the 2011 and 2012 patient surveys with no breakdown of waiting times or lengths of stay. Chi-square test was performed to examine the waiting time reduction due to hospital remodeling. R version 3.1.0 was used for statistical analysis.

4 Results

In 2010, of the 650 outpatients and 995 inpatients, 301 outpatients (46 %) and 284 inpatients (29 %) responded to the survey, of which the number of valid respondents was 229 (35 %) and 198 (20 %), respectively. In 2011, of the 1393 outpatients and 414 inpatients, 756 outpatients (54 %) and 250 inpatients (60 %) responded to the survey. The number of valid respondents was 434 (31 %) and 182 (39 %), respectively. For 2012, of the 3654 outpatients and 377 inpatients, 855 outpatients (23 %) and 236 inpatients (62 %) responded to the survey, of which the number of valid respondents was 607 (17 %) and 151 (40 %), respectively.

4.1 Patient Characteristics

For all the outpatient surveys, the respective percentages of male respondents (26–39 %) were lower than for the female respondents (37–48 %); the percentages of respondents older than 60 years were approximately 50 % (Table 3). The percentages of respondents whose waiting times were less than 30 min increased after the completion of hospital remodeling (Table 3). Chi-square test found a significant difference among the number of respondents by waiting time (Chi-squared $= 300.5, p < 0.001$). For all the inpatient surveys, the respective percentages of male respondents (46–51 %) were greater than for the female respondents (41–44 %); the percentages of respondents older than 60 years ranged between 54 % and 58 % (Table 4). In 2011, the percentage of respondents whose lengths of stay were 7 days or less (14 %) was lower than for either 2010 (22 %) or 2012 (23 %.)

Table 3 Outpatient characteristics

		Gender			Age in years			Waiting time			
	All	Male	Female	Unknown	≤59 years old	≥60 years old	Unknown	≤29 min	30–59 min	60–89 min	≥90 min
Year	n	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)
2010	229	59 (26)	84 (37)	86 (38)	96 (42)	115 (50)	18 (8)	92 (40)	82 (36)	37 (16)	18 (8)
2011	556	181 (33)	258 (46)	117 (21)	244 (44)	269 (48)	43 (8)	218 (39)	213 (38)	89 (16)	36 (6)
2012	607	234 (39)	292 (48)	81 (13)	268 (44)	302 (50)	37 (6)	324 (53)	179 (29)	75 (12)	29 (5)

Freq frequency, *min* minutes

Table 4 Inpatient characteristics

		Gender			Age in years			Hospitalization period			
	All	Male	Female	Unknown	≤59 years old	≥60 years old	Unknown	≤6/7 days	7–13/ 8–14 days	14/15 days–1 month	≥1 month
Year	n	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)
2010	198	100 (51)	82 (41)	16 (8)	61 (31)	130 (66)	7 (4)	43 (22)	50 (25)	46 (23)	59 (30)
2011	182	87 (48)	80 (44)	15 (8)	51 (28)	123 (68)	8 (2)	26 (14)	46 (25)	50 (27)	60 (33)
2012	151	70 (46)	64 (42)	17 (11)	62 (41)	82 (54)	7 (5)	34 (23)	38 (25)	33 (22)	46 (30)

Freq frequency

4.2 Reclassification of Scale, Waiting Time, and Length of Stay

The 5-point scale was reclassified into a 3-point scale by correspondence analysis; "general," "unsatisfied/not satisfied," and "very unsatisfied/not satisfied at all" were integrated and labeled as "Low"; "satisfied" was labeled as "Medium", and "very satisfied" as "High." Waiting times in the 2010 outpatient survey were reclassified to "less than 60 minutes" and "60 minutes and over" [11]. Lengths of stay in the 2010 inpatient survey were reclassified to "no more than 6 days," "between 7 days and less than one month," and "1 month and over" (results not shown; see [11]).

4.3 The Effects of Waiting Time on the Structure of Patient Satisfaction

In both of the waiting time classifications in the 2010 survey, "information signage" and "approach from staff" formed a cluster by themselves with the largest percentages of "Low" (Fig. 1; the rectangles in Figs. 1, 4, 7, and 10 indicate the clusters). In the waiting time "less than 60 minutes," the second cluster consisted of four items: "overall rating," "communication with smile," "greeting," and "answer from staff." The third cluster was comprised of seven items: "examination and treatment," "courteousness," "listening," "staff appearance," "explanation by staff," "responsiveness," and "privacy protection." The second and third clusters showed similar rating percentages, though the latter had a slightly greater "High" number (Fig. 1a, b). In the waiting time "60 minutes and over," the "overall rating" cluster included "privacy protection," "courteousness," and "explanation by staff." The second and third clusters also showed similar rating percentages but with a lower percentage for "High." For both waiting times, "overall rating" formed the same cluster with "greeting" and "answer from staff" but not with "examination and treatment" and "listening." "Examination and treatment" formed the same cluster with "listening" and "responsiveness" (Fig. 1c, d).

Correspondence analysis is used to explore the relation between rows and columns of a table [8]. For the waiting time "less than 60 minutes," most of the items were between "High" and "Medium," but in the waiting time "60 minutes and over," they moved away from "High." "Approach from staff" and "information signage" were placed across "Low" in both of the waiting times (Figs. 2a and 3a; circles in the correspondence analysis figure correspond to clusters).

MDS indicates that items near the coordinate origin and items placed closely receive similar ratings and that items on the edge receive different ratings [6]. "Information signage" on the edge and "answer from staff" in between did not change their positions by waiting time, nor did "approach from staff." "Staff appearance" moved in between in the waiting time "60 minutes and over." However, in clustering results these two items were not differentiated in either of the waiting times (Figs. 2b and 3b; items in inner circle indicate proximity) ([11] Analysis was revised by R version 3.1.0.).

4.4 The Effects of Length of Stay on the Structure of Patient Satisfaction

In 2010, "information signage" and "food" formed a cluster by themselves with the lowest percentages for "High" in the length of stay "no more than 6 days." The second cluster

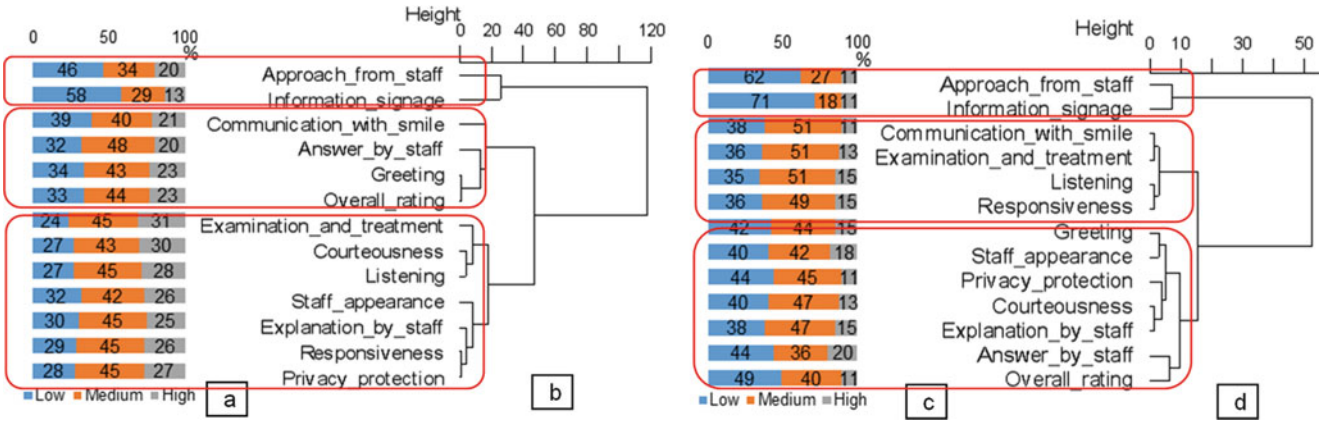

Fig. 1 Distribution graph and clustering results of the outpatient survey in 2010. (**a**, **b**) Waiting time "less than 60 minutes," $n = 174$; (**c**, **d**) Waiting time "60 minutes and over," $n = 55$

Fig. 2 Correspondence analysis and MDS of the outpatient of waiting time, "less than 60 minutes," in 2010, $n = 174$. (**a**) Correspondence analysis. (**b**) MDS

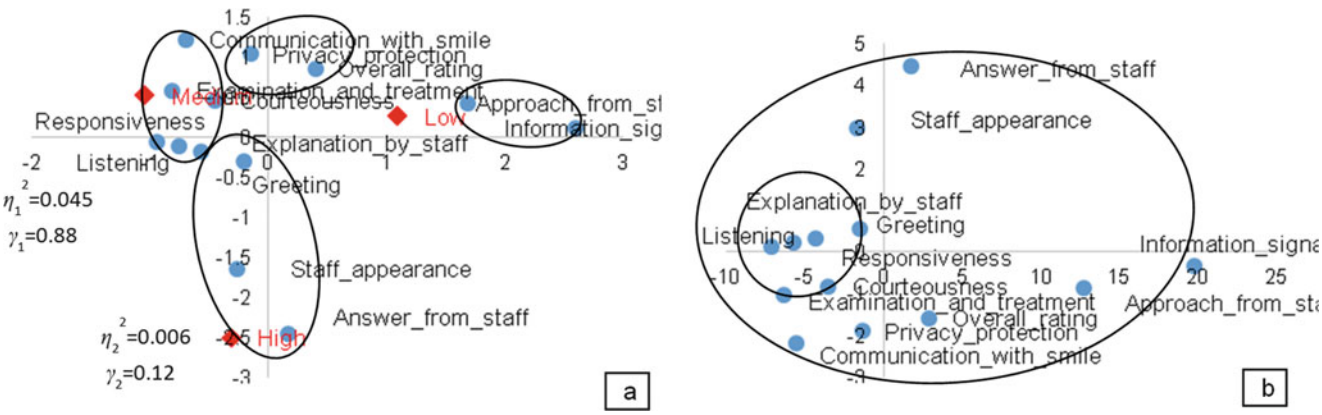

Fig. 3 Correspondence analysis and MDS of the outpatient of waiting time, "60 minutes and over," in 2010, $n = 55$. (**a**) Correspondence analysis. (**b**) MDS

consisted of eight items, including "privacy protection" and "explanation by staff" with the greatest percentages for "High." The third cluster consisted of five items including "overall rating," "examination and treatment," and "environment" with lower percentages for "High" (Fig. 4a, b). In the length of stay "between 7 days and less than one month," "privacy protection" lowered its rating and joined the third cluster (figures not shown.) In the length of stay "one month and over," "examination and treatment" and the interpersonal skill items formed a cluster. "Food" itself formed

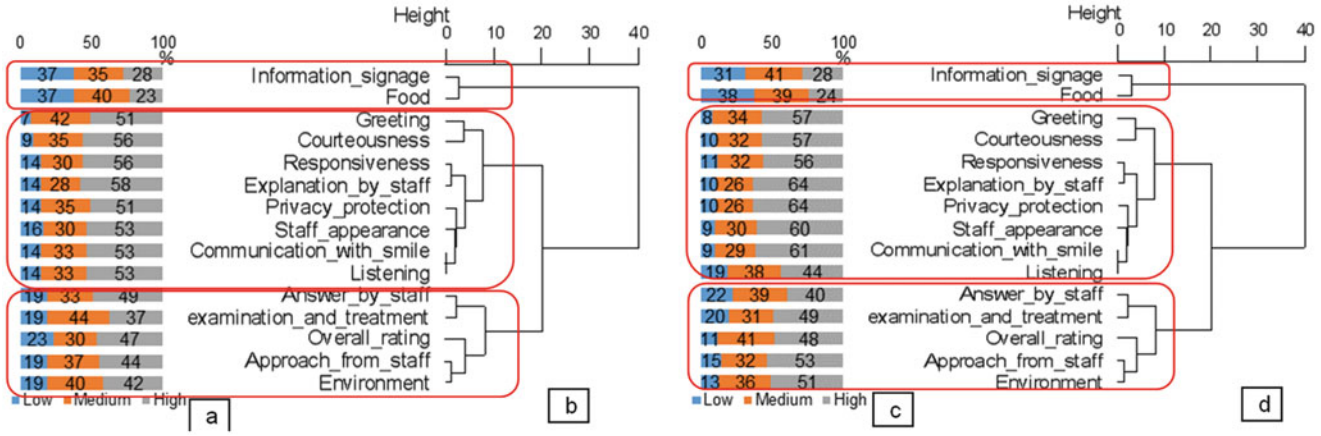

Fig. 4 Distribution graph and clustering results of the inpatient survey in 2010. (**a**, **b**) Hospitalization period, "no more than 6 days," $n = 43$; (**c**, **d**) length of stay, "one month and over," $n = 59$

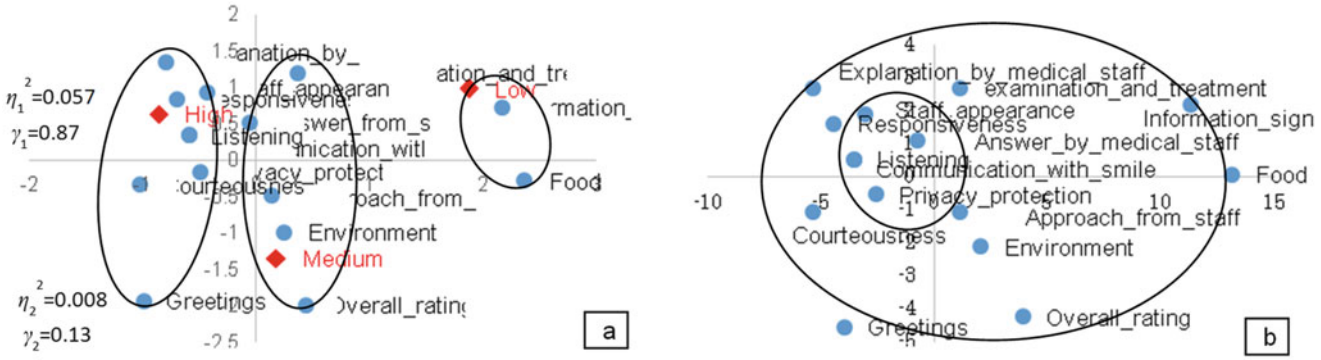

Fig. 5 Correspondence analysis and MDS of the inpatient with length of stay, "no more than 6 days," in 2010, $n = 43$. (**a**) Correspondence analysis. (**b**) MDS

another cluster with the greatest percentage for "Low." "Overall rating," "information signage," and "environment" formed the other cluster (Fig. 4c, d).

Correspondence analysis showed that in length of stay "no more than 6 days," most items were scattered between "High" and "Medium," while in length of stay "one month and over," they moved closer to "High." However, "environment" moved across "Medium," closer to "overall rating." "Information signage" also moved toward "Medium." "Food" alone moved across "Low" (Figs.5a and 6a) [11]. (Analysis was revised by R version 3.1.0.)

MDS showed "information signage," "food," and "overall rating" did not change their positional relation with the others by length of stay. In length of stay "one month and over," "information signage" moved inside, but still away from the inner items. "Environment" moved toward the edge, closer to "overall rating." "Greeting" was on the edge in length of stay "no more than 6 days," but clustering did not differentiate it from the others (Figs. 5b and 6b).

4.5 The Effects of Hospital Remodeling on the Structure of Patient Satisfaction

4.5.1 Outpatient Survey

The 2011 survey showed a similar structure of patient satisfaction to the 2010 survey for waiting time "less than 60 minutes," with the exception of "information signage," which was clustered by itself. After the completion of hospital remodeling, the 2012 outpatient survey formed four clusters with the newly introduced survey items. "Listening" improved its rating and formed a cluster by itself. "Information sign" improved its rating and joined the cluster of "privacy protection" and "recommendation" (Fig. 7a, b). "Examination treatment," "explanation by doctor," "courteousness," and "language use" formed a four-item cluster. Another cluster consisted of seven items including "overall rating" (Fig. 7c, d) ([11]. (Analysis was revised.) For both during and after hospital remodeling, "overall rating" and "examination and treatment" were separated.

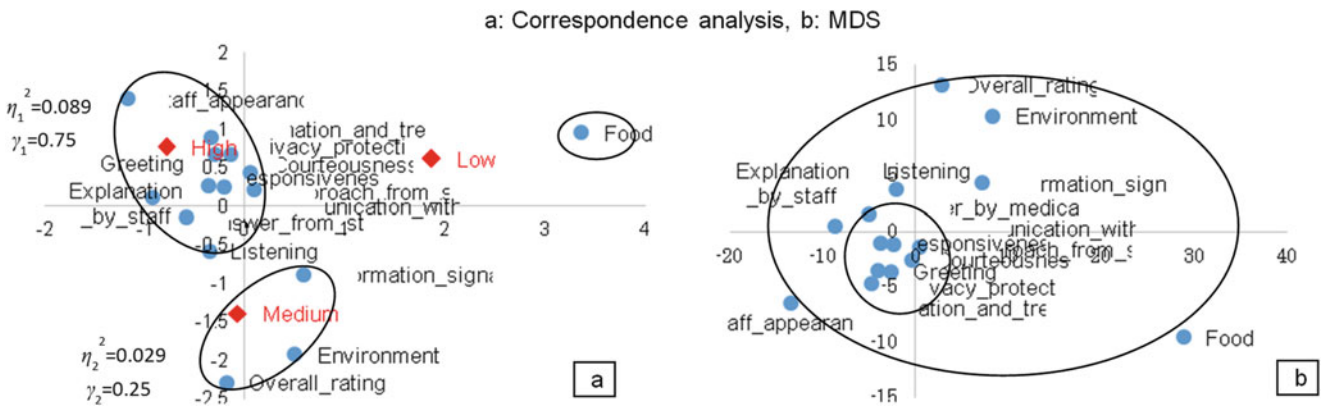

Fig. 6 Correspondence analysis and MDS of the inpatient with length of stay, "one month and over," in 2010, $n = 59$

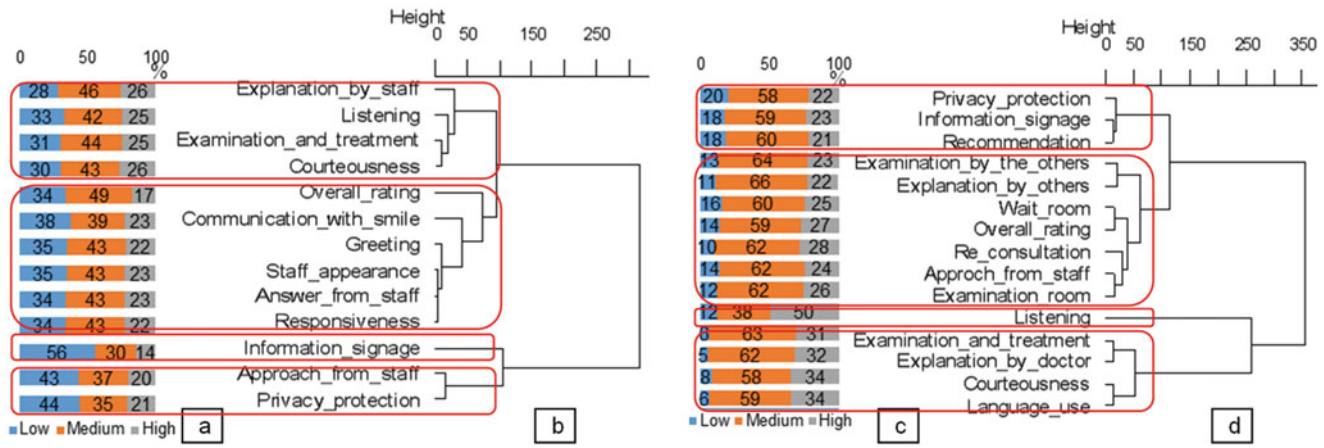

Fig. 7 Distribution graph and clustering results of the outpatient survey in year 2011 and 2012. (**a**, **b**) Year 2011, $n = 556$. (**c**, **d**) Year 2012, $n = 607$

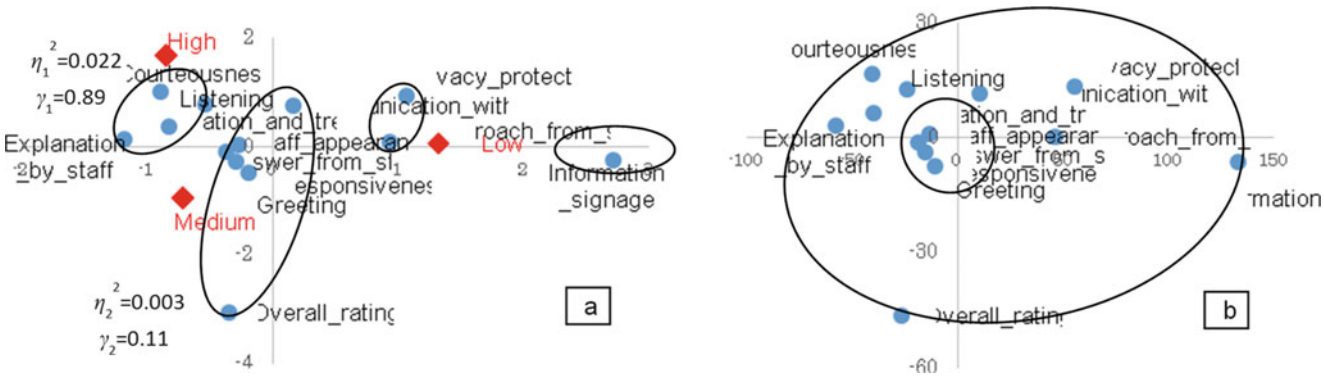

Fig. 8 Correspondence analysis and MDS of outpatients in 2011, $n = 556$. (**a**) Correspondence analysis. (**b**) MDS

Correspondence analysis showed that, in 2011, the majority of items were distributed within the three ratings, while in 2012 items moved near "Medium." "Listening" moved outward across "High," and "information signage" moved inward across "Low" (Figs. 8a and 9a).

MDS in 2011 found "information signage" and "overall rating" on the edge, with "privacy protection" and "approach from staff" in between. But in 2012 only "listening" was away from the others and on the edge (Figs. 8b and 9b).

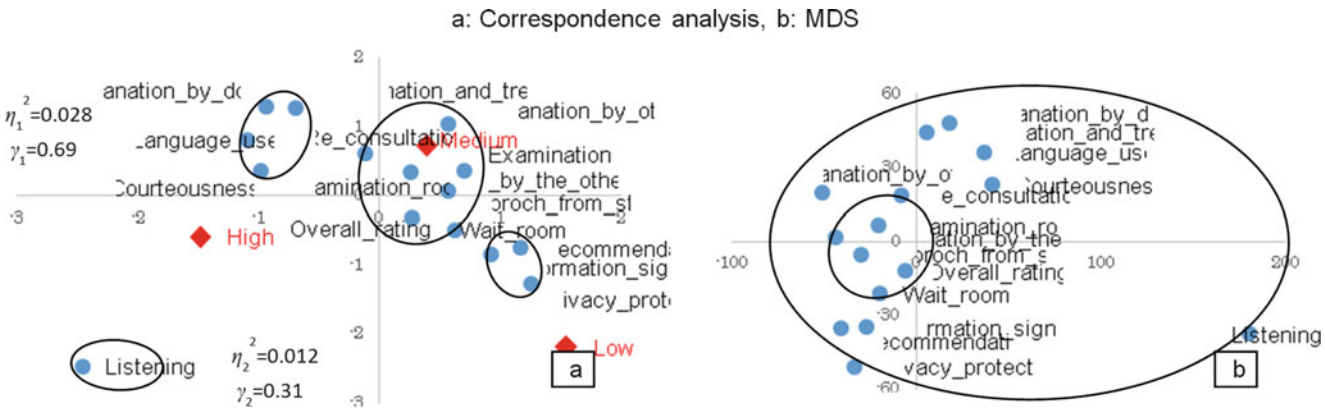

Fig. 9 Correspondence analysis and MDS of outpatients in 2012, $n = 607$

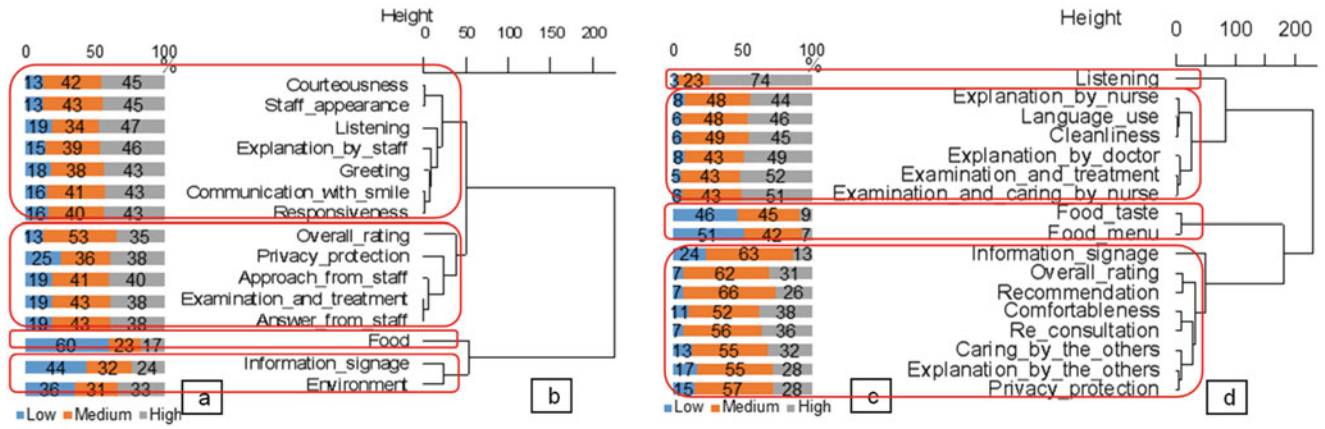

Fig. 10 Distribution graph and clustering results of the inpatient survey in year 2011 and 2012. (**a**, **b**) Year 2011, $n = 182$; (**c**, **d**) year 2012, $n = 151$

4.5.2 Inpatient Survey

The survey during the hospital remodeling in 2011 showed four clusters with slight differences from 2010. "Food" formed a cluster by itself, while "information signage" and "environment" formed another. The other two were similar to the 2010 clusters (Fig. 10a, b). In 2012 after the completion of the hospital remodeling, four clusters were formed: a cluster of the most improved "listening"; a food cluster; a six-item cluster of doctor- and nurse-related items; and an eight-item cluster of the three overall assessment items, "information signage," "comfortableness," "caring by the others," "explanation by the others," and "privacy protection" (Fig. 10c, d) ([11]. (Analysis was revised.)

Correspondence analysis for 2012 showed "food" moving inward almost across "Low." "Information signage" moved closer to "Medium" from "Low." "Listening" moved outward across "High" (Figs. 11a and 12a).

5 Discussion

5.1 The Effects of Waiting Time on the Structure of Outpatient Satisfaction

"Overall rating" formed clusters with different items by waiting time. Given that "greeting" and "communication with a smile" are considered general interpersonal skills to unspecified patients and that "answer from staff," "privacy protection," and "explanation from staff" are person-to-person care, it is surmised that in the shorter waiting time, "overall rating" showed similarities to general interpersonal skills, but in the longer waiting time, to more personalized care. "Examination and treatment" always showed similarities to "listening" and "responsiveness." This would

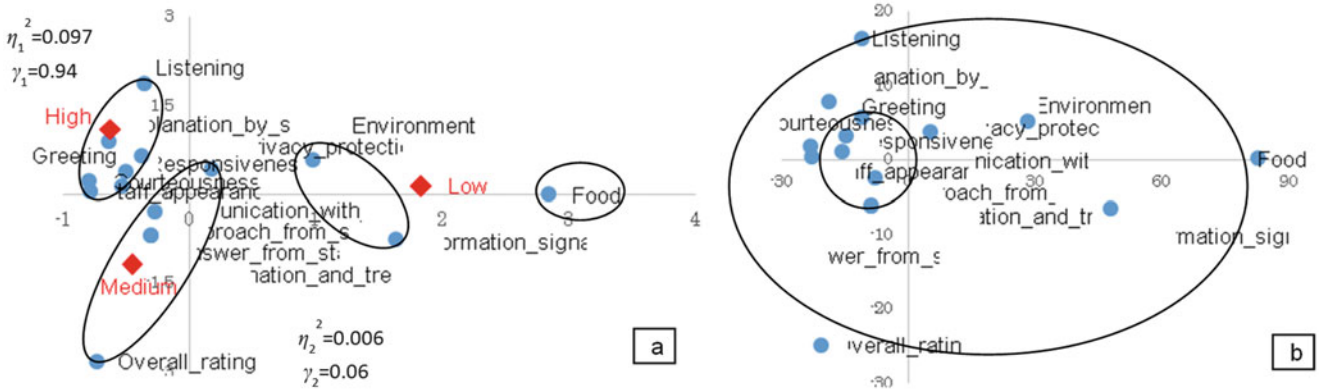

Fig. 11 Correspondence analysis and MDS of inpatients in 2011, $n = 182$. (**a**) Correspondence analysis. (**b**) MDS

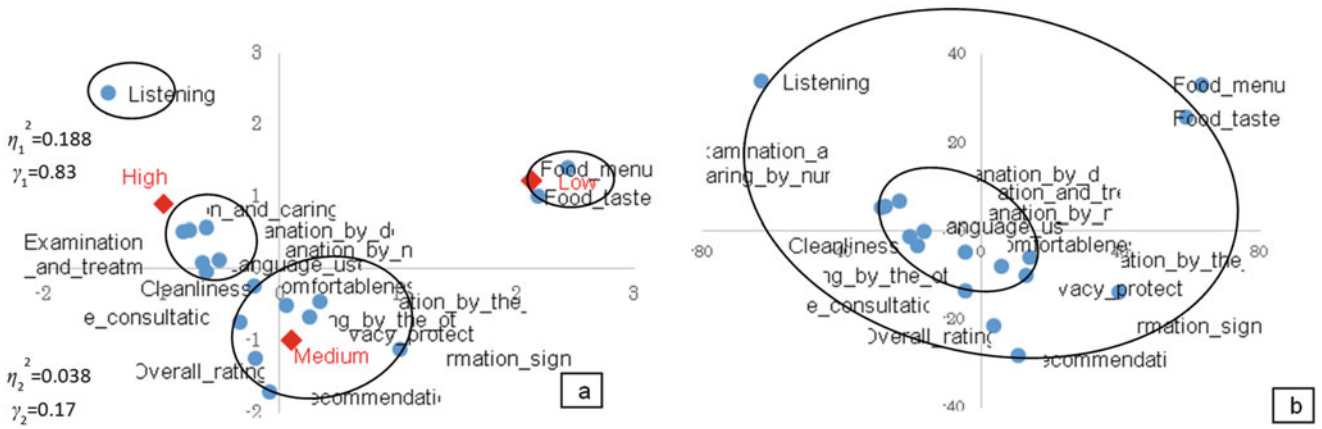

Fig. 12 Correspondence analysis and MDS of inpatients in 2012, $n = 151$. (**a**) Correspondence analysis. (**b**) MDS

seem to indicate that the structure of patient satisfaction also suggests an association between patient satisfaction and doctor's interpersonal skills in a fashion similar to correlation studies and regression models [30, 31]. "Information signage" and "approach from staff" kept their similarities in the longer wait time in both clustering results and MDS. Because information signage is to assist patients in moving about the hospital, it is surmised that patients found it difficult to do so and waited for assistance from hospital staff.

Studies using correlation, multiple linear regression, and logistic regression on outpatient satisfaction surveys [14–17] reported waiting time had a negative association with patient satisfaction. Analysis using distance revealed that longer waiting time did not basically change the structure of outpatient satisfaction, a low-rated group associated with moving around inside the hospital, and another group associated with interpersonal skills, technical skills, and overall assessment. But more detailed examination found the second group consisted of overall assessment-related items and technical performance-related items. Patients appeared to differentiate between general interpersonal skills and more personalized care.

5.2 The Effects of Length of Stay on the Structure of Inpatient Satisfaction

One of the three clusters in the shorter length of stay consisted of "information signage" and "food" with the largest percentage for "Low." This group was also evident in correspondence analysis and MDS. But the difference between the cluster of interpersonal skills and the other cluster including "overall rating" and "examination and treatment" was not as clear as the clusters in the longer length of stay. In the longer length of stay, "food" made a cluster by itself with the worsened assessment. As food service satisfaction is associated with a patient's appetite, food amount, variety, temperature, and timing of meal choice and to self-rated health [32, 33], it is easy to imagine the difficulty of the task of meeting these qualities, particularly in a large emergency hospital. Menu repetition of hospital meals is probably related to the lower food rating as the length of stay increases. In the longer length of stay, "information signage" showed similarities to "overall rating" and "environment," perhaps an indication that patients became better accustomed to the hospital environment and were able to more comfortably get about.

Analysis using distance revealed that the structure of inpatient satisfaction consisted basically of three groups: food service, environment-related items, and interpersonal skills. The relation between the items changed slightly relative to the length of stay. As the length of stay increased, overall assessment showed similarities to environment, whereas technical skills showed similarities to interpersonal skills. This contradicts the conclusions of earlier quantitative work which did not find a relation between lengths of stay and overall assessment [21–23]. An explanation for this may be the nonlinear change of patient satisfaction by length of stay.

5.3 The Effects of Remodeling on the Structure of Patient Satisfaction

5.3.1 Outpatient Satisfaction

Following completion of hospital remodeling in 2012, "listening" improved sufficiently to make a cluster by itself, most likely due to doctors being able to focus more effectively on patients with the help of medical clerks, leading to greater patient satisfaction likely because of the quality of patient-doctor relations [34]. Hospital remodeling also affected the structure of patient satisfaction. The more balanced questionnaire produced a doctor-related cluster and three others, suggesting patients differentiate the performance of doctors from that of other hospital staff. The pre-modified questionnaire placed a disproportionate emphasis on interpersonal skills; but because of that, it effectively revealed the change of the structure of patient satisfaction by waiting time.

5.3.2 Inpatient Satisfaction

The 2011 survey showed that the structure of inpatient satisfaction consisted of approximately two clusters, an environmental cluster and another cluster, and more detailed inspection showed the latter was divided by general interpersonal skills and technical skills. The environmental factor was of greater weight likely due to the longer average length of hospital stay in Japan relative to other countries. The more balanced 2012 questionnaire produced more clearly divided clusters than the 2010 survey, showing that patients did not differentiate the performance of nurses from that of doctors. Study on the structure of inpatient satisfaction in the USA reported the same results [13]. In that study, communication with doctors and communication with nurses formed the same cluster even at hospitals with differing survey sizes. The improvement of "listening" may have been induced by confirmation bias by the completion of hospital remodeling as the ward remodeling was completed two years earlier. As the similarities between "overall assessment" and "privacy protection" did not change, privacy protection is considered to play a big role in overall assessment.

Although the pre-modified questionnaire placed a disproportionate emphasis on interpersonal skills, it revealed that inpatients, like the outpatients, differentiated general interpersonal skills from more personalized care. The revised 2012 questionnaires also indicated that inpatients and outpatients had different ideas about overall assessment, as the outpatient survey showed "recommendation" in a cluster separate from "overall rating" and "reconsultation," while the inpatient survey placed all three within the same cluster.

It is possible that patients in this study assessed hospital performance in a more positive manner than their actual perceptions as the survey was administered while the patients were either visiting or were hospitalized, making it more difficult for them to give an accurate assessment while receiving care and treatment [35]. As the questionnaire does not cover information giving or patient-centered decision making, it should be further revised to include these two aspects of patient satisfaction and with an aim to provide better quality of care [2].

5.4 Limitation

This study has a limitation due to its cross-sectional design at one hospital in Japan. The structure change of patient satisfaction may have been due to the modification of the questionnaires.

5.5 To Improve Patient Satisfaction

To improve patient satisfaction, hospitals would be advised to pay greater attention to staff education and training covering not only the enhancement of general interpersonal skills such as greetings and communicating in a friendly manner but also a proactive approach to patients, to listening skills, to explanation skills, and to privacy protection. A patient-friendly hospital environment should be emphasized through clearer information signage and adequate privacy protection.

6 Conclusion

Patient surveys at a large emergency hospital in Japan revealed that waiting time, length of stay, and hospital remodeling changed the structure of patient satisfaction. Patients differentiate general personalized skills and more personalized interpersonal skills. Interpersonal skills influenced the patients' overall assessment to a greater extent than did technical skills, especially for outpatients. For inpatients, environmental factors outweighed technical skills, in terms of satisfaction.

The use of a descriptive model to describe all the data and to discover natural groupings in the data will help improve the quality of health care from the patient's point of view as patients' problems are diverse. This method has been mainly used for classifying patients in medicine, but because analysis using distance can be applied to any questionnaire-based survey, application to hospital services as well may be useful in shedding more light on the different aspects of patient satisfaction.

References

1. Donabedian, A., 1988, The Quality of Care, How can it be assessed?, JAMA, 260, 1743–1748.
2. Crow, R., Gage, H., Hampson, S., Hart, J., Kimber, A., Storey, L., Thomas, H., 2006, The measurement of satisfaction with healthcare: implications for practice from a systematic review of the literature, Health Technology Assessment, 6(32), 1–244.
3. Jha, A., Orav, E., Zheng, J., Epstein, A., 2008, Patients' perception of hospital care in the United States, N Engl J Med, 359, 1921–1931.
4. Fillary, J., Chaplin, H., Jones, G., Thompson, A., Holme, A., Wilson, P., 2015, Noise at night in hospital general wards: a mapping of the literature, Br J Nurs.,. 24, 536–540.
5. Hand, D., Mannila, H., Smyth, P., 2001, Principles of Data mining, Massachusetts Institute of Technology, 271–326.
6. Izenman, A., 2008, Modern multivariate statistical techniques, Multidimensional scaling and distance geometry, Springer Texts in Statistics, 463–504.
7. Izenman, A., 2008, Modern multivariate statistical techniques, Cluster analysis, Springer Texts in Statistics, 407–462.
8. Izenman, A., 2008, Modern multivariate statistical techniques, Correspondence analysis, Springer Texts in Statistics, 633–666.
9. Vachon, M., Achille, M., Barama, A., 2007, Psychosocial characteristics and satisfaction with healthcare following transplantation, Dialysis Transplant, 36, 637–647.
10. Bjertnaes, O., Skudal, K.E., Iversen, H.H., 2013, Classification of patients based on their evaluation of hospital outcomes: cluster analysis following a national survey in Norway. BMC Health Serv Res., 2013 13:73.
11. Okuda, M., Yasuda, A., Tsumoto, S., 2013, The relation between waiting time and outpatient satisfaction, and between admission length and inpatient satisfaction, The journal of the Shimane Medical Association, 33(3), 8–13. [in Japanese]
12. Okuda, M., Yasuda, A., Tsumoto, S., Patient satisfaction Survey results before/after hospital relocation, The 33rd Joint Conference on Medical Informatics, Kobe, Japan, 354–359, Nov. 2013. [in Japanese]
13. Okuda, M., Yasuda, A., Tsumoto, S., Exploratory analysis on factors of patient satisfaction in HCAHPS databases, The 2nd International Conference on Serviceology, Yokohama, Japan, 97–108, 14–16, Sep. 2013.
14. Campbell, J., 1994, General practitioner apointment systems, patient satisfaction, and use of accident and emergency services – a study in one geographical area, Fam Practice, 11, 438–445.
15. Dansky, K.H., Miles, J., 1992, Patient satisfaction with ambulatory healthcare services, waiting time and filling time. Hosp Health Serv Adm., 1997, 42, 165–177.
16. Hopton, J., Howie, J., Porter, A., 1993, The need for another look at the patient in general practice satisfaction surveys, Fam Pract., 10, 82–87.
17. Bleustein, C., Rothschild, D., Valen, A., Valatis, E., Schweitzer, L., Jones, R., 2014, Wait times, patient satisfaction scores, and the perception of care, Am J of Manag Care, 20, 393–400.
18. Imanaka, Y., Araki, S., Murata, K., Nobutomo, K., 1993, Determinants of patient satisfaction and intention to continue service utilization: analysis of a survey of outpatients at general hospital, Japanese Journal of Public Health, 40, 624–635. [in Japanese]
19. Hasegawa, M., Sugita, S., 1993, Factors determining patient satisfaction with their medical care, Journal of the Japanese Society on Hospital Administration, 30, 31–40. [in Japanese]
20. Imai, T., Yang, X., Kojima, S., 2000, Patient satisfaction with care in a university hospital: analysis of factors associated with in- and out-patient satisfaction, Journal of the Japanese Society on Hospital Administration, 37, 63–74. [in Japanese]
21. Cleary, P, Edgman-Levitan, S., McMullen, W., Delbanco, T. L., 1992, The relationship between reported problems and patient summary evaluations of hospital care, Q Rev Bull, 18, 53–59.
22. Koerner, B., Cohen, J., 1985, Collaborative practice and patient satisfaction: impact and selected outcomes, Eval Health Prof., 8, 299–321.
23. Borghans I., Kleefstra S., Kool, R., Westert, G., 2012, Is the length of stay in hospital correlated with patient satisfaction, Int J Qual Health Care, 24, 443–451.
24. Fleming, G., 1981, Hospital structure and consumer satisfaction, Health Serv Res., 16, 43–63.
25. Carmel, S., 1985, Satisfaction with hospitalization: a comparative analysis of three types of services, Soc Sci Med, 21, 1243–1249.
26. Kline, T., Baylis, B., Chatur, F., Morrison, S., White, D., Flin, R., Ghali, W., 2007, Patient satisfaction: evaluating the success of hospital ward redesign, J Healthc Qual.,29, 44–49.
27. Kotzer, A., Zacharakis, S., Raynolds, M., Buenning, F., 2011, Evaluation of the built environment: staff and family satisfaction pre- and post-occupancy of the Children's Hospital, HERD, 4, 60–78
28. OECD Health Data 2014, http://www.oecd.org/els/health-systems/health-data.htm
29. OECD, 2014, Reviews of Health Care Quality, JAPAN, Raising Standards, Assessment and Recommendations, 5, Nov.
30. Comstock, L., Hooper, E., Goodwin, J., Goodwin. J., 1982, Physician behaviors that correlate with patient satisfaction, J Med Educ., 57, 105–112.
31. Lochman, J., 1983, Factors related to patients' satisfaction with their medical care, J Community Health, 9, 91–109.
32. Wright, O., Connelly, L., Capra, S., 2006, Consumer evaluation of hospital foodservice quality: an empirical investigation, Int J Health Care Qual Assur Inc Leadersh Health Serv., 19, 181–194.
33. Wright, O. R., Connelly, L. B., Capra, S., Hendrikz, J., 2013, Determinants of foodservice satisfaction for patients in geriatrics/rehabilitation and residents in residential aged care, Health Expect., 16, 251–265.
34. Williams, S., calnan, M., 1991, Key Determinants of Consumer Satisfaction With General Practice, Fam Pract, 8, 237–242.
35. Mirvis, D., 1998, Patient satisfaction: can patients evaluate the quality of health care? Tenn Med, 91, 277–279.

Service Satisfaction and Consciousness-Attitude Gap for Foreign Tourists Visiting Japan

Kenju Akai, Kohei Yamashita, and Nariaki Nishino

Abstract

This study investigates the service satisfaction and consciousness-attitude gap of foreigners visiting Japan with the aim of finding methods of increasing visitors' levels of expenditure. Structural equation modeling is employed to investigate the relationships between service quality, service value, customer satisfaction, loyalty, and willingness to pay. The results show that lodging, food and drink, and shopping services all have an influence on loyalty. Shopping services also have a significant influence on willingness to pay. More than half of the tourists maintain expenditure gap, as their actual spending is less than their expected budgets. Although they have a higher willingness to pay in relation to food and drink services, these services do not provide more satisfaction and loyalty than other services.

Keywords

Travel • Survey • SEM • Loyalty • Willingness to pay

1 Introduction

The market share of the service industry in relation to Japanese industry in general is increasing and currently occupies approximately 70 % of Japan's GDP [1]. However, the productivity of the service industry is lower than that of the manufacturing industry. Therefore, we organized a survey in order to discover methods of increasing the expenditure of visitors to Japan. This survey was focused on the travel services aimed at these tourists. The quality of travel services has been studied by many researchers [2–4].

In accordance with the growth in foreign tourism worldwide, the number of foreigners visiting Japan is increasing and, in 2014, reached 13 million people. However, the per capita expenditure of foreigners visiting Japan has recently decreased. In order to expand the travel industry, we must increase the expenditure of foreigners visiting Japan.

Two measures can be employed in order to increase per capita expenditure [5]. First, we can investigate a segment of Japanese travel services that consumes a large amount of money and promote that segment aggressively. Second, we can observe the behavior of travelers and increase their expenditure by promoting areas of Japanese society that interest them. The Japan Tourism Agency has previously implemented the first measure and has used that promotion principle to invite foreigners to Japan. However, there are currently no steps being taken in relation to the second measure. Therefore, this study focuses on the observation of visitors' behavior with a view to increasing per capita expenditure.

We use the following process in order to observe the behavior of foreigners visiting Japan and hence to increase their expenditure. First, we ascertain foreigners' opinions of services in Japan. On the basis of these results, we then investigate the gap that exists between visitors to Japan and the suppliers of these services. Then, we evaluate the service value that suppliers provide and improve the services. In short, this study aims to achieve the following two measures: to evaluate the service satisfaction of

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foreigners visiting Japan and, secondly, to investigate the gap between foreigners visiting Japan and service suppliers.

2 Designing the Questionnaire

2.1 Process

This study evaluates the service satisfaction of foreigners visiting Japan and investigates their consciousness-attitude gap. First, using related literature, we develop a model and create a questionnaire on the basis of this hypothetical model. The questionnaire is aimed at foreigners visiting Japan. We analyze the result of the questionnaire using structural equation modeling (SEM) and extract service elements that influence loyalty and willingness to pay (WTP). Additionally, this survey also investigates the demand-supply and expenditure gaps.

2.2 Hypothetical Model

This study uses the basis model (Fig. 1) from related literature [6–8] and creates a hypothetical model (Fig. 2) that adds willingness to pay (WTP) to the basis model.

From the basis model, it can be seen that service quality influences service value and customer satisfaction (CS), while service value influences CS and loyalty, and CS influences loyalty. Service quality has no direct influence on loyalty but has an indirect influence through service value and CS. Therefore, by inspecting the basis model, we can extract service elements that influence loyalty.

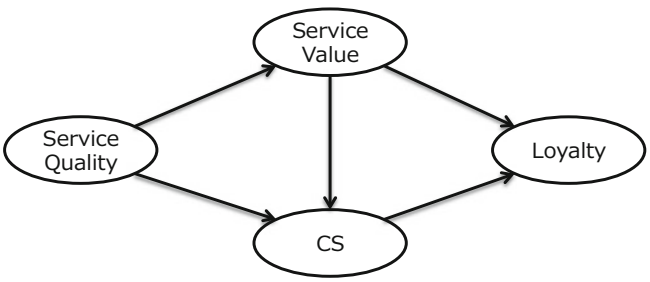

Fig. 1 Basis model

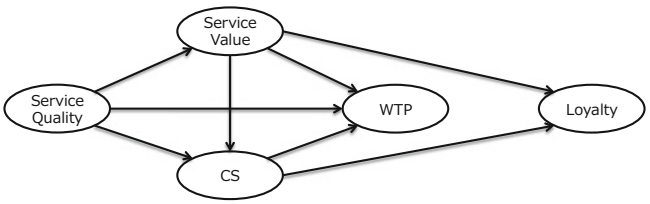

Fig. 2 Hypothetical model

In regard to the hypothetical model, the goal is to ascertain levels of loyalty and WTP. The relationship between service quality, service value, CS, and loyalty is identical to that of the basis model. We hypothesize that service quality, service value, and CS have positive influences on WTP. According to a large number of related literature, we should distinguish loyalty from WTP, as no relationship exists between the two. By inspecting the hypothetical model, we can extract service elements that influence WTP and investigate methods that can be used to increase this tendency. These results reveal the important factors required to increase the expenditure of foreigners visiting Japan.

In addition to the hypothetical model, two hypotheses are used in this study.

Hypothesis 1: The results of the inspected model depend on differences in services.

When we inspect the basis and hypothetical models, the result shown for each service is an observed variable that represents the service quality and service value. The result concerning the entire trip is also an observed variable that indicates CS, loyalty, and WTP. However, the results of each service are also observed variables that explain service quality, service value, CS, loyalty, and WTP, in accordance with hypothesis 1. When examining the basis and hypothetical models, we inspect the results regarding CS, loyalty, and WTP throughout the entire trip. Using hypothesis 1, we examine the results for CS, loyalty, and WTP through each service. Finally, we compare these results.

