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AN APPLICATION OF A SERVICE DESIGN TOOL AT A GLOBAL WAREHOUSE PROVIDER

Mattias Lindahl, Erik Sundin, Tomohiko Sakao and Yoshiki Shimomura

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1 Introduction

The concept of "sustainable development", introduced for the first time in the report "Our Common Future" and promoted as a common aim for the entire world [1], can be defined as "*a development that satisfies the needs of today without compromising the possibility of future generations to fulfill their needs.*" Thus far, this concept has been considered as visionary and therefore difficult for companies to implement into concrete plans of action. However, various suggestions have been proposed, such as dematerialization [2, 3], eco-efficiency [4] and remanufacturing [5]. However, another solution is perhaps more or less a consequence of today's prevalent trend towards a more service-oriented society, and with a focus on the value (satisfaction) that products provide their users through their functionality. The shift from a manufacturing-centered economy towards a service-centered economy have the potential to result in a reduction of the mass consumption of natural resources [6, 7]. Sustainable development is, in a company perspective, not only related directly to environmental issues, as in the definition above, but also in the company's capacity for sustainable market competition. The sharp and rapid increase in global raw material prices, however, is a threat to this; one way to decrease this influence is to reduce the need for raw materials.

In parallel, manufacturing companies around the world are consistently striving to make more profit through, e.g. a larger share of the market and larger share of the product value chain. This can, according to the authors, be achieved by a change to, or at least move towards, a higher extent of functional sales. The business concept of functional sales means, according to Lindahl and Ölundh [6], "*to offer from a life-cycle perspective a functional solution that fulfils a defined customer need. The focus is, with reference to the customer value (defined customer need), to optimize the functional solution from a life-cycle perspective. The functional solution can consist of combinations of systems, objects and services.*"

Given the economic role of services, as well as a shift towards a more dematerialized economy driven by sustainable needs, new methods and tools for service design are required to develop services meeting customer quality needs. These methods and tools are also needed to meet the requirements of other stakeholders, including environmentally related ones, more effectively. As a consequence, it is likely that there will be a need for new methodologies in order to incorporate and improve not only the product, but also the service content depending on the context [8, 9].

1.1 Objective

The two Japanese authors of this paper have carried out research on “Service engineering”, which deals with services in an engineering manner [10]. They have developed a service modeling method [11], a method for evaluating services [12], a method for designing services [13] and a software tool called Service Explorer for supporting service design [14]. Thus far, they have applied some of these methods and tools through application in, for example, the hotel industry.

The objective of this paper is to apply the proposed software tool for service design (Service Explorer), and subsequently to identify its pros and cons.

2 Methodology

The success of a method or tool depends not only on the method or tool itself, but also on the context in which it is used [15]. This context is different for every occasion, and makes it difficult to generalize the results of an evaluation until the effects and interrelationships of the different influences are known. It is partly because of this that Blessing *et al.* [16] discuss the difficulties involved in the verification and validation of methods and tools.

The developer of a method or tool should not to be the major evaluator of his or her own method or tool, due to the possibility of bias. At the same time, it is useful to have a close dialogue with the developer in order to be able to conduct an accurate evaluation. Therefore, in order to perform an appropriate verification as possible of the service design tool, the work was divided between the authors of this paper. With the exception of an introductory workshop in Linköping, Sweden in August 2005, the actual modeling of the warehouse service and data collection was performed primarily by the Swedish authors. The Japanese authors and those at the Shimomura Laboratory (RACE) at the University of Tokyo have provided feedback and support concerning the methodological questions and their Service Explorer software.

The Swedish researchers have studied the warehouse equipment supplier’s business strategy of functional sales. Several people from the company staff have been interviewed at both management and operational levels. One part that has been especially analyzed is the remanufacturing process of warehouse equipment, which is conducted within the company group.

The following three different data collection strategies have been used to gather the empirical data needed in this research project:

Literature review – Different company-produced pamphlets and reports, as well as company websites, were reviewed. In addition to this, external reports concerning the company were also examined.

Interviews – Several semi-structured interviews were conducted with respondents at different positions within the company in order to gather empirical data about warehouse service offerings and how they handled the internal operations of their service.

Questionnaire – A questionnaire was developed and sent out to gather customers’ needs and requirements on the warehouse service. Before the questionnaire was sent out, the company reviewed it. The company provided the authors with a list containing 15 different customers of various sizes and type of business. Altogether, 7 customers (47%) sent back completed questionnaires.

3 Methods and tools for Service Engineering

This chapter gives a brief description of service engineering, service modeling and service explorer. (For more information about problems in current service design and existing research on service design, see for example Sakao and Shimomura [13] and Sakao *et al.* [8].)

3.1 Service Engineering

A service is defined as *an activity that a provider implements, usually with consideration, which causes a receiver to change from a state to a new state that the receiver desires, where both contents and a channel are means to realize the service* [10], see figure 1. Hence, a service receiver satisfies with just content, which can be any material, energy, or bit of information. A service channel is used to transfer, amplify, and control the service contents. In this definition, artifacts can change from contents to channels, and vice-versa. Since artifacts have their own functions, behaviors, and states, they can be designed with conventional CAD systems. Further, since both service channels and service contents also have the above-mentioned characteristics, the similar methodology is introduced into the design of services.