Hypothesis 2: The results of the inspected model depend on attributes.

This study inspects the models using specific attributes and analyzes the effects of these attributes on tourist behavior. There are 13 questions concerning attributes in the questionnaire regarding: sex, age, nationality, number of visits to Japan, trip length, companion, reason for visiting Japan, what tourists look forward to before visiting Japan, how travel was arranged, main source of information concerning travel, Japanese language proficiency, monthly income, and what tourists think is important.

2.3 Designing the Questionnaire

The target participants of the questionnaire are foreigners visiting Japan, with the exception of people who had been living in Japan for more than a year. The locations used for the survey featured in this paper are Asakusa, Shibuya, and Kamakura.

The travel service consists of many services. In this study, the questions relate to lodging services (LS), food and drink services (FDS), and shopping services (SS). This is because foreigners visiting Japan spend a considerable amount of money on these services. The questionnaire is composed of five parts: attributes, LS, FDS, SS, and the trip as a whole. The questions concerning attributes include 13 items. The questions in the other four parts concern service quality, service value, CS loyalty, and WTP. A five-point scale is used for each answer.

3 Results

3.1 Questionnaire Results

The questionnaire's implementation term was from December 17, 2014, to January 17, 2015, and 85 submissions were collected. Except for nationality, the distribution of attributes was almost identical to the result of a survey that was conducted by the Japan Tourism Agency. In regard to area of origin, 35 % of the participants were Asian, 28 % were European, and 22 % were North American, although Asians actually account for approximately 70 % of all foreigners in Japan.

3.2 Inspected Model Results

3.2.1 Factor Analysis Concerning Service Quality

From the result of a factor analysis that was performed regarding LS, FDS, and SS, all of these services were found to have only one factor. Thus, we employed three items that have higher-ranking factor loadings. The result of the factor analysis is shown in Fig. 3.

From Fig. 3, it was found that LS have a strong relationship with the quality of the room (a3) and ease of checking in/out (a12), the EDS are strongly related to staff hospitality (b1) and the pleasantness of the atmosphere, and SS have a strong relationship with staff hospitality (c1) and the intelligibility of product information (c7).

3.2.2 Basis Model

According to the results of the basis model inspection, the connections between service quality and CS and between service value and CS are not statistically significant at a 5 % level. In order to obtain an appropriate model, we therefore split the basis model into two models (Figs. 4 and 5).

In basis model 1, the connection between service quality and CS is not statistically significant at a 5% level.

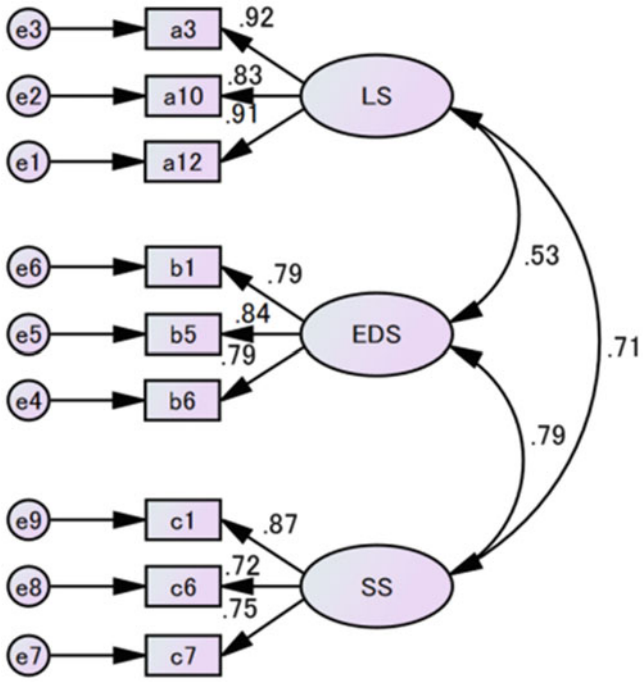

Fig. 3 Result of factor analysis concerning service quality

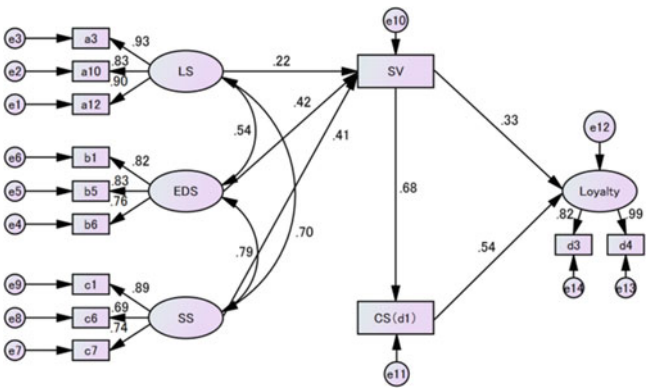

Fig. 4 Basis model 1

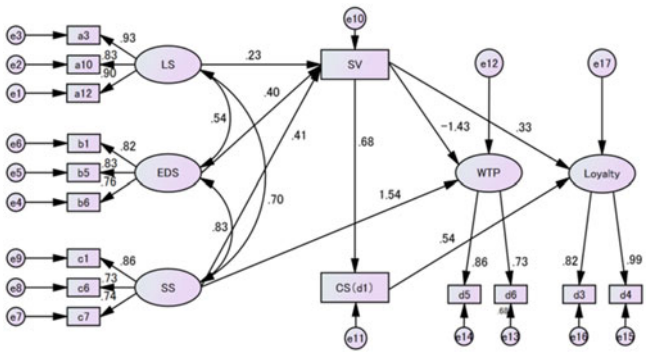

Fig. 5 Basis model 2

From Fig. 4, it was found that both FDS and SS have a strong influence on service value, and service value positively influences CS and loyalty.

In basis model 2, the connection between LS and FDS, and CS, and the connection between service value and CS are not statistically significant.

Figure 5 shows that SS have a strong influence on service value, while FDS and LS also have an influence on service value, although it is slightly weaker. However, CS is only influenced by SS. Additionally, service value and customer satisfaction influence loyalty.

3.2.3 Hypothetical Model

Because the basis model becomes two models, the hypothetical model is also divided in two (Figs. 6 and 7). In both of the resultant models, the connection between LS, FDS, and WTP and the connection between CS and WTP are not statistically significant. Hence, we can neglect these connections.

Hypothetical model 1 is created from basis model 1. As can be seen in Fig. 6, connections concerning service quality, service value, CS, and loyalty have an almost identical coefficient to the basis model. With regard to WTP, SS have a strong positive influence, while service value has a negative influence.

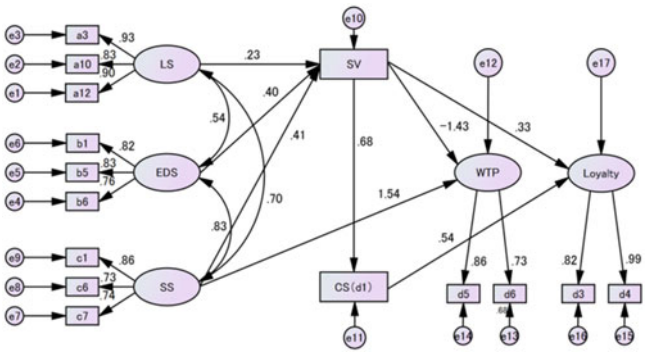

Fig. 6 The hypothetical model 1

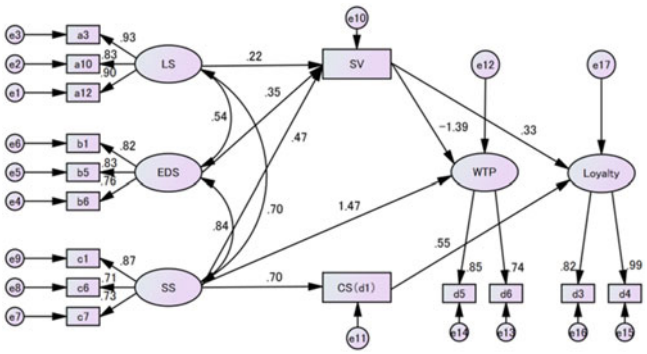

Fig. 7 Hypothetical model 2

Hypothetical model 2 is created from basis model 2. In Fig. 7, it can be seen that the relationship between service quality, service value, CS, and loyalty is identical to that of the basis model. In relation to connections with WTP, SS has a strong positive influence and service value has a negative influence.

3.2.4 Hypothesis 1

The following is the result of inspections of the models in regard to hypothesis 1. When inspecting the basis and hypothetical models in relation to LS, only the basis model was established. In the hypothetical model, links connecting service value and CS with WTP are not statistically significant. In relation to FDS, the results of the inspection of the basis and hypothetical models were identical to those for the lodging services. However, both models were established in relation to SS.

3.2.5 Hypothesis 2

Although this study inspected the basis of hypothesis 2, all models except sex were uncertain. As only 85 questionnaires were collected, there is low reliability as regards analysis by attitude. We were only able to obtain appropriate results in regard to the male participants. Comparing the male model with the overall model, for males, SS have a more positive influence on both loyalty and WTP for males than for the entire pool of respondents collectively.

4 Discussion

4.1 Basis Model

A common factor of both of the basis models is that both LS and FDS always influence loyalty through service value. Furthermore, service value and CS are essential in order to increase loyalty levels. The difference between the two basis models is the indirect effect of service quality on loyalty. The results of the indirect effects of each service on loyalty are shown in Table 1. The following material is presented in this table: in basis model 1, all services have a positive influence on loyalty; however, SS have a more positive effect than other services.

From basis model 1, it is found that improving service value is important for increasing loyalty and, therefore, we should improve all services. Meanwhile, basis model 2 shows that improving SS is especially important.

Table 1 Indirect effects of each service on loyalty

	Lodging services	Food and drink services	Shopping services
Basis model 1	0.149	0.297	0.291
Basis model 2	0.070	0.126	0.546

Table 2 Total effect of each service on willingness to pay

	Lodging services	Food and drink services	Shopping services
Hypothetical model 1	−0.335	−0.570	0.946
Hypothetical model 2	−0.229	−0.488	0.816

In this regard, there are two interpretations of the two models. Therefore, we must increase the number samples and inspect the models more accurately.

4.2 Hypothetical Model

From the inspection of the hypothetical model, it was found that CS had no influence on WTP, and SS and service value influenced willingness to pay.

The results of the total effects of service on WTP are shown in Table 2. From this table, it can be seen that only SS have a strong positive influence, and LS and FDS have a negative influence. As a result, improving the quality of SS is important in order to increase visitor's WTP. Although LS and FDS have a negative influence, they are also important elements that are required to increase loyalty; therefore, we must promote different measures to increase both loyalty and WTP.

4.3 Hypothesis 1

Hypothesis 1 shows that, of the entire travel service, LS and FDS have the most negative influence on the WTP levels but also that WTP does not have a relationship with every service. Moreover, SS have a positive influence on WTP, not only in relation to shopping but also to the entire travel service. Therefore, it can be said that SS have a strong effect on WTP.

4.4 Hypothesis 2

As a result of the small number of data, for this study, we were only able to analyze hypothesis 2 in relation to sex. Eighty-five samples were taken, but over 385 samples are required in order to achieve a positive result. The usefulness of inspecting each attitude has already been proven, so it would be beneficial to collect over 385 questionnaires per attitude in a future study.

Inspecting the basis model for males shows that males' relationships with FDS and staff hospitality, and their relationship with SS and staff hospitality are stronger than the corresponding relationships for the entire study collectively. However, the relationship between SS and intelligibility of product information for males is weaker than the corresponding relationships for the entire study. In addition, for males, a connection between service value and loyalty is not statistically significant. This shows that, for males, CS is more important for loyalty than service value. The result of the inspection of the hypothesis model was that SS have a stronger influence on WTP for males than for visitors as a whole.

4.5 Demand-Supply Gap and Expenditure Gap

Concerning the demand-supply gap, it was found that CS and loyalty in regard to FDS is lower than that for other services, although more than 70 % of foreigners visiting Japan look forward to experiencing FDS before visiting the country. The Japan Tourism Agency's survey [9] states that the majority of those surveyed performed basic activities (relating to LS, FDS, and SS) at first, but the number of people who wish to avail of these services a second time is less than 50 %. On the other hand, almost half of visitors wish to soak in a hot spring, experience Japanese traditional culture and history, and enjoy the four seasons in Japan.

Regarding the expenditure gap, under 50 % of people overspend their budget over the course of their trip, so we can state that there is room for increasing the expenditure of foreigners visiting Japan. However, only a quarter of the people surveyed stated that they may have spent more money if the services had been better. Therefore, we must accumulate data in order to investigate whether improving service quality will increase the expenditure of foreigners visiting Japan.

5 Conclusion

This study inspects service elements that influence loyalty and willingness to pay of visitors to Japan. On the basis of this analysis, lodging, food and drink, and shopping services were found to influence loyalty. However, only shopping services have an influence on willingness to pay. Furthermore, more than half of the tourists maintain the expenditure gap; their actual spending is less than their expected budgets. Although they have a higher willingness to pay for food and drink services, these services do not yield as much satisfaction and loyalty as other services.

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References

1. Ministry of Economy, Trade, Indsutry, 2007, Report of increasing productive efficiency and innovation in service industries.
2. Ho, C. I., & Lee, Y. L. (2007). The development of an e-travel service quality scale. *Tourism Management*, *28*(6), 1434–1449.
3. Pritchard, M. P., & Howard, D. R. (1997). The loyal traveler: Examining a typology of service patronage. *Journal of Travel Research*, *35*(4), 2–10.
4. Van Riel, A. C., Semeijn, J., & Pauwels, P. (2004). Online travel service quality: the role of pre-transaction services. *Total Quality Management & Business Excellence*, *15*(4), 475–493.
5. Shintani, K., 2014, Program enhancing consumptions for tourist visiting Japan at the time for billion people.
6. Cronin, J. J., Brady, M. K., & Hult, G.T.M., 2000, Assessing the effects of quality, value and customer satisfaction on consumer behavioral intentions in service environments, Journal of Retailing, 76(2), pp193–218
7. Hutchinson, J., Lai, F., & Wang, Y. 2009, Understanding the relationships of quality, value, equity, satisfaction, and behavioral intentions among golf travelers. *Tourism management*, *30*(2), 298–308
8. Bigne, J., E., Andreu, L., & Gnoth, J., 2005, The theme park experience: An analysis of pleasure, arousal and satisfaction, Tourism Management, 26, pp833–844
9. Japan tourism agency, 2014, Consumption trend for tourist visiting Japan.

Part V

Theoretical Perspectives on Service

Service as Artifact: Reconsideration of Value Cocreation

Kanji Ueda, Takeshi Takenaka, and Nariaki Nishino

Abstract

An artifact, or something made by a human being, can create value through mutual interaction among providers, consumers, and other artifacts. Moreover, an artifact can alter its nature to products or services according to the information completeness of its purpose and environment. This paper presents a discussion of how value is cocreated in a society by considering some relevant concepts or theories for "cocreation" such as emergent synthesis, the theory of "ba," coproduction, and service-dominant logic (SDL). Additionally, the value of a service is reconsidered from the perspective of economic or behavioral value. Finally, this paper presents discussion of the new role of science and technologies to cocreate value in a sustainable society through mutual interaction among consumers and producers.

Keywords

Artifact • Value cocreation • Emergent synthesis

1 Introduction

The increasing economic importance of service activities compared with manufacturing, the so-called service economy, necessitates that we reconsider the value of products or services because both products and services are inseparable in terms of value creation in a society. As service activities increase, the boundary between manufacturing and service industries has also become more blurred [1]. Recently, many companies in both industries set the term "value cocreation" as their corporate policy to emphasize the importance of the relationship with customers or business partners to create new and sustainable value. Simultaneously, this phenomenon implies that it becomes much more difficult for product/service providers to predict customer needs and satisfaction in advance of rapid environmental changes. In other words, increasing complexity of social interactions among providers, consumers, and artifacts can alter the value of products or services dynamically against their original purposes.

This problem has been discussed deeply in the research fields of "artifactual engineering" proposed by Yoshikawa [2] and "the science of artificial" proposed by Simon [3]. Yoshikawa [2] proposed artifactual engineering in 1992, and the Research into Artifacts, Center for Engineering (RACE), was established based on his proposal to the University of Tokyo in the same year. The purpose of this new field is to bridge the gap separating specialized engineering domains (e.g., mechanical and electrical) that have evolved separately. Yoshikawa argues that scientists must transcend their territoriality of scholarship to resolve social problems or "evils" of the present time that are brought about, ironically, by the artifacts which humans have created. Actually, artifacts such as tools, products, services, and social systems can sometimes bring undesirable results (e.g., unexpected accidents) as well as wealth in a society, even if

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an artifact is created based on well-established human knowledge of each specialized domain. Therefore Yoshikawa asserts that an artifact should be designed not by domain-specific knowledge but by deterritorial and integrated knowledge through an abduction process for creative design.

In line with his thought, RACE started with three research fields: (1) design science, (2) manufacturing science, and (3) intelligence science. After 10 years, in 2002, RACE was newly reorganized into four new research divisions: (1) life cycle engineering, (2) service engineering, (3) digital value engineering, and (4) cocreation engineering. After a further 10 years, in 2012, RACE introduced two new divisions: socio-artifactology and human-artifactology. These new two divisions aim to investigate the processes of value cocreation through interaction among artifacts, humans, and society [4].

During the active 1990s of Yoshikawa, Simon proposed a new research field, "the science of artificial," which examines artifacts, in contradistinction to natural science, which studies nature [3]. He deeply discussed the inseparable relation between the design of artifacts and their value for humans, whether tangible or intangible. For example, music, among the oldest artifacts, is intangible and vanishes soon, but it can move listeners. It can be created by human naive intuition or using alternative knowledge such as computer systems within an environmental condition. It can also be evaluated by humans as well as other artifacts. Moreover, the value of music depends on listeners with various preferences. It is particularly notable that Simon asserts the importance of bounded rationality in human decision-making. He pointed out that the value of artifacts is not always expressed as expected because of cognitive limitation of receivers or relevant environmental constraints. This concept of bounded rationality also complements the rational optimization assumption in traditional economics, which regards consumers' decision-making as a fully rational process of finding an optimal choice given the available information [5].

As discussed above, the value of an artifact can emerge through mutual interaction among artifacts, humans, and society. Moreover, it cannot be fully expected in advance because of environmental constraints or a receiver's cognitive limitations. Recently, Freud pointed out the importance of emergent approach to cocreate value in a bottom-up economy where social interaction is embedded [6]. The nature of value should also be considered from various perspectives such as functional, behavioral, economic, and social aspects. Actually, scientists have discussed the different aspects of value from their own specialized viewpoints such as philosophy, economics, psychology, or engineering. In those fields, value has been defined variously as ideas, pleasure, labor, use value, exchange value, surplus value, utility, function, price, or sustainability [7]. Furthermore, the definition of value cocreation remains an open question from analytic and synthetic viewpoints.

This paper starts with a discussion of how artifacts create value as services or products. Then, it presents discussion of how value cocreation could be defined and modeled from some scientific viewpoints. Additionally, it presents important aspects of value from behavioral and economic viewpoints. Finally, it proposes a new role of scientists to cocreate value through research on services in a sustainable society.

2 Synthesis Problem of Artifacts

This section presents a discussion of how humans can design artifacts to create value from the viewpoint of emergent synthesis [8]. Then it proposes a new concept, the variable nature of artifact, which exhibits the capability of an artifact to alter its nature to products or services from the viewpoint of emergent synthesis.

2.1 Emergent Synthesis

The creation of a new artifact starts from acquisition of knowledge related to existing ones. Knowledge of an object to be acquired is extracted from the complicated and dynamic real world, which is made up of environments (nature and society), human beings, and artifacts that already exist on the assumption that mutual interactions among them can be ignored. Then, portions of the recognition object that are understandable through analyses are obtained as partial knowledge. Subsequently, artifacts are created as a result of collection, selection, configuration, structuring, and materialization of acquired knowledge for a useful purpose. The nature of engineering focused on design is to configure an entire structure from partial knowledge. Therefore, it is a process of synthesis, not analysis. A fundamental asymmetric nature exists between analysis for extracting partial knowledge from the whole of existing artifacts and synthesis for configuring a new whole with partial knowledge [9].

A notation of configuration from parts to a whole is actualized when we regard a process from a required function to an adaptive structure as not simply "design" but "synthesis." Such synthesis includes not only top-down but also bottom-up characteristics. Figure 1 portrays the problem of synthesis [7, 8], which is the design process from function (purpose) to structure (action). The problem of synthesis, which must be resolved for designing artifacts that can satisfy required functions, is called the inverse problem: determination of the system's structure to perform its function and thereby achieve a purpose under

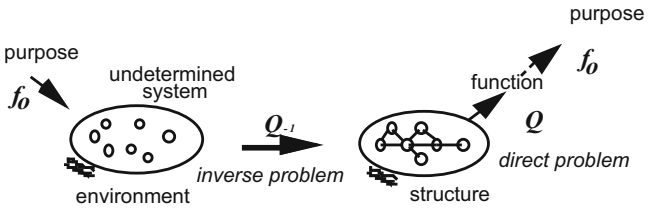

Fig. 1 Problem of synthesis

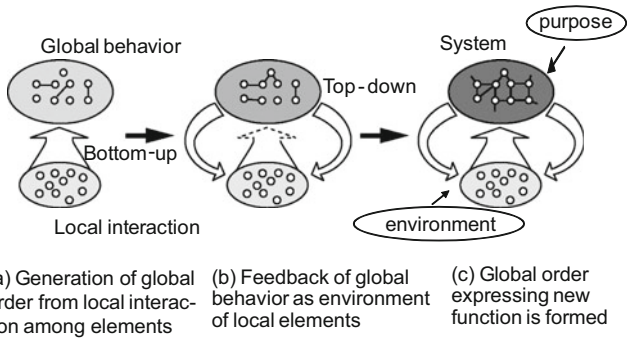

Fig. 2 Concept of emergence

environmental constraints. Unlike a process from overall design to partial design, such synthesis includes bottom-up characteristics in the process of configuring the whole. At this time, it can be called a deterministic design if the whole can be assembled by following a predetermined procedure. Otherwise, emergence plays a crucially important role in the design.

In fact, artifacts cannot exert their functions independently. They do so through interaction with the environment. Aerodynamic lift force cannot be realized by the structure of a wing alone. Simon [3] positioned the design issue in which the internal environment becomes adapted to the external environment as the optimization issue for conceivable alternative processes, which is the scientific nature of artifacts. However, even artifacts operate within an environment in which they exist as structures, although the structures of artifacts are not necessarily designed with complete understanding of such environments. Environments vary unpredictably. Even designers' objectives might not be fixed firmly. The issue, therefore, is not adaptation to the known but adaptation to the unknown, where emergence becomes fundamentally involved in the design to a greater or lesser degree.

Historically, discussions of emergence are related to the generation of qualitatively novel structures and functions which cannot be resolved into characteristic elements. Figure 2 portrays the concept of emergence [8]. Emergence was also discussed in terms of the phrase "the whole is more than the sum of its parts." Initially, the discussion was somewhat idealistic, but emergence was structured as computational in the artificial life initiated by Langton [10] and in the study of complex adaptive systems [11] by the Santa Fe Institute, where Holland played a leading role in evolutional calculation. The notion of emergence is also discussed from the viewpoint of thermodynamic emergence (e.g., dissipative structures) and model relational emergence. In emergent synthesis, however, "emergence is the formulation of structural order representing new functions, characters, and actions through an interactive and dynamic process where global behavior is expressed by local interaction among elements and the global behavior restricts such elements' behavior." Consequently, emergent synthesis shares a basic commonality with computational emergence.

2.2 Classification of Difficulties in Synthesis

According to the completeness of information related to the objectives of artifacts and environments, emergent synthesis has the following model classifications [8, 12]:

- Class I – Problem with complete description: If information of the environment and purpose is given completely, then the problem is described entirely, but it is often difficult to find an optimal solution.
- Class II – Problem with incomplete environment description: The purpose is complete, but information related to the environment is incomplete. Because the problem is not described completely, coping with the unknown environment's dynamic properties is hard.
- Class III – Problem with incompleteness: The environment description and the purpose are incomplete. Problem solving must therefore start with an ambiguous purpose. Human interaction becomes important. In Class III, establishing objectives is coupled with searching for a solution. Involvement of the source of design and cocreation are the central issues.

A combinational optimization problem is one instance of a Class I problem. For example, an evolutional calculation incorporating a biological evolution system is effective for solving it. A conventional framework (e.g., mathematical programming) can also handle the problem. Effective solutions for Class II problems are self-organization and learning which can be adapted to environmental changes. A research example in an early stage is the biological manufacturing system [12], which adjusts itself to unpredictable changes in a production environment and which organizes itself. Class III problems are coupling problems

that clarify objectives by obtaining the involvement of the source of design in a system while concurrently solving the problem. The involvement of the sources of design and cocreation are the central issues of Class III problems; the study of interactive manufacturing [13] is one example. As to be discussed later, cocreation defined from the viewpoint of computation theory represented by emergent synthesis has become the theoretical foundation of value cocreation.

2.3 Variable Nature of Artifact: Product-Oriented Artifact and Service-Oriented Artifact

In this section, we propose a new concept, "variable nature of artifact," which asserts that an artifact can alter its nature into a product-oriented or service-oriented artifact. As discussed above, difficulties of synthesis are classifiable into three classes according to the completeness/incompleteness of information related to purpose and environment. We assume that the fundamental difference between a product and service as an artifact can be clarified using this classification.

Figure 3 presents the concept of the variable nature of artifact. In essence, it is oriented to a product if an artifact is designed for the fixed purpose under an unchanged (predictable) environment; it is a "product-oriented artifact" even if it is not product but a service. In such a case, a Class I strategy, an optimization strategy is useful. For example, if a worldwide fast-food chain aims to optimize and standardize all their service provision processes, then their service is a "product-oriented artifact." The chain is doing mass production of services.

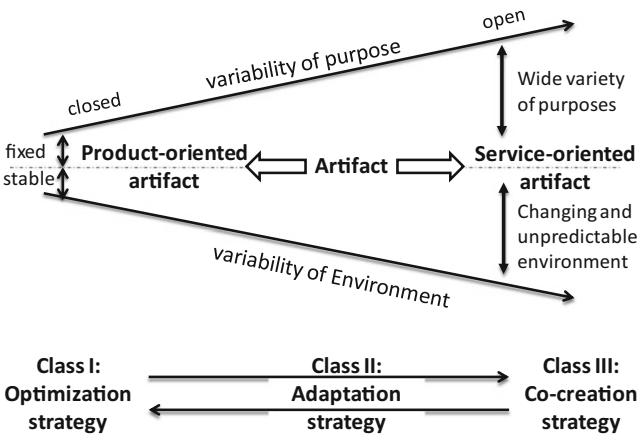

Fig. 3 Variable nature of artifacts

If an artifact is designed to adapt environmental changes (Class II) or if it is designed for more open purposes (Class III), then the artifact would be oriented to the nature of service: a "service-oriented artifact." For example, the concepts of customization or personalization have been used for both products and services. Their common goal is to design an artifact adapted to customers of various types. Moreover, some artifacts are not to be designed for a fixed purpose; the purpose is open to users. For example, R language and software environment are widely used among statisticians and data miners. It has been designed and used for various purposes through the participation of users or programmers. Although such computer language can be either a product or service, it is at least said to be a service-oriented artifact.

Table 1 presents some examples of artifacts that can alter their nature to services or products. What we would like to emphasize here is that the value for customers is sometimes mutually complementary between services and products if the artifact value is mainly defined as a function. For example, massage is a typical one-to-one service provided by a massage professional. However, modern technologies can replace the basic function of massage for customers as a product. A massage chair, therefore, is a product-oriented artifact. However, the limitation of a typical massage chair is that it is difficult to adapt to various customers with different physical sizes, health conditions, and preferences for massage techniques. Future hybrids and personalized massage systems might be realized using combinations of massage professionals' counseling and a precise massage machine that has expensive sensors, actuators, and learning functions. It should be a service-oriented artifact that can produce a combination of a product and service. Finally, a massage service by a massage professional can sometimes provide more value rather than a physical function; a person might heal a customer's emotional fatigue with counseling. In such a case, the customer value proposition is open. Value can be cocreated.

As discussed above, the nature of services and products as artifacts can be understood according to the classification of emergent synthesis. However, more discussion of Class

Table 1 Example of product- and service-oriented artifacts

Example of artifact	Product-oriented artifact	Intermediate artifact	Service-oriented artifact
Massage	Massage chair	Hybrid massage system	Massage by professional
Music	Selling a compilation CD at shop	Music download service	Live music for customer requests
Education	Traditional textbook	Customized textbook with human advice (e.g., Kumon Method)	Interactive education by supervisor

III problems, which include human interaction and value cocreation, is needed. Although value cocreation is an intrinsically open system problem, deeper discussion of the boundary of service systems and of definitions of value cocreation is desired. In the next section, we discuss value cocreation from the viewpoint of a value creation model based on emergent synthesis and the existing definition of cocreation and value.

3 Model for Value Cocreation

Before discussing value cocreation, one must rethink how value is created through the interaction among stakeholders including providers, receivers, and the product/service.

3.1 Modeling of Value Creation Based on Emergent Synthesis

In previous studies, Ueda proposed a value creation model based on emergent synthesis [7, 14]. Figure 4 depicts the class model of value creation, which describes the structure and complexity of problems based on the emergent synthesis introduced in the previous section.

It is not logical to recognize artifacts, human beings, and societies as isolated systems. In the real world, they are deeply and mutually related. Using three stakeholders, artifact (product/service), their sources of supply (provider), and sources of demand (receiver) as well as environments in which the three stakeholders are situated as components, the class model formalizes how differences in synthesis structures contribute to value creation through the interaction of such components. In the model, value is classified into providing value (Class I), adaptation value (Class II), and cocreative value (Class III):

- *Class I: Providing value*
  Class I is useful to clarify the value of sources of production (provider) of artifacts (products/services) and the value of sources of consumption (receiver) independently. It can fix an environment preliminarily. The model can be described as a closed system. In addition, Class I can be described completely as a closed model. The problem to be addressed is the search for the optimal solution.
- *Class II: Adaptive value*
  Class II is useful to clarify the value of sources of production (provider) of artifacts (products/services) and the value of sources of consumption (receiver) independently. Nevertheless, it suffers from the problem of unpredictability in the face of various environments. The model is a system that is open to the environment. The problem which must be addressed is the adaptive strategy.
- *Class III: Cocreative value*
  Class III cannot be used to clarify the value of sources of production (provider) of artifacts (products and services) or the value of sources of consumption (receiver) independently. Furthermore, the former cannot fix the value of the latter preliminarily. The two values are strongly and mutually correlated and cannot be separated. The issue for Class III is cocreation of value.

An example of Class I is a mass-produced product that is easily commoditized and which allows followers with low production costs to catch up. Class II actualizes unpredictable variations in production environments and unscheduled requirement changes by customers in services. Inefficiency as a sector of the service industry is often pointed out because issues in the service industry are treated as Class II when they should be optimized as Class I and also perhaps because the service industry remains at a level similar to that of the manufacturing industry before modern factory management was introduced by F. Taylor. In contrast, the manufacturing industry often overemphasizes strategies to minimize costs as a closed system and is reluctant to expand value in line with customers' expectations. In the process of their use, products frequently generate new value beyond that intended by producers. In this sense, products can be a service, and the manufacturing industry must consider expanding social surplus through value cocreation as Class III instead of sticking to the idea of a zero-sum game as a strategy to minimize costs.

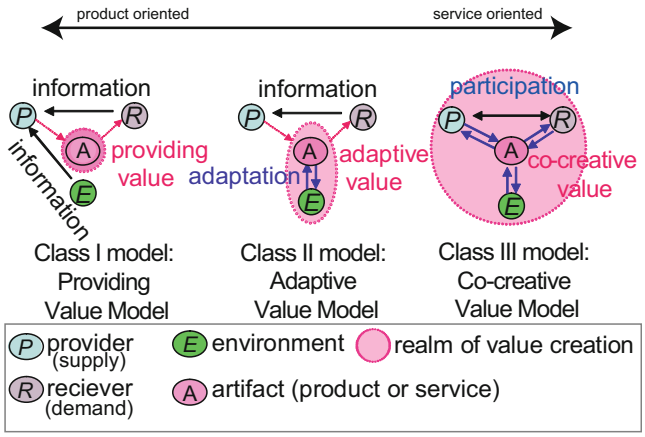

Fig. 4 Value creation model

Unlike ordinary material goods, services are intangible assets, cannot be stored or transferred, and are consumed while being produced. In a sense, the process cannot be separated from the product in services. Consequently, value cannot be generated when suppliers and users are separated. In addition, services are classified as Class III, in which the environment and services themselves are put together at the place of the service and cannot be separated as individual elements, thereby internalizing designers. For this reason, cocreation is advocated proactively in the service industry.

3.2 Origin of Value Cocreation: What Is Cocreation?

Cocreation, the origin of value cocreation, has at least three sources: the idea of "place and cocreation" proposed by Hiroshi Shimizu et al., the methodology of emergent synthesis explained in the previous section, and coproduction by firm and consumers as proposed by Prahalad and Ramaswamy.

"Ba (place)" and cocreation has been developed as an idea beyond science and the liberal arts based on natural intelligence as proposed by Shimizu. The origin of place and cocreation was the "Japan–Germany Conference on Place and Syntopy" (1996–1997) based on criticism of Cartesian self–other separatism. Shimizu published his book *Ba and Co-creation* in 2000 [15, 16]. The concept of ba does not follow the Western assumption of a distinction between a self and other. Instead, ba refers to the field in which interaction emerges, where the participants as well as the surrounding environment stand as components that are mutually indistinguishable. In other words, the inseparability between a self and other serves as a base for cocreation. Therefore, the design of ba is a central issue of cocreation.

The class model of emergent synthesis was developed with the research project named "the emergent synthesis methodology," which was promoted during 1995–2000 by the Japan Science and Technology Agency. The prototype to class classification was presented in the paper "Differentiation of the Realms of Artifacts and Information [17]: How Does It Relate to Parts/Whole and Inside/Outside?" published in *Artificial Life V*. Subsequently, the Class III emergent synthesis model was defined as cocreative decision-making [14, 18]; a book *What Is Co-creation*? was published in 2004 in Japan [19].

The third origin of the cocreation is from management theory. Prahalad and Ramaswamy started with a discussion of coproduction in firms with customers [20] in 2000. Then they developed their idea of cocreation, which emphasizes the importance of customer experiences [21, 22]. Subsequently, their papers attracted controversy in the difference between coproduction and cocreation from the service-dominant logic viewpoint [23, 24]. As to be discussed later, Vargo and Lusch refined the definition of value cocreation from their viewpoint of service-dominant logic in contradiction to goods-dominant logic (GDL) in 2004 [25].

As described above, ideas of cocreation were proposed independently during an approximately 15-year period from around 1990 to the mid-2000s. It is noteworthy that the science of recognizing complex systems as a whole has developed into the science of design as complex systems. Under these circumstances, in 2002, a technical committee on cocreation system was established in the Society of Instrument and Control Engineers in Japan [26]. As described in the "Introduction", a research division named cocreation engineering was established at the University of Tokyo in 2004. Furthermore, in 2007, cocreation was discussed at the international scientific conference "Science of Design: Researching the Nature of Creating and Understanding" promoted by Ramaswamy, Pöppel, Yoshikawa, and Ueda in Kyoto and Tokyo. Recently, the idea of cocreation has been extended to a general term. It is an adjective used in business strategies, names of municipal projects, and titles of innovation policies of ministries and agencies.

3.3 Service-Dominant Logic and Value Cocreation

Basic theories that can serve as guiding principles for service research have been proposed in the fields of design science, production engineering, information science, business science, and economics. Yoshikawa promoted service research as a field of function science, thereby laying the foundation for the systematization of service engineering [27]. Shimomura, Tomiyama, and Arai defined the characteristics of a service as a subject of engineering design and proposed a new field, service engineering, around 2001 [28, 29]. In the USA, service science was proposed around 2003 with IBM playing the lead role [30], and service-oriented architecture (SOA) theory was established in the field of information science at that time. Against this backdrop, engineering, information, and management researchers founded the Society for Serviceology in December 2012. In addition, numerous conferences related to service research, including those of academic associations in the marketing field and product–service systems (PSS) and International Conference on Serviceology (ICServ) of the International Academy for Production Engineering (CIRP), have since been held.

What is now attracting the attention of researchers of service marketing and service science is service-dominant

logic (SDL). Actually, SDL is a new dominant theory proposed by Vargo and Lusch in 2004 [25]. Value cocreation is the core aspect of this new concept. SDL is described as a framework that transcends the limits of goods-dominant logic (GDL), which is tied to the viewpoint of the conventional manufacturing industry. SDL is a new mindset proposed in response to criticism that GDL is a concept of value creation based on goods' value-in-exchange products as tangible assets. They do not produce value when they themselves are exchanged. Value is created from services during the process of using the products. Therefore, "service" is a superordinate concept. This is the SDL concept. According to the principles of SDL, what dominates economic activities is not production but service and not value-in-exchange but value-in-use. In other words, the experience of using a product, not production of that product, determines a product's value.

In their first paper on SDL [25], Vargo and Lusch state that the essence is value-in-use, not value-in-exchange. Later they also propose the concept of value-in-context to explicate the contextual aspects of value-in-use [31]. It is noteworthy that SDL is based on the notion that value is created in use, but no definition or model has yet been established to indicate that such value is actually value-in-context. Its relation with economic value remains unclear. Moreover, the meaning of value-in-context is unclear: it cannot be described with a utility function. Therefore, more examination of the definition of value is needed.

Ueda et al. [7] deeply discussed the history of axiology (philosophy of value) to elucidate the nature of value from various perspectives. Historically, value has been studied from philosophical, ethical, economical, psychological, and technological viewpoints. Moreover, values are classifiable by absoluteness, objectivity, and subjectivity. Subjective value rose to prominence as a main concern for psychology founded in the late nineteenth century. However, it has been a difficult problem for psychologists to define value. For example, Freud, who founded the psychoanalytic school of psychology, examined human natural values from the viewpoint of unconsciousness [32]. Although value-in-context proposed by Vargo and Lusch might include embodiment aspects of human as well as conscious or cognitive aspects, it is an intrinsically difficult problem to measure. In the behaviorism of the early twentieth century, value was studied from the viewpoint of learning [33]. Operant conditioning is a topic of the psychology of learning, which studies the modification of voluntary behavior or "operant behavior" through conditioning using reinforcement and punishment. It might be inferred that those approaches did not examine cognitive values but instead examined behavioral values.

However, from an economic viewpoint, value has been long discussed variously and formulated as computable models. In classical economics, originated by Adam Smith, value was thought of being objectively measurable as the amount of labor that is required to produce its product. It is so-called labor theory of value. In that theory, the idea of use value and exchange value was already discussed. After that, the marginal utility, formulated independently by Menger, Jevons, and Walras in the 1870s, presented a unified explanation of use value and exchange value with a specific examination of the idea of utility [34]. As such, value is often formulated in the manner of mathematics as utility function. At that time, however, an idea of cardinal utility was used, meaning that the magnitude of utility is meaningful and presents how much one valuates its product. In other words, utility was still considered as being measurable objectively. After that, economics had been trying to build scientific basis and finally systemized economic theory where utility function was formulated as just an ordinal one, which claims that the magnitude of utility does not matter and preference order makes sense. Pareto played an extraordinary role in formulation of ordinal utility function. Then, today's neoclassical economics is established on ordinal utility concept. In that sense, many economists have so far made a huge effort and constructed a foundation to treat value scientifically in the field of economics. However, the controversy over the definition of utility still remains: for example, behavioral economics pursues actual human behavior that cannot be explained by economic theories. Therefore we need more consideration for a contrast between value-in-exchange and value-in-use in terms of "value" from an economic viewpoint.

By the way, Lusch and Vargo [35] used the term "complex adaptive system" in their discussion on SDL without citing the source literature. As described in the previous paragraph, the complex adaptive system was set as a theme by the Santa Fe Institute after Holland's proposal. However, Lusch and Vargo did not mention this point. A value cocreation class model with emergent synthesis as the starting point is based on computational emergence common to the central concept of the Santa Fe Institute and can be verified by evolutional calculation, machine learning, multi-agent systems, network analysis, social intelligence, game theory, mechanism design, and experimental economics.

In fact, Kowalkowski stated in "What does a service-dominant logic really mean for manufacturing firms?" [36] that it is important to ascertain whether either GDL or SDL exhibits a significant difference in performance based on the type of enterprise. He also states that it should be beneficial to link SDL to the complex adaptive system of Holland et al. and the value class model developed by Ueda [7]. It must be acknowledged that SDL served as a wake-up call for believers of traditional GDL, who believed excessively that all customer value could be determined during the manufacturing stage. However, the homework showing

how to connect value-in-context to economic value remains to be done.

The value creation class model introduced herein is expected to be effective both for intangible and tangible assets. It is an artifact value model that can formulate integration and differentiation of both types of assets. In this sense, it is appropriate to refer to it as artifact-dominant logic (ADL). Artifacts include not only products manufactured at factories and services that emerge in such products' use but also socially produced big data and academic results. In fact, ADL can be summed up as a framework effective for the design not only of economic value but also of academic and receptive value.

4 New Roles for Science and Technology as Sources of Behavior

This chapter presents a description of social value cocreation and discusses the new roles of science and technology from the viewpoint of the artifact-dominant logic proposed in this paper. Ueda described in detail the activity phases ranging from research and development to products, processes, standardization, innovation, and business models from the viewpoint of class models [37]. This paper revealed that the role of contributors of science and technology must be redefined.

In other words, what should be discussed is which roles researchers and research organizations, who are sources of behavior who lead science and technology, should play in the era of the interactive society. Science and technology are about research on the creation of new artifacts by analyzing natural phenomena and composing knowledge obtained from such efforts. As stated by the Council for Science, Technology, and Innovation and the Science Council of Japan, science has been asked recently to be science not for the sake of science but for society's sake. In other words, what is important is not simply analysis of subject matter but the creation of subject matter through synthesis. According to this notion, the roles of science and technology should not remain within the field of what is generally known as fundamental research. Instead they should extend actively to research that will produce new products or services. The roles of science and technology are placed on the side of producers in the socioeconomic system. Research is positioned to develop and produce socially useful products.

However, as discussed herein, while such roles might remain on the producer's side in Class I problems, it is necessary for the roles to become visibly involved on the consumer's side in Class II. Therefore, while the clockwise role shown in Fig. 5 will be involvement on the source of supply as before, it is important to become involved on the source of demand as expressed by the counterclockwise role. The former is the contributor of producer innovation, whereas the latter is the contributor of user innovation. Science and technology are the contributors of both. They will eventually increase the expectations of both the supply and demand sides in economic systems: the producer who wants to create and sell excellent new artifacts and the consumer who wants to buy and use them. It should not to only promote cocreation simply by individual producers and individual consumers but rather should also increase the social surplus through social cocreation.

For example, the smartphones and tablets that have been rapidly spreading throughout our society are not simply

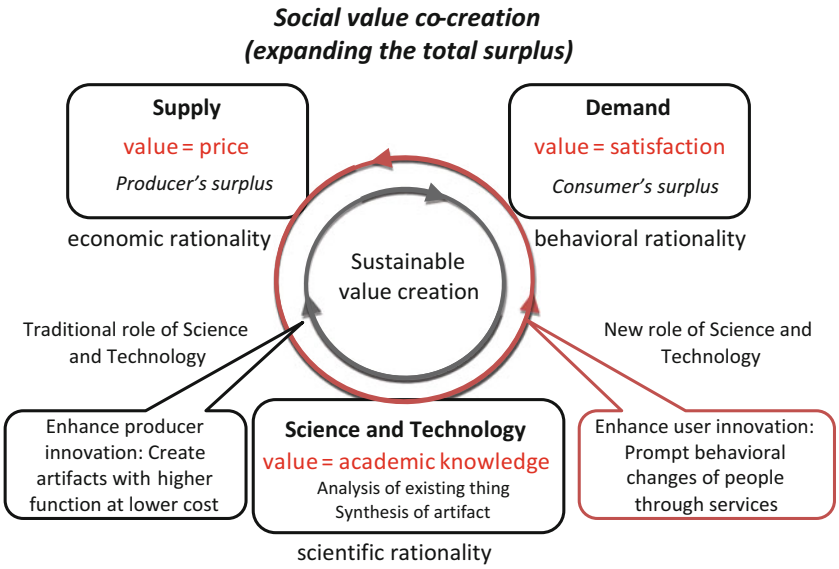

Fig. 5 New roles of science and technology as sources of behavior

things that producers provide to consumers. These devices are designed to enable anyone to add application functions and even conduct development independently. They provide a platform that creates a cocreation relation between users and providers so that both might continue to grow and evolve. A new style of innovation based on such a cocreation relation is now necessary, a relation that increases the number of users for greater diffusion, facilitates cocreation with users for more evolution, and increases social surplus. The new role of science and technologies is to stimulate and enhance consumers' behavioral changes and thereby to support industries to create valuable products or services. The conventional approach is excellent in that it solves Class II problems by coordinating stationary stakeholders. This approach, however, already fails to cope with Class III problems. The starting point for innovation is being shifted to consumers.

5 Conclusion

This paper presents a discussion on the nature of service as an artifact from the viewpoints of emergent synthesis and cocreation. The value of an artifact is created through mutual interaction among various stakeholders as well as environments. This paper also presents discussion of the new role of science and technologies to cocreate value in a sustainable society. Future work will explore a new research methodology to enhance cocreation among product/service providers and consumers in society. Science and technology has a new role for innovation through the enhancement of behavioral changes of people through design of services as artifacts.

References

1. Chen, C., 2009, The Research on the Interaction Development between the Producer Services and Manufacturing Industry. International Business Research, 2(3):92–97
2. Yoshikawa, H., 1992, Proposal for Artifactual Engineering: Aims to Make Science and Technology Self-Conclusive, ILLUME, A TEPCO Semiannual Review, Tokyo Electric Power Co., 41–56
3. Simon, H. A. The sciences of the artificial., 1996, Vol. 136. MIT Press, Cambridge, MA, USA.
4. Ota, J., Nishino, N., Hara, T., Fujita, T., New research trends in artifactology – Modeling of individuals and socialization technology –, 2014, Synthesiology, 7(4): 211–219.
5. Gigerenzer, G., & Selten, R. (Eds.), 2002, Bounded rationality: The adaptive toolbox. MIT Press, Cambridge, MA, USA.
6. Freud, R., 2012, Co-Creation and Bottom-Up Economy, Keynote of the 5th International Conference on Mass Customization and Personalization in Central Europe (MCP - CE 2012), http://www.robertfreund.de/blog/wp-content/uploads/2012/10/MCP-CE-2012-Freund.pdf
7. Ueda K, Takenaka T, Vancza J, Monostori L., 2009, Value Creation and Decision-Making in Collaborative Society, Annals of CIRP 58(2):681–700.
8. Ueda K., 2000, Emergent Synthesis, Artificial Intelligence in Engineering, 15/4:319–320.
9. Yoshikawa, H., 2008, Synthesiology as sustainability science. Sustainability Science, 3/2:169–170.
10. Langton, C., 1998, Artificial Life, Santa Fe Institute study in the science of Complexity 1, Proceedings, Redwood City, CA, Addison-Wesley
11. Holland, J., Adaptation in neural and artificial systems, 1992, MIT Press, Cambridge, MA, USA.
12. Ueda, K., Makus, A., Monostori, L., Kals, H.J.J., and Arai, T., 2001, Emergent synthesis methodologies for manufacturing. CIRP Annals – Manufacturing Technology, 50/2:535–551.
13. Ueda, K., Vaario, J. and Fujii, N., 1998. Interactive Manufacturing: Human Aspects for Biological Manufacturing Systems. CIRP Annals – Manufacturing Technology, 47/1:389–392.
14. Ueda, K. and Takenaka, T., 2007, Classification of service model and value creation. Proceedings of the Ninth IEEE International Conference on E-Commerce Technology Tokyo, Japan: 497–498.
15. Shimizu H., 2000, Ba and Co-creation, NTT publisher, (in Japanese)
16. Saft, S, 2014, Rethinking Western individualism from the perspective of social interaction and from the concept of ba. Journal of Pragmatics, 69:108–120.
17. Ueda, K., 1996, Differentiation of the Realms of Artifacts and Information: How Does It Relate to Parts/Whole and Inside/Outside?, Artificial Life V, MIT Press, 272–277.
18. Ueda, K., Kito, T., and Takenaka, T., 2008, Modelling of Value Creation Based on Emergent Synthesis. CIRP Annals – Manufacturing Technology, 57/1:473–476.
19. Ueda, K., and Kuroda, A. (Eds.), 2004, What is co-creation, Baifukan (in Japanese).
20. Prahalad, C.K., and Ramaswamy, V., 2000, Co-opting customer competence, Harvard Business Review, 78(1): 79–90.
21. Prahalad, C.K., Ramaswamy, V., 2001, The co-creation connection, Strategy and Business, 50–61.
22. Prahalad, C.K., Ramaswamy, V., 2004, The Future of Competition: Co-creating Unique Value with Customers. Harvard Business School Press, Boston, MA.
23. Vargo, S.L., Lusch, R.F., 2006. Service-dominant logic: what it is, what it is not, what it might be. In: Lusch, R.F., Vargo, S.L. (Eds.), The Service-Dominant Logic of Marketing: Dialog, Debate, and Directions. M.E. Sharpe, Armonk, NY, pp. 43–56.
24. Chathoth P, Altinay L, Harrington R.J, Okumus F, Chan E.S.W., 2013, Co-production versus co-creation: A process based continuum in the hotel service context. International Journal of Hospitality Management, 32:11–20.
25. Vargo, S.L., Lusch, R.F., 2004. Evolving to a new dominant logic for marketing. Journal of Marketing 68 (1), 1–17.
26. Technical Committee on Co-creation System, the Society of Instrument and Control Engineers in Japan, http://www.sice.jp/wp-content/uploads/file/org/D9.pdf
27. Yoshikawa, H., 2008, Introduction to theory of service engineering – Framework for theoretical study of service engineering –, Synthesiology, 1(2): 111–122.
28. Shimomura, Y. and Tomiyama, T., 2005, Service modelling for service engineering, FIP International Federation for Information Processing,168:31–38.
29. Arai, T. and Shimomura, Y., 2005, Service CAD System – Evaluation and Quantification. CIRP Annals – Manufacturing Technology, 54/1:463–466.
30. Spohrer, J. and Maglio, P.P., 2008. The emergence of service science: Toward systematic service innovations to accelerate co-creation of value. Production and Operations Management, 17(3):238–246.

31. Vargo S.L., Maglio P.P., Akaka M.A., 2008, On value and value co-creation: A service systems and service logic perspective. European Management Journal, 26:145–152.
32. Valenstein, A.F., 1989, Pre-oedipal reconstructions in Psychoanalysis. International Journal of Psycho-Analysis, 70:433–442.
33. Zuriff, G.E., 2002, Philosophy of behaviorism. Journal of Experimental Analysis of Behavior, 77/3:367–371.
34. Dobb, M., 1975, Theories of value and distribution since Adam Smith, Cambridge University Press.
35. Lusch, R.F., Vargo, S.L., 2006, Service-dominant logic: reactions, reflections and refinements. Marketing theory. 6:281–288.
36. Kowalkowski, C, 2010, What does a service-dominant logic really mean for manufacturing firms? CIRP Journal of Manufacturing Science and Technology, 3:285–292.
37. Ueda, K., 2010, System Theory of Research & Development and Innovation: – Synthetic Approach to Value Creation—, Journal of the Japan Society for Precision Engineering, 76(7), 737–742.

Development of Conceptual Framework for Value Cocreation of Service Based on the Japanese Governmental Service Science Research Program

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Abstract

This paper develops the conceptual framework for value cocreation of service through key concept analysis, developed for this paper, extracting constituent concepts from the key concepts involved in project statement documents from the Japanese governmental service science research program, identifying structural relationships among the constituent concepts, and integrating them into the framework. The developed framework reveals several structural features of value cocreation of service, namely, the importance of the introduction of the reproduction cycle into the service-dominant logic, the introduction of the value cocreation mechanism into the provider side, and three types of value created in service.

Keywords

Value cocreation of service • Conceptual framework • Key concept analysis • Service-dominant logic

1 Background and Objective

In 2004, two significant changes occurred in the field of service, that is, the birth of the concept of service science in Palmisano Report and the proposition of a service-dominant logic by Vargo and Lusch. Those changes started to have an impact on Japan after a delay of approximately 2 years.

In 2006, the Ministry of Economy, Trade and Industry organized a "study group on productivity improvement and innovation in the service industry," then in 2007, in response to the so-called Ushio report, a new economic organization, the Service Productivity and Innovation for Growth (SPRING), was established with the support of five other ministries and the participation from the academic community to promote service innovation in Japan.

In 2007, the Japanese education ministry started the new program to develop education curriculum to educate promoters of service innovation. Then, in 2008, the National Institute of Advanced Industrial Science and Technology established the Service Engineering Research Center.

Among the growing interest in such scientific and engineering approach to service innovation in Japan, the service science research program supported by the Japanese government, S3FIRE, abbreviated from Service Science, Solutions and Foundation Integrated Research Program, was launched in 2010 by the Research Institute of Science and Technology for Society (RISTEX) of the Japan Science and Technology Agency (JST).

In preparation to launch S3FIRE, RISTEX carried out many expert interviews, workshops, and the request for advices to expert committee and others. Despite those efforts, although how the service science research program should be conducted was clarified, what the service science is was not sufficiently clear.

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In such a situation, James Spohrer, who may be referred to as the father of a service science, was invited to Japan and gave two important messages.

First, service science is a genre in development process even in the United States that is still expanding its genre from service science (SS) to service science, management, and engineering (SSME), then to service science, management, engineering, and design (SSME&D), so that a simple chase for the United States would not make sense.

Second, a service science research should not ignore the service-dominant logic, which was born in the field of marketing, and its basic concept of service as value cocreation between customers and providers. In fact, there was no reference to a service-dominant logic in the preparatory examination process of the service science research in Japan before his visit. Virtually, James Spohrer connected a service-dominant logic and a concept of value cocreation of service to a service science in Japan.

Therefore, when the management team of S3FIRE was organized by 15 expert members including the author headed by Norihisa Doi, a rough consensus that a service science is a scientific and engineering approach to a service and at the same time is related to the concept of service as value cocreation had grown among them.

Immediately after the formation, the management team must start the recruitment of entries and the selection of awarded projects. During 4 years from 2010, 391 proposals were submitted and 18 projects were awarded.

The program management of S3FIRE can be said to have been carried out in a triangle, consisting of service innovation and service-dominant logic and service science and the concept of value cocreation of service just located in the center of this triangle.

The central concept of the service-dominant logic is a value cocreation of service. A service science is based on the mind-set of service-dominant logic. Therefore, the service science takes a value cocreation of service as a central concept. The service innovation in the twenty-first century would be developed to stand on the service science and the service-dominant logic, so that the service innovation also takes a value cocreation of service as a central concept.

This paper aims to develop a conceptual framework for value cocreation of service, by analyzing the project statement documents of 18 awarded projects, applying key concept analysis developed for this paper, explained in the following chapter.

Prior to this paper, there exists a Japanese paper of the author [1], written in the form of a case study of the formation process of conceptual framework for value cocreation in the program management of S3FIRE. Since this paper deals with the same subject from a different aspect, there are many parts described in the same manner, though the language is different.

2 Method of Approach

In order to conduct an analysis of project statement documents of 18 projects to build a conceptual framework for value cocreation of service, "key concept analysis" was developed for this paper.

The paper aims to directly process concepts as data and to create new concepts from such concept processing without the mediation of numerical data. Therefore, ordinary correlation analysis and multivariate analysis are not useful for this paper.

Key concept analysis is a series of procedures newly developed for directly processing concepts involved in the project statement documents of the Japanese governmental service science research program to develop a conceptual framework for the value cocreation of service.

2.1 Key Concept Analysis

Key concept analysis is performed by going through the following eight procedural steps:

- Step 1: Extracting key concepts
  Key concepts are extracted from the project statement documents submitted to S3FIRE at the commencement of the project. These documents describe the essence of the method and contents of research in two pages including conceptual project diagrams.
  As of January 2015, only 14 project documents had been translated into English and uploaded to the website of RISTEX, out of 18 projects [2]. Therefore, in this paper, the key concept analysis is conducted on the Japanese versions of the 18 project statements and then translated into English for this paper.
  Different from ordinary text mining methods, the extraction of key concepts is not done to extract words by morphological analysis in a sentence, but instead to extract "concepts" that meaningfully express the contents of the research in each project.
  It should be noted that the statement document is submitted by the project team prior to the start of actual research activities. Thus, the outcome of each project is not necessarily identical to what is described in the project statement document.
- Step 2: Classifying key concepts by function
  In the next step, the key concepts extracted in Step 1 are classified in accordance with the functions implied by the concepts in the research activities, into research content, research field, targeted outcome of research, and research method.
- Step 3: Classifying key concepts for research content by level of abstractness

Choosing only key concepts classified in the category of the research content, which are assumed to directly contribute to the development of the conceptual framework for value cocreation of service, the chosen key concepts are classified, in accordance with the concept's level of abstractness, into a single concept, a multiple concept, and a meta-concept.

- Step 4: Identifying the constituent concept for the conceptual framework
  Examining the set of key concepts classified into three categories, particularly the set of single concepts for each project, the constituent concepts, which will form a major component of the conceptual framework for value cocreation of service, are identified.
- Step 5: Identifying key structural relationships
  The key structural relationship, defined as the relationship among constituent concepts, which forms part of the structure of the conceptual framework, is revealed. The key structural relationships that will shape the structure of the framework are identified, by mainly examining the set of multiple concepts and meta-concepts.
- Step 6: Integrating constituent concepts and key structural relationships to formulate the conceptual framework
  Integrating the results of Step 4 and Step 5, the conceptual framework for value cocreation of service is developed. The conceptual framework is presented in the shape of a smiley diagram, which will encourage the intuitive understanding of practitioners in service industries such as management and operational personnel.
- Step 7: Validation of appropriateness of the developed conceptual framework
  The conceptual framework is developed through abstraction of certain sets of identified constituent and key structural relationships obtained through Step 6. The developed framework is validated by examining to what extent entire key concepts obtained in Step 3 can be explained by the developed framework.
- Step 8: Analysis of residual key concepts
  The results of Step 7 will show that it is not possible to perfectly explain all key concepts of Step 3. The analysis of the characteristics of the residual key concepts will reveal the orientation of change and evolution of the developed framework.

2.2 Practice Science Approach

Although the key concept analysis here takes the appearance of a logical, reproducible, and universal process of analytical steps, the extraction of key concepts and the identification of constituent and key structural relationships are supported by participant observation of practice science, not of rigorous positive science.

The combinations of morphemes, brought about by the morphological analysis of a sentence in the project statement document, are numerous. The measure to extract several meaningful key concepts with the same granularity, out of numerous combinations of morphemes and words, is an algorithm of concept processing generated by the S3FIRE management team's observations of program management for more than 4 years including four selections of awarded projects.

The same measure is applied to identify the constituent concepts out of the key concepts and key structural relationships out of the constituent concepts for value cocreation of service.

The management team of S3FIRE was faced with the difficult task of selecting one project out of about 20, of which it could be said, "this is the service science research project," without knowing which it should be. Naturally, a very lively and heated discussion occurred among the members, all with versatile backgrounds in science and industry.

The practices of the program management team, adding new knowledge derived from a serious exchange of opinions with the applicants, and discussion of the selection policy among the team in awarding the research funds, and navigating the whole program year over year, created shared understandings among the team through this process. These practices are thus the source of the algorithm of the concept processing with the same granularity.

3 Extraction and Classification of Key Concepts

The key concepts, extracted in Step 1, are a unit of words that expresses a meaningful concept related to the essential content and method of research contained in each S3FIRE project and not merely morphemes derived from morphological analysis of a sentence or words without any specific implications in view of the context of the specific research project.

For example, in Fujikawa project [3] (the projet statement document of Fujikawa project [3] appears in the Web site of S3FIRE [2] and the same applies to all the 18 projects of S3FIRE cited in the following part of the paper), the key concept of "decontextualization" is extracted from the project statement document. A morphological analysis in Japanese derives three words, "de," "context," and "tualization," but the key concept unique to Fujikawa project [3] is "decontextualization"; neither "de" nor "context" nor "tualization" does not express a unique concept in the research of Fujikawa's project.

The sentence "Beyond the stage of presenting cases where the concept applies" includes ten words, each word of which does not hold any specific means meaningful to Fujikawa's research, so that no key concept is extracted from this whole sentence.

From the sentence "Structuring and typification of the value cocreation process," four key concepts, "structuring," "typification," "value cocreation," and "value cocreation process," are extracted. A project team tries to put as many concepts as possible in a limited length of project statement document. Therefore, this paper tries to extract as many key concepts as possible. In the exercise of Step 1, altogether, 522 key concepts were identified from 18 projects.

In Step 2, in order to distinguish which key concept directly contributes to the development of conceptual framework for value cocreation of service, key concepts are classified in accordance with the characteristics that each key concept expresses in research activities.

As a result, they are classified into four categories, namely, research content, research field, targeted outcome of research, and research method as shown in Table 1.

The category of research content which directly contributes to the formation of conceptual framework is the largest in number, but the total of the rest is larger than its number. There is a general tendency that the number of targeted outcome of research is larger than one of research method in the project wherein concrete method has not established before the project starts.

In the next step, Step 3, key concepts belong to the "research content" category, amount to 201, and are segregated and classified into three categories, that is, "mono concept" which is a single and independent concept, "multiple concept" in which multiple "mono concepts" are combined, and "meta-concept" which is abstracted from mono- and multiple concepts involved in the research.

In this exercise, the procedure from Step 1 to Step3 is conducted on all 18 projects, but for the sake of the limitation of the length of the paper, the result of the extraction and classification of key concepts of the Fujikawa project [3] is shown in Table 2.

Table 1 Key concepts classified by characteristics

Characteristics	Number of key concepts
Research content	201
Research field	29
Targeted outcome of research	132
Research method	160
Total	522

In the same manner, the Fujikawa project [3], which is one of the first bunches of projects awarded in 2010, is taken as a representative of 18 projects throughout the paper.

4 Key Structural Relationships and Constituent Concepts on Value Cocreation of Service

When S3FIRE started, the management team must have immediately moved into action to select awarded projects, without holding any concrete knowledge of what to select. At that time, the most instrumental tool for the management team was the Arai-Shimomura model for the definition of a service, expressed as a concept diagram using a smiley shown in Fig. 1.

The Arai-Shimomura model introduced an operational concept that an improvement of service is to improve the content directly connected to receiver's state parameters by improving channel or its mutual relationship, so that five constituent concepts are involved for conceptual framework for value cocreation, namely, "provider," "receiver," "channel," "content," and "change in state" which imply the creation of value.

The key concept analysis went beyond the Arai-Shimomura model and partially the service-dominant logic. In the following, the paper shows how the key concept analysis of 18 projects expand those five sets of constituent concepts under what kind of key structural relationships,

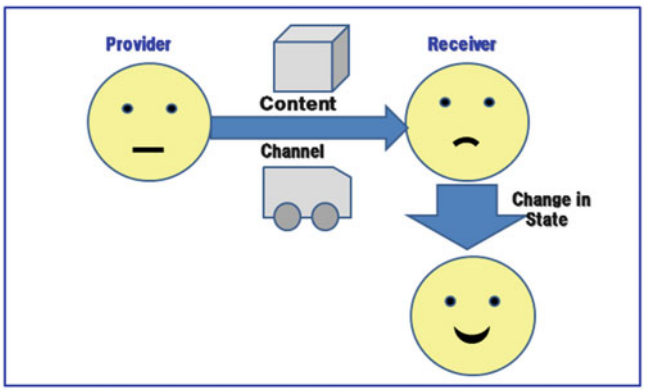

Fig. 1 The Arai-Shimomura model [4] for the definition of service

Table 2 Example of extracted and classified key concepts of research content (case of the Fujikawa project)

Category	Key concept
Research content (mono concept)	Context/service provider/service customer/value in exchange/value in use/value in context/top management/researcher
Research content (multiple concept)	Decontextualization/recontextualization
Research content (meta-concept)	Value cocreation/service-dominant logic/value cocreation process/process model

taking the key concepts extracted and classified in Step1 to Step 3 as foothold, based upon the participant observation of the program management process of S3FIRE.

In actual participant observation, identifying first constituent concepts, the granularity of which is similar to five constituent concepts in the Arai-Shimomura model, such as "content" and "channel," and then key structural relationship expressed as big-boned structural relationship among related constituent concepts is deducted.

However, in describing the process, presenting first the structural relationship among the constituent concepts as key structural relationship and then the constituent concept related to the structure is described by using various key concepts extracted from each individual project. In doing so, the essential characteristics of all 18 S3FIRE projects are introduced briefly in one way or another, using the key concepts extracted from each project, as many as possible.

4.1 Value Proposition Through Channel with Content

The first observation on the key structural relationship is that many projects awarded in the first year, 2010, under the influence of the Arai-Shimomura model, related to the structure of value proposition by "provider" to "receiver" through specific "channel" with specific "content."

The Uchihira project [5] focused its attention on new "channel" of Twitter-like "quasi-real-time" "hands-free voice communication" using "voice intercom (transceivers)" in the field of "healthcare services," through which the "contents" of "useful recognitions" are contained in "voice messages" of nurses and doctors, otherwise vaporized in vein, being "stored on a server" and "automatically delivered to the right person at the right time."

In the following sentences as above, the identified constituent concept is put in double quotation mark and the extracted key concept is put in single quotation mark.

The Hara project [6] designed a "service system" which utilizes the service "content" as "tour design process" providing attractive "customer experience" by "travel agents" as "provider" to "foreign visitors" as "receiver," through the "customer participation" in "service planning support system" as a "channel."

There are many projects of this type which try to realize service innovation by sophisticating both content and channel, such as the Ishida project [7] realizing "service-oriented multilingual communication environment" between the Vietnamese agricultural community and Japanese agronomists, Nakakoji project [8] designing museum experiences as services creating inspirational communication, and Hamagami project [9] trying to design intelligent social service platform taking an "intelligent call triage system" for an "emergency medical care center" as a case. Actually, approximately one third of S3FIRE projects fall on this category.

4.2 Importance of Context and Bunch of Context

The second observation on key structural relationship is that the recognition of importance of "context," on top of "content" and "channel" in the structure of value proposition, was shared among the management team in rather early stage of program management process.

The Fujikawa project [3] brought up the importance of "context" as a constituent concept which connects the value proposition of "provider" to the "value cocreation processes" by proposing the pair concept of "decontextualization" and "recontextualization."

This indicates that "content" and "channel" in the Arai-Shimomura model are the "content" in the specific "context" and "channel" in the specific "context," so that the model should be expanded to express this aspect.

The Kobayashi project [10] develops the "model of value creation mechanism" of "Japanese creative service," such as "long-established businesses," "Japanese foods service," "traditional culture and art," and "Japan cool."

Then, the project aims to support the "international deployment of service industries" by clarifying how Japanese services deeply rooted on the Japanese culture represented by "omotenashi (Japanese hospitality)," "kizuki (attention to details)," and "long-term trust" relationship could be transplanted beyond different "contexts."

This means there are many "contexts," at least, as many as the number of countries; moreover, a service is, undeniably, "context" dependent. A service is a practice affected by numerous variables, such as the combination of provider and receiver, venue, time, atmosphere, climate, environment, and so on. Therefore, one can say that there is no service exactly the same as the service.

In this respect, a service should be regarded as a practice which realizes as the specific "content" through the specific "channel," on a bunch of different "contexts." How skillfully the "provider" bunches the bunch of "context" determines the competitiveness of the "provider."

In early 1990s, Richard Wurman [11], the founder of the TED, made the researches in informatics, recognized how important the "context" was in the communication process, in addition to the "channel" and the "content." Adding the "context" to the Arai-Shimomura model, the essential characteristics of service as a communication process in which provider and receiver try to better understand each other became much clearer.

4.3 Value Cocreation of Service as Dynamic Reproduction Cycle: Customer Satisfaction and Prior Expectation

The third observation on the key structural relationship is that a service is not completed when "value in use" is cocreated by "receivers" and "providers," responding to the value proposition made by "providers." The "customer satisfaction" or dissatisfaction follows the process, and then it is followed by the "prior expectation" which will become the source of the next round of value cocreation by the same "receiver" with perhaps the same "provider," if the "provider" was regarded as satisfactory.

4.3.1 Customer Satisfaction

In the second year of S3FIRE, the Fujimura project [12] proposed an interesting nature of service, "benefit delay effect," taking the issue of "patient satisfaction" as a theme in the field of "medical care service."

In the case of a certain type of medical care, such as X-ray irradiation and anticancer therapy, no concrete benefit develops in the "delivery process of the service." The benefit only develops with delay "after the delivery of the service." Therefore, the "patient satisfaction" only develops at this delayed stage, so that the "estimation of patient satisfaction" "tends to be skewed."

Generally speaking, "customer satisfaction" is measured after the practice of service; naturally, there is a time delay between the realization of the "value in use" and the measurement of "customer satisfaction," and therefore, it indicates there must be other constituent concepts located after the stage of value cocreation in the form of the development of "value in use," as long as the value cocreation process deals with "customer satisfaction" stage which is essential to service as a business.

The "benefit delay effect" appears to be a specific nature of medical care service, but when one overviews a service as a whole, the benefit delay phenomena can be observed rather widely in service, such as in education service and in disaster prevention service. The Fujimura project [12] tries to solve this issue by promoting voluntary "patient participation" to the medical care process.

4.3.2 Prior Expectation

In the customer satisfaction index of SPRING [13] which conforms to the Michigan model, customer satisfaction creates words of mouth in the short term and customer loyalty in the long run. In order to connect the primary cycle of service process to the next cycle and make this process as sustainable reproduction cycle, there must be another medium between them.

It is "prior expectation" that Yoshitake Suwa, one of the members of the management team of S3FIRE, insisted the importance in service management from early on [14].

A customer as a "receiver" forms the "prior expectation" at t + 1, based on the "customer satisfaction" or dissatisfaction at time t, then responding to the value proposition of provider at time t + 1, and enters into the value cocreation process at time t + 1. In this way, value cocreation of service becomes sustainable reproduction cycle.

In this respect, fundamental premises (FP) in service-dominant logic [15] presume a static system describing the state of the matter, whereas most of service science research projects of S3FIRE regard a service as a dynamic system where a time plays an important role.

In the key concept analysis, the Kobayashi project [10] deals with "prior expectation" in the context of "dynamic service evaluation" that incorporates "prior expectation" and their satisfaction.

4.4 Value Cocreation of Service in Provider Side: Learning/Evaluation and Skill/Know-How

The fourth observation on key structural relationship is that many projects of S3FIRE dealt with some sort of value creation in provider side, and this fact leads to the idea that there is a similar structure of value cocreation in the provider side as in the receiver side. The exploration of constituent concepts based on this view leads to two constituent concepts, "learning/evaluation" and "skill/know-how."

4.4.1 Value Cocreation in Provider Side Creating Value in Experience

The first project that provided the hint that the similar structure of value cocreation exists in provider side is Tateoka project [16] in 2011. This project focused on "voluntary suicide prevention counselors" and tries to clarify the structure of the "development of altruism" found in the accumulation of experiences by the "exchange of messages" between "counselors" and "someone contemplating suicide" and to reveal the "value creation factors" in the provider side leading to the "altruism" involved in this service.

Unfortunately, this project was terminated as S3FIRE project since it failed to maintain this delicate research field; this project plays an important role to pay attention to the value creation aspect in provider side.

If the same structure exists, what is the value created in provider side as value in use in receiver side?

Multiple projects in 2013 indicate that the value created in provider side is "value in experience." The first project of this nature is the Asama project [16] which aims to "visualize" and "quantify" the "value in experience" fully utilizing "three-dimensional measurement technologies," taking "skill training service" as a research field.

Another is the Shimomura project [17] which aims to clarify the "value cocreation mechanism" in "learning

behavior" in higher education, introducing a pair of concepts of the "competency of provider" (capability of teachers) and "literacy of receiver" (capability of students) and establish a practical methodology to realize the "higher education service with higher value added." The factor enhancing the "competency of provider" is the "value in experience."

4.4.2 Learning/Evaluation in Provider Side

In the case of receiver side, if "customer satisfaction" developed as a result of value cocreation, then what is the constituent concept derived from the value cocreation in provider side?

What connects the outcome of value cocreation in provider side to the next round of value proposition is "learning" of teacher ("provider") as the accumulation of "competency" understanding "learning behavior" necessary for "target achievement" of student ("receiver") in the Shimomura project [17] and "learning" accumulating "value in experience" of "instructor" ("provider") of "skill training," receiving "feedback" of the "level of proficiency" and "satisfaction of trainee" ("receiver") in the Asama project [16].

In the Shimomura project [17], the organized higher education brings about two types of "evaluation," namely, "formative evaluation" and "overall evaluation." In the same manner, in the Asama project [16], the "level of satisfaction of trainee" and "quantitative evaluation of the level of proficiency" are brought about as a result of training. Those evaluations are not the evaluation for evaluation, but the evaluation to make learning more efficient.

In this respect, the outcome of value cocreation in provider side is regarded as "learning/evaluation" as against to "customer satisfaction" in receiver side.

4.4.3 Skill/Know-How as Operant Resources

Then, what is the missing link connecting "learning/know-how" to the next cycle of value proposition? The project that indicates this missing link is the Murai project [18] in 2012. The Murai project recognizes that the reason why the "turnover rate" in "nursing care industry" in Japan is in such a high level is that no objective method has been established for "assessing the quality of service in caregiving work" and no method to evaluate the essential "nature of the outstanding skills of experienced workers."

The project aims to quantify and visualize the individual "caregiver's awareness" of "care receiver's condition," so as to recognize the "difference among caregivers regarding their awareness" and to develop an "evaluation model of the level of proficiency" of "skill/know-how" of caregivers. The outcome will lead to a practical application to "human resource development" and "evaluation service of nursing care."

In sum, the constituent concept which connects "learning/evaluation" as the outcome of the value cocreation in provider side to the next round of reproduction cycle is "skill/know-how" as the foothold and operant resource as defined by Vargo and Lusch [15] for creating the value proposition at time t+1.

4.5 Expanded Reproduction of Value Cocreation of Service: Value in Exchange in the Market

The fifth observation on key structural relationship is that, starting from the Arai-Shimomura model, structuring concepts from the first to the fourth formed the reproduction cycles of value cocreation for both receiver side and provider side, but they are only a simple reproduction cycle. In order to make the simple reproduction cycle to expanded reproduction cycle as a viable business, the practice of service should bear a sustainable flow of profit, so that "return" is larger than "cost" in "value in exchange" in the market.

4.5.1 Cost and Return

The Kaihara project [19], awarded in 2012, deals with this most primary issue of service as a business. However, the "value in experience" is accumulated in the provider side and the quality of service improved a great deal; if the service is not attractive in the economic sense, the service is not viable as a business.

The Kaihara project [19] aims to examine, in the field of "restaurant industry," to what extent economic benefit increases and "inefficiency of service delivery" is improved, so that "cost" is reduced when various forms of "cell-type" systems, which frequently appear in automobile industries, are introduced and "layout of kitchen" and "layout of personnel's shift" are changed.

Taking agricultural irrigation system as its field, the Iida project [20] focuses on "return" side rather than "cost" side. In the long history of Japanese 'agricultural irrigation system' since the ancient time, it was run in the manner the 'upstream' and 'supply side' is always advantageous over 'downstream' and 'demand side', but the Iida project introduced a 'demand-responsive system' regardless of the location in the stream, introducing simple 'water measurement system' utilizing smartphones and trying to measure the 'socioeconomic impact' of this system.

This cost-return relationship is one of the major subjects of service science; many projects, including the Murai project [18], Hamagami project [9], and Toya project [21], paid special attention to this aspect.

4.5.2 Triple Sides of Cocreated Value: Value in Use, Value in Experience, and Value in Exchange

Three types of value, "value in use," "value in experience," and "value in exchange," develop in the value cocreation

process, but those three are not mutually exclusive. Those three types develop simultaneously in one cycle of value cocreation; one only looks into the same result of value cocreation of service from three different aspects, that is, receiver side, provider side, and market side.

There is a project in S3FIRE which focuses on this triple-sided nature of cocreated value. The Toya project [21] tries to develop a measurement scale for three values, taking financial service as a field, interpreting "value in use" as "emotional value," "value in experience" as "intellectual value," and "value in exchange" as "monetary value" in order to express the nature of value in a more intuitive way.

5 Conceptual Framework for Value Cocreation of Service

The constituent concepts identified as a result of key concept analysis are now integrated into a total framework based on the observations on key structural relationships.

The appropriateness of developed conceptual framework is tested in key concept analysis.

5.1 Formation of Conceptual Framework for Value Cocreation of Service

The conceptual framework for value cocreation of service is shown in Fig. 2 as a result of the integration.

Multilayered "contexts" are added to "channel" and "content" of the Arai-Shimomura model. Then, if "prior expectation" of the "receiver," expressed as the specific "content" through the specific "channel" on the specific "context," matches with the value proposition of the "provider," "value in use" is realized by the value cocreation with the "provider."

As the outcome of the realization of "value in use," the receiver develops "customer satisfaction." The degree of satisfaction affects the "prior expectation" which influences the "receiver," whether the "receiver" repeats the service and becomes loyal to the "provider" in the next round of value cocreation or not.

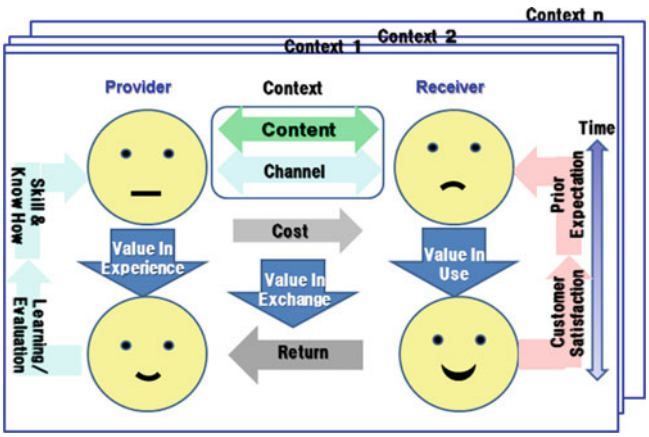

Fig. 2 Conceptual framework for value cocreation of service

As a result, value cocreation in the receiver side forms a dynamic reproduction cycle, a realization of "value in use"⇒ "customer satisfaction"⇒ "prior expectation"⇒ next cycle of realization of "value in use."

In the diagram, concept of time is drawn, in order to show all the variables have a time constant, such as t at the present cycle and t+1 at the next cycle.

The same reproduction cycle structure is formed in the provider side as in the receiver side with mutual similarity. The "value in experience" in the provider side corresponds to "value in use" in the receiver side. In the same manner, "learning/evaluation" corresponds to "customer satisfaction" and "skill/know-how" to "prior expectation."

As in the receiver side, a reproduction cycle of realization of "value in experience"⇒ "learning/evaluation"⇒ "skill/know-how"⇒ next cycle of realization of "value in experience" is formed in the provider side.

There is a triple-sided nature in value cocreation of service. In order to maintain the reproduction cycle as an expanded reproduction so that the service is viable as a business, the difference between "return" and "cost" of "value in exchange" in the market must be positive, in addition to the normal realization of "value in use" in the receiver side and "value in experience" in the provider side.

In realizing the "value in use" in the receiver side, value proposition of "provider" is communicated to the "receiver" by means of "content" and "channel." In the same manner, in realizing the "value in experience" in the provider side, some sort of signals of "prior expectation" of the receiver are transmitted to the provider side.

Therefore, in this diagram, arrows extend from both sides of "content," expressing this bidirectional flow of information and signals between the receiver and the provider. Since "channel" is by definition bidirectional, "channel" also has arrows on both sides.

The realization of "value in use" and "value in experience" is expressed by different facial expressions of smiley. In this way, the conceptual framework for value cocreation of service is shown as smiley diagram, not as seven or ten metaphysical fundamental premises or as an enumeration of capital letters, such as SS, SSME, and SSME+D, so that practitioners in service industries can intuitively understand the essence.

5.2 Validation of the Appropriateness of Developed Conceptual Framework

The framework was developed through certain abstraction of sets of identified constituent and key structural relationships

obtained up to Step 6. In this sort of conceptual analysis, it seems to be not possible to verify the accuracy of the developed framework, whereas in this paper, the appropriateness of the framework is validated using the key concepts as data. Validation is conducted by testing to what extent entire key concepts obtained in Step 3 can be explained by the developed framework and included constituent concepts.

Whether the key concept B is explained by constituent concept A or not is tested by whether the relationship between A and B falls on any one of the relationships in the following list shown in Table 3.

For example, 14 key concepts of the Fujikawa project [3] related to the research content listed in Table 2 are explained by constituent concepts of the framework as shown in Table 4.

The key concept of the example of type D, multiple relationship, "the linkage of customer experience with tour package design," appears in the Hara project [6] and is a compound of "value in use" and "content."

In the same manner, the key concept of the example of type E, inclusive relationship, "hands-free interaction" appears in the Uchihira project [5] and is included in "channel."

The result of validation is shown in Table 5. The result indicates 88.1 % (177/201) of key concepts for research content are explained by the developed framework. There is no established criterion to judge the validity; the figure just indicates it is higher than 80 %, but less than 95 %.

Figure 3 indicates the result of mapping of 18 S3FIRE projects by selecting the constituent concept which is regarded as the nearest to the main theme of each individual project and locating the name tag of the project at a nearby place of the selected constituent concept in the diagram.

Each project conducted the study focusing the main theme, but it is unlikely to conduct the study only on the main theme. For example, in the case of the Fujikawa project [3], judging from the project statement document entitled "Context Management Approach to Value Co-creation," it

Table 3 Relationship between key concept A and constituent concept B indicating B is explained by A

Type/relationship	Characteristics
(A) Identical	B is A
(B) Analogous	B is analogous to A
(C) Adjacent	B is adjacent to A
(D) Multiple	B is formed by multiple A
(E) Inclusive	B is included in A or multiple A
(F) Usable	B is explained using A or multiple A
(G) Abstract	B is abstracted from multiple A

Table 4 Explanation of key concept by constituent concept (example of Fujikawa project)

Key concept	Constituent concept	Relationship
Context	Context	(A)
Service provider	Provider	(B)
Service customer	Receiver	(B)
Value in exchange	Value in exchange	(A)
Value in use	Value in use	(A)
Value in context	Value in use	(C)
Top management	Provider	(B)
Researcher	Provider	(C)
Decontextualization	Context	(F)
Recontextualization	Context	(F)
Value cocreation of service	All	(G)
Service-dominant logic	All	(G)
Value cocreation process	All	(F)
Process model	All	(G)

Table 5 Result of validation of the developed framework (unit: number of key concept)

Project	Key concept for content	Explained	Residual	Total
Fujikawa	14	14	0	42
Kijima	4	1	3	23
Hara	14	13	1	34
Uchihira	7	7	0	26
Fujimura	16	16	0	26
Iida	8	8	0	24
Ishida	18	16	2	32
Kobayashi	17	14	3	34
Tateoka	6	6	0	19
Kaihara	10	10	0	28
Murai	18	17	1	34
Nakakoji	13	12	1	29
Nakashima	4	2	2	30
Toya	14	10	4	29
Asama	15	15	0	43
Hamagami	11	6	5	28
Nishino	3	1	2	21
Shimomura	9	9	0	20
Total	201	177	24	522

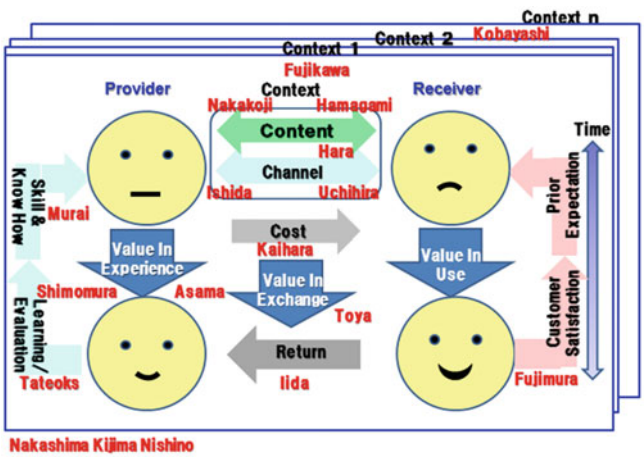

Fig. 3 Mapping (by the author) of S3FIRE projects to the developed framework

is obvious to locate it nearby "context," but the actual study of the Fujikawa project [3] expanded a great deal, as far as "content," "channel," "customer satisfaction," and "learning/evaluation." The same can be said for all S3FIRE projects, to a greater or lesser extent.

There are three projects which are different from other 15 projects. They are Kijima, Nakashima, and Nishino projects. The Kijima project [22] aimed to develop a "service system science" as a new scientific discipline by "service systems modeling," taking the "community participation process" in the "industrial agglomeration" of the 'Suwa-Okaya area' as the research field. The Nakashima project [23] pursues to develop an entirely new methodology for novel "societal service design," by applying the concept of "Smart Access Vehicle System (SAVS)" to the 'transport system of Hakodate', Hokkaido. The Nishino project [24] challenges to build a comprehensive "mechanism design theory" based on the "classification of the service systems" by utilizing the "value creation model" developed by the Japanese engineer and philosopher, Kanji Ueda [25].

Those three projects try to develop a new methodology in the layer higher than that of value cocreation of service which is the layer of the framework of this paper, and the development of the new methodology itself is the main objective of the project.

Calculating the ratio of key concepts on research content in total key concepts, the lowest row of Table 5, average figure for 18 S3FIRE projects is 38.5 %, whereas 17.4 % for Kijima [22] project, 13.3 % for Nakashima project [23], and 14.3 % for Nishino project [24]. The small figures for this ratio mean the number of key concept for research content is small, whereas on the contrary, key concepts regarding research method and targeted outcome of research are very fertile. Therefore, in mapping those three projects, they are located outside of the framework, meaning methodology-oriented project.

Figure 3 reveals that the rest of 15 projects were selected in the manner being distributed rather evenly over constituent concepts of the framework, but relatively thicker for "content," "channel," and "context" part and thinner for "prior expectation" part.

5.3 Limitation and Possibility: Analysis of Residual Key Concepts

As a result of the validation of the framework, 88.1 % of key concepts were explained by the framework. That means there are residual key concepts of approximately 12 %. Table 6 presents lists and classifications of them in four clusters.

The first cluster includes key concepts belonging to the layer of the study of methodology which is different from the layer for the developed framework.

The second cluster falls on the actors who are outside of provider-receiver relationship such as stakeholders and service agents. If stakeholders play an important role in value cocreation process, this framework should be expanded in a proper way.

The third cluster is various types of relationship that hold among various actors. In order to deal with those relationships, the framework should be expanded to dynamic multi-agent model. In such a case, careful examination whether it is worthwhile or not is necessary.

The fourth cluster related to the new type of value of this framework is not covered. Those new types of value, such as customer lifetime value and risk aspect, are the target of future challenge of this framework.

The rest of the key concepts in this cluster, "creative added value" and "collective creativity," reveal essential characteristics of the developed framework that it has a strong affinity with a process innovation-type service innovation. On the contrary, this framework is, perhaps, not useful to deal with product innovation-type service innovation, in which new relationship among constituent concepts and even entirely new structure of value cocreation emerge.

The residual of key concept analysis is different from the residual in statistical analysis of numerical data. The analysis of the residual in key concepts analysis reveals various limitations of this framework, but at the same time, it reveals various directions of change and evolution of the developed framework.

Table 6 Residual key concepts impossible to explain by the developed framework

(1)	Service system/service system/large-scale service system/service mechanism/dynamics of service structure/SAVS
(2)	Various stakeholders/society and local society as stakeholder/stakeholder/social acceptance of stakeholder/social acceptance/consensus formation/service agent/nonprofit organization/volunteer economy
(3)	Improvement of relationship of customers and local society/relationship network among customers/long-term trust relationship/sustainability in change and change in sustainability
(4)	Customer lifetime value/subsidiary profit/risk/creative added value/collective creativity

6 Conclusions

The conceptual framework for value cocreation developed in this paper based on the Japanese governmental service science research program introduced three new aspects to the service-dominant logic. First, the developed framework introduced a dynamic reproduction cycle into the service-dominant logic. Second, it introduced the mechanism of value cocreation into the provider side, not only the receiver side. Third, it also revealed that to establish an expanded reproduction cycle for the value cocreation process, the created value should be viewed from three angles, that is, "value in exchange" added to "value in use" and "value in experience."

With regard to the methodology, the key concept analysis specifically developed for this paper, with the support of participant observation, although premature as a methodology, revealed to be a useful practical tool to directly process concepts as data and to create new concepts from concept processing without the mediation of numerical data.

The developed framework can explain most of the research content of the S3FIRE projects, and it is already utilized as a routine tool to manage the service science research program in Japan and expected to contribute to navigation and exploration in the study of serviceology. As studies in serviceology accumulate based on the framework, the framework will become a useful tool to examine the quality of service innovations and to generate useful suggestions to elaborate service models which lead to the expanded reproduction cycle of value cocreation, to reinforce business models of various service businesses.

References

1. Murakami, T., 2014, Conceptual Framework for Value Co-creation of Service (Japanese). Serviceology, Vol.1, No.2: 6–13 (Author translated Japanese references in this paper to English)
2. All the project statement documents of S3FIRE are shown at the following in English and in Japanese. http://www.ristex.jp/servicescience/EN/project/ http://www.ristex.jp/servicescience/project/
3. Fujikawa, Y., 2010, Context Management Approach to Service Value Co-Creation Model, S3FIRE
4. Arai, T., & Shimomura, Y., 2006, Service Engineering – How to Accelerate Servitization, Hitotsubashi Business Review, Vol. 54. No.2
5. Uchihira, N., 2010, Innovation for Service Space Communication by Voice Tweets in Nursing and Caring, S3FIRE
6. Hara, T., 2010, Architecting Service with Customer Participation Based on the Analysis of Customer Experience and Design Processes: Sophisticating Tour Design Processes as a Case Study, S3FIRE
7. Ishida, T., 2011, Realizing Multilingual Communication Environments based on Service-Oriented Collective Intelligence, S3FIRE
8. Nakakoji, K., 2012, Museum Experiences and Service Science, S3FIRE
9. Hamagami, T., 2013. Construction of Foundation for Smart Social Service Systems, Creating Secure and Safe Community through the Advancement of Emergency Medical Care, S3FIRE
10. Kobayashi, K., 2011, Analyzing Fundamentals of Japanese Creative Services and Its Application to Global Service Enhancement, S3FIRE
11. Wurman. R. S., 1989, Instruction Anxiety, Doubleday
12. Fujimura, K., 2011, Research on Patient Satisfaction with Medical Care Services in Consideration of 'Benefit Delay' Effect, S3FIRE
13. SPRING, 2010, Customer Satisfaction Index
14. Suwa, Y., 2009, Customers Purchase Service-Management of Prior Expectation to Enhance Customer Expectation (Japanese), Diamondsha
15. Vargo, S. L. & Lusch, R.F., 2014, Service-Dominant Logic – Premises, Perspectives, Possibilities, Cambridge University Press
16. Tateoka, Y., 2011, Research on the Service Science of Actualizing Altruism-driven Society; focusing on the Suicide Prevention Activities, 3FIRE
17. Shimomura, Y., 2013, A method for the Transition to Value Co-creative Service by Enhancing Provider's Competency and Receiver's Literacy, S3FIRE
18. Murai, J., 2012, Development and Practical Application of a "Human Resource Development and Evaluation Service" based on On-site Evaluation of Quality of Care by Using IT Platform, S3FIRE
19. Kaihara, T., 2012, Development of Adaptive Service Model with Co-creative Design under Dynamic Environment – Application into Restaurant Service -, S3FIRE
20. Iida, T., 2011, Quantitative Valuation and Demand-oriented Provision of Irrigation Service, S3FIRE
21. Toya, K., 2012, A Co-creation Measurement for Financial Services: Scale Development and Validation, S3FIRE
22. Kijima, K., 2010, Visualization and Support of Value Co-creation at Industrial Clusters by Service Systems Modeling, S3FIRE
23. Nakashima, H., 2012, IT-enabled Novel Societal Service Design, S3FIRE
24. Nishino, N., 2013, Service System Categorization Based on Value Creation Models and Design Theory of Service Mechanism, S3FIRE
25. Ueda, K., Takenaka, T., Fujita, K., 2008, Toward Value Co-creation in Manufacturing and Servicing, CIRP Journal of Manufacturing Service and Technology, 1 [1]

An Interactive Model for the Synthesis of Service Functions Through Use Processes

Tatsunori Hara, Tamio Arai, and Aman Gupta

Abstract

Service use processes have assumed a significant role in recent service development. In response to a need for the development of a service Computer Aided Design (CAD) with use-oriented design method, this paper examines the relationship among use processes, functions, and service provision based on Yoshikawa's study on function in engineering and service-dominant logic in marketing. We extend a service model between a provider and a receiver to represent dynamic synthesis of functions through use processes. Design operations executed on the model can include contributions by both the provider and receiver in terms of effectiveness, adaptation, and creation. Finally, we apply the model to two case studies from different industries and verify its effectiveness.

Keywords

Service-dominant logic • Service modeling • Function design • Use

1 Introduction

Service use processes have assumed a significant role in recent service development. The relationship between "design" and "use" has become a core issue in user-centered design approaches [1]. This implies a holistic view of design as tightly coupled with practical use that continues during the life cycle of the artifact [2]. The use phase must be incorporated into the design phase, and the design must be adapted to users; manufacturers and users must collaborate in the design of a product or service. A variety of use situations, which can display design-like characteristics, can become realistic sources of innovation and material for further designs [3]. Based on a study on service Computer Aided Design (CAD) [4], this paper develops a model that facilitates computerized design operations with respect to function, service, and use.

An earlier study by the authors [5] suggested that an ecosystem consisting of different types of designs can link design and use. Design-of-use and design-in-use by the customer can function as a bridge between different types of value creation: providing value, adapting value, and co-creative value [6]. Design-from-use, which is amplified by accumulated use data, contributes to value co-creation for the manufacturer and the customer community. Although this study provides an overview of the relationship between design and use, the content of design activity is absent. In the process of conceptual design, the concept of function is crucial to represent design objects and to describe human intention.

In response to a need for the development of a use-oriented design methodology, this paper explores an interactive model for the synthesis of service functions through use processes. The remainder of this paper is composed of the following:

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1. Section 2 reviews previous studies in the design and marketing field that discuss the threefold relationship of function, service, and use processes. Human use is defined as the binary opposite of function by service or individuals. Service can be a medium by which function and use are interconnected.
2. Section 3 explains an earlier study on a service model and elaborates on the model's capacity as an interactive service model between a provider and a receiver. An elaborated model defines design operations during use processes.
3. In Sect. 4, we present a case study from the construction industry to demonstrate the proposed model.
4. Section 5 concludes the paper.

2 Related Study

2.1 Yoshikawa's Study on Function, Service, and Use

Yoshikawa proposed a synthetic-type engineering curriculum [7] based on his function studies including the general design theory. The curriculum includes the theory of function, the theory of service, and the theory of use. The relationship between function, service, and use that comprises this curriculum is as follows and is derived from the literature [8]:

- All entities have functions, and a function has value or meaning to individuals.
- Individuals possess an ability to manifest function.
- A function is latent and manifests gradually through action or use. However, a different function may manifest depending on the mode of the action or use.
- A service is a manifest function, which implies that the function services the individual.
- The speed at which a latent function becomes apparent represents a time measure for service delivery, and general service is included in this category.

Figure 1 represents the relationship between function, service, and use. This study emphasizes the relationship between function and service, whereas use represents the extract effect of latent function (i.e., service delivery). The variety of manifested functions caused by the different mode of action or use has not yet been discussed in the relevant literature.

2.2 Service-Dominant Logic

Service-dominant logic (S-D logic) (e.g., [9, 10]) is concerned with the relationship between service and use

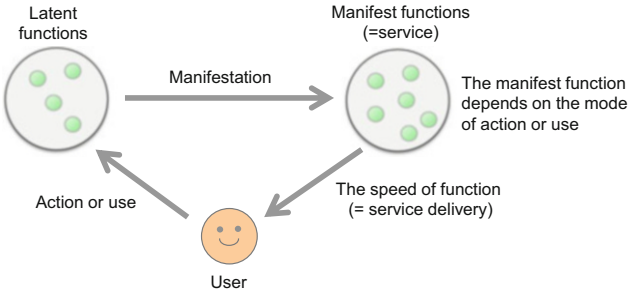

Fig. 1 The relationship between function, service, and use

(i.e., value-in-use), although design objects, such as functions, are not detailed in the related literature. S-D logic has emerged as, arguably, the most important scholarly marketing debate in the last decade [11]. S-D logic is based on ten foundational premises (FPs). The following FPs are particularly relevant to this paper:

- FP1: Service is the fundamental basis of exchange.
- FP3: Goods are a distribution mechanism for service provision.
- FP4: Operant resources (i.e., knowledge and skills) are the fundamental source of competitive advantage.
- FP6: The customer is always the primary co-creator of value.
- FP7: The enterprise cannot deliver value, but only offers value propositions.
- FP10: Value is always uniquely and phenomenologically determined by the beneficiary.

2.3 Comparison and Problem Setting

An additional explanation for FP3 is that "goods (both durable and nondurable) derive their value through use and the service they provide." Here, let the term "goods" in S-D logic be rephrased as "entities in which latent functions are embedded." Given this perspective, we find common ground between Yoshikawa's study [8] and S-D logic in terms of function, service, and use. Operant resources, referred to in FP4, are similar to the concept of function. Value proposition is considered a set of latent functions from the provider.

S-D logic considers value co-creation to be based on a customer's contribution to integrating proprietary knowledge and skills in service, as described in FP6. Although value co-creation may be central to a sustainable society, S-D logic represents contribution on a conceptual level or describes the mindset of individuals. S-D logic development as operational knowledge is necessary so that designers or practitioners realize the practical synthesis in a

real-world context. Thus, based on a study on service CAD [4], this current study develops a model that facilitates computerized design operations with respect to function, service, and use.

3 The Synthesis of Service Functions Through Use Processes

3.1 A Basic Definition of Service

The authors defined a service as "an activity that changes the state of a service receiver" [12]. A change in state refers to a physical change (e.g., state, place), body/physiological change (e.g., recovery from exhaustion), or cognitive change (e.g., an increase in knowledge). To define the change in the receiver, we introduced a receiver state parameter (RSP) [4, 12], which is assumed to be observable and controllable. The method of "persona" is useful to specify a receiver's RSPs, which are relevant to the value provided to the customer. A receiver's lifestyle and behavioral patterns are described in terms of personal characteristics, such as occupation and social status. This definition of service represents a one-way directional expression but may include a receiver's reactions to the activity of the provider.

3.2 Procedural Representation for Preparation and Activation

This paper introduces servset, a concept defined as "a set of functions that may cause state change in the receiver." The term servset is derived from the combination of service and set. A servset represents the total delivery of service content from the provider to the receiver. With the introduction of RSP and servset, service is modeled as a prepared and activated servset that may change RSP(s). The following is the procedural representation of service:

1. A provider designs and manufactures a servset as a set of latent functions SS_L composed of material and nonmaterial factors.
2. The provider delivers the servset SS_L as a value proposition to the receiver. At this point, all functions are latent, and the receiver evaluation of the functions is irrelevant.
3. The receiver receives the servset, and the receiver use manifests some servset functions SS_M.
4. Among the manifested functions, SS_M, the receiver evaluates only the functions that affect RSP(s) indirectly or directly to the extent that the receiver's state changes.

For clarity, the remainder of this paper considers service to represent the structure of activity as a whole, as in S-D logic or as shown in Fig. 2, whereas service delivery represents each manifested function to a receiver as shown on the right-hand side of Fig. 2.

3.3 Bidirectional Aspect of Service: Contribution by Receiver

If we consider the opposite direction of service delivery, from the receiver to the provider, use action occurs. In this case, as described in FP1, because "service is exchanged for service" in the context of S-D logic, it is natural to think that the receiver also provides knowledge and skills in receiving service, which enhances the value-in-use of the service. From this perspective, however, the above (3) process resembles value-in-exchange of the service within the evaluation of the value proposition prior to use. This could result in misplaced emphasis on value-in-exchange as the traditional goods-dominant logic, rather than value-in-use. Therefore, the next section revises the above process (3) from the perspective of the receiver's contribution and value-in-use.

3.4 Structural Transformation of Function and Service Through Use Processes

We define value-in-exchange and value-in-use as follows:

- Value-in-exchange: the value of service when the value proposition offered at the time of purchase is performed as planned.

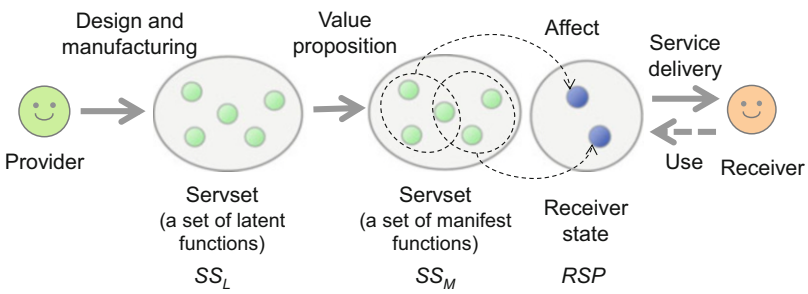

Fig. 2 Procedural representation of preparation and activation of service

- Value-in-use: the value of service obtained by a receiver through various situations (including interactions with other service systems) during the use process after purchase.

A complete process, summarized in Fig. 2, is divided into several processes: the exchange process and several use processes. Figure 3 illustrates the sequential transformation of functional structure in service according to separate processes. This transformation is caused by the provider's actions and the receiver's use. The effects of the receiver's actions, which may create new value, are also uniformly represented as a transformation of functional structure. Based on this model, Table 1 summarizes design operations that can be executed on the model including contributions by the provider and receiver in terms of effectiveness, adaptation, and creation. Operation (p0) occurs in the process of exchange for which value-in-exchange is determined as a value proposition. Operations (p1)-(p4) and (r1)-(r4) occur in the use process and transform the function structure in a complete service. Therefore, we extended the existing model by focusing on the three-way relationship among function, service, and use.

4 Illustrative Examples

4.1 Komatsu KOMTRAX

4.1.1 Rationale for Selection

Komatsu's services are example of a business to business (B2B) process. It represents a case of servitization in a manufacturing company and is a suitable case study to demonstrate the proposed model and operations concerning the synthesis of service functions through use processes.

4.1.2 Overview of Komatsu KOMTRAX

A Japanese construction machinery supplier, Komatsu Company Limited, is renowned as the first company to introduce technologies such as GPS (global positioning systems) for construction businesses [13, 14]. Komatsu has developed a system called KOMTRAX that gathers product usage

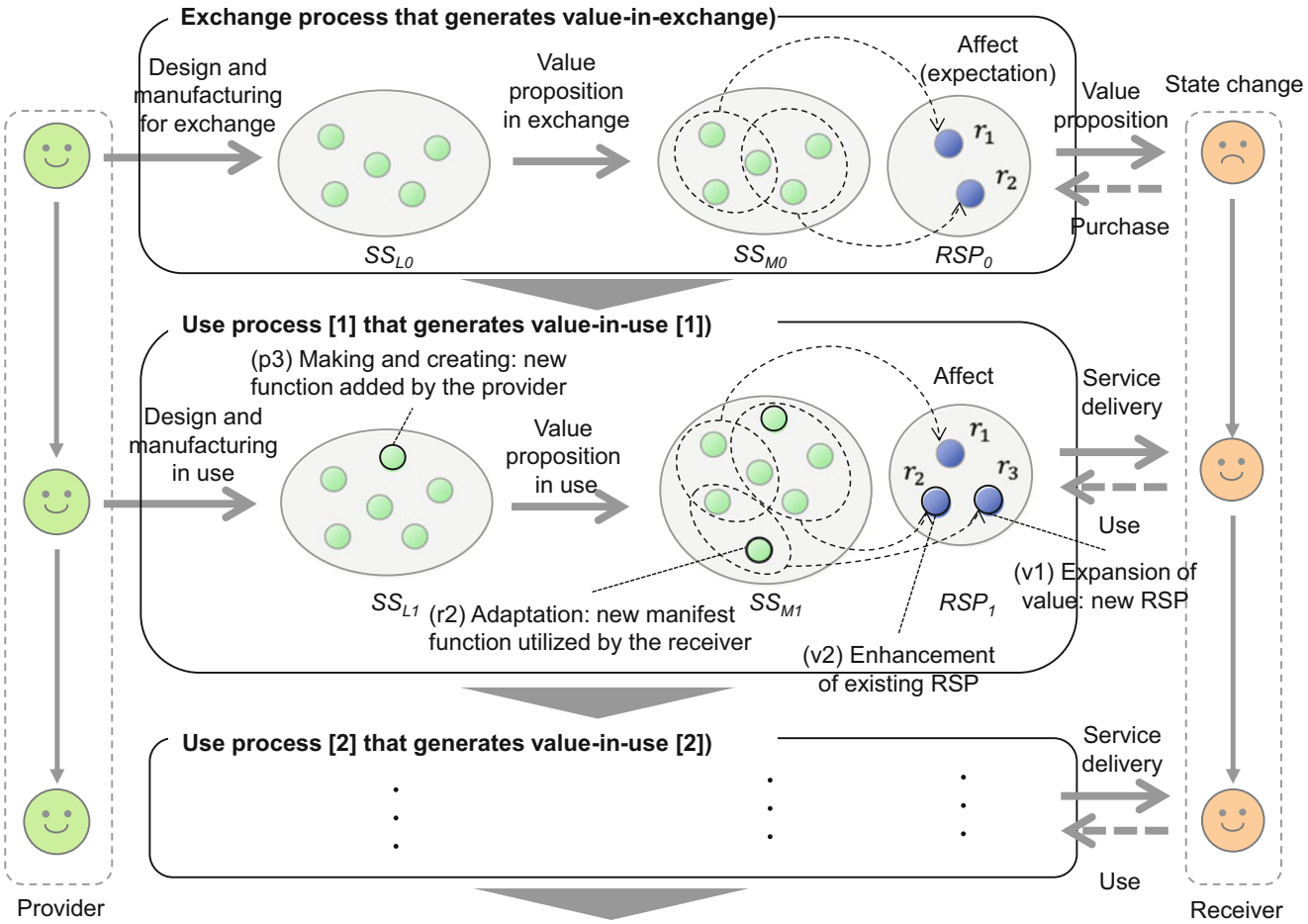

Fig. 3 An interactive model for synthesis of functions through use processes (partial operations)

Table 1 Operations on the interactive model for synthesis of functions through use processes

Phase	Operations
Exchange process	(p0) Offering value proposition SS_L by the provider's knowledge and skills in the process of exchange
Use processes	*Developing value proposition SS_L by the provider's knowledge and skills in the process of use*
	(p1) Effectiveness (the provider manifests a certain latent function in SS_L in an intended, more appropriate manner)
	(p2) Adaptation (the provider newly manifests a certain latent function in SS_L in an unintended manner)
	(p3) Making and creating (the provider simultaneously defines and manifests a new latent function in SS_L which is *not* derived from any other manifest function)
	(p4) Making and creating (the provider simultaneously defines and manifests a new latent function in SS_L which is derived from any other manifest function)
	Developing service SS_L and SS_M by integrating the receiver's knowledge and skills into the value proposition SS_L in the process of use
	(r1) Effectiveness (the receiver manifests a certain latent function in SS_L in an intended, more appropriate manner)
	(r2) Adaptation (the receiver newly manifests a certain latent function in SS_L in an unintended manner)
	(r3) Making and creating (the receiver simultaneously defines and manifests a new latent function in SS_L which is *not* derived from any other manifest function)
	(r4) Making and creating (the receiver simultaneously defines and manifests a new latent function in SS_L which is derived from any other manifest function)
	Setting value from a change of context ($RSP_{i-1} \rightarrow RSP_i$')
	(v1) Expansion of value (new RSP is set)
	(v2) Enhancement of value (a new relationship between a certain RSP and function is set)

information using GPS for each of the construction machines it has sold worldwide, which number over 200,000. Komatsu can now provide customers with the operation status of construction equipment, and customers can check the progress of work, run maintenance checks, and locate vehicles at each construction site [13]. However, when Komatsu introduced this system in the 1990s, the system's original purpose was only to locate construction machines for repair and maintenance work. As KOMTRAX diffused and usage information was accumulated, Komatsu and customer companies gradually realized the system's potential and jointly developed the aforementioned emerging services including antitheft, management support, and insurance [13, 14].

4.1.3 The Modeling Results

Table 2 summarizes the results of the obtained model and operations. Figure 4 focuses on transformation of functions in the model. We describe Komatsu's business, starting with selling "L_1: basic functions of construction machines (CM)." "L_3: maintenance (repair)" is supported by "L_2: monitor the position of CM." In use process number 2, by holding dialogs with customers in a real world, Komatsu utilizes the function of "L_2: monitor the position of CM" as a different function "M'_2: prevent theft of CM" by quickly locating a stolen CM. The customer company (i.e., receiver) uses the same function "L_2: monitor the position of CM" as a different function "M''_2: monitor usage of CM." After the provider notices the emerging function "M''_2: monitor usage of CM" by the receiver, in use process number 3, the function is embedded as a new latent function offered by the provider. As the provider and the receiver interact in this way, use collaboratively transforms and synthesizes the function structure through service provision and improvements in use. In this case, the interactive processes expand KOMTRAX's services in terms of productive construction to business management.

4.2 Twitter

4.2.1 Rationale for Selection

Twitter is an example of a business to consumer (B2C) service. As the literature review in the following paragraph would indicate, Twitter's service presents a very good example of how user innovations [3] lead to temporal changes in the entire service or product. Such innovations have been treated as manifestations of original latent functions of Twitter in our research. New twitter features, driven by user innovation, have been designated as new latent functions derived from manifestations. The details have been described in the following sections. Hence this is an apt example to demonstrate the proposed model and operations concerning the synthesis of service functions through use processes.

4.2.2 Overview of Twitter Service

Twitter, launched in 2006, has grown to become an important social networking platform with 140 million active users by 2012 [15]. Its key features differ markedly from Facebook in a number of important aspects, which have also led to its widespread use especially for public discussion and during acute events, along with resulting in several user innovations to enable such usage. Twitter messages, like

Table 2 Obtained model and operations on a B2B case study of construction industry: KOMTRAX

Process	#	Functions		Receiver's action or use to manifest latent function ($L \rightarrow M$)	RSPs (value)	Operations										
						Provider					Receiver				Value	
		L: latent functions in SS_L (provider or service functions)	M: manifest functions in SS_M (=service delivery)			p0	p1	p2	p3	p4	r1	r2	r3	r4	v1	v2
Exchange	1	L_1: basic functions of CM	M_1: (same content as L_1)	Operate CM (usual use)	Efficiency in construction (R_1)	✓									✓	
		L_2: monitor the position of CM	M_2: (same content as L_2)	Operate CM (usual use)	Decrease in downtime (R_2)	✓										
		L_3: maintenance (repair)	M_3: (same content as L_3)	Call for maintenance	Decrease in downtime (R_2)	✓										
Use	2	L_2: monitor the position of CM	M_2: prevent theft of CM	(Theft action by thief)	Antitheft of CM (R_3)			✓							✓	
		L_2: monitor the position of CM	M_2: monitor usage of CM	Manage operation (in individual way)	Productivity of construction (R_4)							✓				
	3	$L_{4\leftarrow 2}$: monitor usage of CM	M_4: (same content as L_4)	Manage operation (in a standardized way)						✓						✓
		$L_{4\leftarrow 2}$: monitor usage of CM	M_4: monitor staff activities on site	Manage staff (in individual way)								✓				
	4	$L_{5\leftarrow 4}$: monitor staff activities on site	M_5: (same content as L_5)	Manage staff (in a standardized way)						✓						✓
		L_6: monitor the status of fuel usage	M_6: (same content as L_6)	Manage fuel					✓							
		L_1: basic functions of CM	M_1: basic functions of CM with less energy	Operate CM in energy-saving way							✓					
	5	$L_{7\leftarrow 4}$: optimize usage of CM	M_7: (same content as L_7)				✓								✓	✓
		$L_{8\leftarrow 5}$: optimize staff activities on site	M_8: (same content as L_8)													
		$L_{9\leftarrow 6}$:	M_9: (same content as L_9)	Manage operation, staff, and fuel according to advice from the provider												
		$L_{10\leftarrow 3}$: manage maintenance history	M_{10}: manage CM asset	Manage several sites (in individual way)	Improvements in business management (R_5)							✓				
	6	$L_{11\leftarrow 10}$: manage CM asset	M_{11}: (same content as L_{11})	Manage several sites (in a standardized way)						✓						✓
		$L_{12\leftarrow 10}$: prepare insurance of CM	M_3: (same content as L_{12})	Take out CM insurance						✓						

M'_i represents a different manifest function, $L_{i\leftarrow j}$ represents a derived latent function based on M_j

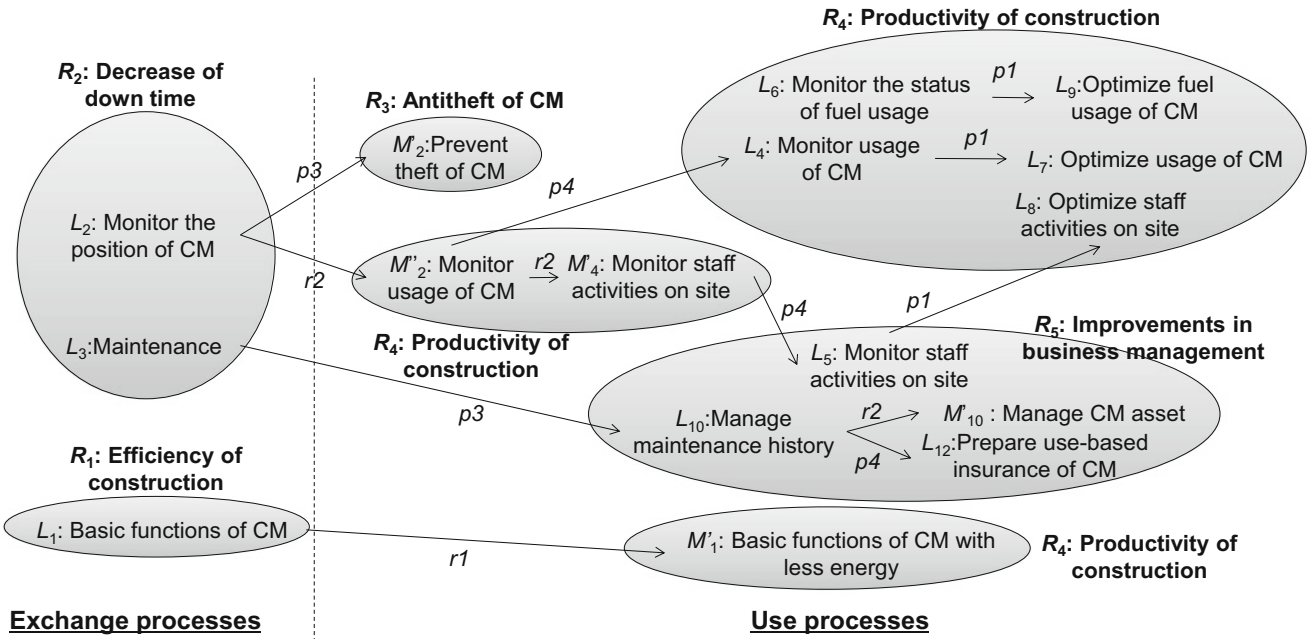

Fig. 4 Transformation of Komatsu KOMTRAX functions

SMS, are restricted in character limit (140 per tweet) which leads to economical use of characters in tweets. Also, most Twitter users maintain a public profile (except when set to private), so people, even outside Twitter, can see tweets without needing user permission, leading to a "flat" social network. Such design features and constraints have led to various user innovations in Twitter usage [16]. Examples include #hashtags, @reply and RT (ReTweet), business or advertising usage, and dissemination of news or events [16, 18, 19]. Initially, Twitter's creators were not very clear on its definition and could realize its potential as an information network only with time and diverse usage [15, 17]. Popularity of some of these user-driven innovations led to their incorporation as features, causing changes in Twitter's functionality. Examples include introduction of replies column, retweet button, hashtag tracking, promoted tweets, and promoted accounts [16, 18, 19].

4.2.3 The Modeling Results

Table 3 summarizes the results of the obtained model and operations. Figure 5 shows transformation of functions in the model. Definition of RSPs in the case study is as follows:

- Change in social outreach (R_1): It refers to the social connectivity of the person (e.g., joining a social network expands the social outreach or connectivity of a person).
- Addition/change in content availability (R_2): It refers to change in amount of content available to the user. Content refers here to online and multimedia content like news, trends, images, and videos.
- Simplification/addition/change in communication method (R_3): It refers to new communication technique/syntax options/new characters imparted with a meaning which become available to the user, often with the purpose of simplifying the communication process.
- Change in third-party tool usage (R_4): This refers to third-party tools available online which augment/compliment Twitter usage.

Starting with the Twitter website as it was in 2006, we have described Twitter's basic features, starting with "L_1: creation of a unique profile and a username on a flat social network" and "L_0: public API of Twitter" and "L_2: personal expression on a social network (Twitter) within 140 alphanumeric/special characters." These constitute the latent functions of the exchange phase. Here, two RSPs are getting simultaneously affected by one manifest function (M_2) which is a major difference in comparison to Komatsu. In use process number 2, the users devise several innovative manifestations of latent functions L_2 and L_0 such as @reply (M_{2a}), RT or ReTweet (M_{2b}), using Twitter to spread news (M_{2d}), spreading business information, or doing advertising on Twitter (M_{2f}). Note that these have been treated as innovative manifestations as these were not originally intended by Twitter's designers (providers) as mentioned in the literature review in the previous paragraph. In use process number 3, Twitter's designers or providers, after considering the growing popularity of such user-driven manifestations, either incorporate or provide support for these manifestations in some form or other, causing changes in

Table 3 Obtained model and operations on a case study of a B2C service: Twitter

Process	#	Functions		Receiver's action or use to manifest latent function ($L \rightarrow M$)	RSPs (value)	Operations										
						Provider					Receiver				Value	
		L: latent functions in SS_L (provider or service functions)	M: manifest functions in SS_M (=service delivery)			p0	p1	p2	p3	p4	r1	r2	r3	r4	v1	v2
Exchange	1	L_0: public API of Twitter	M_0: (same content as L_2)	Seeing Twitter data outside Twitter	Addition/change in content availability (R_2)	✓									✓	
		L_1: creation of a unique profile and a username on a flat social network	M_1: (same content as L_1)	Creating a Twitter account	Change in social outreach (R_1)	✓										
		L_2: personal expression on a social network (Twitter) within 140 alphanumeric/special characters	M_2: (same content as L_3)	Tweeting	Simplification/addition/change in communication method (R_3)	✓										
Use	2	L_2: personal expression on a social network (Twitter) within 140 alphanumeric/special characters	M_{2a}: reply to a tweet	Adding @prefix to reply to a tweet	Simplification/addition/change in communication method (R_3)							✓			✓	✓
			M_{2b}: retweet	Adding RT prefix to retweet								✓				
			M_{2c}: creation of trends/specific content	Adding hashtags in tweets to create trends/specific content	Addition/change in content availability (R_2)							✓				
					Simplification/addition/change in communication method (R_3)											
			M_{2d}: live reports of news/events	Tweeting news	Addition/change in content availability (R_2)							✓				
			M_{2e}: sharing content/links	Adding links in tweets in order to share content								✓				
			M_{2e}: sharing content with shortened URLs	Adding shortened URLs in tweets in order to share content with help of third-party services	Change in third-party tool usage (R_4)							✓				
					Simplification/addition/change in communication method (R_3)											
			M_{2f}: business/advertising	Using a Twitter account as official business account to spread business information	Simplification/addition/change in communication method (R_3)							✓				
					Addition/change in content availability (R_2)											
		L_0: public API of Twitter	M_0: use of public API for data analysis with purpose of business	Analyzing tweets to gain relevant information using third-party services	Change in third-party tool usage (R_4)							✓				

	3	$L_{3\leftarrow 2a}$: reply column	M_3: (same content as L_3)	Using reply column to see replies	Simplification/addition/change in communication method (R_3)					✓						✓	
		$L_{4\leftarrow 2b}$: retweet button	M_4: (same content as L_4)	Using retweet button to retweet						✓							
			$M_{4'}$: manual retweet	Prefixing MT to distinguish manual retweet from automated one								✓					
		$L_{5\leftarrow 2c}$: inbuilt hashtag tracking	M_5: (same content as L_5)	Clicking on hashtags to view similar posts	Addition/change in content availability (R_2)					✓							
		$L_{6\leftarrow 2e}$: tweet button for instant content sharing	M_6: (same content as L_6)	Using tweet button on websites to instantly share content	Simplification/addition/change in communication method (R_3)					✓							
		$L_{7\leftarrow 2e}$: support for sharing media (images/videos)	M_7: (same content as L_7)	Attaching images/videos in tweets	Addition/change in content availability (R_2)					✓							
					Simplification/addition/change in communication method (R_3)												
		$L_{8\leftarrow 2e}$: inbuilt URL shortening service	M_8: (same content as L_8)	Using URL shorteners to fit URLs in character limits	Change in third-party tool usage (R_4)					✓							
		$L_{9\leftarrow 2f}$: promoted tweets and accounts	M_9: (same content as L_9)	Using promoted tweets/accounts for greater business outreach	Addition/change in content availability (R_2)					✓							
					Simplification/addition/change in communication method (R_3)												
		$L_{10\leftarrow 0}$: inbuilt data analytics service	M_{10}: (same content as L_{10})	Using data analytics for personal/professional usage	Change in third-party tool usage (R_4)					✓							

M'_i represents a different manifest function, $L_{i\leftarrow j}$ represents a derived latent function based on M_j

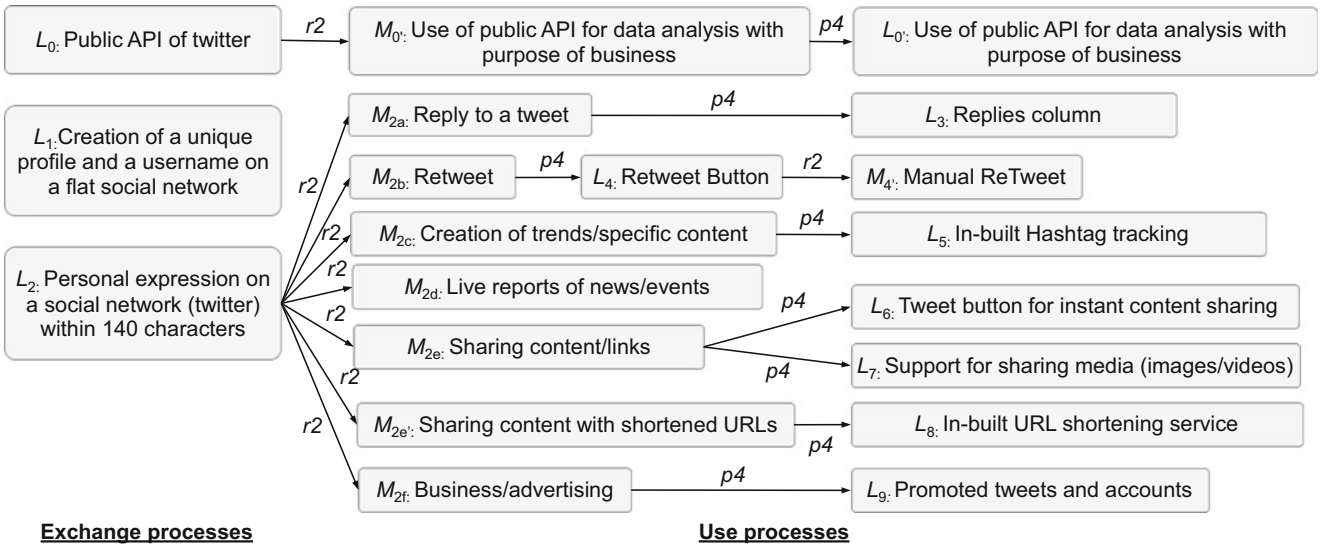

Fig. 5 Transformation of Twitter functions (simplified)

Table 4 Comparison of Komatsu and Twitter services

Characteristic	Komatsu	Twitter
Nature of service	B2B (business to business)	B2C (business to consumer)
Functions' relationship with RSPs	A particular function does not affect more than one RSP	A particular function can affect more than one RSP at an instant
Customer base	Smaller, select, and less diverse	Large and diverse forms of usage
Terms and features of service	Clearly defined	While legal usage terms and technical features have been clearly defined, no specific definition is given on the purpose of uses, leading to diverse usage
Communication with customers	Direct	Indirect
Scope for user innovation	Relatively limited in comparison to Twitter which can be seen in comparatively less number of r2 operations	Reflected in large number of r2 operations exerted, showing good scope for user innovation. Possibly attributed to large, diverse customer base

Twitter's functionality. Hence, in use process number 3, new latent functions, derived from user manifestations (like $L_{3<\text{-}2a}$, $L_{5<\text{-}2c}$, $L_{10<\text{-}0'}$), emerge which are offered in service set SS_{L2}. Except for the case of $M_{4'}$, all manifestations, as seen in operations in Table 3, are as per provider intentions. As the provider and the receiver interact in this way, use collaboratively transforms and synthesizes the function structure through service provision and improvements in use. In this case, the interactive processes expand Twitter's services in terms of changes in communication methods for users to change in content availability for them.

5 Comparison of the Two Case Studies

After going through modeling results of the two cases, notable differences can be pointed out between them. Comparisons have been made on the parameters of customer communications, characteristics of customer base, scope for user innovation, relationships with RSPs, and possible reasons behind such differences. The discussion has been summarized in Table 4. The reasons for such differences need to be established through future studies on even more cases.

6 Conclusion

This paper developed the interactive model that facilitates computerized design operations with respect to function, service, and use by integrating views of the S-D logic into engineering studies on function. Two case studies in different industries with the model were illustrated, and it was demonstrated that use collaboratively transforms and synthesizes the function structure through service provision and improvements in use. The differences between B2B and

B2C cases were also discussed. Future work includes development of a use-oriented design method based on the proposed interactive model and operations.

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References

1. Redstrom, J., (2006), Towards user design? On the shift from object to user as the subject of design, Design Studies, 27/2:123–139.
2. Jovane, F., et al., (2008), The incoming global technological and industrial revolution towards competitive sustainable manufacturing, CIRP Annals – Manufacturing Technology, 57/2: 641–659.
3. Hippel E. Von, (2005), Democratizing innovation, MIT Press.
4. Hara, T., et al, (2009), Service CAD System to Integrate Product Behavior and Service Activity for Total Value, In CIRP Journal of Manufacturing Science & Technology, 1/4:262–271.
5. Hara T. and Arai T., (2013), Design-of-use and design-in-use by customers in differentiating value creation, CIRP Annals -Manufacturing Technology, 62/1: 103–106.
6. Ueda, K., et al, (2009), Value Creation and Decision-making in Collaborative Society, CIRP Annals - Manufacturing Technology, 58/2:681–700.
7. Yoshikawa, H., (2013), Service as a Fundamental of Engineering, Keynote Presentation in the 1st International Conference on Serviceology. (http://icserv2013.serviceology.org/yoshikawa.pdf)
8. Yoshikawa, H., (2008), Introduction to Service Engineering, Synthesiology, 1/2: 103–113.
9. Vargo S. and Lusch R.F., (2004). Evolving New Dominant Logic for Marketing. Journal of Marketing, 68/1: 1–17
10. Vargo S. and Lusch R.F., (2008), Service-dominant logic: continuing the evolution. Journal of the Academy of Marketing Science, 36/1: 1–10.
11. Kowalkowski, C., (2010), What does a service-dominant logic really mean for manufacturing firms?, CIRP Journal of Manufacturing Science and Technology, 3/4: 285–292.
12. Arai, T., Shimomura, Y., (2004), Proposal of Service CAD System-A Tool for Service Engineering, CIRP Annals 53/1:397–400.
13. Fujikawa Y., et al., (2011), Context Management Approach to Value Co-Creation (VCC): Toward Dynamic Process Model of Customer as Value Co-Creator, The Proceedings of The 20th Frontiers in Service Conference,14–15.
14. Kodama F., (2014), MOT in transition: From technology fusion to technology-service convergence, Technovation, 34:505–512.
15. Twitter (Mar 21, 2012), 'Twitter turns six', Official Blog of Twitter (https://blog.twitter.com). Accessed on 28 May 2015.
16. Bruns A. (2012), Ad Hoc Innovation by Users of Social Networks: The Case of Twitter, Zentrum für Soziale Innovation (ZSI) – Centre for Social Innovation.
17. Lapowsky I., (Oct 4, 2013), 'Ev Williams on Twitter's early years', Wire, Inc.com (www.inc.com/wire). Accessed on 29 May 2015.
18. Wildrich L., (Jun 8, 2011), 'How Twitter evolved from 2006 to 2011', Buffer Social Blog (https://blog.bufferapp.com). Accessed on 29 May 2015.
19. Quin R., (Apr 9, 2015), 'The Evolution Of Advertising On Twitter, And What Comes Next', SocialBro blog (http://www.socialbro.com/blog). Accessed on 1 June 2015.

Statistical Estimation of Software Quality in Hospital Information System

Shusaku Tsumoto, Shoji Hirano, and Toshihiko Kawamura

Abstract

Clinical environment is very complex, and flexible and adaptive service improvement is crucial in maintaining quality of medical care. Thus, incremental software development in hospital information system and its evaluation are important. This paper introduces a statistical estimation method of an embedded software in which service logs are used to measure the differences between responsive time before and after a new interface has been introduced. The empirical results show that statistical methods are useful to evaluate the system performance in a real clinical environment.

Keywords

Hospital information system • Quality management • Service computing

1 Introduction

More than 20 years have passed since clinical data were stored electronically as a hospital information system [1]. Stored data give all the histories of clinical activities in a hospital, including accounting information, laboratory data, and electronic patient records. Due to the traceability of all the information, a hospital cannot function without the information system. However, reuse of the stored data has not yet been discussed in details, except for laboratory data and accounting information to which OLAP methodologies are applied. Data mining approach just started about 15 years ago [2, 3].

In this paper, we introduce the following data-mining-centered software development process. First, data extracted from hospital information system is used for capturing the peculiarities of the divisions in the university hospital. Then, the mining results were interpreted by medical staff and the solutions were discussed. Based on the discussions, new interfaces were developed, whose performance was evaluated by using the service logs. The process was empirically evaluated in Shimane University Hospital, which shows that the process will give a new framework for quantitative evaluation of software development in hospital information system, which can be viewed as an application of active mining process (Fig. 1) [4].

The rest of the paper is organized as follows. Section 2 shows the background of our study, which shows the results obtained by visual temporal data mining and the interpretation process. Section 3 focuses on the evaluation process by using service histories stored in a hospital information system. Section 4 presents the evaluation results. Section 5 discusses the process. Finally, Sect. 6 concludes this paper.

2 Background

2.1 Hospital Information System

Clinical information has been stored electronically as a hospital information system (HIS) [5, 6]. The database stores all the data related with medical actions, including

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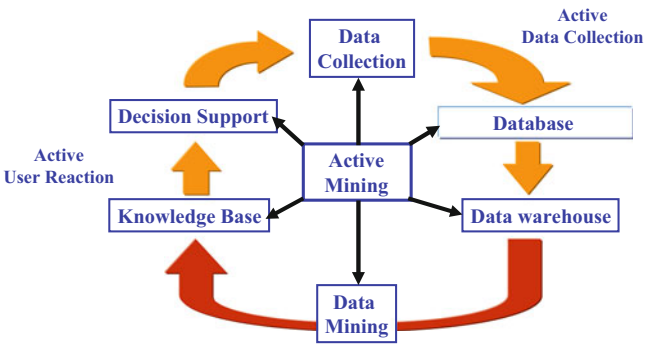

Fig. 1 Active mining process

accounting information, laboratory examinations, and patient records described by medical staff. Incident or accident reports are not an exception: they are also stored in HIS as clinical databases.

For example, Fig. 1 shows the structure of the HIS in Shimane University Hospital.

As shown in the figure, all the clinical inputs are shared through the network service in which medical staff can retrieve their information from their terminals.

Since all the clinical data are distributed, stored, and connected as a large-scale network, HIS can be viewed as a cyberspace in a hospital: all the results of clinical actions are stored as "histories." Tsumoto and Tsumoto analyzed the relations between length of stay and medical payment by applying conventional statistical techniques to the data stored in hospital information systems [7, 8]. It is expected that similar techniques in data mining, web mining, or network analysis can be applied to the data. Dealing with cyberspace in a hospital will give a new challenging problem in hospital management in which spatiotemporal data mining, social network analysis, and other new data-mining methods may play central roles.

2.2 Basic Unit in HIS: Order

The basic unit in HIS is an "order," which is a kind of document or message which conveys an order from a medical practitioner to others. For example, prescription can be viewed as an order from a doctor to a pharmacist and a prescription order is executed as follows:

Outpatient Clinic
1. Prescription given from a doctor to a patient.
2. The patient brings it to medical payment department.
3. The patient brings it to pharmaceutical division.
4. Execution of order in pharmacist office.
5. Delivery of prescribed medication.
6. Payment.

The second to fourth steps can be viewed as information propagation: thus, if we transmit the prescription through the network, all the departments involved in this order can easily share the ordered information and execute the order immediately. This also means that all the results of the prescription process are stored in HIS.

These sharing and storing processes, including histories of orders and their results, are automatically collected as a database: HIS can also be viewed as a cyberspace of medical orders.

2.3 Visualizing Hospital Actions from Data

Let us show the primitive mining results of HIS. Figures 2 and 3 depict a chronological overview of the number of orders on Tuesday in fiscal 2010. Vertical axis denotes the number of orders for each day, classified by the type of orders. Horizontal axis gives each date. The plot shows that the temporal behavior of each order is periodical with respect to holidays and very stationary.

The shape of the temporal changes captures the characteristics of clinical division, where temporal data-mining methods, such as trajectories mining [9, 10], can be applied as discussed in [11, 12].

For example, Figs. 4 and 5 show the chronological overviews of orders of hepatology and rheumatology in the same fiscal year. While the patterns of Fig. 3 are very similar to Fig. 2, those of Fig. 4 have significant changes as follows. First, the number of orders of laboratory examinations have a peak in 9–10 am. Secondly, records and reservation have long plateaus from 10 am to 5 pm. Finally, reservation is an important element of clinic of rheumatology, compared with hepatology. In the similar way, any division can be characterized by the shapes of the number of orders [11, 12].

After discussion with division of laboratory examinations and rheumatology, we found two discoveries for interpretation of the peculiarities of Fig. 3. One is that the peak corresponded to the time zone when laboratory staff asked the doctors to make missing orders. The other is that rheumatologists usually booked orders after their inpatient clinic, where they sometimes forgot to book because they are not good at operating the electronic patient records. Usually, the doctors should make orders for each patient during or just after his/her visit, so rheumatologists do not follow such work flow, whereas hepatologists follow the standard workflow. From the statistics, they examined 6–7 patients per hour, totally 30–35 patients on Tuesday. However, they forgot to book about seven patients. So roughly speaking, the forget rate is about 20–23 %, which may cause for the patients to wait for examination longer than other divisions. It is notable that even for hepatology, the forget rate is very

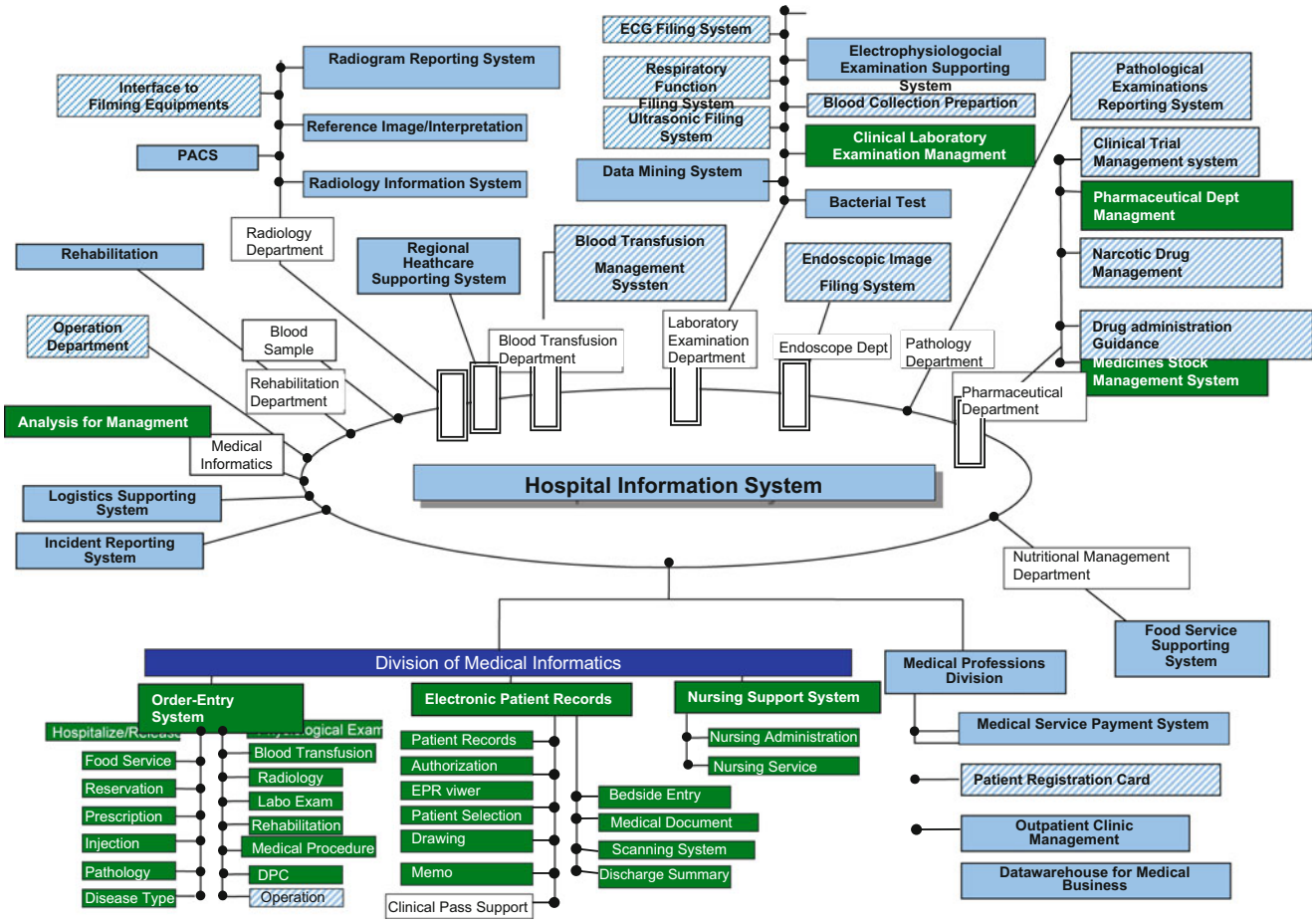

Fig. 2 Hospital information system in Shimane University Hospital

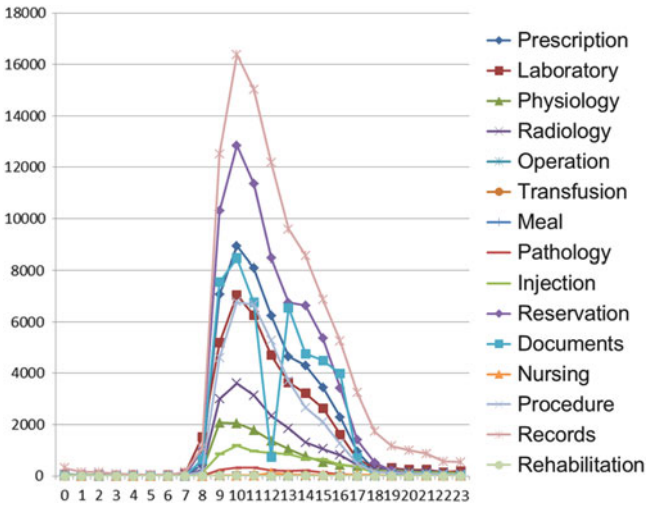

Fig. 3 Chronological overview of total number of orders (fiscal year 2010)

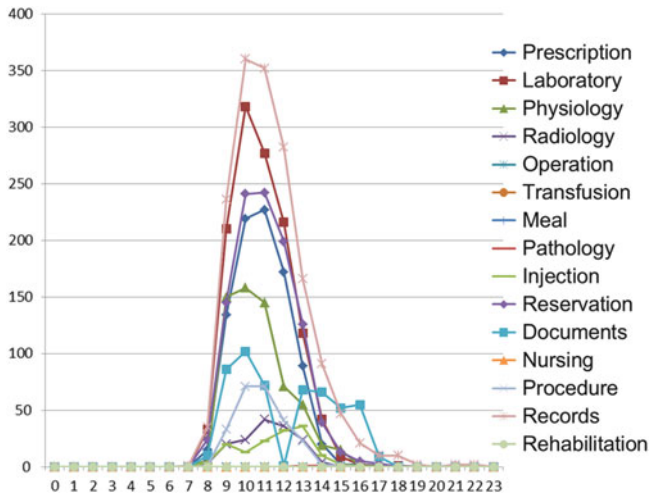

Fig. 4 Chronological overview of orders of hepatology (fiscal year 2010)

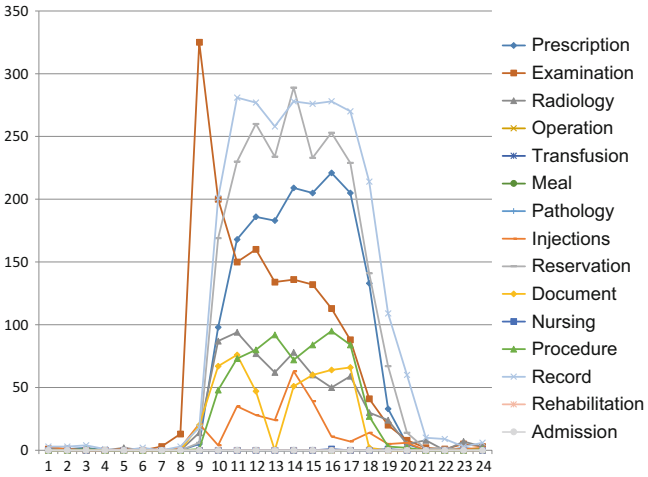

Fig. 5 Chronological overview of orders of rheumatology (fiscal year 2010)

few, but not zero (<1 %), which shows that due to some exceptional factors, the same error will occur.

Thus, these patterns indicated the lower quality of clinical service, which should be improved. We started the improvements of the interface of hospital information system as shown in Sect. 3.

3 Methods

3.1 Settings

Figure 6 depicts the workflows of outpatient clinic of hepatology and rheumatology, which are obtained by the interviews with the clinicians. Since hospital information system stores the logs of clinical actions, the statistics of history of service can be calculated from the service log. Thus, these histories can be visualized as Figs. 3 and 4, respectively.

Then, the next step is to measure the temporal interval between these steps: the time needed between reception and execution of order, the time needed between execution of order and its report, and the time needed between reporting and physical examination. Also, since each patient has a reserved timeslot, the temporal difference between reservation and actual examination is recorded. Tables 1 and 2 shows the statistics of waiting time of hepatology and rheumatology in fiscal year 2010. For example, the first column, reception to laboratory division, shows that the patients of hepatology waited for laboratory examination for about 10 min, but those of rheumatology waited for 15 min. Since these medians are the same, the average values show that the distribution of waiting time of rheumatology is heavier than that of hepatology.

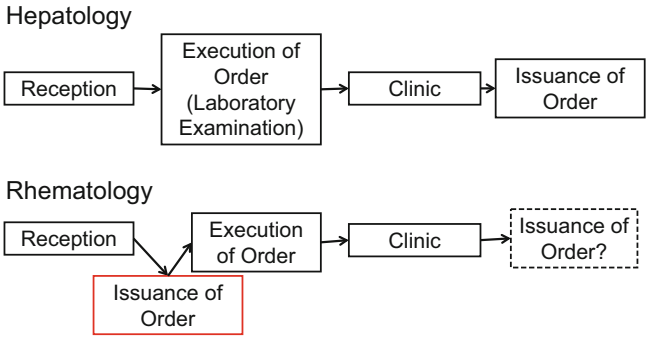

Fig. 6 Workflow of outpatient clinic of hepatology and rheumatology

Table 1 Statistics of waiting time of hepatology and rheumatology in fiscal year 2010

	Hepatology		Rheumatology	
	Average	Median	Average	Median
Reception-lab	10.48	4	14.83	4
Lab-lab report	25.22	20.0	19.0	17
LaboReport-clinic	96.83	77.0	95.58	77.0
Reservation-clinic	48.45	31.0	51.82	48.0

3.2 Two Improvements

After discussion with rheumatologists, in fiscal year 2011, we first set up the direct interface, which seemed to solve the problem mentioned above. The error is twofold. When clinicians made the reservation of a patient, they input the comment in the reservation confirmation, such as "laboratory examinations needed," but the doctors forgot to issue the orders. Then, the patients and laboratory staff recognized the missing orders when they visit the examination room. Then, the laboratory staff will call the doctors and ask them to issue an order. Since it seemed that the discrepancy between the description of reservation confirmation and the issued order was the main problem, the first step was to implement an interface which alerts the discrepancy: if a clinician input the comment on laboratory examination in a reservation sheet and he/she has not yet issued an order before they closed their windows for a patient, an alert will come up from the screen.

After a 1-year trial, statistics showed that the improvement in waiting time was very small; as shown in the next section, we discussed with rheumatologists again, and they asked us to prepare for the interface for checking the orders when they finished their clinic and before they logged off. Thus, in fiscal year 2012, we set up the management screen where all the forgot orders for patients who visited that day will be displayed, and the doctors can go back to issue orders.

Table 2 Statistics of waiting time of hepatology from 2010 to 2013

	Reception to laboratory	Laboratory examination to reporting	Reporting to inspection	Reservation to inspection
2010	10.17 ± 19.31	23.95 ± 17.53	85.60 ± 66.19	36.16 ± 58.00
2011	10.48 ± 20.00	25.21 ± 17.25	96.83 ± 79.18	48.45 ± 76.20
2012	8.94 ± 22.38	27.23 ± 14.98	92.14 ± 73.68	44.10 ± 67.37
2013	7.79 ± 20.29	26.04 ± 13.60	95.57 ± 73.85	43.94 ± 65.67

3.3 Quality Evaluation

From the service log, the times when a patient came to visit a reception and a laboratory division, when results of laboratory examinations were output, when a doctor started to examine in his/her clinic was extracted, and the time differences between events were calculated, and these values were used for the evaluation statistics. Fiscal years 2010, 2011, and 2012 were regarded as the baseline, the period when the first improvement was implemented and that when the second improvement implemented, respectively. Comparison of statistics (median and average) was used for evaluation, and Tukey test was applied for checking the differences during 3 years. For statistical analysis, R3-1-1 was used.

4 Results

4.1 Comparison Among 2010–2013 (Hepatology)

Figure 7 shows the temporal change of averaged values of temporal intervals from 2010 to 2013 in hepatology. Interestingly, although the difference between 2010 and 2011 is very small, that between 2011 and 2012 is statistically significant, which suggested that the second improvement was observed even for hepatology (Table 2). Compare with the second one, the first one did not affect the process for hepatologists. Moreover, the other waiting times increased, so total waiting time was not changed. Thus, although patient satisfaction may have been improved for laboratory examination, overall satisfaction may not. Table 3 shows the results of Tukey test with respect to the time interval between reception and execution of laboratory examinations. The results supported intuitions obtained from Fig. 7 and Table 2.

4.2 Comparison Among 2010–2013 (Rheumatology)

Figure 8 shows the temporal change of averaged values of temporal intervals from 2010 to 2013 in rheumatology. In this division, since the values are monotonically decreasing, both of the interface implementations are effective, although the difference between 2010 and 2011 is not statistically significant. The differences also show that the second improvement is much better than the first one also for rheumatology (Table 4). However, the other waiting times increased, so total waiting time was not changed. Thus, although patient satisfaction may have been improved for laboratory examination, overall satisfaction may not.

Table 5 shows the results of Tukey test with respect to the time interval between reception and execution of laboratory examinations. The results supported intuitions obtained from Fig. 8 and Table 4. Furthermore, p-values are much smaller than ones for hepatology.

5 Discussion

Although evaluation of technology in hospital, including hospital information system is important, empirical evaluation has just started [13]. One of the reasons is that it is very difficult to acquire evaluation data in an automatic way and usually questionnaires of end users are used for estimation, similar to software evaluation in other fields. However, software services are now embedded not only into large-scale software but also into hardware, where executed histories (logs) are automatically collected as "big data." Thus, from the viewpoint of big data analytics, the way how to use the stored data is indispensable for future improvements in embedded services. The key point is that big data analytics and data mining are discussed in the context of "retrospective analysis," where the evidence obtained is not stronger than that obtained by "prospective analysis." Active mining process may start from such prospective analysis, but intervention by the obtained results will make the analytic process prospective, which means that the active mining process will give an important tool for designing software evaluation.

5.1 Our Goal: Framework on Data-Mining Based Healthcare Services

Figure 9 shows our goal for hospital services, which consists of the following three layers of hospital management:

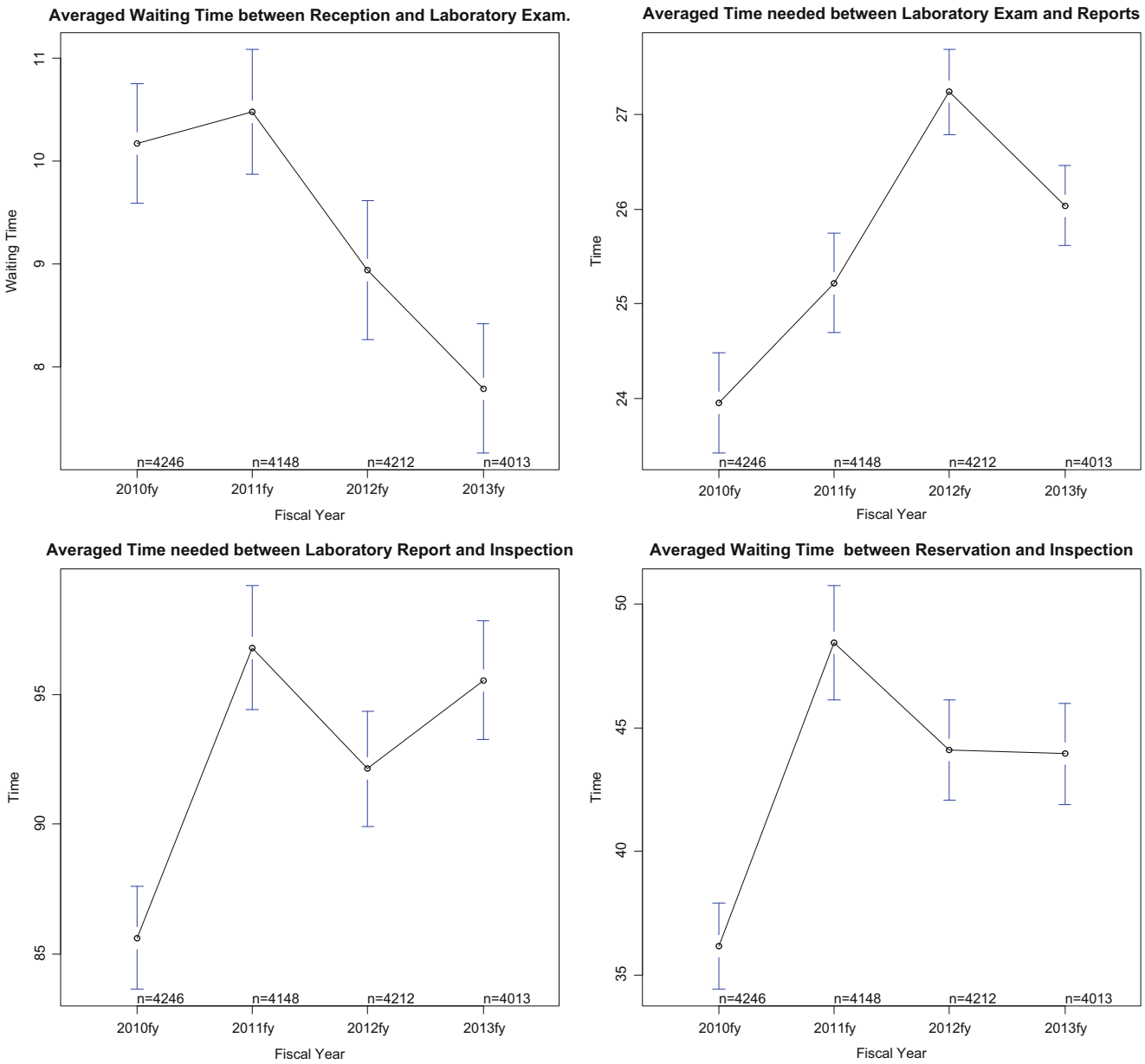

Fig. 7 Comparison among waiting time of hepatology in 2010–2013

Table 3 Tukey test for time interval between reception and execution of laboratory examinations (p-value)

	2010	2011	2012	2013
2010	–	0.8992695	0.0301240	0.0000008
2011		–	0.0033875	<0.0000001
2012			–	0.0520923

services for hospital management, services for medical staff, and services for patients. Data mining in hospital information system plays a central role in achieving these layers.

The first layer is called services for patients which supports the improvement of healthcare service delivery for patients. This is a fundamental level of healthcare services in which medical staff directly gives medical services to the patients. Patient records and other results of clinical examinations support the quality of this service.

The second layer is called services for medical staff which supports decision making of the medical practitioner. Patient histories and clinical data are applied to data-mining techniques which gives useful patterns for medical practice. Especially, detection of risk of patients, such as drug adverse effects or temporal status of chronic diseases will improve the qualities of medical services. The top layer is called services for hospital management. This level is achieved by capturing global behavior of a hospital: the bridging

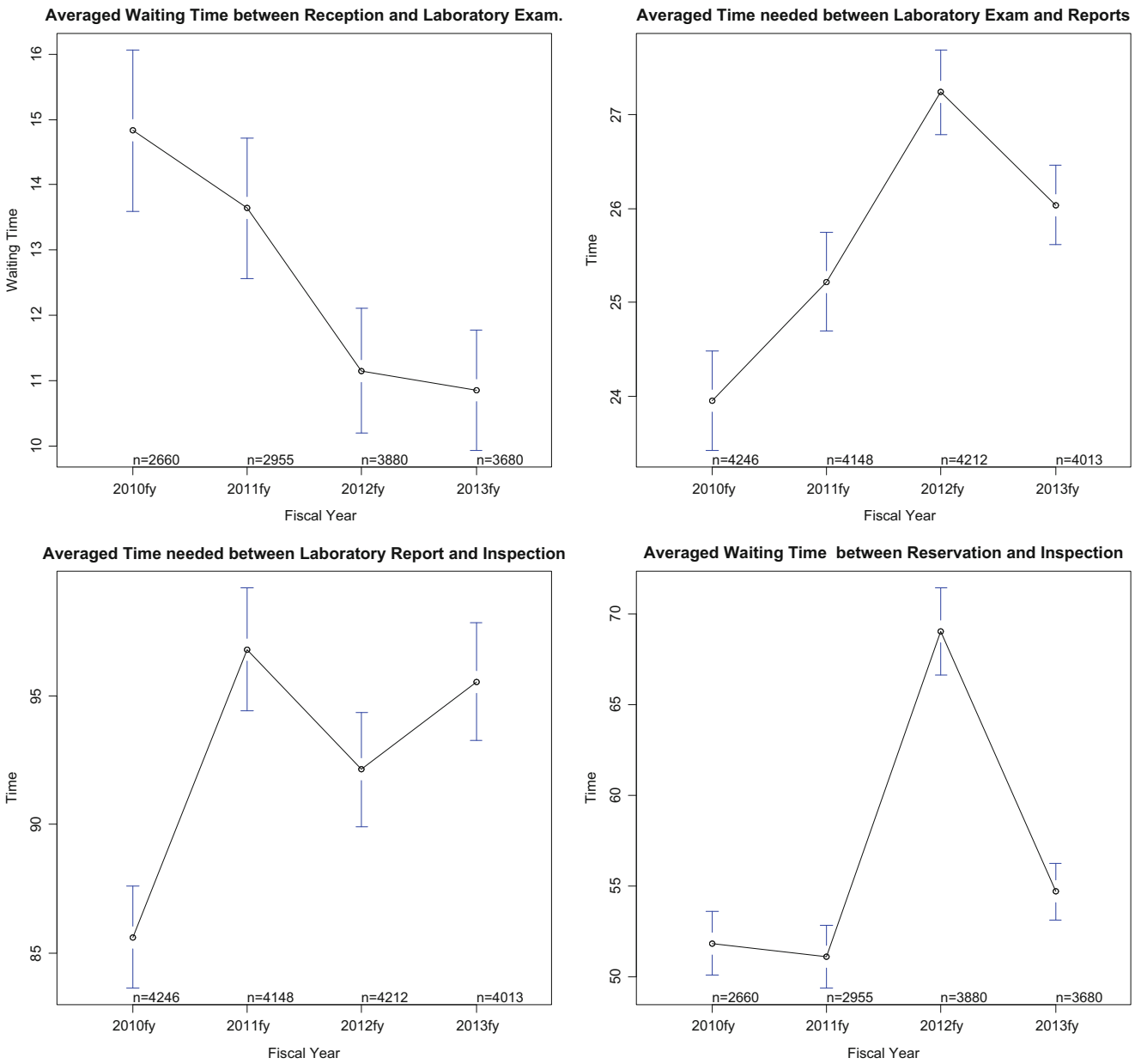

Fig. 8 Comparison among waiting time of rheumatology in 2010–2013

Table 4 Statistics of waiting time of rheumatology from 2010 to 2013

	Reception to laboratory	Laboratory examination to reporting	Reporting to inspection	Reservation to inspection
2010	14.83 ± 32.50	19.98 ± 13.67	95.58 ± 84.60	51.82 ± 46.21
2011	13.64 ± 29.64	21.34 ± 13.33	96.16 ± 81.6	51.08 ± 47.88
2012	11.16 ± 30.52	22.05 ± 11.08	115.71 ± 101.70	69.05 ± 76.70
2013	10.85 ± 28.52	22.01 ± 11.12	101.83 ± 85.07	54.68 ± 47.93

Table 5 Tukey test for time interval between reception and execution of laboratory examinations (p-value)

	2010	2011	2012	2013
2010	–	0.4519799	0.0000080	0.0000014
2011		–	0.0041991	0.0010783
2012			–	0.9725369

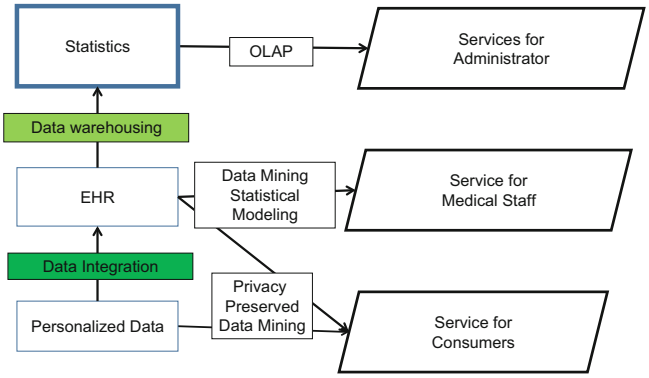

Fig. 9 Service-oriented healthcare management

between microscopic behavior of medical staff and macroscopic behavior of hospital is very important to deploy medical staff in an optimal way for improving performance of the hospital.

5.2 Future Healthcare Analytics

Although electronic patient records store data for disease management, this may not be enough for comprehensive management of chronic diseases, because a patient may visit his/her outpatient clinic every 2 weeks to 3 months. On the other hand, self-monitoring data or consumer health data can record the patients' behavior every second to hour. Thus, medical records can be viewed as a summarized or averaged function of big sensor data. Since temporal intervals for data collection are different, conventional temporal analysis cannot be applied to integrated data. Thus, a new type of mining techniques should be required. If we can develop mining techniques for complex temporal data, the future healthcare analytics will be given as Fig. 10, which leads to evidence-based personalized health.

Figure 11 will show the final picture after we achieve the implementation of mining temporal complex data from the viewpoint of medical staff. Data integration of consumer health data and electronic patient records will give almost complete data for patients' status. Mining such data will

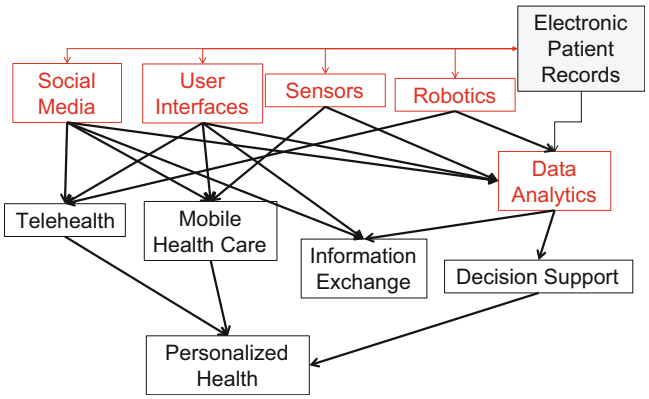

Fig. 10 Innovative healthcare analytics

discover knowledge useful for disease management for each patient, which will give a tool not only for decision support from medical staff but also for patients' decision. This will enhance innovative healthcare service. From the viewpoint of process management, the process can be summarized as Fig. 12. More discussions can be found in [15, 16].

6 Conclusions

In this paper, we introduce the following data-mining-centered software development process. First, data extracted from hospital information system is used for capturing the peculiarities of the divisions in the university hospital. Then, the mining results were interpreted by medical staff and the solutions were discussed. Based on the discussions, new two types of interfaces were developed, whose performance was evaluated by using the service. The one is the embedded system which alerts the discrepancy between doctors' decision and their issued orders and reduces the errors on missing orders. The other is the final checking system where the end users can see the whole executed orders during their clinic, which manages the discrepancy between decision and issuance. After implementation, service logs were collected and analyzed by conventional statistical techniques. In other words, the process was empirically evaluated in Shimane University Hospital. The results show that the latter method gained higher performance than the form method with respect to response time. The process, which can be viewed as a variant of active mining process, will give a new framework for quantitative evaluation of software development in hospital information system, which can be viewed as an application of active mining process.

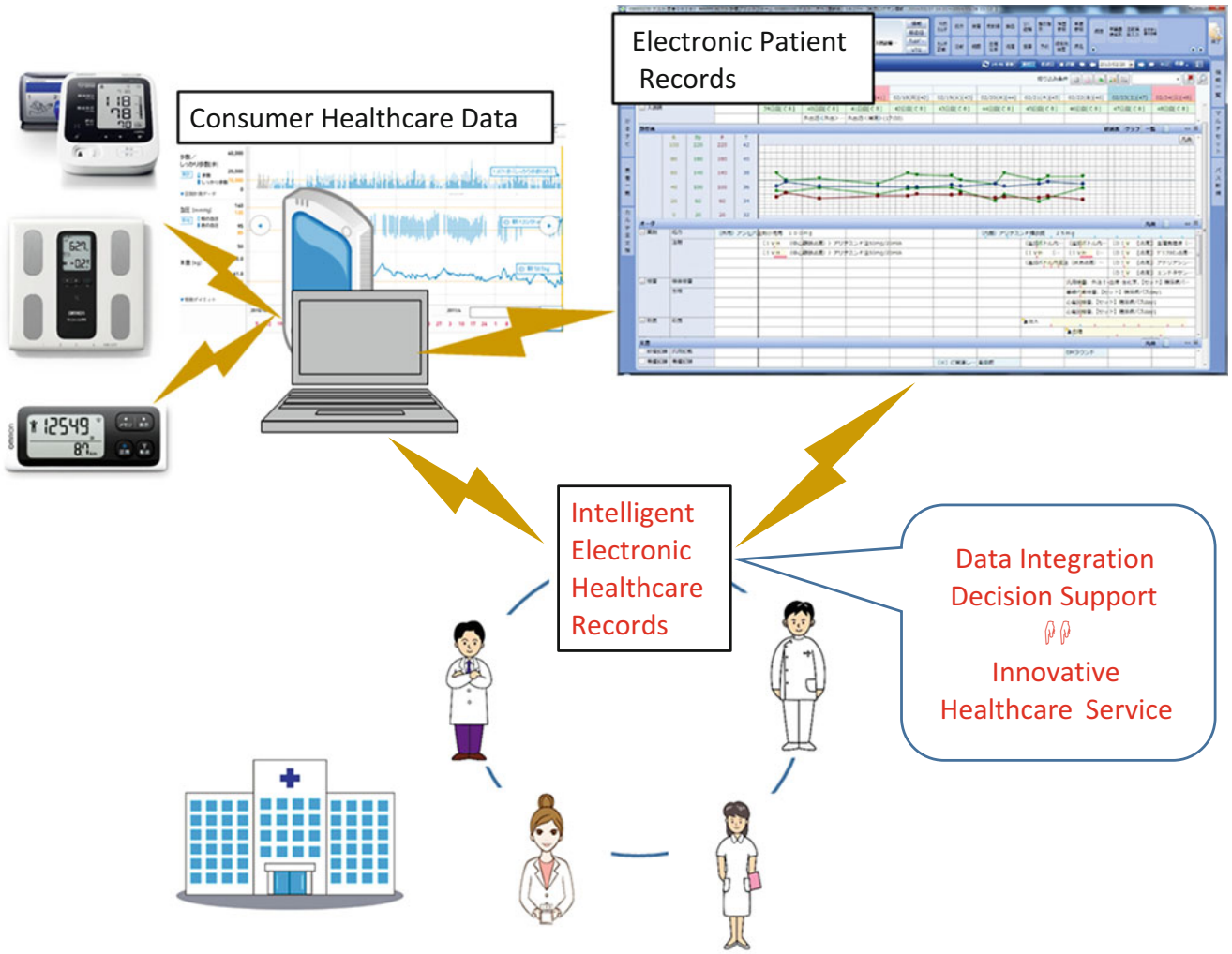

Fig. 11 Innovative healthcare analytics

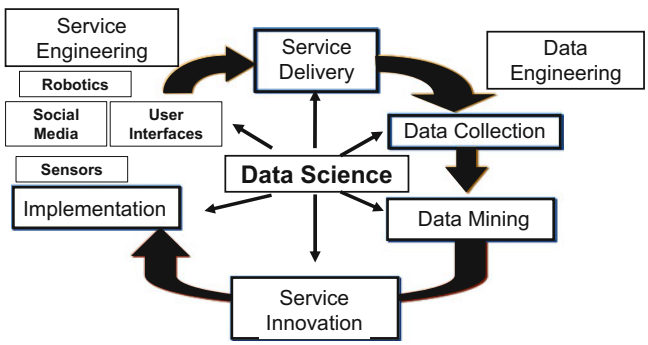

Fig. 12 Healthcare service process

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References

1. Shortliffe, J. Cimino (Eds.), Biomedical Informatics: Computer Applications in Health Care and Biomedicine, third ed., Springer, 2006.
2. Shusaku Tsumoto, Knowledge discovery in clinical databases and evaluation of discovered knowledge in outpatient clinic, Information Sciences,124, pp. 125–137, 2000.
3. Shusaku Tsumoto, G5: Data mining in medicine, Handbook of Data Mining and Knowledge Discovery, W.Kloesgen and J. Zytkow, Eds. Oxford: Oxford University Press, 2001, pp. 798–807.
4. Shusaku Tsumoto, Takahira Yamaguchi, Masayuki Numao, Hiroshi Motoda (Eds.): Active Mining, Second International Workshop, AM 2003, Maebashi, Japan, October 28, 2003, Revised Selected Papers. Lecture Notes in Computer Science 3430, Springer 2005, ISBN 3-540-26157-5

5. Bichindaritz, Memoire: a framework for semantic interoperability of case based reasoning systems in biology and medicine, Artif. Intell. Med. 36 (2): 177–192, 2006.
6. Habib, J. L. "EHRs, meaningful use, and a model EMR". Drug Benefit Trends 22 (4): 99–101, 2010.
7. Yuko Tsumoto, Shusaku Tsumoto: Exploratory Univariate Analysis on the Characterization of a University Hospital: A Preliminary Step to Data-Mining-Based Hospital Management Using an Exploratory Univariate Analysis of a University Hospital. The Review of Socionetwork Strategies 4(2): 47–63 (2010)
8. Yuko Tsumoto, Shusaku Tsumoto: Correlation and Regression Analysis for Characterizations of a University Hospital. The Review of Socionetwork Strategies 5(2): 43–55 (2011).
9. Shoji Hirano, Shusaku Tsumoto: Multiscale Comparison and Clustering of Three-Dimensional Trajectories Based on Curvature Maxima. International Journal of Information Technology and Decision Making 9(6): 889–904 (2010)
10. Shusaku Tsumoto, Shoji Hirano: Detection of risk factors using trajectory mining. J. Intell. Inf. Syst. 36(3): 403–425 (2011)
11. Shusaku Tsumoto, Shoji Hirano: Multidimensional temporal mining in clinical data. IHI 2012: 563–572, 2012.
12. Shusaku Tsumoto, Haruko Iwata, Shoji Hirano, Yuko Tsumoto: Similarity-based behavior and process mining of medical practices. Future Generation Comp. Syst. 33: 21–31 (2014)
13. Miniati R, Frosini F, Cecconi G, Dori F, Gentili GB. Development of sustainable models for technology evaluation in hospital, Technol Health Care. 2014 Aug 5. [Epub ahead of print]
14. Writer's Handbook. Mill Valley, CA: University Science, 1989.
15. Shusaku Tsumoto and Shoji Hirano: Integration of Consumer Healthcare Data and Electronic Medical Records for Chronic Disease Management, Proceedings of IEEE GrC 2014, 3110–315, 2014.
16. Shusaku Tsumoto: Healthcare Service Innovation Process, SRII 2015 Global Conference (submitted).

A Consideration of the Pricing Structure of Aesthetic Services: An Example of Consumer Decision Making with Ambiguous Information

Ryoko Wada

Abstract

This study discusses the microstructure of the prices of aesthetic services using the model developed by Epstein and Schneider [1]. Because ambiguity regarding the quality of novel aesthetic technology prompts consumers to behave based on the assumption of the worst possible outcome, the demand for aesthetic services is low before the consumer experiences a novel aesthetic service. In addition, even though visitors see signals of the good quality of future services through their first experience, they remain pessimistic regarding the quality of the future services because of the variance in outcomes. For consumers, purchasing multiple tickets in one specific salon increases idiosyncratic risk. Thus, transparent information is crucial to increasing demand.

Keywords

Decision making • Ambiguity • Uncertainty • Bayesian update • Price structure • Aesthetic services

1 Introduction

New aesthetic salon services that are delivered using novel technologies, such as body slimming, breast lifts, leg rejuvenation, and face spot removal, are provided at deeply discounted prices, which are usually 50 % of regular prices. Customers who experience the new services and effectiveness of the novel technologies have four possible subsequent actions: (1) purchase a package of multiple services that are not as deeply discounted as the trial services; (2) visit another salon to continue their search for services at deeply discounted prices; (3) postpone their decisions to purchase multiple tickets, visit the same salon at a later date, and purchase the services at normal undiscounted prices; and (4) purchase no more tickets at any salon.

According to a report by market research company Recruit, "The beauty census 2014 (second half of the year): Aesthetic industry" [3], concerning the consumption of facial aesthetic services, the most frequent way consumers buy tickets is "pay-as-you-go," in which they pay after receiving the service in salons (i.e., they do not pay for the service in advance), accounting for 52 % of all ticket purchases. About 39 % of the purchases are for so-called trial services or first purchase of a service at a deeply discounted price. This implies that customers who experienced the first trial course at a salon continue to visit the same salon and pay for the services at the regular price proposed by the salon.

With regard to body slimming aesthetic services, the most frequent way consumers purchase a service is through the trial service, accounting for 61 % of all purchases. Pay-as-you-go purchases account for 34 % of total purchases, and advance purchases account for 36 %.

For any salon, sales from trial services that do not lead to subsequent sales at normal prices result in low profit. Most salons are micro-personal management companies, and therefore, the acquisition of customers who would purchase services regularly from them is very important. Furthermore,

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over half of their visitors pay only for the introductory discounted prices, and so, customers who end up signing long-term contracts with the salon essentially subsidize the trial services of the other visitors. Such a price structure does not reward customers with a high willingness to pay for aesthetic services in the long run. This study clarifies what is needed for the aesthetic services industry to avoid such a situation and to increase demand.

I begin by discussing the differences between the purchasing behavior of facial aesthetic services consumers and body slimming aesthetic services consumers. The greatest differences are in the consumers' uncertainty about the effectiveness and safety of new technology used in the services.

While the technologies for facial aesthetic services have been established for quite some time, those for body slimming body are advancing quite rapidly. In addition to endermologie (a technology that works on subcutaneous fat by applying machinery stimulus to the skin for deep reactive activity by dormant cells), which was introduced a few years ago, other new technologies have emerged in recent years, such as cavitation (a technology that forms an empty space within a solid part of the body using radio waves; the same technology is used for medical examinations of the internal body). Customers do not know the effects of using these technologies before they actually experience the service and, so, are uncertain about the technology's effectiveness as advertised by the salon. The pay-as-you-go price of a service is normally much higher than when the service is purchased in advance as part of a package of tickets. Salons that supply packages tickets could explain the reason for the price structure to ensure the results of a slimmed-down body by successive use of the machine and massage. Furthermore, when a trial service customer cannot afford to purchase the package of services (which usually includes at least three more sessions of the service) thereafter, the salon could offer one or two more sessions of the service at a middle price (i.e., between the introductory and regular prices).

Therefore, in the aesthetic services industry, a price structure is observed in which the price of a service increases with the frequency of purchase. Such structure is seldom observed for other goods and services. It is possible that this price structure is adopted as part of a price discrimination strategy, but it is also reasonable to consider that the increasing prices are caused by the fact that consumers cannot form a unique distribution of the variation of the quality of the services. Because of the ambiguous information on aesthetic services, consumers consider the advanced purchase of such services as risky, just like the purchase of lottery tickets. This study determines what needs to be done to increase the demand for aesthetic services given the ambiguous information available to customers. The model developed in this study essentially is an extension of that introduced by Epstein and Schneider [1].

2 Basic Model

2.1 A Lottery Model of Choice with Ambiguous Information

In this section, I discuss how consumers form their priors from their experience of services when they cannot acquire the information as a unique distribution of outcomes with probability.

I compare the updating of the prior using the signal following Bayes' rule and the updating using the recursive utility introduced by Gilbor and Schmeidler [3].

2.1.1 The Case in Which the Priors Are Updated Using Bayes' Rule

Assume that the parameter $\theta \in \Theta$, which consumers would like to know, distinguishes the true utility level from future aesthetic services, if the consumers could have a unique probability density function $\theta \sim N(m, \sigma^2)$. However, if the consumers' priors are decided by a signal with an error term that follows a normal distribution, the signal can be expressed in the form $S = \theta + \epsilon, \epsilon \sim N(0, \sigma^2)$. In this case, the consumers update their priors following Bayes' rule:

$$\theta \sim N\left(m + \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_z^2}(s - m), \frac{\sigma_z^2 \sigma_\theta^2}{\sigma_\theta^2 + \sigma_z^2}\right).$$

$\sigma_s^2 \in \left[\underline{\sigma_s^2}, \overline{\sigma_s^2}\right]$ is acquired. m shows the average utility from the aesthetic services. It is clear that the ex post distribution reflecting the signal that is acquired from the first experience depends on the difference between s and m.

Consumers who acquire the signal s > m would estimate $\boldsymbol{\theta}$ such that they would obtain a good signal because of the high variation in the signals, or they would estimate $\boldsymbol{\theta}$ such that they would obtain a bad signal because of the low variation in the signals.

Note that both good and bad experiences result in pessimistic estimations of the real parameter and reduce the demand for future aesthetic services.

Consumers can evaluate the high signals they previously acquired that were distributed with a low variance only when they receive two consecutive good signals. If the second experience brings consumers utility that is higher than the average, the consumers become convinced that the technology of the salon's service is reliable, and their willingness to pay for future services shifts upward. This is one possible reason that the price of a service increases with the frequency of use.

2.1.2 Updating Priors with an Ambiguity-Averse Model

Suppose that consumers are not Bayesian but ambiguity averse. Then, their dynamic utility maximization problems are written by the recursive utility function that was introduced by Gilbor and Schmeidler [1]:

$$U_r(c; s^t) = \min_{p_r \in P_r(s^t)} E^{P_r}[u(c_t) + \beta U_{t+1}(c; s^t, s_{t+1})]$$

s^t shows the history of signals and $\{P_t(s^t)\}$ is the set of the beliefs. In this multi-prior model, consumers always decide their consumption volume c under the assumption that the worst-case scenario might occur. With this formulation, the purchase of future services is decided by the future discount rate β, the specification of the belief function by the first signal s_0 and the history of signals, and the prospect of utility that is decided by the belief function.

In this setting, the priors of the future services that consumers want to know are given as follows.

Let $\mathcal{M}_0$ show the probability measure on the parameter space Θ. A distribution ℓ of s is decided by the likelihood function $\mathcal{L}$, and the history of likelihood is

$\ell^t = (\ell_1, \ell_2, \ldots \ell_r) \in \mathcal{L}^t$. Consumers form the set of beliefs $\{P_r(s^t)\}$ as follows.

First, a posterior of period t $\mu_t(c; s^t, \mu_0 \ell^t)$ is formed as an update of the first prior $\mu_0 \in \mathcal{M}_0$ following Bayes' rule. Next, the entire set of posterior $\mathcal{M}_t(s^t)$ is acquired by updating the derivatives $d\mu_t$ as for all $\mu_0 \in \mathcal{M}_0$ and as for all $\ell^t \in \mathcal{L}^t$. By integrating $d\mu_t$, the one-step-ahead set of beliefs $\{P_t(s^t)\}$ is acquired.

2.2 The Case in Which a Consumer Selects a Salon from Among *n* Available Salons

In this subsection, the case in which consumers acquire signals from their experiences in the selected salon among several salons in the market is considered. If consumers live in the city area, they usually can choose from among many salons that supply services using the same technologies.

Consider the case in which a consumer selects salon A from among n available salons. The signal that the consumer receives has two dimensions: the idiosyncratic error of the salon and the error attributed to the specific technology. The idiosyncratic error of a salon is expressed by $\alpha \geq 0$. The signal that the consumer receives is expressed by $s = \alpha\epsilon^A + \epsilon^{\text{tec}} + \epsilon^i$. Note that when n is large enough, α is close to 0. If there is only one salon for a consumer living in a rural area, then $n = 1$, $\alpha = 1$.

The distribution of one-step-ahead beliefs are expressed as

$$\epsilon \sim N(0, \alpha^2\sigma_A^2 + \sigma_{\text{tec}}^2 + \sigma_i^2).$$

When the variation of the technology is unique, the regression coefficient is

$$\gamma(\sigma_{\text{tec}}^2) = \frac{\text{cov}(s, \epsilon^{\text{tec}} + \epsilon^1)}{\text{var}(s)} \frac{\alpha\sigma_A^2 + \sigma_1^2}{\alpha^2\sigma_A^2 + \sigma_1^2 + \sigma_{\text{tec}}^2}.$$

In this case, $\gamma(\sigma_{\text{tec}}^2)$ shows the measurement of the quality of the technology, which is partially resolved ambiguity by the signal s. In this case, the posterior density function acquired by the signal s also follows a normal distribution.

However, when it is assumed that consumers are not sure about the effectiveness of novel technology of the aesthetic service, but know that the technology has possible ranges in variation, then

$$\sigma_{\text{tec}}^2 \in \left[\underline{\sigma_{\text{tec}}^2}, \overline{\sigma_{\text{tec}}^2}\right].$$

It is easy to understand that γ also has some range in its coefficients, $\gamma \in \left[\overline{\gamma}, \underline{\gamma}\right]$. The distance of $\overline{\gamma} - \underline{\gamma}$ shows the size of the ambiguity aversion. Note that the quality of technology is no longer measured from γ.

Here, the effect of an experience in salon A on the price of an aesthetic service is discussed. The utility of the service supplied by salon A is expressed as $d = m + \epsilon^{\text{tec}} + \widetilde{\epsilon}^i$, and the sum of the utilities of the services supplied by the other salons is expressed as $\widetilde{d} = \widetilde{m} + \epsilon^{\text{tec}} + \widetilde{\epsilon}^i$. Consider the case in which a consumer purchases all of the tickets in the market; her expected utility from all the tickets becomes $d_p = \frac{1}{n}dA + \frac{n-1}{n}\widetilde{d}$. She may succeed in diversifying the risks.

2.2.1 Purchasing Any Package of Tickets at a Specific Salon Inevitably Increases Idiosyncratic Risk

Assume that a consumer is risk averse. The utility is expressed by $u(c) = -e^{-\rho c}$, with the parameter of absolute risk aversion ρ. The reservation price at $t = 0$ of salon A is $p_0^A = m - \rho\text{cov}(\text{d}, d_{\text{p}}) = m - \rho\left(\sigma_{\text{tec}}^2 + \frac{1}{n}\sigma_i^2\right)$.

After the trial experience, the reservation price at $t = 1$, which reflects the prior that is updated by Bayes' rule, becomes

$$p_1^A(s) = m + \gamma s - \rho\left(\left(1 - \alpha\underline{\gamma}\right)\sigma_{\text{tec}}^2 + \frac{1}{n}\left(1 - \underline{\gamma}\right)\sigma_i^2\right).$$

Note that if a consumer has many alternatives and n becomes large, the term for the idiosyncratic risk approaches 0, and only the ambiguity and risk of the technology is left. The purchase of the package of tickets inevitably increases the idiosyncratic risk. Even though the unit price for the long-term contract is reduced by the salon, it is still not attractive enough for most customers.

2.2.2 Ambiguity Aversion of Consumers Results in Deeply Discounted Prices for the Trial Service

Assume that a consumer is ambiguity averse; the reservation price that reflects her demand based on recursive utility can be expressed by

$$p_a^A(s) = \min_{\sigma_{\text{tec}}^2 \in \left[\underline{\sigma_{\text{tec}}^2}, \overline{\sigma_{\text{tec}}^2}\right]} E[d]s] = \begin{cases} m + \underline{\gamma} s & \text{if} \quad s \geq 0 \\ m + \overline{\underline{\gamma}} s & \text{if} \quad s < 0 \end{cases}.$$

Note that even though the number of salons she visits increases, she decides her consumption based on the worst-case scenario. Even though she distinguishes the idiosyncratic error from the common error of the technology, her estimation of the future satisfaction from the services is always low. When she receives a highly positive signal, she estimates a lower variation of the technology, and when she receives a negative signal, she estimates a high variation of the technology.

The price structure in which any signal from the first experience yields pessimistic estimations holds again; therefore, it seems unclear whether the consumer will update her expectation using Bayes' rule or whether she will decide her consumption based on minimizing her risk under ambiguity.

However, there is a big difference in the timing of the devaluation between Bayesian and ambiguity-averse behavior.

Consider the case in which a consumer who is ambiguity averse thinks about whether or not she will receive a signal from her experience from the trial. Her reservation price is dependent on how ambiguity averse she is, the common risk of the technology, and the idiosyncratic risk of the salon that she may visit:

$$\begin{aligned} p_a^A &= \min_{\sigma_{tec}^2 \in \left[\underline{\sigma_{\text{tec}}^2}, \overline{\sigma_{\text{tec}}^2}\right]} E\left[p_1^A\right] \\ &= \min_{\sigma_{\text{tec}}^2 \in \left[\underline{\sigma_{\text{tec}}^2}\, \overline{\sigma_{\text{tec}}^2}\right]} E\left[m + \underline{\gamma} s + \left(\overline{\gamma} - \underline{\gamma}\right) \min\{s, 0\}\right] \\ &= m - \left(\overline{\gamma} - \underline{\gamma}\right) \frac{1}{\sqrt{2\pi\underline{\gamma}}} \sqrt{\alpha\sigma_{\text{tec}}^2 + \sigma_i^2}. \end{aligned}$$

This striking result comes from the ambiguity-averse consumer devaluing the quality of the services before she receives any signal. Therefore, the existence of ambiguity aversion explains the more than 50 % discount of service prices during trials.

Even though technological development is desirable for consumers, it takes time for a technology to be proven safe and/or effective as suppliers advertise. The lack of information about the technology prompts consumers to behave based on the worst-case outcome of the technology, which, in turn, decreases the demand for the services utilizing the technology.

Furthermore, in reality, consumers cannot distinguish the idiosyncratic errors from the common errors in the new technology, which may also decrease the demand for the aesthetic services.

3 Effectiveness of Models in Increasing Demand for Aesthetic Services: Package of Tickets of a Specific Salon Increases Risk

Most aesthetic service salons are privately run small business. The salons invest in cutting-edge technologies for their services in competitive market and, thus, need to sell long-term contracts to consumers who experience the trial service at deeply discounted prices. However, the purchase of multiple future services is similar to the purchase of lottery tickets that yield outcomes with variations. The distribution of the variation is not unique for customers because the technology is too new for them to know much about its effectiveness. In addition, the variations in the outcomes of the future services may come from the idiosyncratic risk at the salon. Therefore, a customer who experiences a high-quality service may not purchase a package of tickets. This outcome is an unintended tragedy for the suppliers in the short term because the newer is the technology introduced by the salon, the more ambiguity a customer has about the technology, which leads to the customer devaluing the technology's quality. Consequently, any effort by the salon, including staff training and advertisements to promote the salon, will not be rewarded. In the long run, the salon that invested in the new technology may experience financial difficulties and ultimately leave the market, and its customers will no longer be able to enjoy the effective results of the new technology. The exit of several salons from the market reduces the alternatives for customers and increases the idiosyncratic risk; in short, α becomes larger. This outcome, in turn, may cause the other salons to go bankrupt because the lesser diversification for customers further decreases the demand. Recall that if customers are ambiguity averse and their utility is described by the multiple priors model by Gilbor and Schmeidler [2], they devalue the quality of future services before they even experience the services. This outcome can significantly damage small businesses.

To reduce the idiosyncratic risk for customers, a salon may attempt to introduce packages that customers can use in the current salon as well as in other salons.

3.1 Importance of Information Transparency

Information on the expected results from a new technology is decisively important to increase demand. This information

should include the worst-case and best-case outcomes, and the probabilities should be as precise as possible. In addition, the ease of availability and minimal cost of such information on the new technology are very important. The results of the model suggest that the priors made by a signal from a salon may affect the evaluation of future experiences in other salons that utilize the same technology. To help salons avoid such a situation, Recruit Co., Ltd., introduced a reservation system called Hot Pepper Beauty, which can be accessed with a smartphone application. The system enables consumers to compare salons very easily, and the most important feature of the system is the ability of customers to post salon reviews on the website. However, customers do not have incentives to post truthful salon reviews on the website because when a customer posts a review, the corresponding salon discounts its prices. This mechanism encourages some customers to post biased reviews. Therefore, a review mechanism that encourages customers to post fair and truthful reviews is needed in the aesthetic services industry.

4 Unsolved Problem

4.1 Need for Tests Using Field Data

The model in this study should be tested using micro data. The prices should be explained by using the competition power of the market discriminated by area and by the novelty of the technologies.

4.2 Need for a Validity Test of Model Assumption

The model of Epstein and Schneider [1] is strongly based on the assumption that the customers' pessimistic evaluations of the signals are based on the observation of prices and behavior in security markets. Wada [4] tries to test this assumption by an experiment, however, the sample size is not large enough. Future studies should also test in laboratory experiments the assumptions that people consider good signals brought about by a high variation in outcomes and those that people consider bad signals brought about by a low variation in outcomes.

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References

1. Epstein, Larry G. and Martin Schneider, 2008, Ambiguity, Information Quality, and Asset Pricing, The Journal of Finance,Volume 63, Issue 1, Feb 197–228.
2. Gilbor, Issak and David Schmeidler, 1989, Maxmin expected utility of nonunique prior, Journal of Mathemtatic Economics, No. 18, 141–153
3. Recruit, The beauty census 2014, Aesthetic Salons, (http://r-bmr.net/wp-content/uploads/2014/12/B_esthetic_sensus_20141204.pdf)
4. Wada, Ryoko 2007, An Analysis of Mechanism of Dynamic Decision Making under Ambiguity; Choice over Time and Attitude toward Ambiguity, the 4th chapter. Hakuto Shobo, 55–84

Part VI

Social Problems in Service

Designing New Business Development Program Based on Systems Engineering Methodology with Participatory Systems Analysis in Small and Midsized Enterprise

Yoshikazu Tomita, Kyoko Watanabe, and Takashi Maeno

Abstract

Developing new businesses is one of the important activities in Japanese companies. There have been many training programs or professional services for developing new businesses in this country. However, most of them have been designed for large enterprises that are rich in resources. On the other hand, small and midsized enterprises (SMEs) that are poor in resources have little access to such programs or services. Meanwhile, SMEs comprise 99.7 % of the total number of Japanese companies. In order for Japan's economy to have sustainable growth, business development in SMEs is critically important. To solve this problem, this paper proposes a system to design training programs for developing new businesses for SMEs. It employs systems engineering methodology with participatory systems analysis. The evaluation result indicates that this system is quite effective and means a lot for SMEs. By applying systems engineering in service design, our study shows that the designed programs could provide high customer satisfaction, even if they were designed by nonprofessionals.

Keywords

Participatory systems analysis • New business development • Education program • Small and midsized enterprises (SMEs) • Systems engineering

1 Introduction

Developing new businesses is one of the important activities in Japanese companies [1]. More and more institutions are providing education programs for developing new businesses. Most of the programs have been designed for and launched at large enterprises. They are rich in resources and can afford the cost of such employee training. In other words, such programs do not exist for small and midsized enterprises that are rather poor in resources [2].

Japan's economy is supported not only by large companies. Small and midsized enterprises comprise 99.7 % of the total number of Japanese companies. In order for the Japanese economy to have sustainable growth, business development in small and midsized enterprises would be absolutely necessary [3].

For this reason, the demand for new business development education programs for small and midsized enterprises is growing.

This paper proposes a system to design an education program for developing new businesses targeted at small and midsized enterprises. It is based on systems engineering (SE) with participatory systems analysis (PSA). By utilizing SE methodology, the system enables even nonprofessionals or those who have little experience in developing education programs to design solutions.

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2 Problem

Reports say Japan's small and midsized enterprises are not showing constant growth and a number of problems have been pointed out [2]. We summarized them in three points:

1. Lack of recognition in new business development
   There is a strong demand for developing new businesses in small and midsized enterprises [2]. However, the activity has been stagnant because it has been regarded less important than many other agendas. Company executives have been focused much more on improving existing businesses than on developing new businesses. In other words, companies' executives have not recognized the importance of new business development.
2. Lack of resources for business growth
   In many companies, it is difficult to depend on existing resources for the cost of development of new businesses. Especially in small and midsized enterprises, new businesses are often poorly financed because their resource is limited and the way of raising fund is also limited. Those companies cannot afford to outsource consulting and other professional services. Without those services, they don't even know what kinds of resource are needed. Low-cost freelance services do exist, but unfortunately they are not effectively utilized [4].
3. Lack of knowledge on how to think or how to do
   There are few opportunities for small and midsized company executives to learn methodologies for developing new businesses. In Japan, local chamber of commerce and financial institutions provide classes for enterprises, but the contents are limited to accounting or finance. Many noted CEOs also provide lectures, but they are based on empirical approach and poorly reproducible.

In summary, there is a demand for methodology for developing new businesses that would meet the actual situation of small and midsized enterprises. The methodology must be designed so that new business development is reproducible. The methodology must be learnable and usable for small and midsized enterprises through some kind of training programs.

3 Approach

In order to solve the above problems, we employed a hybrid approach of SE methodology and PSA in designing training programs.

3.1 Systems Engineering (SE) Methodology

We employed SE methodology in designing an education program for developing new businesses. In the following section, we discuss what systems engineering methodology is and how it is effective in this study.

3.1.1 What Is Systems Engineering?

According to INCOSE handbook [5], a book published by the world's biggest council for SE, INCOSE (International Council on Systems Engineering), SE is a set of best practices, and it is established to design large-scale complicated systems such as the Apollo project. SE has been developed to make the best use of diversity in the engineering field of study. Its standards have been compiled based on military standards in the United States.

SE is not a tool or technique but a methodology. It is a methodology to think about and solve complicated problems. It can be applied in solving problems in any fields. This methodology enables interdisciplinary systems integration and enables people to design solutions in certain domains even if they are inexperienced in those domains.

SE is considered to be effective not only for designing mechanical systems but also for societal systems. INCOSE is calling for expansion of its role into societal systems [6]. Societal SE requires not only quantitative viewpoints but also qualitative viewpoints. That is why the SE methodology is effectively applied in designing societal systems such as organizations. What is required in the systems engineering is not simply science but the way of thinking between art and science.

3.1.2 SE for Societal Systems Design

What is societal system? P. Checkland was the first researcher to analyze societal systems in an aspect of systems engineering. He discussed societal systems in two aspects [7]. One is an artificial system that is man-made and easily recognized as a system such as automobiles, computer programs, laws, and mathematics. The other is a human activity system where activities are conducted by people in the society. In this aspect, societal systems could be described as human activities and their interrelations. In this study, we employed systems approach that views systems as elements and their interrelations in dealing with societal systems [8].

3.1.3 Application of SE to Societal Systems Design

Structures of societal systems are becoming more and more complicated. Societal systems are consolidated and bring out the best ability as a system of systems [9, 10]. SE is effective in understanding such complicated situations [11].

Fig. 1 Example picture of PSA

3.2 Participatory Systems Analysis (PSA)

Another approach we employed in designing education programs is PSA. This is a bottom-up approach for problem solving conducted not by just the stakeholders but together with external experts [12].

No man-made system is designed naturally. People intentionally design them [8]. Systems are designed and managed with purposes in order to achieve specific goals.

People interact with systems. Especially in social systems, those who interact with the systems are not limited to their direct users or operators, but they include many other stakeholders. Each stakeholder has one's own mental model for the system and its purpose based on his/her own experience, education, understanding, or sense of value [13]. Therefore, it is important to design systems using the PSA methodology that involves many stakeholders of the system (see Fig. 1).

In this study, we employ this approach to identify problems and to analyze systems utilizing tools and techniques developed in the field of systems thinking.

4 Solution Design

4.1 System Boundary

In designing solutions to the problem of small and midsized enterprises, we first defined the boundary of the system of interest.

Elements related to developing new businesses cover many different fields. Interrelations among those elements are quite complicated. According to INCOSE's definition of "systems," new business development is considered as a "system" [5]. To design system solutions, it is necessary to define the boundary of the system of interest.

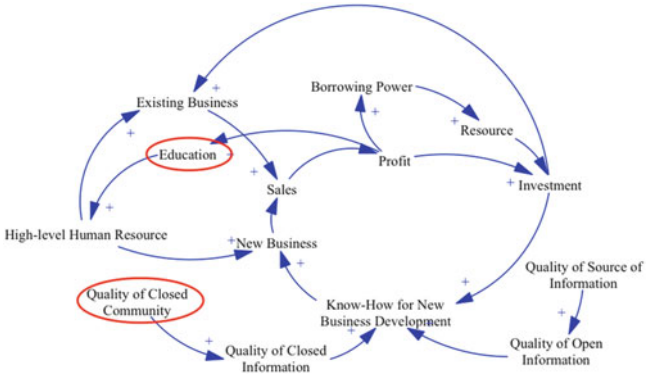

Fig. 2 Leverage point in the causal loop diagram

In order to define the system boundary, we conducted a workshop for small and midsized company executives for developing new businesses in February 2014. First we interviewed and conducted a questionnaire survey on workshop participants and consultants who cohosted this event. Participants discussed the result of the interview and questionnaire and depicted a causal loop diagram. Causal loop diagram is one of the tools to analyze complicated situations in the perspective of causes and their effects. It defines how systems elements are interrelated to each other and visualizes cause-effect relations among the elements [14]. Causal loop diagram was initially developed as a tool for quantitative analysis in systems thinking. But it is now widely used also for qualitative analysis in social science [15].

Using the result of that activity, participants defined a leverage point in the causal loop diagram. The leverage point is where the most important variable to improve the whole system exists.

As shown in the Fig. 2, we found that the most important leverage point (red circle) for developing new businesses in small and midsized enterprises was "guided mastery." We also found that "community support" plays a key role in new business development. We identified these two as key elements for the solution design.

4.2 Design Process

We designed a training program for small and midsized enterprises incorporating "guided mastery" and "community support" as key elements. The program design process consists of the following steps, (1) requirement analysis, (2) architectural design, and (3) program design.

1. Requirement Analysis

According to ANSI/EIA-632, requirements determine "what" will achieve the given goal and "how well" and "in

what conditions" it will be achieved [16]. Requirement analysis is the process where stakeholder requirements are transformed into system requirements with a technical view to fulfill the required quality. The process consists of defining user requirements, clarifying the boundary of the system to be designed, defining the system to be delivered as the result of the design process, and defining technical specifications. To start the program design, we first conducted the requirement analysis.

1.1. Identifying the current circumstance of the object

We identified the current circumstances by both qualitative and quantitative analysis. We utilized tools and techniques including interview, questionnaire survey, and observation. Here, separating "facts" and "opinions" is quite important.

Out of this process, we found three major problems as described in chapter "Design of Service Ecosystem Based on Interactive Design Support in the Case of Job-Hunting Support Services": lack of recognition in developing new businesses, lack of resources, and lack of knowledge on how to think or how to do.

1.2. Clarifying the life cycle of the program

Every man-made system has a life cycle, even if it is not formally defined. In keeping with increased awareness of environmental issues, the life cycle for any system of interest must encompass not only the development, production, and utilization stages but also provide early focus on the retirement stage where decommissioning and disposal of the system occur [5].

Training program is not an exception. It also has a life cycle. As ISO15288 defines, the life cycle model is to be tailored in accordance with the object [17]. Based on the output of the workshop and interview described in Sect. 4.1 above, we defined the life cycle of this training program by tailoring the generic model. Since the objective of the program is the activity of new business development, its life cycle came out as the one focused on operations of the program.

The defined life cycle is as follows. It has three phases: learning phase, active learning phase, and self-practice phase (see Fig. 3). Each phase is divided into three subphases (see Fig. 4).

Analyzing and designing the life cycle involve processes of context analysis and use case analysis. Through iterations of these processes, requirement analysis progresses.

1.3. Defining stakeholders' requirements by context analysis and use case analysis

We conducted context analysis and use case analysis for each of nine subphases. That process enabled us to further clarify the boundary of the solution to be designed.

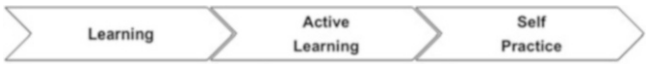

Fig. 3 The defined life cycle as three phases

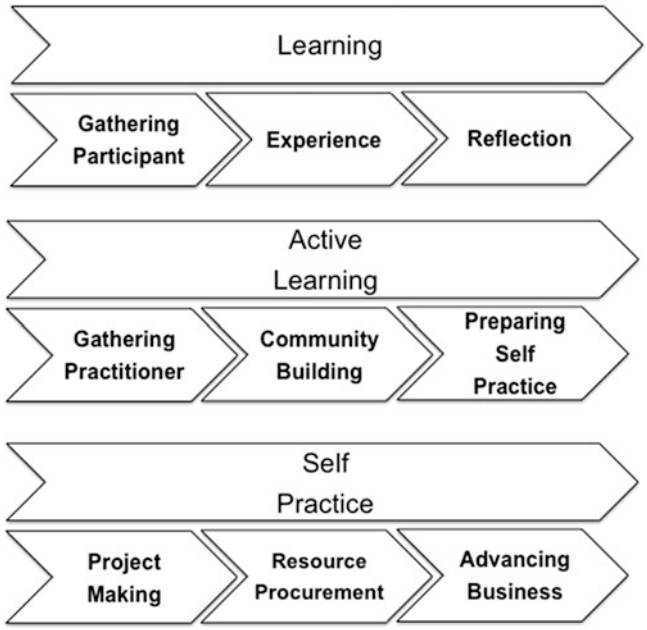

Fig. 4 Three phases divided in six subphases

<Context analysis>

Context analysis is a method to analyze and identify influences that the system would give to and receive from the outer environment. This analysis is conducted on every phase and subphase [18].

No system is designed to exist by itself. It always has interactions with the outer environment. Therefore, the solution must be designed in consideration with such interactions and coping with any influences the systems would give to and receive from the environment. System never works as intended without considering contexts the system would have.

System design starts from requirement analysis. In this process the purpose and the intended environment of the system are clearly defined. So context analysis is a critical process to design the right system.

Context analysis is conducted on every phase. The output of the analysis often largely transforms as the phase changes. In other words, the change in the contexts tells the change in phases.

Figure 5 shows an example of context analysis output we worked out. Putting the training program as a system to be designed in the center, we identified objects that would give and receive influences to and from the system and clarified the context.

Using the output of the context analysis, we determined which objects to include inside the system boundary and

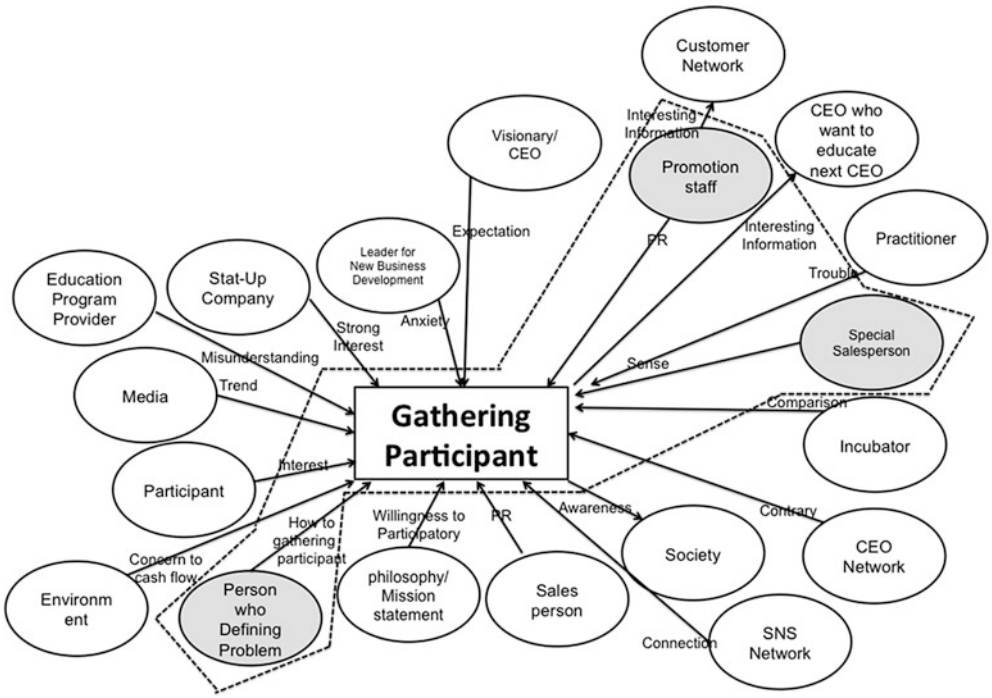

Fig. 5 An example of context analysis output

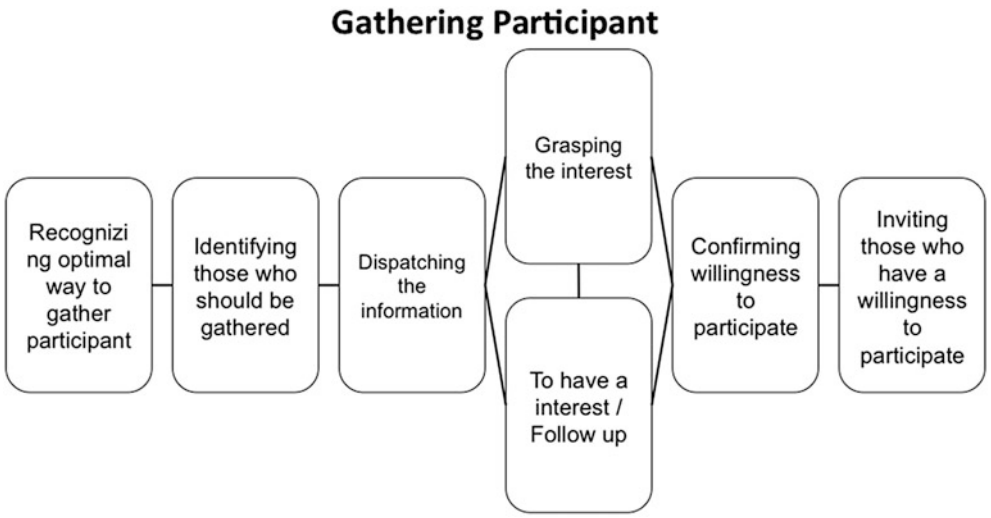

Fig. 6 An example of use case diagram

which to exclude. That is how the system boundary is defined.

<Use case analysis>

Use case analysis is a method to clarify functions and scope of authority the system is required to have by identifying external factors and their interrelations with the system [18]. The external factors include people and things. In this study, by looking at the system in the viewpoints of external factors, we objectively observed the training program to be designed and recognized how the training program would behave in the intended environment. We first depicted a use case diagram and put each use case in descriptions (see Fig. 6).

1.4. Extracting requirement functions for program design

We extracted requirement functions for program design as the final process of requirement analysis. That is a preparatory process to clarify the system to be delivered and to identify technical specifications. Functions are extracted out

of context analysis and use case analysis. The performance necessary for the system to exert is also identified in those analysis. And necessary performance for each function is assigned. When the same functions are extracted from the two analyses, the function extracted from use case analysis is usually given priority over the one from context analysis. Results of context and use case analysis could be revised when necessary.

After defining functions, we put them in a flow diagram. In that process, we defined how the functions behave in order to realize defined requirements for the training program and also to secure completeness of requirements (see Fig. 7).

2. Architectural Design

Architectural design process is where the function and performance required for the system are appropriately allocated to physical elements that constitute the system, thus clarifying the specifications of the physical elements and interfaces among the elements as well [5]. Here, we extracted functions that are necessary to design the training program, identified physical elements, and designed interfaces among the elements.

2.1. Extracting functions for program design

Extracting function process is where the required functions for the system are broken down into lower-layer functions. Here, the abstract required functions are transformed into detailed functions. We conducted this process by depicting function flow block diagram (see Fig. 8). In doing this, functions were broken down in a block with a single function.

The above process eventually clarifies the function flow that fulfills requirements in each phase of the life cycle. This process materializes functions of the system, allowing defining measures to realize the functions.

2.2. Allocating functions to elements

Concrete measures need to be identified to realize functions. This is the process of designing how to realize functions. First, measures necessary to realize functions are identified. In this context, measures can be described as physical elements. Such elements include people, organizations, and engineered things. Then broken-down functions are allocated to identified physical elements. Figure 9 shows the result of this process. All the requirements for the training program were incorporated in the design by defining concrete measures to realize the requirements.

3. Program Design

Based on the architectural design, we designed a concept of the training program. Life cycle of the program consisted of three phases (see Fig. 10).

Based on this concept design, we conducted evaluation.

5 Evaluation

5.1 Evaluation Method

5.1.1 Evaluating Through PSA

PSA is utilized not only for systems analysis but also for designing systems. When utilized for designing, this process is iteratively conducted and constantly gets feedbacks. PSA is an evolutional process and never ends. Especially societal systems such as our training program need to be evolutional [19]. Evolutional systems are constantly evaluated and verified.

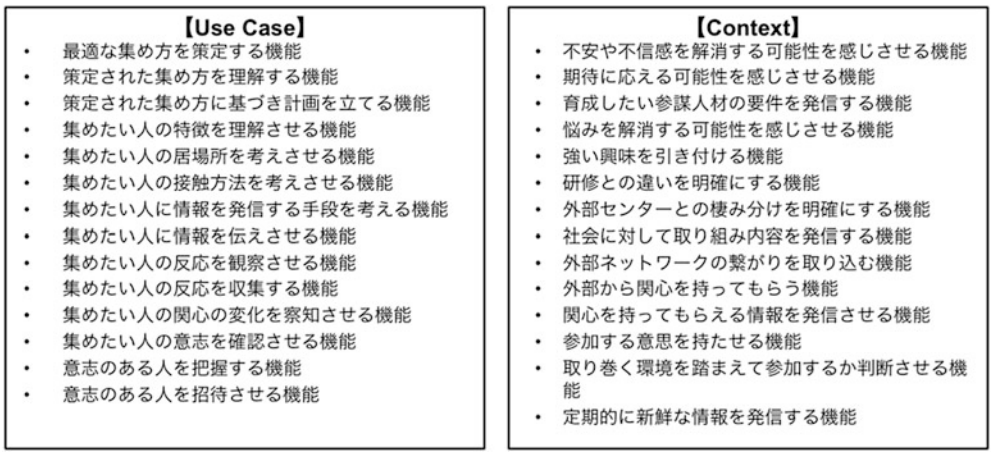

Fig. 7 An example of extracting requirement functions (*Japanese ver.)

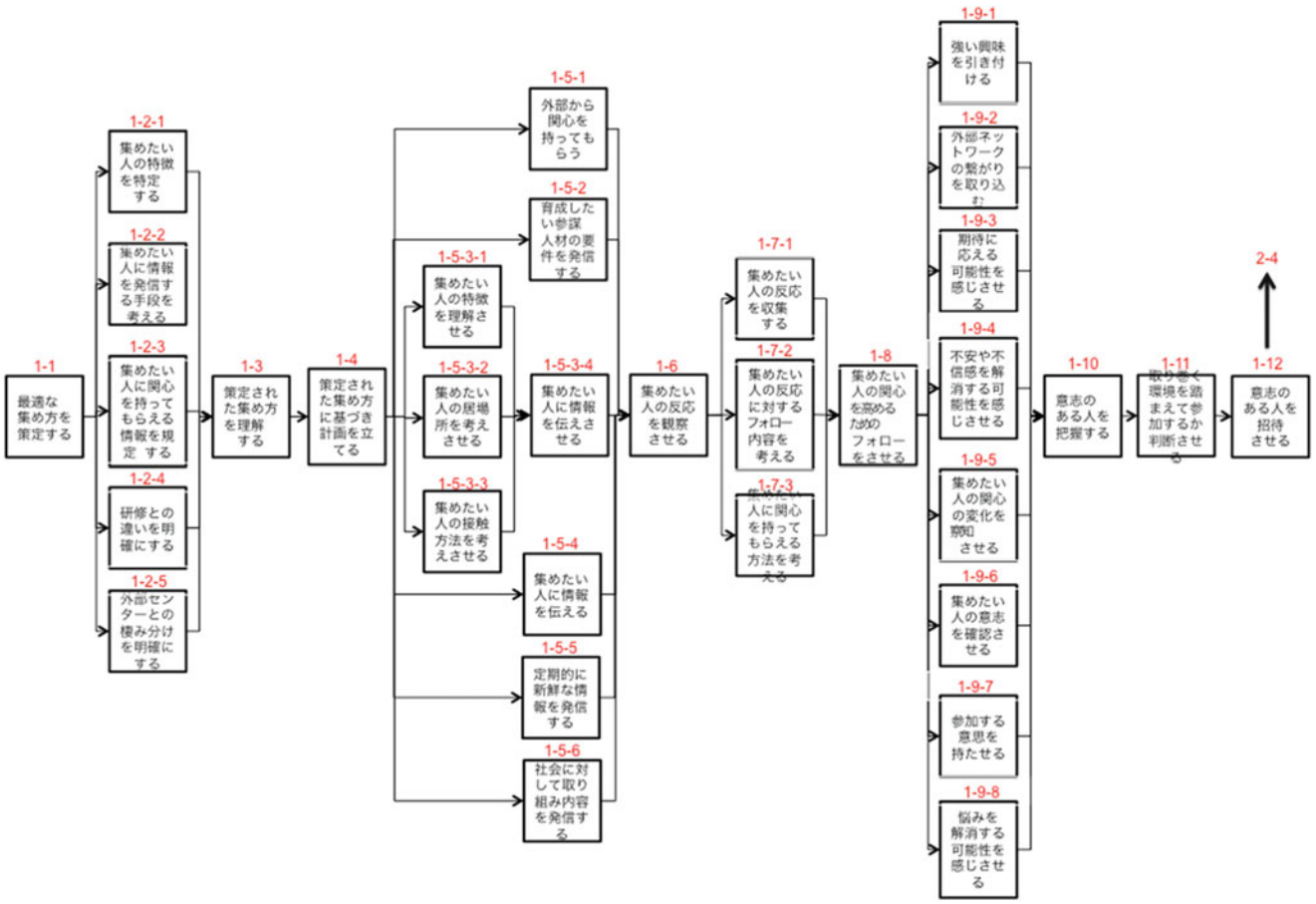

Fig. 8 An example of function flow block diagram (*Japanese ver.)

They are not evaluated and verified when the design is finished, but they are evaluated and verified while they are designed.

This means that this training program was evaluated and verified by stakeholders throughout design processes.

5.1.2 Interviews with CEO and Professional

To evaluate the designed program, we interviewed several CEOs and business support professionals. The summary of the interview is as follows:

1. Interviews with CEO:
   - New business development process is clearly stated and convincing.
   - Since small and midsized company executives often feel lonely, community support is quite important.
   - Constant support from ideation through commercialization must be effective.
   - Working with other small and midsized enterprises in developing new businesses. It's innovative and quite interesting.
   - Would like to proceed to the commercialization phase.
2. Interviews with professional:
   - The program covers all the support we have been providing to clients.
   - Quite impressive to know that every element that is necessary to support businesses could be identified by considering the life cycle of business development.
   - Some of the extracted functions seem unrealistic to us because we are not CEOs.
   - Many stakeholders' knowledge and perceptions are well aggregated.

5.2 Evaluation Result

We conducted evaluation of the education program using PSA in one department of a company that supports many small and midsized enterprise managements. The evaluation result indicated that this education program for developing new business would be quite effective and would mean a lot for small and midsized enterprises.

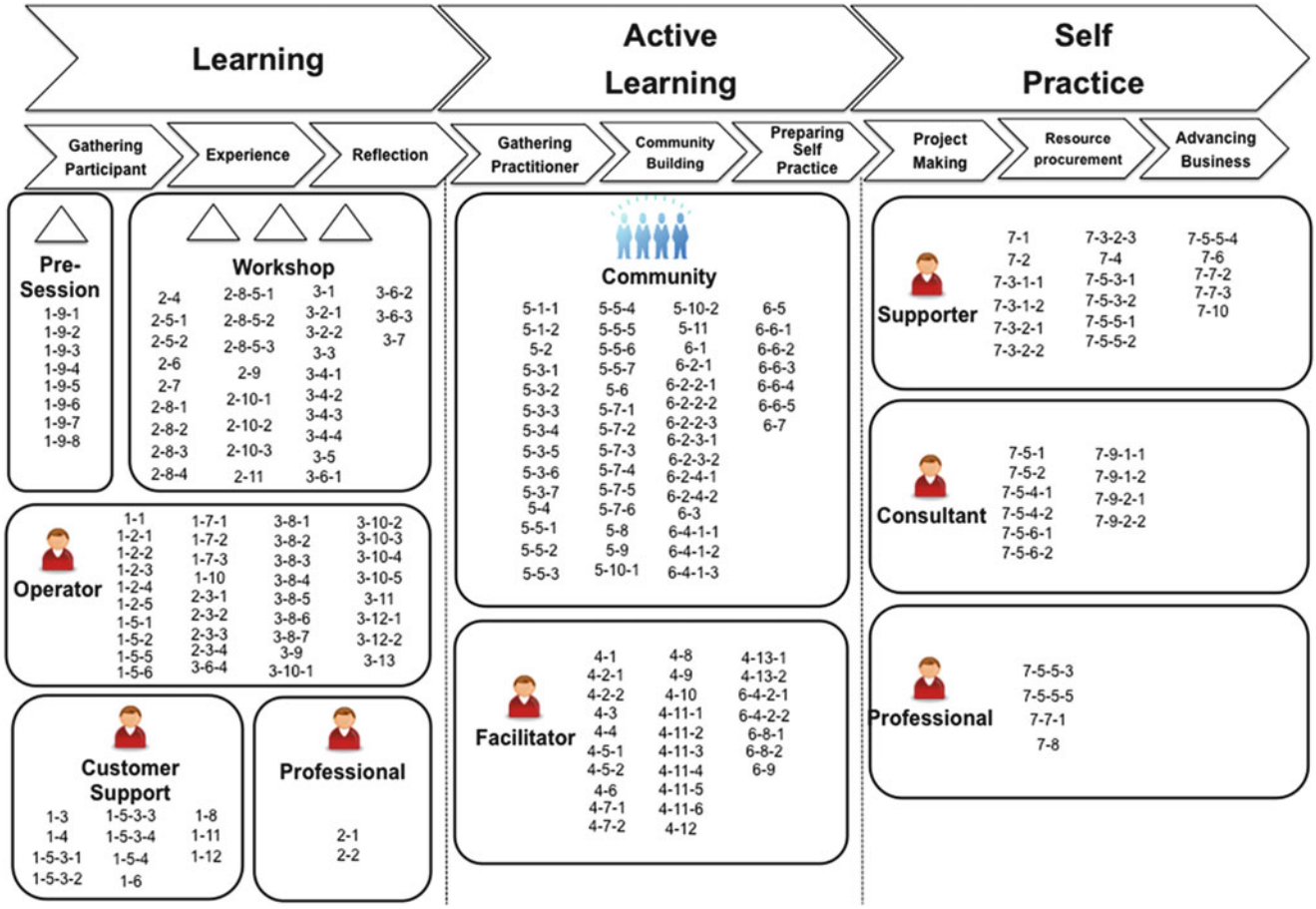

Fig. 9 An example of allocating functions to elements

Fig. 10 Concept design of the education program

6 Discussion

Evaluation results qualitatively supported efficacy of the program. Especially a viewpoint of problem definition and a consistency of solution were highly evaluated.

The authors observed the degree of satisfaction through PSA and it was qualitatively significant. This result indicates that participants of the program could build a new business rather than an existing solution.

This result implies that a program designer may design the entire process easily to build a new business,

especially for small and midsized enterprises that are poor in resources.

7 Conclusion and Further Research

7.1 Conclusion

This paper proposes designing an education program for developing new businesses based on systems engineering methodology with participatory systems analysis in small and midsized enterprises where the resource is limited.

The efficacy of the education program was qualitatively validated through interviews. The program contributed significantly to help participants design new business development. The program was proved to collect diverse knowledge of stakeholders and to provide correct knowledge for building a new business.

It is considered that applying the systems engineering methodology in service design worked effectively in (1) developing a service that could realize high customer satisfaction and (2) letting even nonprofessionals design such services.

7.2 Further Research

Following this study, we consider that we will need further detailed verification and validation of this program. In this study, we have conducted concept validation. Our next work will be system validation and system verification through the entire process of new business development activity.

Acknowledgments I would like to give hearty thanks to participants of the workshop who provided helpful comments and suggestions. Special thanks also go to joint research partners who gave us invaluable comments and warm encouragements. The responsibility of any errors is of course mine.

References

1. Venture Enterprise Center, 2014, International research on entrepreneurship and growth venture (Kigyouka to seityo venture ni kansuru kokusai tyousa).
2. Japan Innovation Network, 2015, http://ji-network.org/en/.
3. The Small and Medium Enterprise Agency, 2014, White Paper on Small and Medium Enterprises in Japan.
4. Okamuro, H., 2009, Economic analysis of technology cooperation "Small and mid-sized enterprises and intercompany joint research and development Industry-academia-government collaboration" (Gijyutsu renkei no keizaibunseki "Chusyokigyo no kigyoukankyo-dokaihatsu to sangakurenkei"), Doyukan Publishing. *This paper is only Japanese ver.
5. International Council on System Engineering, 2010, INCOSE System Engineering Handbook, Version 3.2.
6. International Council on System Engineering, 2004, INCOSE System Engineering Vision 2020.
7. Checkland, P., Scholes, J., 1990, Soft Systems Methodology in Action, John Wiley & Sons, Inc.
8. Jackson, M., 2003, Systems Thinking: Creative Holism for Managers, John Wiley & Sons, Inc.
9. Martin, J., 2011, Transforming The Enterprise Using a Systems Approach, INCOSE 2011 International symposium in Denver.
10. Dominique Luzeaux et.al., 2010, System of Systems, John Wiley & Sons, Inc.
11. Rechtin, E., 1999, Systems Architecting of Organizations: Why Eagles Can't Swim, CRC Press.
12. Bosch, O., et al., 2013, Addressing the Critical Need for "New Ways of Thinking" in Managing Complex Issues in a Socially Responsible Way, Business System Review. Selected papers of the 1st B.S.Lab International Symposium, Special Issue -Volume 2, Issue 2, 48–70.
13. Nguyen, N.C., et al., 2010, 'Creating 'Learning Laboratories' for Sustainable Development in Biospheres: A Systems Thinking Approach'. Systems Research and Behavioral Science, Syst. Res, 28, 51–62.
14. Sterman, J.D., 2000, Business Dynamics: System Thinking and Modeling for a Complex World, Boston: McGraw Hill Higher Education.
15. Senge, P.M., 1990, The Fifth Discipline: the Art & Practice of the Learning Organization, New York: Doubleday.
16. ANSI/EIA, 1999, Processes for Engineering a System, ANSI/EIA-632.
17. The International Organization for Standardization, 2008, Systems and software engineering - System life cycle processes, ISO/IEC 15288:2008.
18. Institute of Electrical and Electronics Engineers, 2005, IEEE Standard for Application and Management of the Systems Engineering Process, IEEE 1220–2005.
19. Bosch OJH, Nguyen NC., 2011, Establishing the Global Learning Laboratories NET for managing complex problems (Working Paper), Brisbane, Australia, School of Integrative Systems, The University of Queensland.

Qualitative Simulation for Early-Stage Service Design

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Abstract

Currently, the importance of services is widely accepted in various industries. Given this background, fundamental research on service engineering is carried out quite actively. Service engineering seeks to provide design methodology for services from an engineering perspective.

In product and service design, designers are generally forced to spend a lot of redesign works if design changes occur at a late stage of the design process. Thus, it is important for designers to validate design solutions in the early stage(s) of the design process by using simulation methods. However, simulation models in the existing methods are built with quantitative information. In the early stages of the service design process, most of the information about a design solution is still not defined; therefore, it is difficult to obtain sufficient quantitative information. For obtaining such quantitative information, service providers need to offer a designed service to their customers as a trial, which impose much effort for building quantitative simulation models. In order to reduce such risks, this research applies a qualitative simulation method, which can be used to analyze the behavior of systems with fuzzy qualitative information. In this paper, we propose a method to build a qualitative simulation model with the design information available at the early stage(s) of the service design process. This method would enable designers to evaluate a design solution in the early stage of a service design process and would increase quality of the service design.

Keywords

Service engineering • Qualitative simulation

1 Introduction

With the global economy beginning to mature, several industries have started to regard services as an effective way of enhancing customer satisfaction. The service industry accounts for more than 70 % of the workforce and gross domestic product (GDP) in Japan, the United States, and the European Union [1]. Of late, some manufacturing companies have been making a fundamental shift from selling only physical products to providing services.

Until recently, research on services was conducted mainly in the marketing or management field, and rational methods for realizing services with high productivity were still in the research phase. Recently, researchers have begun to examine services from an engineering or scientific perspective rather than from the traditional marketing or management view. For example, in Japan, Shimomura et al. conducted a study to design services from an

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engineering viewpoint. This research belongs to the "Service Engineering [2, 3]" series. In other regions, especially Europe, product-service systems (PSSs) [4] are considered the new business model that will help manufacturing firms gain competitiveness. A PSS consists of tangible products and intangible services, which are designed and combined so that they are jointly capable of fulfilling specific customer needs. Studies in service science, management, and engineering (SSME) [5] have been conducted mainly in the context of the United States. SSME proposes a scheme to create the basis for systematic service with knowledge integration.

In general product and service design, designers would need to spend a lot of money and time if design changes occur in the final stage of the design process. In order to obviate design changes, simulation methods are effective in predicting problems that could happen in the last stage of the design process. This approach would enable designers to address these problems and decrease redesign works. Thus, it is important for designers to evaluate design solutions in the early stage(s) of the design process by using simulation methods.

While existing simulation methods are effective for decreasing reworks, difficulties remain in the construction of simulation models. In the extant simulation methods, the simulation models are built with quantitative information. In the early stages of the service design process, most of the information about the design solution is still not defined. In addition, services are produced and consumed simultaneously in many cases. That is, services only exist while offering goods to or conducting some activities for the customers. This characteristic of services is called "simultaneity" [6]. In order to obtain quantitative information for constructing simulation models, service providers need to offer a designed service to customers as a trial and evaluate a current service. Thus, service designers must invest a lot of time and effort in building the quantitative simulation models.

In contrast, some prior researchers in the field of product design applied the concept of qualitative simulation [7] to the conceptual design of products [8, 9]. The qualitative simulation method can be used to analyze the behavior of systems with fuzzy qualitative information. This qualitative information is useful for evaluating the behavior of physical features in the early stage(s) of the product design process. In order to address the difficulties associated with constructing quantitative simulation models for a service design, this paper applies qualitative simulation methods to the service design process. In particular, this paper focuses on building a valid simulation model. The proposed method could enable designers to evaluate a design solution in the early stage (s) of a design process.

2 Service Design Process and Simulation

2.1 Service Design Process

In the service design process, such as IT-enabled service, the V-model [10] is widely used. The V-model is a process model that shows the correspondence between the design and development process and the test execution phase in a V shape (Fig. 1). In Fig. 1, the design and development phase are shown on the left-hand side of the model. In the define service requirements phase (the second stage on the left-hand side), the customer requirements, business targets, and service levels are defined according to the results of the previous phase (define customer business requirements). The third stage, i.e., the design service solution phase, focuses on designing the system architecture. In this phase, an overview of the service solution that includes availability management, capacity management, and cost of providing service is developed. Subsequently, in the design service release phase, the fundamental policy and procedure into the real environment are defined. Finally, in the develop service solution phase, the detailed service design and all the required coding are conducted.

2.2 Existing Service Simulation

As was mentioned in Sect. 1, designers would need to spend a lot of time and money if design changes happen in the later phase, i.e., the right side of the V-model. Thus, it is important for designers to predict problems that could occur in the last stage of the design process; subsequently, they need to take measures to prevent such problems. A number of computational simulation technologies have been developed for predicting problems and evaluating design solutions [11–14].

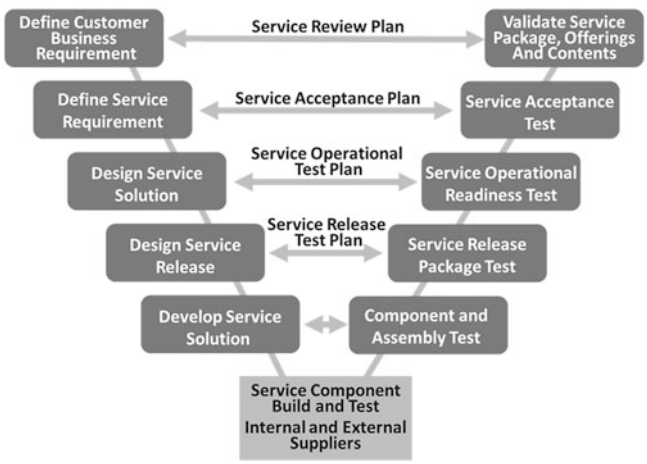


Fig. 1 V-model representing the service design process

Petri net models [15] are widely used to visualize service behaviors. For example, Yamaguchi developed a modeling method for analyzing the workflow in a restaurant. In this context, a Petri net simulation is useful for evaluating the effectiveness of introducing an information and communications technology system to the workflow [11]. Hatakeyama developed a simulator called "TEMPO SYSTEM" that analyzes a customer's purchasing behavior in a fast-food restaurant by using Petri net models. Further, Tsubouchi developed a simulator to enhance the efficiency of operating on-demand buses that people use for ride sharing by using a reservation system [13].

In the extant research on PSS design, some simulation and modeling methods have been investigated. For example, Meier proposed a PSS simulation method for predicting the business growth of companies [16–18]. Akasaka proposed a modeling and simulation method to design PSSs that could realize high values for each stakeholder [16]. These prior studies aimed at delivering a design and engineering approach for dynamic PSS business models using system dynamics (SD) [19].

3 Approach of This Study

In the existing simulation methods, the simulation models are generally built with the quantitative information that can be obtained from the results of service offerings in a real situation.

One problem with existing simulation methods is that it takes a lot of time and cost to obtain the quantitative information required for the simulation model. In contrast, qualitative simulation is a simulation method that can be used to analyze the behaviors of systems with fuzzy information. The qualitative simulation method is expected to predict service behaviors in the early stage(s) of service design, when it is difficult to obtain the quantitative information required for the simulation model.

This paper applies the qualitative simulation method to the service design process to ensure efficient service design.

3.1 Qualitative Reasoning

Qualitative reasoning is an area of artificial intelligence that provides the means to formally represent reasoning with conceptual knowledge. Qualitative reasoning has proven to be a cost effective, reliable, and efficient means of analyzing the behavior of systems without numerical information. The qualitative prediction of behavior is conducted by reasoning about the physical world that changes over time. This prediction is called qualitative simulation. In the qualitative simulation model, the state of each parameter consists of the qualitative value and the derivative value. The qualitative values are expressed by a finite number of landmarks; the derivative values are expressed by a qualitative value: "increases," "decreases," or "becomes stable."

3.2 Qualitative Process Theory

In a series of studies, Forbus developed a process-based approach for qualitative reasoning, called the qualitative process theory [20]. A typical example of such processes is heat flow or movement.

According to the qualitative process theory, there are two causal relations between parameters: direct influence and indirect influence. Direct influence I+ (Q2, Q1) causes the parameter Q2 to increase if Q1 takes a positive value.

Indirect influences correspond to relationships between two parameters that represent some mechanisms for the process. They set the derivative of the target parameter depending on the derivative of the source parameter. An indirect influence P+ (Q2, Q1) causes the parameter Q2 to increase (decrease) if another parameter Q1 increases (decreases). Therefore, indirect influences are referred to as qualitative proportional relations.

A qualitative reasoning engine generally takes as input a scenario that describes the initial state of the system. Subsequently, the qualitative engine produces a state graph that qualitatively captures the distinct states of the system. A state graph consists of a set of states, i.e., state transitions. Thus, a state graph shows a set of possible paths of system behaviors. A state transition specifies how one state changes into another state. A sequence of states connected by state transitions is called a behavior path. The following example describes a qualitative simulation for heat flow (Fig. 2) [21]:

1. After the heater is turned on, the heat flow process causes heat to flow from the heater to the container and the water. This causes the temperature of the container and

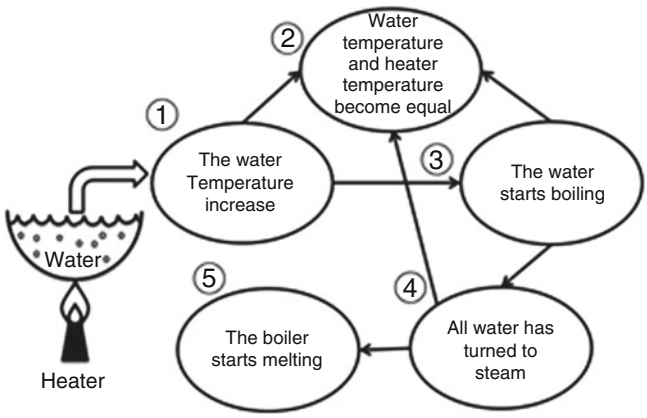


Fig. 2 Behaviors of heat flow

the water to increase. This behavior may lead to other states (state 2 or state 3).
2. The temperature of the water in the container is now equal to the temperature of the heater. From here on, no further changes can take place.
3. The water temperature reaches boiling point. A new process "boiling" becomes active, which causes the generation of steam. This behavior may lead to another state (state 4).
4. All the water has now turned into steam. The boiling process has stopped, but the heat flow continues. This behavior may lead to other states (state 2 or state 5).
5. If the heater is warm enough, it may ultimately cause the container to melt because the container will reach its melting point. Hence, the simulation stops here.

4 Service Design Process Using Qualitative Simulation

4.1 Overview

In this study, qualitative simulation methods are applied to the early-stage design process to ensure efficient service design.

Figure 3 presents an overview of the proposed design cycle, which consists of three phases: Service Modeling, Behavioral Pattern Classification, and Convergence to the Ideal Behavior. In the Service Modeling phase, the qualitative simulation model is constructed by setting the parameters and qualitative causal relationships based on the service design model. In the Behavioral Pattern Classification phase, the system behaviors that could possibly arise from the qualitative simulation model are produced by the qualitative simulation, and the behaviors are classified. Finally, the designers identify an ideal behavior from among the produced behavioral patterns; subsequently, some conditions or constraints are added to the qualitative simulation model in the Convergence to the Ideal Behavior phase.

To design services efficiently, valid simulation models that reflect the designer's recognition need to be constructed. Therefore, this paper focuses on Service Modeling and Behavioral Pattern Classification in order to construct a valid qualitative simulation model in stages (red dashed line in Fig. 3).

4.2 Service Modeling

The first step (Service Modeling) of the design cycle is meant for analyzing the service structure. The goal of this step is to construct a coarse qualitative simulation service model. A qualitative simulation model is constructed based on information obtained during the early stage(s) of the design process. In this study, an actor network model [22] that describes the service structure with the element's stakeholder and requirement (Fig. 4) plays a key role. The simulation model is based on the constructed actor network model. The parameters that represent the changeable features in the simulation model are determined by each stakeholder's requirement(s). In addition, the parameters related to these requirements are also determined. This qualitative simulation model includes direct/indirect influences between the parameters in the manner proposed in the qualitative process theory.

4.3 Behavioral Pattern

For the simulation, the initial state of the system needs to be defined. According to the initial values of each of the parameters, the possible system behaviors are produced by qualitative simulation.

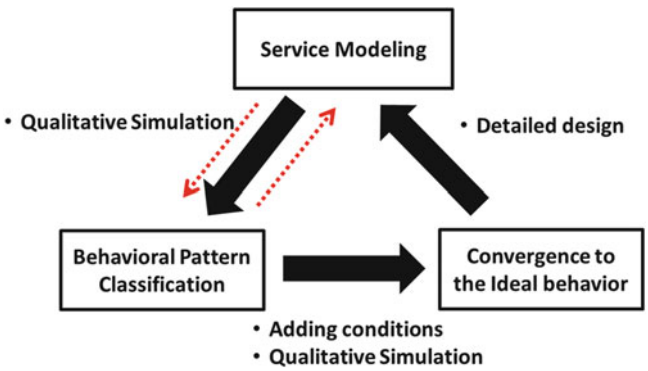


Fig. 3 Overview of the proposed design cycle

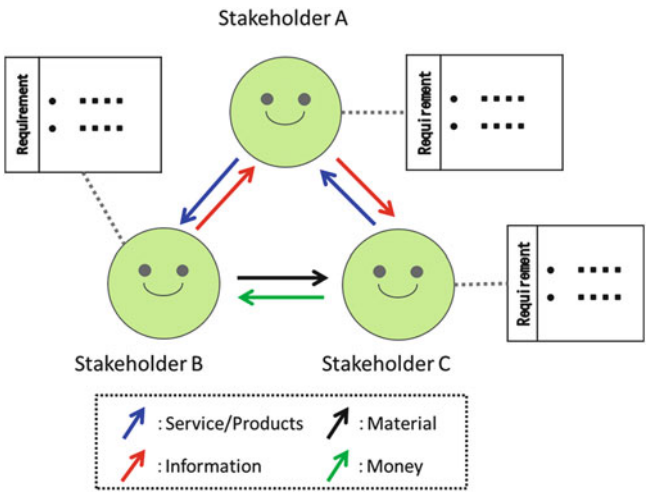
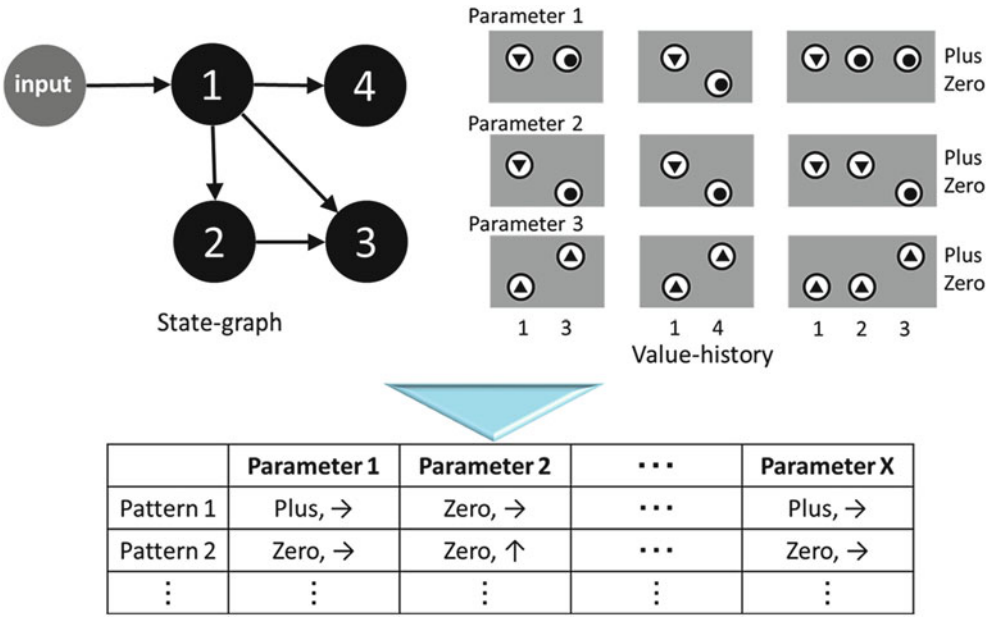


Fig. 4 Actor network model



	Parameter 1	Parameter 2	···	Parameter X
Pattern 1	Plus, →	Zero, →	···	Plus, →
Pattern 2	Zero, →	Zero, ↑	···	Zero, →
⋮	⋮	⋮	⋮	⋮

Fig. 5 Classifying behavioral patterns

The state graph and the histories of each parameter's value are shown in Fig. 5. The produced behaviors are classified into various patterns based on the final state of the parameters (Fig. 5). By referring to these results, the designers confirm whether all of the assumed behaviors were produced. If the assumed behaviors are not produced, the designers restructure the simulation model and simulate it once again. A simulation model is ensured validity in the different stages through Service Modeling and Behavioral Pattern Classification.

4.4 Convergence

Based on the simulation results, the designers select one ideal behavior from all the behaviors. The ideal behavior represents a tentative design solution that could satisfy the stakeholders' requirements from the service. In order to ensure convergence to the ideal behavior, the designers seek conditions (e.g., constraint conditions between two parameters or initial condition); subsequently, these conditions are added to the simulation model. These conditions correspond to the design guideline. This addition enables the simulation model to produce the ideal behavior. If the simulation result satisfies the designer's ideal behavior, the simulation model indicates progress in service design.

5 Application to Sample Case

In this section, the proposed design cycle—especially the Service Modeling and Behavioral Pattern Classification phases—was applied to a sample service case. This application has two purposes. One is to construct a valid simulation model. The other is to determine whether the assumed behaviors will be produced. The example used in this study involved a car sharing service (CS). Car sharing is a business where the users share their cars with registered members.

5.1 Modeling of Car Sharing

First, the structure of car sharing was modeled using the actor network model. Figure 6 illustrates the result of the actor network model. As shown in Fig. 6, the stakeholders include the car sharing user (CS user), the car sharing provider (CS provider), and the car manufacturer. Each stakeholder has his/her own requirements. The CS user's requirements include low cost and high availability; the CS provider's requirements include high profit; and the car manufacturer's requirements include high amount of sales.

Based on the constructed actor network model, the parameters for the simulation model were determined according to each stakeholder's requirements. For instance, "Pay for the use of cars" in the simulation model was set as a parameter to represent the qualitative state of the CS user's requirement "Low cost."

Subsequently, the parameters were connected to one another with causal relationships, and the simulation model was constructed. The result of the simulation model is shown in Fig. 7. For instance, "Profit of the CS provider" increases if the qualitative value of "Pay for the use of cars" is positive. Therefore, there is a positive direct influence (I+) between "Pay for the use of cars" and "Profit of the CS provider."

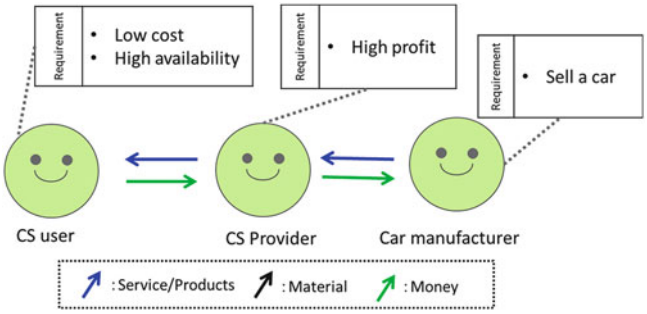


Fig. 6 Result of the actor network model

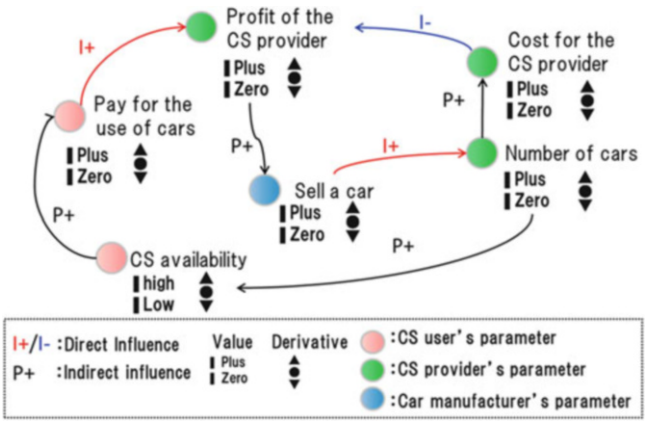


Fig. 7 Result of the simulation model

Table 1 Behavioral patterns produced in first simulation

	Profit of the CS provider	Cost for the CS provider	Number of cars	Pay for the use of car	CS availability	Sell a car
Scenario	Plus		Plus		Low	
Pattern 1	Plus, ↑	Plus, ↑	Plus, ↑	Plus, ↑	High, ↑	Plus, ↑
Pattern 2	Plus, →	Plus, ↑	Plus, ↑	Plus, ↑	High, ↑	Plus, →
Pattern 3	Zero, ↓	Plus, ↑	Plus, ↑	Plus, ↑	High, ↑	Plus, ↓

↑ increase, ↓ decrease, → stable

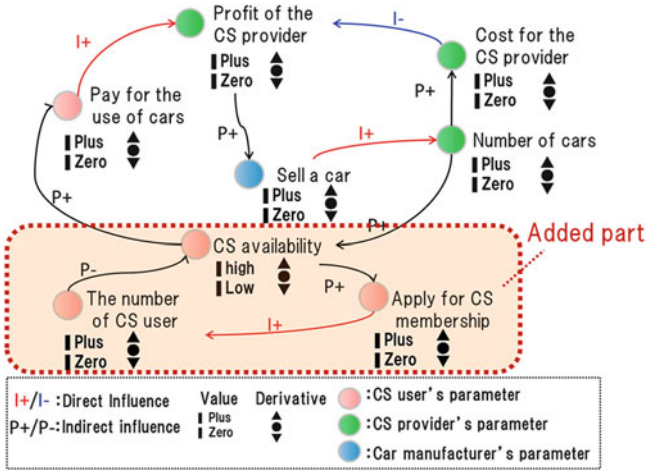


Fig. 8 The revised simulation model

On the other hand, the CS provider considers buying more cars to expand his/her business as profit increases. Therefore, "Sell a car" is proportional to "Profit of the CS provider;" i.e., there is an indirect positive influence (P+) between "Profit of the CS provider" and "Sell a car."

Each parameter has qualitative values and derivative values as quantity spaces. In this paper, two qualitative values, namely, "Plus" and "Zero" or "High and Low," are set to express whether or not the amount existed. For "CS availability," qualitative values {"High" and "Low"} are set to express magnitude of quantities.

5.2 Behavioral Pattern

The qualitative simulation model was built and the qualitative simulation was carried out using Garp3 [21], which is a software for qualitative process theory-based simulation.

The initial qualitative values of the parameters in the simulation are as follows:

- The value of "Profit of the CS provider" is Plus
- The value of "The number of cars" is Plus
- The value of "CS availability" is low

In the car sharing example, the qualitative simulation model produced three patterns as service behaviors (see Table 1). For example, Pattern 1 in Table 1 indicates that all the parameters increase. However, in actual business, "CS availability" may decrease, remain stable, or increase depending on the number of CS users. Therefore, we added the parameters "Number of CS users" and "Apply for CS membership" to the model. The result of the refined simulation model is shown in Fig. 8. For instance, in the refined simulation model, there was an indirect negative influence (P-) between "CS availability" and "Number of CS users." Table 2 presents the results of the second simulation.

The simulation for the reconstructed model produced nine patterns of behaviors as shown in Table 2. For instance, depending on the values of the other parameters, "CS availability" could increase (e.g., Pattern 1), decrease (e.g., Pattern 2), or remain stable (e.g., Pattern 4).

From these results, Pattern 1 in Table 2 was accepted as a tentative design solution, since Pattern 1 appears to satisfy the requirements of all the stakeholders ("CS availability," "Profit of the CS provider," and "Sell a car"). However, further consideration is required to improve the solution since "Pay for the use of cars" would increase in Pattern

Table 2 Behavioral patterns produced in second simulation

	Profit of the CS provider	Cost for the CS provider	Number of cars	Pay for the use of cars	CS availability	Apply for CS membership	Number of CS users	Sell a car
Scenario	Plus		Plus		Low	Plus	Plus	
Pattern 1	Plus, ↑	Plus, ↑	Plus, ↑	Plus, ↑	High, ↑	Plus, ↑	Plus, ↑	Plus, ↑
Pattern 2	Plus, ↑	Plus, ↑	Plus, ↑	Plus, ↓	Low, ↓	Plus, ↓	Plus, ↑	Plus, ↑
Pattern 3	Plus, ↑	Plus, ↑	Plus, ↑	Plus, ↑	Low, ↓	Plus, ↓	Plus, ↑	Plus, ↑
Pattern 4	Plus, ↑	Plus, ↑	Plus, ↑	Plus, ↑	Low, →	Plus, →	Plus, ↑	Plus, ↑
Pattern 5	Plus, →	Plus, ↑	Plus, ↑	Plus, ↓	Low, ↓	Plus, ↓	Plus, ↑	Plus, →
Pattern 6	Plus, →	Plus, ↑	Plus, ↑	Plus, ↑	Low, ↓	Plus, ↓	Plus, ↑	Plus, →
Pattern 7	Plus, ↓	Plus, ↑	Plus, ↑	Plus, ↑	Low, ↓	Plus, ↓	Plus, ↑	Plus, ↓
Pattern 8	Plus, ↓	Plus, ↑	Plus, ↑	Plus, ↑	High, ↑	Plus, ↑	Plus, ↑	Plus, ↓
Pattern 9	Plus, ↓	Plus, ↑	Plus, ↑	Plus, →	Low, ↓	Plus, ↓	Plus, ↑	Plus, ↓

↑ increase, ↓ decrease, → stable

1 as shown in Table 2. As was discussed in Sect. 5.1, one of the CS user's requirements is low cost. The tentative simulation model in Fig. 8 has no parameters and causal relationships that could satisfy the CS user's "Low cost" requirement. A detailed service design is required to address this issue.

6 Discussion

In this paper, a simulation model was constructed based on an actor network model. The initial simulation model in Fig. 7 produced a service behavior that was different from the behavior we had assumed. Therefore, we included additional parameters to obtain the assumed service behaviors. It was clear that we needed to add "Number of CS users" and "Apply for CS membership" as parameters related to "CS availability." The reconstructed simulation model in Fig. 8 produced the assumed behaviors that exist in actual business situations (see Table 2).

These results indicate that the proposed design cycle enables designers to increase the validity of the simulation model in stages. In this study, the simulation model was restructured by trial and error. Future work could include a procedure for systematically improving the simulation models.

Further, this paper applied the proposed design cycle to a small-scale example. Future work could attempt to apply this design cycle to a large-scale example.

7 Conclusion

The purpose of this study was to improve service design quality. We proposed a service design cycle applying qualitative simulation methods to improve the service design process. This paper focused on constructing a valid qualitative simulation model that could yield the assumed behaviors.

In order to evaluate the proposed design cycle, we applied the proposed design cycle to the case of a car sharing service. We constructed a valid qualitative simulation model through Service Modeling and Behavioral Pattern Classification. This application exemplified the construction of a valid simulation model in stages; the results (in Table 2) represent the assumed behavioral that were produced.

The third design cycle (divergence behavioral pattern) needs to be applied to the example case in the future work. In addition, future research should attempt to construct a wider-scale service model to ensure efficient design in the early stage(s) of service design.

References

1. Japan's Ministry of Economy, Trade and Industry, 2012, "Trade in Services: Report on Compliance by Major Trading Partners with Trade Agreements - WTO, FTA/EPA and BIT."
2. Arai, T. and Shimomura, Y., 2004, "Proposal of Service CAD System: A Tool for Service Engineering," Annals of the CIRP, Vol. 53, No. 1, pp. 397–400.
3. Shimomura, Y. and Tomiyama, T., 2005, "Service Modeling for Service Engineering," IFIP International Federation for Information Processing, Vol. 167, pp. 31–38.
4. Tukker, A. and Tischner, U., 2006, "Product-services as a Research Field: Past, Present and Future. Reflections from a Decade of Research," Journal of Cleaner Production, Vol. 14, No. 17, pp. 1552–1556.
5. Maglio, P. P., Kreulen, J., Srinivasan, S. and Spohrer, J., 2006, "Service Systems, Service Scientists, SSME, and Innovation," Communications of the ACM, Vol. 49, No. 7, pp. 81–85.
6. Raymond, P. F. and Stephen, J. S., 2007, Interactive Service Marketing, South-Western Pub.
7. Bobrow, D.J., ed., 1984, Artificial Intelligence, Special Issue on Qualitative Reasoning about Physical System, Vol. 24.
8. Moritsu, R., Wakabayashi, H., Tshumaya, A., Shirase, K. and Arai, E., 2001, "Development of Qualitative Kinematic Simulation System for Concept Design," JSME Annual Meeting, No. 01-1(VI), pp. 47–48.
9. Kiriyama. T., Tomiyama, T. and Yoshikawa, H., 1992, "Qualitative Reasoning and Conceptual Design with Physical Features," Faltings. B and Struss. P (ed.) Recent Advances in Qualitative Physics, The MIT Press, Cambridge, MA, USA, pp. 375–386.

10. Office of Government Commerce, 2007, Service Transition, UK, TSO, pp. 78.
11. Yamaguchi, S., Hattori, M., Ge, Q. W. and Tanaka, M., 2002, "A Modeling Method Based on High-level Petri Nets for Food Business Workflows," Proc. of ICFS 2002, pp. 31–36.
12. Hatakeyama, S. and Yokomura, K., 1990, "A Development of TEMPO System: Shop Model and Simulator," Simulation, Vol. 9, No. 3, pp. 180–188.
13. Tsubouchi, T., Yamato, H. and Hiekata, K., 2010, "Development of the Simulator for the On-demand Bus Introduction," Journal of the Japanese Society for Artificial Intelligence, Vol. 25, No. 3, pp. 400–403.
14. Tan, Y. and Takakuwa, S., 2007, "Predicting the Impact on Business Performance of Enhanced Information System Using Business Process Simulation," Winter Simulation Conference, pp. 2203–2211.
15. Murata, T., 1989, "Petri Nets: Properties, Analysis and Application," Proceedings of the IEEE, Vol. 77, No. 4, pp. 541–580.
16. Meier, H., Lagemann, H. and Boßlau, M., 2013, "Dynamic Influences on Workforce Capacity Planning for IPS2 Delivery," Proceedings of the 5th CIRP International Conference on Industrial Product-Service Systems, pp. 323–334.
17. Meier, H. and Boßlau, M., 2013, "Design and Engineering of Dynamic Business Models for Industrial Product-Service Systems," Proceedings of the 4th CIRP International Conference on Industrial Product-Service Systems, pp. 179–184.
18. Akasaka, F., Nemoto, Y. and Shimomura, Y., 2013, "Product Service Systems Design Focusing on System Aspect: Total Value Creation for various Stakeholders," Proceedings of CIRP, IPS2 Conference 2013, pp. 371–382.
19. Sterman, J. D., 2000, Business Dynamics: System Thinking and Modeling for a Complex World, McGraw-Hill.
20. Forbus, K. D., 1984, Qualitative Process Theory, Artificial Intelligence, Vol. 24, No. 1–3, pp. 85–168.
21. Bredeweg, B., et al., 2009, "Garp3-Workbench for Qualitative Modelling and Simulation," Ecological Informatics, Vol. 4, No. 5, pp. 263–281.
22. Hewitt, C., 1977, "Viewing Control Structures as Patterns of Passing Messages," Artificial Intelligence, Vol. 8, No. 3, pp. 323–364.

Impacts of Seasonal Factors on Travel Behavior: Basic Analysis of GPS Trajectory Data for 8 Months

Masahiro Araki, Ryo Kanamori, Lei Gong, and Takayuki Morikawa

Abstract

Understanding people's activities and travel behaviors has gained attention in service research field as well as in transportation research field. Recently, there are a lot of studies utilizing GPS (Global Positioning System) trajectory data to analyze travel behaviors after identifying each trip. Although transportation service level (e.g., travel time or waiting time) and our travel behaviors would change due to weather and seasonal factors, there is no research to evaluate an automated detection/identification model for GPS trajectory data. In this study, we compare a trip frequency (trip purpose of shopping and health, which are nonmandatory trips) and an accuracy of the detection/identification model by using long-term person trip survey data, which is conducted for each 4 months in summer and winter in Hakodate city, Japan. From the results, we confirm that a variation of car trip frequency is small and a tendency of mode change from bicycle in summer to walking in winter is strong due to snowy roadside condition. Moreover, random forest method as the detection/identification model has small effect to seasonal variations if multi-seasonal data is combined.

Keywords

Global Positioning System • Trajectory data • Travel behavior • Seasonal factor • Random forest method

1 Introduction

Understanding people's activities and travel behaviors is important not only in transportation planning but also in service planning. Person trip (PT or household travel) survey has been conducted as an official survey in Japan to observe traffic volume and analyze travel behaviors in urban area. However PT survey has several problems such as high survey cost and low frequency of update. Currently, traffic data getting from a traffic counter or a railway IC (integrated circuit) card are available more easily due to information-communication technology, and some studies tried to analyze such "big data." Mobile technologies for activity-travel data collection is a remarkable example as an alternative or a complementary of conventional travel survey method, since it is easy to collect trajectories by using cell phone equipped with GPS (Global Positioning System) device [1, 2].

In order to analyze travel behaviors from the massive trajectory data, it is efficient to detect automatically a trip information (i.e., to judge staying or moving and to identify transportation mode by a machine learning method). For analyst, bigger sampled and continuous trajectory data is a desirable one. If data of travel behaviors can be collected for a long time (e.g., during multi-season), transportation service level (e.g., travel time) and our travel behaviors would change due to weather and seasonal factors. However, there is no study to evaluate the automated detection/identification model for GPS trajectory data.

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This study aims to compare the trip frequency (trip purpose of shopping and health, which are nonmandatory trips) and the accuracy of the detection/identification model by using a long-term GPS trajectory data, which is conducted for each 4 months in summer and winter season in Hakodate city, Japan.

2 Smartphone-Based Travel Survey

2.1 Study Area

We conducted travel survey at Hakodate city, Hokkaido, Japan, shown in Fig. 1. Hakodate city is located in the southwestern part of Hokkaido and is a regional city with approximately 300,000 population. Although Hokkaido is famous as a heavy snowfall area, Hakodate city is a relatively little snowfall area, but it is not unusual to be less than below-zero 10°. Because snowfall is also observed constantly, a road-surface condition greatly changes, and it seems that individual travel behaviors are greatly influenced by seasonal factors.

Hakodate city has a bus location system which can record arrival and departure time. From this record we can calculate a delay time from 350 million data. Figure 2 shows calculated delay time depending on the weather. Horizontal axis represents which number bus stop they are from the first station and vertical axis represents delay time, and it becomes longer at further bus stops. The big difference is not shown in the delay time on sunny day and rainy day, but the delay time of snowy day becomes extremely longer. Change of service level due to weather also affects individual traffic behavior in Hakodate city.

Fig. 1 Study area

2.2 Probe Person Travel Survey (PP Survey)

Road traffic conditions in Hakodate city greatly changed in winter season due to snowfall observed constantly every year. Therefore it is necessary to conduct a long-time travel survey for a comparison between the condition in summer and winter. The comparison makes it possible to analyze individual travel behaviors.

Nakashima et al. [3] conducted PP survey for each 4 months in summer (June–October, 2013) and winter (December, 2012–February, 2013) in Hakodate city. This survey collects data by having subjects carry a smartphone whose GPS device was put on for a long term. And smartphone application (android version) to reduce burden on subjects is developed.

2.3 Smartphone Application for PP Survey

The smartphone application that Nakashima et al. developed can get trip purpose, destination, transportation mode, and trajectory data by carrying and operating a smartphone. The outline is described as follows.

2.3.1 Input of a Plan

After having started the application, the subject inputs an activity plan. Specifically, the trip purpose, destination, and transportation mode are input. Table 1 shows selectable

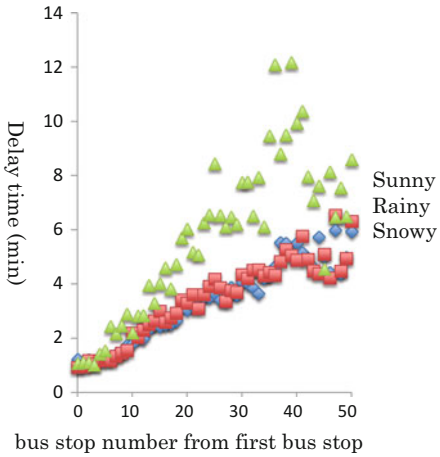

Fig. 2 Delay time of the bus every weather

Table 1 Input item on application

Trip purpose	Return home, commute, meal, shopping, recreation, exercise, go to hospital, promenade, others
Destination	Home, workplace, school, restaurant, supermarket, amusement facilities, park, hospital, others
Transportation mode	Walk, bicycle, car, taxi, bus, train, tram, airplane, ship

Table 2 Questionnaire result

	Gender	Age	Licensed driver	Driving frequency
Subject A	Man	60s	○	Sometimes per month
Subject B	Woman	40s	○	Almost everyday

purpose, destination, and transportation mode by this application.

2.3.2 Deriving of GPS Trajectory Data

After inputting plans, the application starts to derive the positional information at about 30 s interval if user has tapped an observation start button. In addition, to protect the user's privacy, a measurement of the positional information comes to be stopped by tapping the end button.

2.4 Implementation of the Survey

PP survey was carried out using the smartphone application described in Sect. 2.2. Nakashima et al. left the smartphone which installed application in two subjects, a man in his 60s and a woman in her 40s. Moreover, questionnaires that asked the gender, age, presence of a driver's license, and so on were carried out at the time the survey started. Table 2 shows the questionnaire results.

3 Data Preparation

3.1 Making Training Data

The final purpose of this research is to generate a trip automatically by detecting, staying or moving, and identifying transportation mode by utilizing GPS trajectory data. Therefore it is necessary to make a training data input into models such as random forest model. The making procedures of training data are as follows:

1. Plot a movement trace on Google Earth based on the coordinate derived from the PP survey (refer to Fig. 3).
2. Delete the data of a period staying at home.
3. If there are poor data (e.g., data with input omission and that a trace is not recorded normally), the day including the data is rejected.
4. Detect the origin, destination, and route to the destination by following a trace by viewing.
5. Identify a transportation mode based on input data of the subject, trace, and moving average speed.
6. Identify a trip purpose based on the input data of the subject's plan and the attribute of the destination.

Fig. 3 Visualization of trajectory data

Fig. 4 Subject A's destinations and frequency in summer

We carried out a process of (1) to (6) on all the data for each 8 months in summer and winter and made the "ground truth" for training data. The number of sample data which could be used for a basic analysis and model analysis finally is 618 trips during 165 days for subject A and 470 trips during 118 days for subject B.

3.2 Destination Distribution

Figures 4, 5, 6, and 7 show all destinations that subjects visited during an investigation period and show the frequency of visits.

Subject A particularly often visits to offices and fitness club. There are several offices and visit frequency of each

Fig. 5 Subject A's destinations and frequency in winter

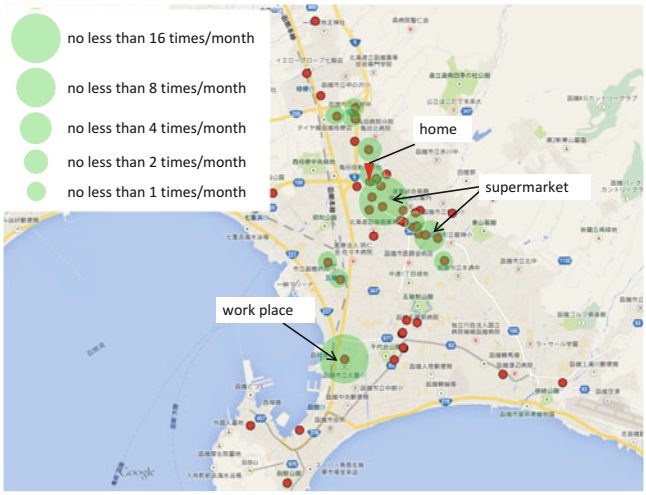

Fig. 6 Subject B's destinations and frequency in summer

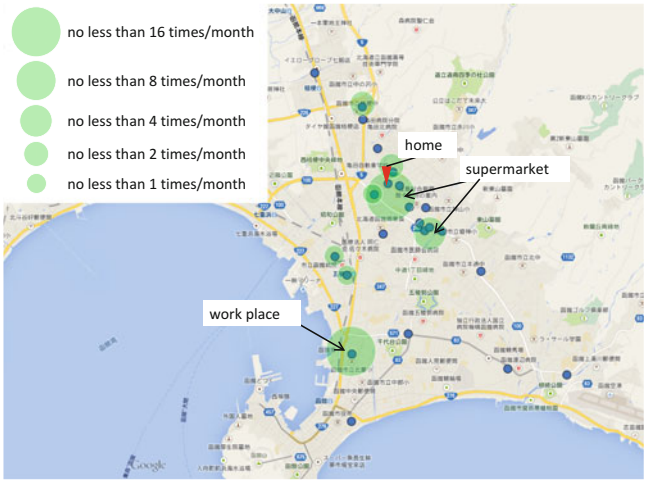

Fig. 7 Subject B's destinations and frequency in winter

office differs greatly. Subject B often visits to an office and supermarkets. Contrary to subject A, subject B has extremely steady life cycle because subject B goes to the same office and seldom changes frequency of visit to the office and supermarkets between summer and winter.

4 Basic Analysis

A basic analysis was done by using all training data. Specifically, we divide it into every season and weather and evaluate what kind of impact those factors have on individual travel behaviors by adding up the data about trip purpose and mode.

4.1 Seasonal Impact Analysis

4.1.1 Subject A

Table 3 shows subject A's count results of the number of the trips according to the trip purpose. The trip purposes of subject A can be classified in seven kinds of activity shown in Table 3 mainly (others are excluded). The average number of trips per day in summer is 3.87 and in winter is 3.59. It means that summer is higher in a going-out rate.

It is one of the characteristics that a lot of "exercise" activity is observed. Subject A goes to the fitness club regularly, and all the destinations of the trip of "exercise" were in the same fitness club. Generally, "exercise" activity at fitness club is one of the leisure activities; thus, such activity and physiological requisite activity (e.g., sleep, meal) or obligatory activity (e.g., labor, studies) are incompatible. It is interesting that such activity was accomplished at high frequency regardless of season. Moreover, the average number of the "commute" trips per day in winter became about a half of that in summer. On the other hand, the

Table 3 Total result of trip purpose in each season for subject A

Activity	Summer (average number of trips per day)	Winter (average number of trips per day)
Commute	108 (1.19)	48 (0.649)
Shopping	24 (0.264)	23 (0.311)
Meal	17 (0.187)	28 (0.378)
Exercise	46 (0.505)	40 (0.541)
Recreation	7 (0.0769)	9 (0.122)
Study	5 (0.0549)	0 (0)
Back home	138 (1.52)	100 (1.35)
Other	7 (0.0769)	18 (0.243)
Number of days	91	74
Number of trips	352	266
Average number of trips per day	3.87	3.59

average number of the "shopping," "meal," and "recreation" trips per day in winter increased. It means that subject A changed behaviors depending on the season.

Transportation mode is also evaluated. Figure 8 shows a ratio of each transportation modes among all trips of subject A. It is remarkable that trips on foot that accounted for 54.1 % in winter decreased to 9.7 % in summer, and, on the contrary, the trips by bicycle which was 0 % in winter increase to 43.5 % in summer. It means that transportation mode is considerably influenced by the seasonal factors. In a heavy snowfall area like Hakodate city, those who move by bicycle in summer have no choice but to convert on foot in winter because there is snow in the edge of the road including sidewalk, and also road surface freezes up. In addition, subject A used a bus and a tram equally during the winter, but the use of the bus decreases, and the use of the tram increases during the summer. Although we expected that the use of a bus decreased in winter because the delay time of the bus became very big on a snowy day as shown in Fig. 2, the results were completely the opposite. Subject A went to the office by tram, bus, or car mainly. Although subject A often worked in the workplace where it was easy to access by tram during summer, he worked not only there but also in the workplace where it was easy to access by bus during winter. Therefore he came to use tram much in summer and also use a bus much in winter inevitably.

4.1.2 Subject B

Table 4 shows subject B's count result of the number of the trips according to the trip purpose, and Fig. 9 shows a ratio of each transportation modes among all trips of subject B. Table 4 shows the trip purposes of subject B can be classified into five kinds of activity, and the average number of trips per day in summer is 4.01 and in winter is 3.92. It means that summer is higher in a going-out rate. Subject B had very high shopping frequency, and she went shopping more than once a day regardless of a season.

Contrary to subject A, subject B has consistent lifestyle such as commuting, going shopping after work, and going back home because commute trips are observed a lot and offices are fixed as showed in Figs. 6 and 7. There are little travel behavior differences between summer and winter as shown in Table 4.

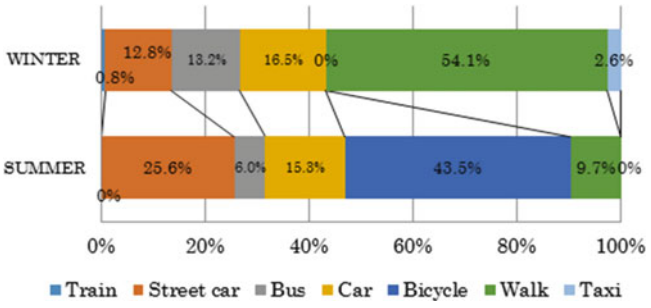

Fig. 8 Mode comparison between two seasons (subject A)

Figure 9 shows that subject B uses a car for most of her travels, while subject **A** hardly changed transportation mode depending on the season. Although Hakodate city has a lot of snow and frozen roads, they are taken measures to meet these situations. Accordingly, those who use cars wouldn't change transportation mode to another one because of road change.

4.2 Weather Impact Analysis

Weather also affects travel behavior. This study focuses on trips for exercise different from physiological requisite activity and obligatory activity by subject A who is relatively free.

The number of average trips decreases both in winter and summer on the raining days (including snowing days) as shown Table 5. Accordingly, precipitation affects individual travel behavior.

Figures 10 and 11 represent days of weeks at horizontal axis and number of trips at vertical axis, and they explain if

Table 4 Total result of trip purpose in each season for subject B

Activity	Summer (average number of trip per day)	Winter (average number of trip per day)
Commute	66 (0.805)	34 (0.944)
Shopping	113 (1.38)	42 (1.17)
Meal	5 (0.0610)	4 (0.111)
Recreation	9 (0.110)	2 (0.0556)
Back home	113 (1.38)	52 (1.44)
Other	23 (0.280)	7 (0.194)
Number of days	82	36
Number of trips	329	141
Average number of trips per day	4.01	3.92

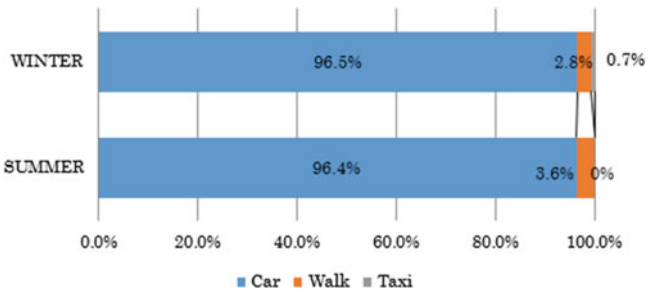

Fig. 9 Mode comparison between two seasons (subject B)

Table 5 Comparison of the number of the average trips between rainy day and others

		No rain	Rain
Summer	The number of days	77	14
	The average number of trip per day	3.91	3.64
Winter	The number of days	44	30
	The average number of trip per day	3.75	3.37

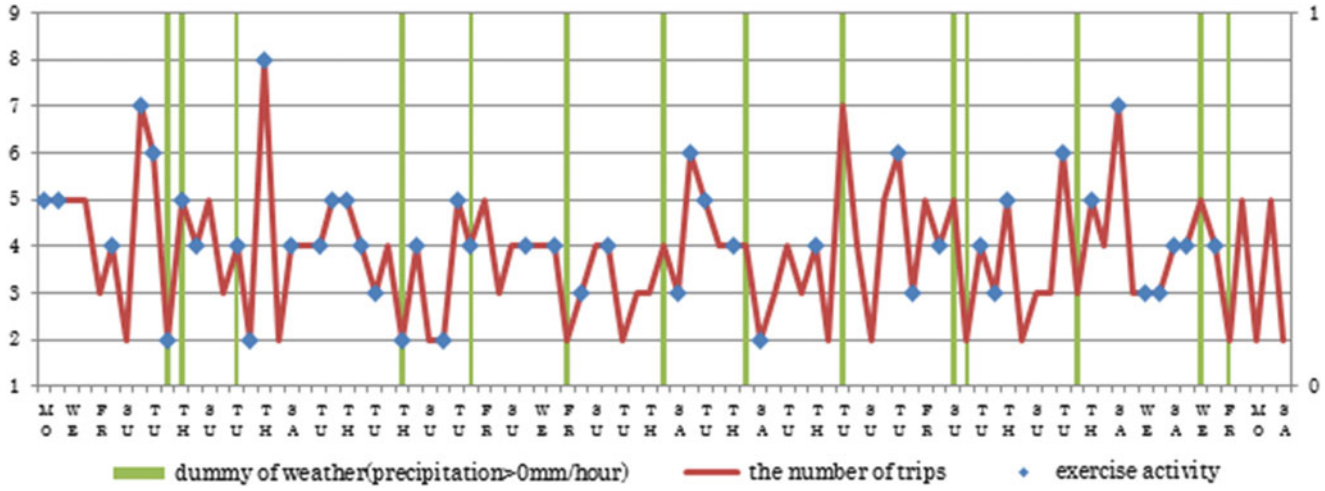

Fig. 10 Weather impacts for activity in summer

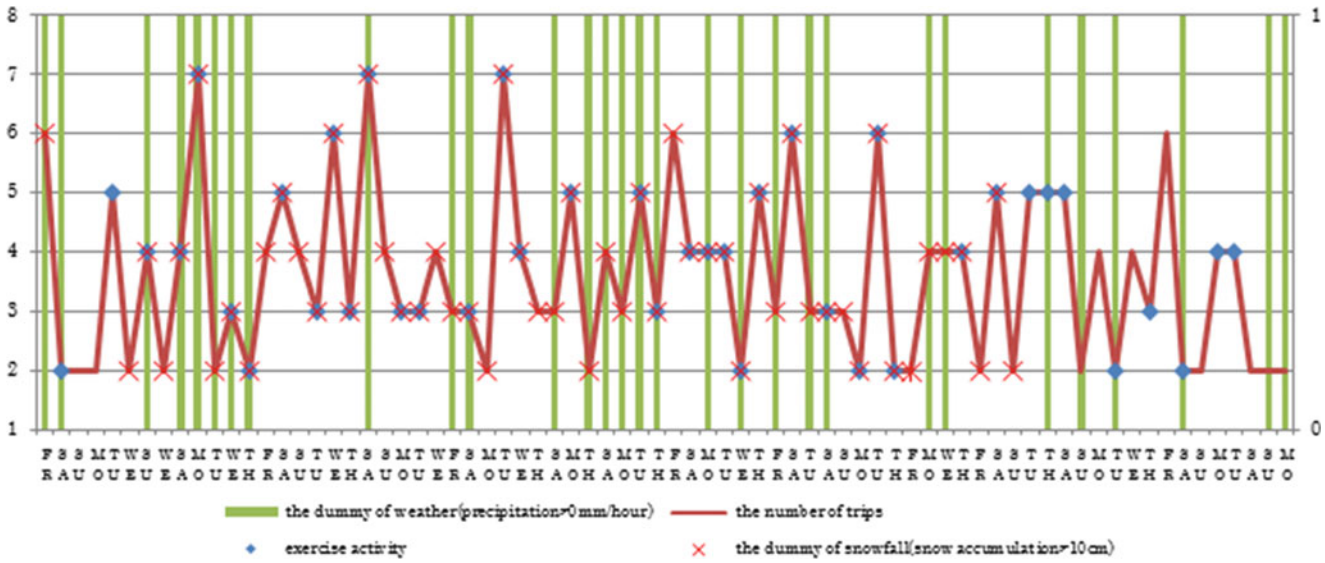

Fig. 11 Weather impacts for activity in winter

there were trips for exercise and if there was precipitation more than 0 mm/h or accumulated snow more than 10 cm. They show that trips for exercise aren't affected by weather although it isn't an obligatory activity because there are many trips for exercise even if there was rain and snow.

5 Transportation Mode Identification

5.1 Aggregate Information of Trips

We analyze two persons' GPS data in Hakodate, Hokkaido, Japan, during the 8 months (including summer and winter). Totally, there are 1,036 trips, 648 trips in summer and 388 trips in winter. The transportation modes utilized during the 8 months include private car/taxi, bicycle, bus, street car, and walk. Private car and taxi are combined due to their similar features.

5.2 Attribute Selection

The attributes used for transportation mode identification include variables related to temperature and trip and activity. Table 6 shows the detailed information of attributes selected for analysis. Temperature-related attributes are in bold.

5.3 Methodology

Random forest method is used to identify transportation mode in a machine learning way. The advantage of random

Table 6 Attribute selected for analysis

ID	Attribute name	Numeric/ descriptive	Values of attribute
1	*Temperature when trip starts*	Numeric	In °C
2	*Average temperature during the trip*		In °C
3	*Snow accumulation when trip starts*		In cm
4	*Average snow accumulation during the trip*		In cm
5	*Precipitation when trip starts*		In mm
6	*Average precipitation during the trip*		In mm
7	Activity duration time		In seconds
8	Trip distance		In meter
9	Time spent during the trip		In seconds
10	Average speed during the trip		In km/h
11	Distance from trip end to workplace		In meter
12	Distance from trip end to home		In meter
13	*Weather when trip starts*	Descriptive	3 categories[a]
14	Period of activity starts		7 categories[b]
15	Period of activity ends		7 categories[b]
16	Weekday/weekend when activity starts		2 categories[c]
17	Weekday/weekend when activity ends		2 categories[c]

Note:
[a]Three categories of weather condition are rain, snow, and others. Rain includes rain, drizzle, and thunder; snow includes snow and sleet; others includes clear, sunny, cloud, and slightly cloud
[b]Seven categories of period are *NP-b-MP* nonpeak before morning peak, *MP(7–9)* morning peak, *NP-b-MP-NOON* nonpeak between morning peak and noon *Noon*, *NP-b-NOON-EP* nonpeak between noon and evening peak; *EP(17–19)* evening peak, *NP-a-EP* nonpeak after evening peak
[c]Two categories of days are weekday from Monday to Friday and weekend from Saturday to Sunday

forests is that it not only provides the accuracy on training set and test set, but also shows the importance of each attribute.

Python and scikit-learn toolbox [4] are used as the platform of random forests.

5.4 Scenarios and Results

5.4.1 Scenarios

In order to assess the necessity that training data set and testing data set should select from the same season or not, four scenarios are set. The details of scenarios present in Table 7. Generally, there will be an accuracy decrease from training set to test set when using the same machine learning method. In order to demonstrate the accuracy difference that is caused by transformation from training to testing or weather-related variables, there are more than one test set in each scenario.

Table 7 Scenario description

Scenario	Training set	Test sets	
Scenario 1	70 % summer data set	1	Winter data set
		2	30 % summer data set
Scenario 2	70 % winter data set	1	Summer data set
		2	30 % winter data set
Scenario 3	70 % combined data set	1	Summer data set
		2	Winter data set
		3	30 % combined data set
Scenario 4	50 % combined data set	1	50 % combined data set (summer part)
		2	50 % combined data set (winter part)
		3	50 % combined data set

Table 8 Results of accuracy

Scenarios	Training set	Test set 1	Test set 2	Test set 3
Scenario 1	99.8 %	**53.6 %**	91.7 %	–
Scenario 2	100.0 %	**67.6 %**	82.6 %	–
Scenario 3	99.9 %	96.4 %	96.1 %	88.3 %
Scenario 4	100.0 %	88.9 %	86.6 %	88.0 %

5.4.2 Results and Discussion

The accuracy of random forest on training set and test set in each scenario is shown in Table 8.

Accuracy of identification in training set in each scenario is very high, almost 100 %. However, if accuracy of test sets is concerned, it varies sharply among sets. It is clear that when data in single season, like scenarios 1 and 2, the accuracy in test set of the other season will drop extremely; however, the accuracy in the test set of the same season drops not as sharply as the other season. It means that using one season data for training and the other season for predicting is not appropriate.

When using 70 % whole data for training in scenario 3, no matter the accuracy of test set of summer or winter, the accuracy is very satisfying. But the accuracy of test set of the other 30 % whole data is not close to the former two test sets. Training set owning almost 70 % of the same data in test sets 1 and 2 is probably the reason. It can be also proved by the results in scenario 4 in which training set and test set do not overlap each other. It demonstrates that using both seasons as training data, no matter the test set is single season data or mixed season data, the accuracy is almost the same.

The importance of each attribute in each scenario is shown in Table 9. It is clear that average speed during the trip is the most important attribute for identifying transportation mode. Trip distance, time spent during the trip, and average distance from trip end to home/workplace are other important attributes. Regarding weather-related attributes, they show a generally medium importance during the identification process.

Table 9 Importance value and rank of each attribute in scenarios

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
Attribute ID	I	R	I	R	I	R	I	R
Attr.1	0.032	9	0.055	6	0.065	7	0.073	6
Attr.2	0.035	8	0.047	7	0.072	5	0.064	7
Attr.3	0.000	17	0.024	10	0.024	10	0.023	10
Attr.4	0.000	16	0.016	12	0.018	11	0.015	12
Attr.5	0.009	12	0.009	14	0.008	14	0.006	15
Attr.6	0.010	11	0.010	13	0.010	13	0.007	14
Attr.7	0.045	7	0.039	8	0.035	9	0.040	9
Attr.8	0.132	3	0.226	2	0.129	3	0.144	3
Attr.9	0.109	4	0.075	4	0.090	4	0.078	4
Attr.10	0.260	1	0.229	1	0.249	1	0.238	1
Attr.11	0.176	2	0.125	3	0.147	2	0.148	2
Attr.12	0.089	5	0.069	5	0.069	6	0.075	5
Attr.13	0.003	15	0.004	16	0.005	15	0.010	13
Attr.14	0.063	6	0.038	9	0.055	8	0.052	8
Attr.15	0.025	10	0.022	11	0.016	12	0.018	11
Attr.16	0.007	13	0.004	17	0.004	17	0.004	17
Attr.17	0.006	14	0.006	15	0.004	16	0.004	16

"I" stands for importance value, "R" stands for rank
Importance values are relative and totally equal to 1 in each scenario

6 Conclusions

This study analyzes how season and weather affect individual travel behavior from probe person survey data in Hakodate and tries to identify which transportation mode is used by using random forest model. Moreover, combined data between training data and test data is used for evaluation of which combination shows highest accuracy. Knowledge from this study is shown below:

- The change of the personal travel action caused by season or weather was clarified.
- It was found that trips by bicycle, walk, and bus are especially dependent on a road state change.
- Model which is overlapped in both data in summer and winter showed highest accuracy in both estimations in summer and winter when random forest model is used for transportation mode distinction.
- In addition, average speed of the trip was the most important as a characteristic to contribute to transportation mode detection. Furthermore, weather condition such as weather, temperature, and precipitation also contributed to some extent.

Future works are shown as follows:

- We performed basic analysis and model analysis from the GPS trajectory data of only two persons. It is useful to increase samples from now and analyze in future.
- We identify only transportation mode by random forest model, but should also detect moving/staying location and trip purpose.
- We will build the mode choice model of the personal level in the Hakodate urban area based on automatic formed trip data.

References

1. Soora Rasouli and Harry Timmermans, 2014, "Mobile Technologies for Activity-Travel Data Collection and Analysis", Information Science Reference.
2. Miao Lin and and Wen-Jing Hsu, 2014, "Mining GPS data for mobility patterns: A survey", Pervasive and Mobile Computing, 12, 1–16.
3. Shoji Sano, Ryo Kanamori, Keiji Hirata and Hideyuki Nakashima, 2013, "Smart City Hakodate Project: Traffic Behavior Reports for a Traffic Flow Simulator", WSSIT2013.
4. Pedregosa, F., Varoquaux, G., Gramfort, A., Michel, V., Thirion, B., Grisel, O., and Duchesnay, É., 2011, "Scikit-learn: Machine learning in Python" The Journal of Machine Learning Research, 12, 2825–2830.

Collaborative Innovation Centers (CICs): Toward Smart Service System Design

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Abstract

This paper begins to integrate the technical literature on smart service systems with the more established policy literature on industry, academic, government collaborations. IBM's existing Collaborative Innovation Centers (CICs) serve to ground the discussion in practice. CICs are an example of a Triple Helix smart service system, designed to rapidly close skills gaps and to accelerate the growth of high-skill jobs, essential to regional economic development and quality of life in knowledge economies. As such, this paper further provides insight into CIC design methodology and comparison with alternate types of collaborative centers highlighting differentiated design dimensions.

Keywords

Service systems • Regional economic development • Collaborative innovation • Value networks and design

1 Introduction

The driving forces for regional economic development are skilled people, technologies, and innovation. While many regional governments have set up long-term strategic plans for economic growth in their regions, a key transformative initiative is public-private partnership, to build in-demand skills, create jobs, and improve life quality through technologies and innovation [1]. IBM has institutionalized a program called Collaborative Innovation Centers to support this initiative [2]. As shown in Fig. 1, CIC is a nested, networked service system at the intersection of academia, industry, and government that would enable resource sharing, value cocreating, and capturing for all the stakeholders.

Technological shifts can give rise to skills gaps and thereby missed or slower economic growth opportunities for some regions, because in the short term there is an insufficient supply of talent to fill business demand and talent to explore entrepreneurial opportunities efficiently in high-skill, high-pay employment areas [3]. Technology shifts can be especially disruptive if they create skill shortages in one economic sector while simultaneously reducing or eliminating the need for older skills that had previously been in high demand in another economic sector. For example, technology shifts have been a factor in the sectoral shifts of employment from agriculture and manufacturing toward service.

When technology shifts occur, a decade or more may be required to reskill a workforce to align with available opportunities [3]. This unfortunately indicate missed economic growth and quality of life benefits, primarily because of the time it takes institutions to coordinate and shift priorities, as well as people to learn new skills and adapt to new opportunities. These time lags can be viewed as a "speed limit" to progress, since technological changes often require complementary education system and regulatory system change; without more rapid and resilient coevolution, progress is slowed and benefits missed [4].

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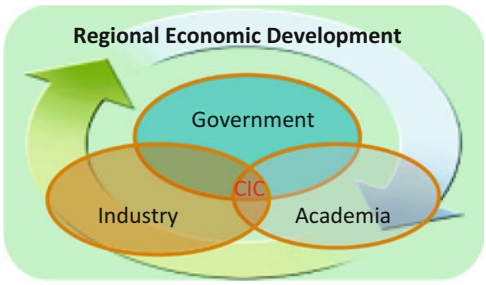

Fig. 1 CIC is a type of service system at the intersection of academia, industry, and government to collaborate on high-skill job growth and regional economic development

When technology shifts happen slowly (equal to or longer than the working lifespan of a person), the next generation can fill the demand for new talent, as the previous generation exits the workforce [5]. However, today technology shifts are happening in less than the lifespan of individuals, and these more numerous technology-driven shifts can impact multiple economic sectors simultaneously. For example, the World Wide Web created skills gaps for setting up websites and e-commerce server farms, and smartphones created skills gaps for creating apps, including mobile e-commerce and social media apps. Today, the rise of digital economy, big data, Internet of Things (IoT), and cybercrime simultaneously creates skills gaps for technology practitioners such as data scientists and cybersecurity experts.

On the other hand, the nature of innovation is changing [6]. Today, continuing digital evolution and revolution, combined with a transition from traditional market-based economic structures to an ecosystem-based environment, has called for collaborative innovation.

New technologies are making business more intelligent, fast, and scalable [7]. As the world becomes more connected, organizations will encounter increasing difficulty competing as solo entities. In today's era of exponentially increasing data and information, and ubiquitous digitization, the new economic equation favors transparency and collaboration. As a result, the focus of innovative organizations is likely to shift in the near future from organization centricity to one that is ecosystem centric. An ecosystem can be thought of as a complex web of interdependent enterprises and relationships that creates and allocates business value.

Within this ecosystem-centric model, universities are ideally suited to play a central role. It's a known fact that universities, especially top-ranked research universities and entrepreneurial centers, at the leading edge of knowledge discovery are significant drivers of regional economic development [8]. Universities uniquely provide a means by which a number of key aspects for societal success can be coalesced into coherent initiatives. For the industry and government, the key is in acknowledging, embracing, and supporting that role.

While establishing regional university-centric centers focused on high-skill, high-pay job creation based on an academic-industry-government partnership is not a new phenomena, the large size of the projected skills gaps and the accelerating pace at which these centers are now being established do clearly suggest a unique opportunity that now exists to improve the theory and practice of establishing these Collaborative Innovation Centers [2, 9–11]. Put differently, there is an opportunity to take steps toward improving the design of CICs as smart service systems for regions to pursue economic development.

In the next section, this opportunity is explored from a theoretical perspective, before presenting CICs in Sect. 3 and its design methodology in Sect. 4.

2 Technical and Policy Literature

The technical literature about smart service systems has been evolving rapidly over the last decade. The US National Science Foundation (NSF) now has a program for smart service system science, management, engineering, and design [12].

> The Partnerships for Innovation: Building Innovation Capacity (PFI:BIC) program supports academe-industry partnerships, which are led by an interdisciplinary academic research team with a least one industry partner to build technological, human, and service system innovation capacity. These partnerships focus on the integration of technologies into a specified human-centered smart service system with the potential to achieve transformational change in an existing service system or to spur an entirely new service system. These technologies have been inspired by existing breakthrough discoveries.

Smart service systems are socio-technical or cyber-physical-social systems that are human centered and dependent on advanced technologies to support the creation and delivery of value. They are dynamic configurations of people, technology, organizations, and information connected internally and externally by value propositions [13]. In this context, service is simply value cocreation interactions and outcomes between entities. Therefore, service can be seen as the application of knowledge by entities (often via complex socio-technical systems) for mutual benefits.

Service systems are both designed as well as evolve over time. The evolving ecology of nested, networked service system entities has a global structure, and species of service systems come and go over time, based on how well entity architectures are adapted to addressing human needs, wants, aspirations, and problems [14].

In practice, designing and improving service systems can benefit greatly from value network mapping and value network analysis techniques [15]. Value network mapping is a practical technique that stakeholders can employ in group meetings to identify and discuss both tangible and intangible

deliverables between role-based entities, collaborating to cocreate value. Value network mapping and value network analysis have been applied to problems of regional economic development.

Practical techniques for designing and improving service systems are being developed within both the service design and service operations' academic research and business practitioner communities. For example, Process Chain Network (PCN) provides a framework for analyzing both direct and surrogate (indirect) interactions, as well as independent processing in service systems and extended service networks [16]. However, service systems are multimodal, multi-scale, and multi-time span, and therefore modeling them is quite challenging. Service system modeling is complex because of the diversity of human cultures and individual differences and capabilities [17].

The policy literature associated with academic-industry-government interactions is more mature and substantial than the technical literature on smart service systems [8]. For example, the Triple Helix community draws on an extensive economic and public policy literature [1]. The Triple Helix refers to the collaboration and the coevolving capabilities, constraints, rights, and responsibilities of the universities, industry, and government. The knowledge-based economies give meaning to information, and certain patterns of interaction (communications and coordination) allow capabilities to evolve more rapidly than others [18].

In order to understand the service innovation and the evolution of service systems, the service research community needs to embrace both technology change and regulation (rules system) change fully [19]. The concept of institutional diversity is highly related to the concept of service system diversity [14, 20].

In sum, the technical and policy literature must be further integrated to provide a more comprehensive theoretical foundation for understanding the design and evolution of CICs. This needs to be done particularly taking into account that the coevolution of technology, regulations, and skills is highly intertwined and complex [21, 22].

3 Collaborative Innovation Centers

Today, there are many ways for private companies to engage with universities. Most are well documented on industry and academic websites, as well as government-affiliated organizations, such as the University-Industry Development Program [23]. These academic engagement models vary depending on collaborative focus and desired outcomes. As a starting point, many, such as the IBM Academic Initiative Program (AI) [24], serve to provide educators, researchers, and students royalty-free access to commercial software for strictly educational and research purposes. Most programs support single-point type of collaboration between faculty and researchers in the industry. At the upper end of this spectrum resides the CIC, which supports the collaboration at an enterprise level with its comprehensive scope and its ability to integrate resources across all program areas. Between stated extremes, Center of Competence (CoC), Center of Excellence (CoE), and Innovation Centers (IC) also serve as collaborative models. However, they tend to be more business oriented, focusing on the support and engagement with their customers. Table 1 reflects design dimensions for CIC and mentioned alternate collaborative models.

CICs are smart service systems whose mission is to close a skills gap and accelerate the growth of regional high-skill jobs. CICs are also central ecosystem players, which most often require government support or investment to be established, as well as an industry partners with local or relocated experts who can work closely with university faculty to establish new integrated education and work practice programs. Ideally, the industry partner brings to the CIC real-world experts, tools, data, and challenges (often the problems of the industry partner's customers). Students in the CIC who master the new skills may be rewarded with jobs, either internships or full-time employment in the industry partner or industry partner's customers businesses or in start-up companies that are part of the universities' entrepreneurial ecosystem.

As shown in Fig. 2, the CIC model is centered on three interdependent, value cocreating activities: education, research, and development.

Table 1 Collaborative model design dimensions

Attributes	AI	COC	COE	IC	CIC
Skills	X	X	X	X	X
Solution development		X	X	X	X
Research/innovation				X	X
Technology exploration				X	X
Entrepreneur/job creation					X
Triple Helix					X
Self sustainable					X

Fig. 2 The essence of CIC design is to tackle shared challenges with shared resources and to maximize the performance under simultaneous constraints

Clearly identifying a skills gap that has significant potential to improve regional economic development and quality of life is one of the motivations for establishing a CIC [25]. While technologies such as predictive and prescriptive analytics can help drive positive business outcomes, ultimately regional economic development comes down to people with the right skills who can lead transformations and sustain change in organizations. A holistic approach must examine many types of skills that are needed in a regional workforce.

At the same time, companies like IBM can provide access to state-of-the-art technology platforms, such as Bluemix [26], which embraces open source software and customer challenges to enrich the curriculum of existing or new degree programs. Other government and industry partners bring data and problems to the CIC to seek help and solutions. Together, they provide students the opportunity to apply what they've learned in the classroom to solve real-world problems. The technologies themselves such as Cloud, analytics, mobile, social, and cognitive computing can also be utilized to enable personalized education for more effective learning as well as provide a catalyst for innovation. In the end, these technologies also further accelerate discovery and the resulting eventual commercial deployment.

Expertise is essential to close skills gaps and to create a skilled workforce; expertise may include inventions and disruptive innovations, as well as insight that leads to new industry solutions. The activities running in the CIC are largely interdependent projects. Education and training develops skills, especially in the context of real-world challenges and real customer interactions and industry solutions. In a CIC, faculty, students, experts from private research institutes, and practitioners from industries all work together, creating a talent pool.

By design, each CIC that is established contributes to the health of a regional innovation ecosystem and acts as a "Think Tank" for the region in emerging skills, technology, innovation areas. Through the research activities and interactions with government agencies (such as local municipalities) and private companies, the CIC becomes a living repository of knowledge, expertise, insight, best practices, and innovation for applying new technologies to transform government and many industries. On the other hand, after a decade or more, the CIC may be absorbed into a traditional academic department, once there is no longer a critical regional skills gap.

CICs are especially appropriate for early-stage technologies where a large skills gap exists. For example, initially a CIC might be an incubator or a test bed for a new technology, where its future consumers can be invited to directly participate in the innovation and development. The tolerance for failure should be higher when a new technology is being tested out at a CIC and before it becomes promising enough for venture capital (VC) investment. As the new technology matures, the CIC can form a Center of Excellence (CoE) or a start-up company in that field as it moves to explore additional new technology and opportunity areas. Commercial start-ups can then be further supported through CIC industrial partners and their networks, such as IBM's Global Entrepreneur Initiative.

Collaborative research across multiple CICs ensures that emerging technologies can be adopted by an entire industry or cross industries rather quickly by providing workers with needed skills; thus, the CIC structure can unlock the power of technologies with minimal delay and maximize their social impact.

This is becoming evident in a close partnership between IBM and State University of North Carolina, which has sparked the creation of a major open source Cloud environment that has blossomed into a multi-institutional asset with a now organized R&D ecosystem of cocreating users. The academic institutional users involved in this partnership further use this as an opportunity to develop "Cloud" skills and foster new research as well.

Currently, there are a number of CICs that have been successfully launched worldwide. For example, in Ohio [9], Governor John Kasich launched the Center for Advanced Analytics at Ohio State University. In doing so, he described the importance of academic-industry-and-government collaboration in areas of research and new skill development. The main objective of this public-private partnership is the creation of 500 new high-skill jobs in the region over 3 years. Dean Christine Poon, Ohio State Fisher School of Business, further elaborated on the Centers' objective: "Our strong collaboration with IBM will help our students across a variety of majors gain the latest skills in this burgeoning Big Data discipline and set them on a path to secure the high skilled jobs of the future."

In Nova Scotia, Canada [10], Premier Darrell Dexter spoke of the economy of tomorrow at the launch of the Nova Scotia Center. This regional partnership will involve multiple colleges and universities, including community colleges. President Don Bureaux, Nova Scotia Community College, said: "Today's students need continuous preparation for a digital world that blends both business and technology skills."

Additionally in Singapore [11], Jayson Goh, Executive Director, Economic Development Board, spoke about data as a new natural resource and building a multidisciplinary future-ready workforce at the launch of the National University of Singapore (NUS) Centre for Business Analytics. NUS School of Computing Dean Ooi Beng Chin said: "Modern economic activities, innovation, and growth go hand in hand with Big Data."

4 Methodology for Establishing CICs

The design of any CIC is based on three main principles:

1. A healthy and diverse ecosystem that pools technical, financial, and talent resources to drive a mutually beneficial socio-technical outcome for a region's economy
2. Innovative use of emerging technologies by collaborators to solve government and industry challenges more effectively than if attempted separately
3. And a nonprofit core that creates high-skill, high-paid jobs, which is part of and run by an academic institution with the goal of being self-funded within 3–5 years

As previously stated, the stakeholders who play roles in a CIC smart service system typically include a regional government, university or academic institution, and industry. The impetus to design and establish a CIC can come from any of these potential collaborators. To start, there needs to be a clear statement of economic need and opportunity for growth in a region. The ecosystem of a CIC should produce more value as a whole, than the sum of the individual participants acting independently. Value capture in a CIC reflects a networked, dynamic, everyone-to-everyone process of exchange. Methodologies such as value network mapping can be used to provide a way for all CIC collaborators to explicitly identify and discuss the tangible and intangible benefits and deliverables they expect to exchange [15].

To quickly review, a service system is a dynamic configuration of people, technology, organizations, and information connected internally and externally by value propositions. A smart service system is one that rapidly adapts to technological shift opportunities, both in the skills of people, the use of the emerging technology, mobilizing relevant organizations to act, and sharing information with others to establish and refine value propositions. A CIC is an exemplar smart service systems responding to skills shortages associated with an emerging technology and mobilizing Triple Helix actors to respond quickly and share information that can improve response times and performance levels over time.

Setting up a CIC is a rigorous process over 6–12 months. The methodology includes four phases: assessment, planning, design, and implementation.

Assessment of the request for a CIC involves investigation of technology, economic, political, and social factors to determine the likelihood of success. The CIC design team evaluates the maturity of the technology in the context of availability of critical expertise to drive skill development, level of interest and support from regional government, economic and political viability of the collaborators involved, availability of seed funding to initiate and ramp up the CIC, and any risk factors. Most importantly, during this phase an assessment is done for self-sustainability of the model. This assessment typically takes over 2 months of weekly calls and face-to-face discussions.

A critical design point for CICs is ensuring that there is enough of a critical mass of subject matter experts in the technology and industry area to support the skill development aspect of the CIC. Conversely if the technology is too mature, the CIC may not be the right service system model for that region or industry. As a result the evolutionary phase of the emerging technology is given careful consideration during the feasibility assessment phase.

Planning is the next phase where the design team meets with an interested core set of collaborators to establish the parameters of the CICs, who needs to have a seat at the table to further specify the critical work that allows the CIC to ramp up quickly and become self-sustaining. During this phase the CIC model is reviewed against the requirements of the collaborators. Desired timeline and initial assumptions captured in the assessment phase are reviewed and revised as appropriate. Rules of engagement are jointly defined. At the end of this phase, the scope, schedule, and budget for the CIC are typically agreed, and a high-level design is created.

The design phase is where all of the details are incorporated into the CIC model and where true customization occurs to optimize the outcomes while meeting the requirements and constraints of all the stakeholders. This includes a new degree program or new courses within an existing program, the architecture of the infrastructure, the technology selection, the governance model based on the concept of cocreation, the pathway for innovation, the knowledge transfer plan and process, and the job design. For example, key architecture and technology design decisions are made regarding technology that will be a main focus at the CIC versus shared technology resources with other CICs such as a Cloud infrastructure environment. All of which serve to achieve a finalized agreement.

Figure 3 shows a simplified value network model for a CIC as a smart service system. The major roles that people

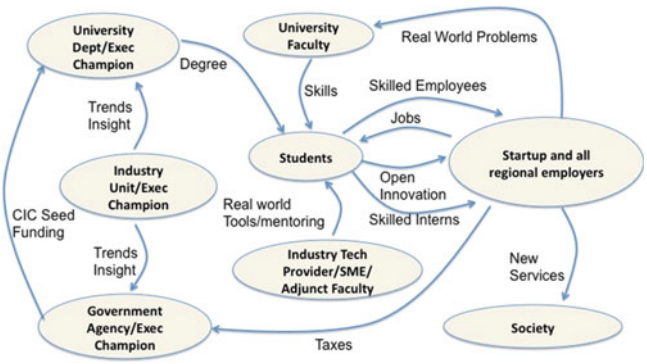

Fig. 3 Simplified CIC value network model

will fill are all shown as labeled ovals, which are interconnected by arrows showing the tangible and intangible value flows between the roles.

The design of a CIC can benefit from the presence of industry adjunct faculty who may be first to see the opportunity for a new CIC. Industry employees who have a more continuous and integrated presence at a university, as in the IBM on Campus program, are more likely to detect an opportunity and bring the relevant people together to discuss the possibilities. Industry employees may be adjunct faculty or simply on a university advisor board. They are "catalysts who energize the network" and who can link industry and university representatives together to collaborate.

Integral to this phase, a financial model is set up so that the CIC becomes self-sustaining after an initial 3–5 years. There could be multiple ways for a CIC to create "value flows." In countries where students pay tuition and fees, a "hot degree" can be a significant source of income. For countries without tuition (such as Nordic), the government could, for example, subsidize a substantial amount of the CICs' cost. Any certificate programs for industry practitioners or an executive training program can be another source of income. Municipalities and industrial companies can either become members of the CIC by paying a membership fee in order to have continuous access to the human capital and technology resources at the center. Alternatively, they can pay a onetime fee to hire students as interns and utilize the technologies at the CIC to work on certain projects of interest. The intellectual property (IP) created at the CIC can potentially generate IP income by licensing the patents to other companies. On the other hand, the students can take the IP and leverage some of the resource in the CIC to create start-up companies and, if successful, eventually provide financial returns to the CIC.

The last phase is implementation, when the CIC is inaugurated. An official ceremony to kick off the CIC, with an announcement to the press/public, is typical [9–11]. Funding is allocated; space is allocated or built and infrastructure is set up; governance board and daily operation team are identified and formed; often a new degree or certificate program is launched. The Center performance needs to be periodically evaluated. Any conflicts need to be reconciled. The channels for value flow may need reconfiguration and further optimization. Thanks to advanced technologies such as analytics and cognitive computing, data collected can be used to improve CICs' efficiency and agility, so that they can quickly adapt in a constant changing environment to create value to the customers and providers.

The CIC integrates teaching, training, research, and consulting for the purpose of creating 100s of high-skill/high-pay jobs in a region. Measures of success include the number of students hired by the industry partner and/or of industry partner customer companies as interns or employees, as well as the number of start-ups coming out based on the industry platforms.

Similar to any innovation initiatives [27], the success factors for CIC besides many mentioned hygiene factors like a cross-functional team, adequate resources, and top management support are strong technology presence (a pooled SMEs from all parties and shared technology resources), input from external parties (requests, challenges, problems, data), visionary leadership (innovation is often disruptive), and emotional commitment from the people who are involved. It is expected that best practices will be shared among several CICs with similar focuses.

5 Conclusions and Future Research

The importance of designing better ways for the academia, industry, and government to collaborate to drive innovation for regional economic development is well established in both the theory-based Triple Helix and practice-based UIDP literature [18, 23]. In this paper, practical examples have been presented of CICs as smart service systems designed to close skills gaps and create high-skill and high-pay jobs that contribute to regional economic development and boost quality of life.

This paper has provided practical steps for getting started, as well as examples of existing CICs and how they are different from, but complementary, to other university-industry collaboration programs and mechanisms where the focus is not on working with regional governments to close emerging skills gaps brought on by technology shifts. Finally, this paper has connected CICs to the broader technical and policy research literature, which is developing the theoretical underpinnings to design smart service systems.

No discussion of CICs would be complete without exploring future research directions. As the number of technology shifts per lifetime increases, regional governments and regional economic development agencies will want to make investments that help close skills gaps more and more rapidly. Regions that become overly specialized become less innovative, less resilient, and more susceptible to disruptive innovations over time [28].

Collaborative innovation models are beginning to articulate the need for university graduates who are T-shaped adaptive innovators, with depth and breadth [29]. I-shapes (depth only) were perfectly adequate in a world where major technology shifts happened once or fewer per generation. T-shapes combine depth in engineering, business, social science, or at least one academic area, with breadth or empathy for learning about, communicating with, and collaborating with people with from complementary areas of expertise. As business and societal problems become more complex, teams of T-shaped adaptive innovators will

likely outperform teams of traditional I-shapes who lack boundary-spanning abilities. The International Society of Service Innovation Professionals (ISSIP.org) has been leading the development of novel T-shaped measurement tools. T-shapes are always ready to learn new skills that open up new opportunities for career development and growth.

Perhaps the most disruptive emerging technology is cognitive computing and rise of cognition as a service [30]. Cognitive assistants for all occupations in smart service systems are coming, and the productivity and creativity of individuals and teams will be dramatically increased as a result. Nevertheless, cognitive systems are a highly disruptive technology shift, and it may eliminate old-style, static knowledge jobs while transforming industries and professions. The transition from old-style jobs to dynamic professions with increasingly intelligent cognitive assistants will be an investment that regional governments and regional economic development agencies will not want to miss. The mantra in industry and academia will likely become "never miss a technological shift."

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References

1. Etzkowitz, H., & Leydesdorff, L., 2000, The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research policy*, *29*(2), 109–123.
2. Ouyang, Q., Perelgut, S., and Spohrer, J., Collaborative Innovation Center as a New Service System to Drive Economic Development. In Atlantis Press, International Conference on Global Economy, Commerce and Service Science, Thailand, 2014.
3. Manyika, J., Hunt, D., Nyquist, S., Remes, J., Malhotra, V., Medonca, L., Auguste, B. & Test, S., 2011, Growth and Renewal in the United States: Retooling America's Economic Engine. *Journal of Applied Corporate Finance*, *23*(1), 8–19. Also Online Whitepaper at McKinsey Global Instititute.
4. Spohrer, J., Giuiusa, A., & Demirkan, H., Ing, D., 2013, Service science: Reframing progress with universities. Systems Research and Behavioral Science, 30(5), 561–569.
5. Perez, C., 2003, Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages. Cheltenham, UK : Edward Elgar.
6. Ikeda, K., Marchall, A., and Majamdar, A., More than Magic. Executive Report, IBM Institute of Business Value, December 2014
7. Davidson, S., Harmer, M., and Marshall, A., The New Age of Ecosystems. Executive Report, IBM Institute of Business Value, July 2014
8. Lella, G., Fischetto, A., Cesarotti, V., Spohrer, J., Ren, G., & Leung, Y., 2012, Universities as complex service systems: External and Internal perspectives. In Service Operations and Logistics, and Informatics (SOLI), 2012 I.E. International Conference on (pp. 422–427). IEEE.
9. Cook, S., and Davis, L.P., 2012, IBM Opens Advanced Analytics Center in Columbus, Ohio. Online Press Release. IBM.
10. Bendzsa, C., 2012, IBM and Nova Scotia Team to Invest in Future Economic Growth. Online Press Release. IBM.
11. Chong, C., and Tan, V., 2013, NUS and IBM to Jointly Establish Centre for Business Analytics to Build World-class Analytics Capabilities. Online Press Release. IBM.
12. Nerlove, S.B., Medina-Borja, A., Paredis, C., Esterwitz, L., Singh, Gurdip, Leonesa, A., 2014, Partnerships for Innovation: Building Innovation Capacity (PFI:BIC). Webpage. NSF.
13. Spohrer J., Maglio P. P., Bailey J., Gruhl D., 2007, Steps towards a science of service systems. Computer 40(1):71–77.
14. Spohrer, J., Piciocchi, P., & Bassano, C., 2012, Three frameworks for service research: exploring multilevel governance in nested, networked systems. *Service Science*, *4*(2), 147–160.
15. Allee, V. & Schwabe, O., 2014, Value Networks and the true nature of collaboration. Online book.
16. Sampson, S.E., 2012, Essentials of Service Design: Developing high-value service businesses with PCN Analysis.Second Edition. ISBN 9781481871655.
17. Freund, L. E., & Spohrer, J. C., 2013, The human side of service engineering. *Human Factors and Ergonomics in Manufacturing & Service Industries*, *23*(1), 2–10.
18. Leydesdorff, L., 2010, The knowledge-based economy and the triple helix model. Annual Review of Information Science and Technology, 44(1), 365–417.
19. Vargo, S. L., Wieland, H., & Akaka, M. A., 2014, Innovation through institutionalization: A service ecosystems perspective. *Industrial Marketing Management*.
20. Ostrom, E., 2009,. *Understanding institutional diversity*. Princeton, NJ : Princeton University Press.
21. Arthur, W. B., 2009, *The nature of technology: What it is and how it evolves*. NY : Simon and Schuster.
22. Wright, R., 2001, *Nonzero: The logic of human destiny*. NY : Random House LLC.
23. Boccanfuso, A.M., 2014, Principled Partnerships: Unlocking and Speeding Innovation : FAQs for Universities and Industry. University-Industry Demonstration Partnership (UIDP). Online article.
24. http://www-304.ibm.com/ibm/university/academic/pub/page/academic_initiative
25. Dirks, S., Gurdgiev, C., & Keeling, M., 2010, Smarter cities for smarter growth: How cities can optimize their systems for the talent-based economy. *IBM Institute for Business Value*. Online Whitepaper. IBM.
26. http://ibm.biz/LearnBluemix
27. Parmar, R., Mackenzie, I., Cohn, D., and Gann, D., 2014, The New Patterns of Innovation. In Harvard Business Review, January-Febuary 2014.
28. Hausmann, R., & Hidalgo, C. A., 2014, The atlas of economic complexity: Mapping paths to prosperity. Cambridge, MA : MIT Press.
29. Donofrio, N., Sanchez, C., & Spohrer, J., 2010, Collaborative innovation and service systems. In *Holistic Engineering Education* (pp. 243–269). NY : Springer.
30. Spohrer, J. and Banavar, G., (submitted), Cognition as a Service : An Industry Perspective. AI Magazine.

Dispersed Energy Storage and Its Effect on Market Efficiency in Electricity Trading with Distributed Power Resources: An Experimental Economics Study

Sangjic Lee, Ryuichi Uda, Kenju Akai, and Nariaki Nishino

Abstract

Electric power systems in the world are undergoing a structural reform. An electricity trading market that is consisted of distributed energy resources such as renewable power generators and bidirectional transmission networks is one idea regarding the future form of electricity market. This study models the electricity market in a way where each player takes both roles of supplier and consumer, power generation capacity is distributed, energy storage is partially installed, and transactions are made by a double auction mechanism. An analysis conducted by the method of laboratory economic experiment focuses on the relationship between various conditions of energy storage distribution among the players and the level of market efficiency. The result is that energy storage has both positive and negative impacts on the market: it reduces the amount of wasted energy and attains the efficient allocation of energy, but on the other hand it has a potential to make the market unstable.

Keywords

Electricity market • Energy storage • Distributed generation • Experimental economics

1 Introduction

Regarding the energy security and the advance of global warming, electric power systems in the world are required a structural reform with introducing renewable power generators [1]. In such a reform of electric power systems, batteries are considered to have an important role to stabilize the power generation from renewable power generators and to enable efficient energy management for consumers [2]. Furthermore, the technology development has proceeded to realize the smart grid or the digital grid [3] that enables bidirectional transmission networks. The electricity trading has already done in electricity market like JEPX in Japan now, so an electricity trading market that is consisted of distributed energy resources such as renewable power generators and bidirectional transmission networks may come true regarding the future form of electricity market. This study models the electricity market in a way where each player takes both roles of supplier and consumer, power generation capacity is distributed, energy storage is partially installed, and transactions are made by a double auction mechanism. An analysis conducted by the method of laboratory economic experiment focuses on the relationship between various conditions of energy storage distribution among the players and the level of market efficiency.

The rest of this paper is structured as follows. In Sect. 2, related work is discussed in the area of energy storage and electricity markets. Section 3 discusses the model of

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electricity market which this study deals with. Section 4 describes the design of the laboratory economic experiment in this study. Section 5 shows the result of experiments and analyzes the effect of batteries on player and market. Finally, Sect. 6 concludes.

2 Related Work

A structural reform of electric power systems has proceeded in the world, so there is lots of work on the application of energy storage to electricity grids.

Vytelingum et al. [4] analyzed efficient energy storage management technique in the smart grid. They provided the storage management technique that minimizes energy purchasing expense corresponding to the energy price that changes over time by the method of agent-based simulation.

Regarding consumers who have their power generator and battery, Atzeni et al. [5] studied on the management of devices that minimizes energy purchasing expense and energy generating cost corresponding to the energy price that changes depending on the amount of energy demand. Furthermore, their study indicated that the energy demand is averaged by consumers who aim at minimizing their own cost for purchasing or generating energy with their power generator and battery.

Yoshimura et al. [6] modeled a community-based energy grid where community members share energy with each other. In such community, they found that each community member was able to use energy more efficiently, and lower cost of the storage battery was accomplished by distributing batteries with small capacity to all members than sharing one battery with large capacity.

On the other hand, work on trading mechanisms for electricity markets also exists. Block et al. [7] suggested a double auction mechanism for electricity markets as the mechanism that makes energy distribution and pricing efficient.

Furthermore, Hosokawa [8] studied on electricity trading with distributed power resources. He modeled an electricity market which consisted of three players each who takes both roles of supplier and consumer with their own power generator and bidirectional transmission networks. He compared market price and social surplus among four different trading mechanisms by the method of agent-based simulation and laboratory economic experiment. The result was that the trading mechanism called "surplus energy-based mechanism" reached the lowest level of market price and the highest level of social surplus: in the market where "surplus energy-based mechanism" is applied, players consume some amount of energy from their power generator first, and then they trade the surplus energy in the market. Then, Lee [9] introduced energy storage to Hosokawa's model. In an electricity market like Hosokawa's model, he allocated a battery to one of three players and analyzed its effect on the market. His study suggested that energy storage makes the level of market price lower and the level of social surplus higher.

Thus, lots of work on the application of either energy storage to electricity grids or trading mechanisms for electricity markets exists, but there is little work on both.

3 Model Description

This section describes the model used in this study. This study considers an electricity market where each player takes both roles of supplier and consumer, power generation capacity is distributed, energy storage is partially installed, and transactions are made by a double auction mechanism (Fig. 1).

3.1 The Power Company

A power company manages this market. To ensure the equality and keep the market stable, it supplies energy at the price $\overline{p}$ constantly, accepts the energy players can't consume, and imposes a penalty on a player who attempts to save energy over their energy storage capacity.

3.2 Players

This model considers a set of consumers I defined as selfish players that always aim to maximize their individual profits. Each player $i \in I$ has a power generation profile and may also have energy storage capacity, namely, $q_i^{\text{generation}}$ and q_i^{capacity}. Player i deals in the market regarding $q_i^{\text{generation}}$ and q_i^{battery} that is the amount of energy in its battery. Player i also has the set of its consumption profile $q_i^{\min}$ and $q_i^{\max}$, where q_i^{min} is minimum amount of energy i has to consume, and $q_i^{\max}$ is maximum amount of energy i can consume. Then each

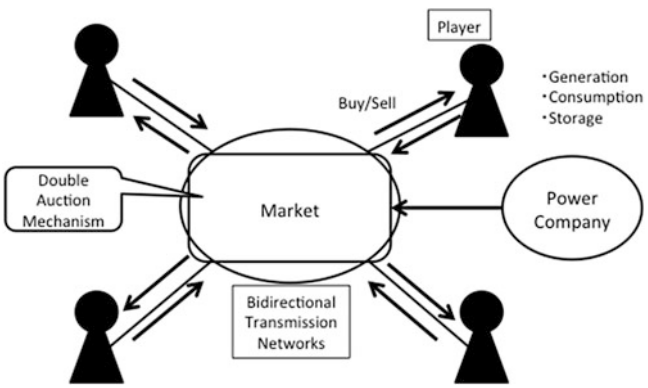

Fig. 1 Electricity trading market model

player $i \in I$ has its demand function defined with $q_i^{\min}$, $q_i^{\max}$, and $\overline{p}$ as the following function:

$$\frac{q_i(p) = -q_i^{\max} - q_i^{\min}}{\overline{p}p + q_i^{\max} \quad (0 \le p \le \overline{p})} \tag{1}$$

In this demand function, p is the price of energy, and it indicates the willingness to pay which player i has for q_i amount of energy.

In this model, players act through three steps, namely, "Ordering Step," "Trading Step," and "Consuming Step."

In "Ordering Step," player i offers information on the set of price and amount of energy which player i wants to buy or sell in the market. In "Ordering Step," players haven't got energy from their power generators yet, so they have to order regarding the amount of energy which they will get from their power generator and energy in their batteries. After all players are finished ordering, "Trading Step" begins. In "Trading Step," the trading price p^* and the energy distribution are determined by the trading mechanism. After "Trading Step," players get energy from their power generators and transactions are carried out, and then "Consuming Step" begins. In "Consuming Step," player i consumes $q_i^{\text{consumption}}$ amount of energy regarding the amount of energy it has, and if i wants, i can buy energy from a power company. As mentioned above, players have a restriction on consumption, so they must consume energy under the following condition (q_i^{add} means the amount of energy player i purchased from a power company):

$$q_i^{\min} \le q_i^{\text{consumption}} + q_i^{\text{add}} \le q_i^{\max} \tag{2}$$

If player i doesn't consume all energy i has, the surplus energy is charged to its battery automatically, but if i attempts to save energy over its storage capacity, the excess amount of energy is taken by a power company and subjected to a fine of $\overline{p}$ per unit energy quantity.

In addition, there are players without batteries. They are considered that they have a battery with 0 capacity and act in the same way as players with a battery. Thus, if a player without batteries doesn't consume all energy, the surplus energy will be wasted.

The series of decision making from "Ordering Step" to "Consuming Step" is called "period," and players are to trade and consume energy for several periods.

3.3 The Profit of Players

Players gain profit by selling or consuming energy. Profit π_i is sum of sale benefit, purchase expense, and utility from consuming energy as follows. In following functions, $p(q_i)$ means the inverted demand function player i has, q_i^{sale} means the amount of energy i really sold, and q_i^{purchase} means the amount of energy i really purchased,

- Utility from consumption (Fig. 2)

$$\pi_i^{\text{consumption}} = \int_0^{q_i^{\text{consumption}}} p(q_i)dq_i \tag{3}$$

- Sale benefit

$$\pi_i^{\text{sale}} = p^* \times q_i^{\text{sale}} \tag{4}$$

- Purchase expense

$$\pi_i^{\text{purchase}} = p^* \times q_i^{\text{purchase}} + \overline{p} \times q_i^{\text{add}} \tag{5}$$

- Profit

$$\pi_i = \pi_i^{\text{consumption}} + \pi_i^{\text{sale}} - \pi_i^{\text{purchase}} \tag{6}$$

As mentioned above, if player i attempted to save energy over its storage capacity, a fine of $\overline{p}$ per unit energy quantity must be paid for the excess amount of energy. Players make decision in order to maximize their individual profits.

3.4 The Trading Mechanism

In this electricity market, trading prices and energy distributions are determined by a double auction mechanism based on buying and selling orders. All buying orders are arranged and combined and referred to as aggregate demand curve (ADC). Likewise, aggregate supply curve (ASC) is made up of all selling orders. If there are some orders with a same bid or ask price, they are arranged at random. There is no way to get information on orders other players offered.

The trading price is determined as a point where ADC crosses ASC, and buying orders with bid price higher than

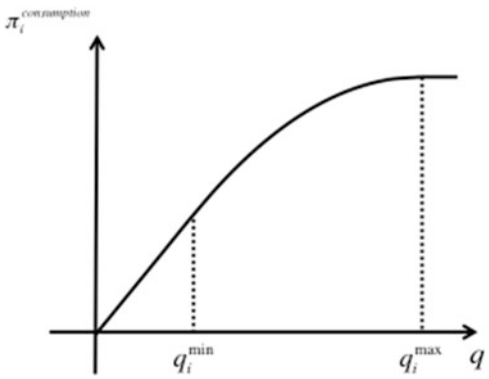

Fig. 2 The utility function each player has

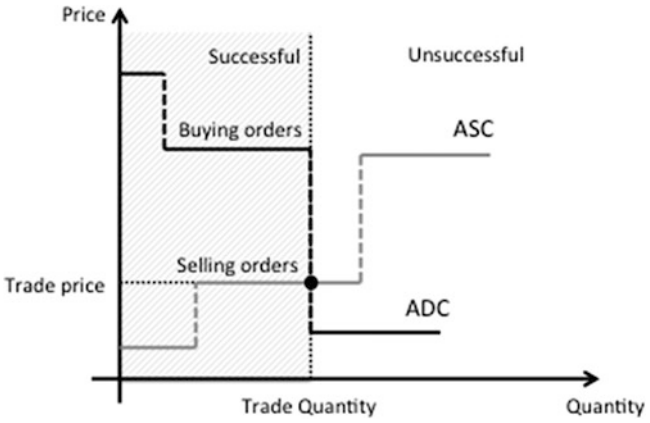

Fig. 3 Trading mechanism

market price and selling orders with ask price lower than it are successful (Fig. 3).

4 Design of Experiments

A key aim of this paper is to study the effect of energy storage on consumers and the market. Thus this study is conducted by the method of laboratory economic experiment in order to observe how people behave under the situation which this model is applied to. This section presents parameters of players and markets.

4.1 Settings of Electricity Market

In the experiment, the electricity market consisted of nine players. Five kinds of experiments were conducted, and each experiment was composed of two parts, namely, the first part and the second part. In each experiment, only the number of players who have a battery is different between its parts. In this paper, each experiment is called using the set of the number of batteries in its parts. For example, the experiment called B0B9 was composed of two following parts: the first part consisted of nine players without a battery, and the second part consisted of nine players with a battery. Table 1 shows the settings of five experiments. Furthermore, to secure data, parts which consisted of nine players without a battery are pooled to the experiment named B0. Likewise, experiments named B3, B6, and B9 are defined.

4.2 Parameters Assigned to Players

Each subject was assigned the role of a player with different parameters on power generation and energy storage in each part of an experiment. Table 2 shows parameters assigned to

Table 1 Settings of experiments

	The number of players with a battery	
Experiment	First part	Second part
B0B9	0	9
B9B0	9	0
B6B3	6	3
B3B9	3	9
B6B9	6	9

Table 2 Parameters assigned to players

$q_i^{\text{generation}}$	$20 \times 3{,}70 \times 3{,}120 \times 3$
$q_i^{\min}$	30 (common for all players)
$q_i^{\max}$	100 (common for all players)
$\overline{p}$	100
q_i^{capacity} (B0)	0×9
q_i^{capacity} (B3)	$300 \times 3, 0 \times 6$
q_i^{capacity} (B6)	$150 \times 6, 0 \times 3$
q_i^{capacity} (B9)	100×9

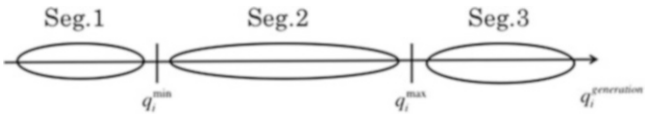

Fig. 4 Segments of players

nine players in each experiment. As shown in Table 2, all players have the same values of minimum amount of energy they have to consume and maximum amount of energy they can consume. Hence, all players also have the same utility function according to functions (1) and (3). In addition, only values of energy storage capacity and the number of players with a battery are different among four experiments.

When assigning parameters, players are classified into three segments as follows (Fig. 4):

- Seg.1: Players who have to buy energy to satisfy their restriction on consumption, namely, players who satisfy the following condition:

$$0 \leq q_i^{\text{generation}} < q_i^{\min} \tag{7}$$

- Seg.2: Players who can consume the minimum amount of energy they have to consume by themselves, namely, players who satisfy the following condition:

$$q_i^{\min} \leq q_i^{\text{generation}} < q_i^{\max} \tag{8}$$

- Seg.3: Players who can get the excess energy to consume from their power generators, namely, players who satisfy the following condition:

$$q_i^{\max} \leq q_i^{\text{generation}} \tag{9}$$

Values of power generation capacity are assigned in order to classify three players in each segment. If there are some players with a battery, values of energy storage capacity are distributed equally, and the sum of all energy storage capacity is 900. Therefore, the value of energy storage capacity distributed to a player with a battery becomes smaller as the number of players with a battery increases. In order to limit the difference among experiments to the values of energy storage, the number of players with a battery is the same among three segments in B3 and B6.

Subjects are only given information on parameters they are assigned.

4.3 Information Given to Subjects

The information given to subjects is as follows:

- Parameters of the player they are assigned
- The graph of the utility function they have
- Values of orders they offered before
- Trading prices
- The amount of energy they purchased or sold
- The value of utility from consumption
- The value of purchase expense or sale benefit
- The value of profit and accumulative profit

In order to enable subjects to make decisions easier, values they decide are limited to the integer: prices they order and quantities they consume are limited to the integer of 0–100, and quantities they order are limited to the integer of 0 and over.

In addition, it is assumed that all players can always get a certain amount of energy from their power generators, and there is no loss of energy by using batteries.

4.4 Procedures

The experiment was carried out for January 6–9, 2015 at University of Tokyo, and there were 72 subjects. Subjects were Japanese undergraduate and graduate students from University of Tokyo. The programs for experiments are made by z-tree [10].

Upon arrival, subjects were seated at separate computer terminals to ensure their privacy and independence. Subjects listened to the instruction explaining the trading rule, the roles they were assigned, and the rewards they were to be given with the printed copy of it. They were permitted neither communications nor questions through the experiment. After the instruction, a practice session was held for 2 periods to help subjects understand what to do, and then, the experiment began for 15 periods. Subjects didn't know periods of the experiment.

Each experiment lasted for about 2 h and average earnings of subjects were 3668 JPY.

5 Results

In this section, results from experiments are shown. This section mentions how players behaved and how energy storage affected the market.

Players usually can't choose the timing when they buy or sell energy due to the property of electricity that the delivery and consumption must take place at the same time. However, energy storage enables players to choose the timing, which gives an incentive to save energy to players. In other words, in order to maximize their individual profits, they will attempt to buy and save energy when low market price is formed and to discharge energy when high market price is formed.

Figure 5 shows the transition of the sum amount of energy in all batteries in the market. Figure 6 shows the gap between aggregate demand and supply. In Fig. 6, positive values mean that the demand exceeds the supply. The quantity of aggregate demand is sum of the quantity of all buying orders, and the quantity of aggregate supply is sum of the

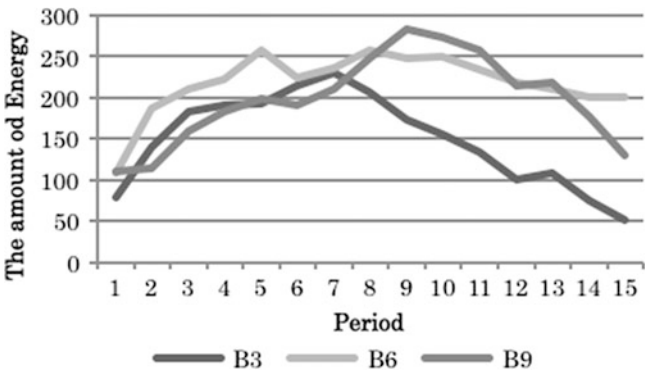

Fig. 5 Transition of the sum amount of saved energy

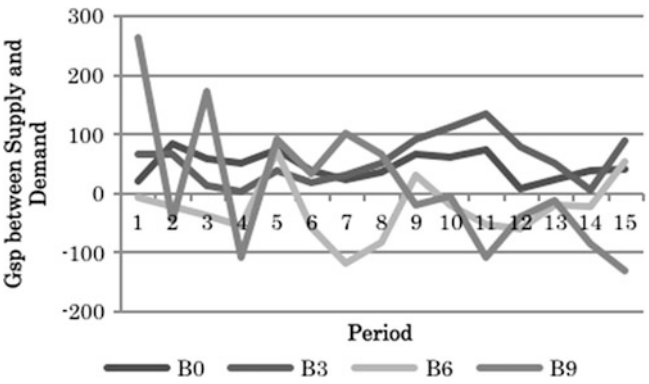

Fig. 6 Gap between supply and demand

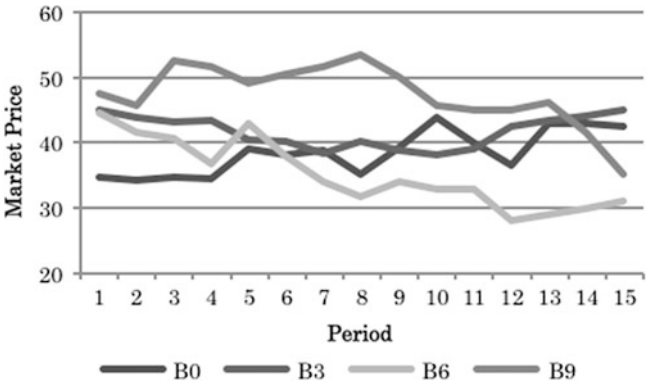

Fig. 7 Transition of market prices

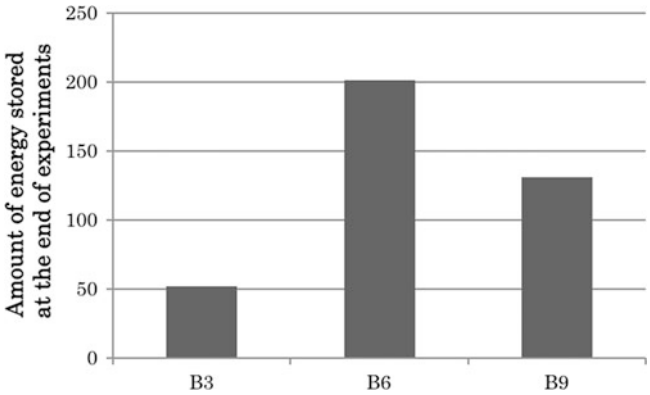

Fig. 8 The amount of energy stored at the end of experiments

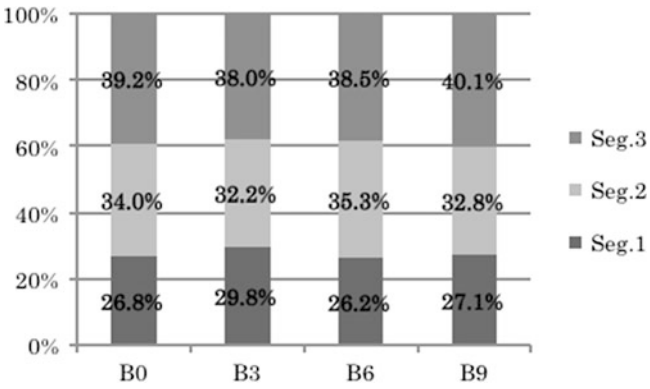

Fig. 9 Ratio of the consumable energy

quantity of all selling orders. According to these figures, players saved energy positively in the former half of experiments, but, on the other hand, the demand decreased. Especially in B6 and B9, the supply exceeded the demand in the latter half of experiments when the amount of saved energy decreased. It indicates that players who want to buy energy saved energy in the former half of experiments to avoid the risk that market price will get higher. Likewise, players who want to sell energy saved energy expecting higher market price in the future. In other words, energy storage makes players estimate the value of energy higher than it really is, which gives an incentive to save energy.

Then the transition of market prices is shown in Fig. 7. From Fig. 7, it is found that the market price changed more drastically as the number of players with a battery increased. Especially, the market price dropped precipitously in the latter half of B9. It might have occurred due to the overestimation of energy by players with a battery. Players who want to buy and save energy attempt to buy a large amount of energy at first, and then they buy less amount of energy and consume from batteries as a certain amount of energy is saved. On the other hand, players with a battery who want to sell energy don't sell energy so much and save to sell when market price get higher. Due to the storage of each player, the demand decreases but the potential supply increases. Hence, the market price can't reach the level which players expect. Then some sellers realize that the market price will not get higher and attempt to sell saved energy, which causes the excess supply and the fall of market price. In short, the divergence between the value of electricity that it really is and that players estimate made the bubble, and it bursted in B9. Hence energy storage has a potential to make the market unstable.

Finally, the market efficiency is discussed here. When the social surplus is defined as the sum of profit each player gained, the value of the social surplus becomes the sum of utility each player gained because sale benefits and purchase expenses reduce each other. However, there was energy stored at the end of the experiment (See Fig. 8), and it is difficult to take the value of that into account for the social surplus. The reason is that players saved energy for different purposes: players in Seg.1 saved energy for consumption, but on the other hand players in Seg.3 stored energy to sell at the higher market price. Therefore, the value of social surplus is inappropriate to measure the market efficiency. Then, the "consumable energy" is defined as the indicator of the market efficiency from the view of energy allocation. Consumable energy is the energy each player consumed and charged to its battery. In this study, all players have the same utility function and its marginal utility is diminishing. Therefore, when a certain amount of energy is consumed in markets, the market where all players consume the same amount of energy will be able to attain the highest level of the social surplus. In other words, it can be said that the most efficient energy allocation is achieved when players who belong to each segment gains the same amount of consumable energy. Thus, the market efficiency is defined by the ratio of the amount of consumable energy got by players in each segment: the level of the market efficiency gets higher as the difference of the ratio of the consumable energy among three segments decreases. In Fig. 9, the ratio of the consumable energy is shown. According to Fig. 9,

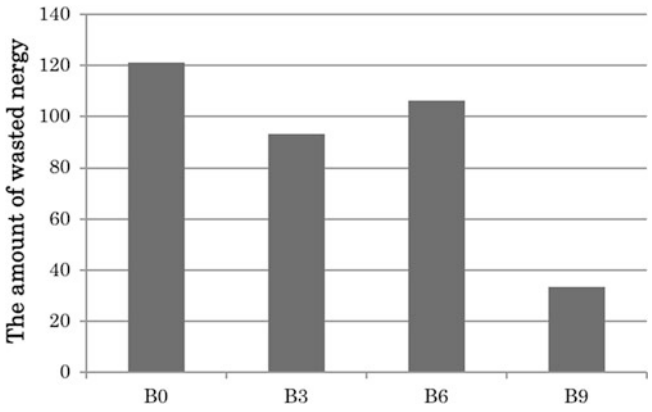

Fig. 10 The amount of wasted energy

experiments can be arranged to B3, B6, B0, and B9 in the ascending order of the difference of the ratio between Seg.3 and Seg.1. It means that the efficient energy allocation was achieved in the market where there were both players with and without a battery. There may be two reasons: one is that energy storage reduces the amount of wasted energy (See Fig. 10), and the other is that the steady energy supply and demand of players without a battery enabled to suppress the influence of behavior of players who have a battery and overestimate the value of energy. Here, wasted energy means the energy players didn't consume or save.

From the above results, it can be said that energy storage has both positive and negative impacts on the market: it reduces the amount of wasted energy and attains the efficient allocation of energy, but, on the other hand, it has a potential to make the market unstable. Thus, even though batteries are diffused widely, the energy allocation will not be more efficient. Hence it indicates that the existence of players without a battery is necessary to suppress the influence of the overestimation of the energy by players with a battery and to stabilize the market. Furthermore, it may also be meant that some kind of agents or systems should manage energy storage devices according to predetermined rules because the reason why the market becomes unstable is the change in behavior of players overestimating the value of the energy with a battery.

6 Conclusions

This study addresses the electricity trading market that consisted of players who take both roles of consumer and supplier and analyzed the effect of energy storage on players and markets by the method of laboratory economic experiment. As a result, buyers with a battery made decisions to avoid the risk that the market price will get higher, and on the other hand sellers with a battery did expecting the higher market price in the future. In other words, energy storage made players estimate the value of energy higher than it really is. As the divergence between this overestimation and the real market price gets larger, the bubble economy can be formed in the market. Hence, energy storage has a potential to make markets unstable. Furthermore, as the number of players with a battery increases, markets become more unstable. Actually, market prices changed drastically as the number of players with a battery increased in the experiment.

On the other hand, "consumable energy" is defined as the indicator of the market efficiency from the view of energy allocation. The result is that markets where both players with and without a battery attains the efficient allocation of energy. Two reasons are considered: one is that energy storage reduces the amount of wasted energy, and the other is that the steady energy supply and demand of players without a battery enabled to suppress the influence of behavior of players who have a battery and overestimate the value of energy.

According to above discussion, this study found out that energy storage has both positive and negative impact on markets, and the existence of players without a battery is necessary to stabilize markets. Furthermore, it may also be meant that some kind of agents or systems should manage energy storage devices according to predetermined rules because the reason why the market becomes unstable is the change in behavior of players overestimating the value of the energy with a battery.

This study sets values of energy storage capacity under the condition that the sum of energy storage capacity is the same in all kinds of markets and so couldn't discuss about which factor is more effective on markets: the capacity of energy storage or the number of players with a battery. Moreover this study also presumes that all players can always get a certain amount of energy from their power generators, and there is no loss of energy by using batteries. However, renewable power generators are affected by several external factors like weather, so there is uncertainty of the power generation actually. In addition, there is also some loss of energy by charging or discharging energy to/from a battery. It is expected to take these points into account to discuss about the market efficiency in more realistic model.

References

1. Ministry of Economy, Trade and Industry, Basic Energy Plan, 2014.
2. Rodriguez G. D., 2010, A Utility Perspective of the Role of Energy Storage in the Smart Grid, Power and Energy Society General Meeting, Minneapolis, MN, 25–29 July: 1–2.
3. Abe R., Taoka H. and McQuilkin D., 2011, Digital Grid: Communicative Erectrical Grids of the Future, IEEE TRANSACTIONS ON SMART GRID, 2: 399–410.
4. Vytelingum P. et al., 2010, Agent-based Micro-Storage Management for the Smart Grid, The 9th International Conference on Autonomous Agents and Multiagent Systems(AAMAS 2010):39–46.

5. Atzeni I. et al., 2013, Demand-Side Management via Distributed Energy Generation and Storage Optimization, IEEE TRANSACTIONS ON SMART GRID, 4: 866–876.
6. Kanamori R., Yoshimura T. and Ito T., 2014, Community Electric Power Management Model for Sharing Home Batteries, The 28th Annual Conference of the Japanese Society for Artificial Intelligence.
7. Block C., Neumann D. and Weinhardt C., 2008, A Market Mechanism for Energy Allocation in Micro CHP-Grids, Proceedings of the 41st Hawaii International Conference on System Sciences, Waikoloa, HI, 7–10 Jan: 172.
8. Hosokawa S. and Nishino N., 2013, Proposal of New Mechanisms in Decentralized Electricity Trading among Small-scale Consumers, IEEJ Transactions on Electronics, Information and Systems, 133: 1738–1751.
9. Lee S., Akai K. and Nariaki N., 2013, Effect of Energy Storage on Decentralized Electricity Market, IEICE Technical Report, 113: 1–6.
10. Fischhacher U., 2007, z-Tree: Zurich toolbox for ready-made ecnonomic experiments, Experimental Economics, 10: 171–178.