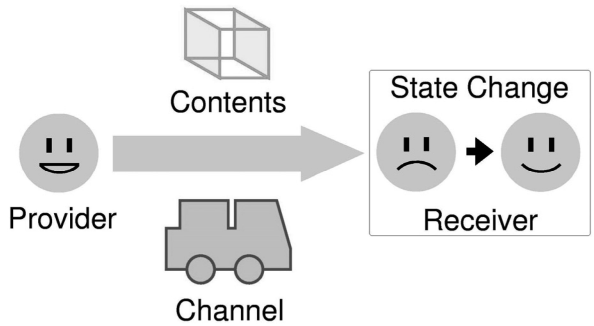


Figure 1. Definition of a service [17].

Service engineering is a design methodology that has both analytical and synthetic aspects. The aim is to, by focusing on service, increase the offered function's value at the same time as its environmental impact is decreased. Service engineering aims at intensifying, improving, and automating this entire framework of service creation, service delivery, and service consumption. To increase the total satisfaction of receivers, functions and/or quality of both channels and contents can be improved; traditionally, engineering design has aimed to improve only functions. In service engineering, however, not only the functions of artifacts, but also the meaning of contents must be matched to the specifications given by receivers [14]. By doing so, the satisfaction of receivers increases.

3.2 Service Modeling

In the argument regarding the design process (see for example Umeda *et al.* [18] and Shimomura *et al.* [19]), it is widely accepted that design might be a search for a physical structure matching the required function. The design of a service is also a search for both physical and non-physical structure, but it differs from the conventional design in terms of evaluation. Conventional design mainly regards the performance of the channels; it does not consider the state change of the receiver except for a happiness that comes with owning the products. The design of a service is based on the degree of satisfaction with the state change of the receiver. Therefore, it is necessary to express state changes by means of the received contents.

Change of a receiver is represented by a set of ***Receiver State Parameters (RSPs)***, see figure 2. Thus, a service can be represented by a set of RSPs necessarily and sufficiently. Since a RSP consists of quantitative values, including Boolean logic and multi-value logic, it is possible to compute any comparison between two RSPs. In addition, the assumption is that all RSPs are observable and controllable. This assumption has not been proven, however, since no reliable methods to measure consumer behavior have been found.

The RSPs change by received contents. In this research, it is assumed that contents consist of various functions which are denoted by a *Function Name (FN),* whose operating objects are *Function Parameters (FPs)* and whose effect is represented by *Function Influences (FIs), see an example in figure 5*. The parameters of channel, which make the flow of content change and thus influence RSPs indirectly, are called channel parameters.

Three types of models are used to describe the service: flow, view and scope models. ***Flow model*** is the name in this research for the sequential chain of both contents and channels. These types of models are useful when focusing on the relationship between a receiver and a provider, where many intermediate agents exist among them. One example of service is a travel agent, which arranges and purchases various tickets on behalf of customers. Contents are different from the tickets, even if the tickets are delivered to the customers. In this way, services can be delivered through complex multiple structures consisting of various intermediaries. The intermediate agents have double characteristics of a receiver and a provider. A provider can be defined as an agent, whose receiver side, inside of the agent, is hidden by the system.

Another type of model is the ***view model,*** which is defined as *a tree of content parameters and channel parameters with a single RSP at its root*. RSPs change according to how the receiver subjectively evaluates the received contents, and an RSP is linked to several content parameters and may be supported by several channel parameters existing in the chain of several agents in the flow model, see figure 2.

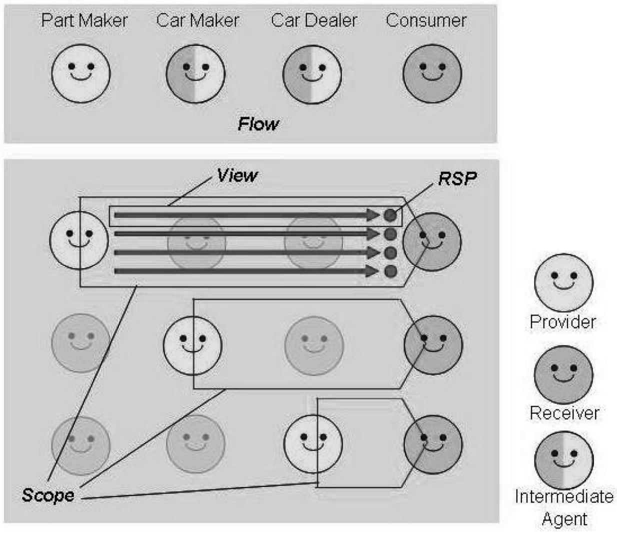


Figure 2. Three kinds of service models: Flow Model, Scope Model, and View Model. [17].

The last type of model is the ***scope model***. Practical services have very complicated structures of intermediate agents, connected to one another on an infinite chain. Therefore, it is necessary to specify the effective range of the service from an initial provider to a final receiver as illustrated in figure 2. In comparison to the view model in which a single RSP is expressed, the scope model can deal with all RSPs within the providers and the receivers. In other words, a scope model handles multiple view models, namely multiple RSPs. Thus, it helps designers to understand the real activities between the providers and the receivers.

3.3 Service Explorer

Service Explorer is a software modeling tool for service design. The current version of Service Explorer was developed using Java (Java2 SDK, Standard Edition 1.4.1) and XML (Version 1.0 in the Microsoft Windows XP Home Edition environment)[1]. The program enables the user to describe services and register them in a database. Users can operate the service in the following ways:

- Express a service model following the definition mentioned above.
- Edit the models, i.e. reroute arcs among function units, change attributes of function units, and so forth.
- Evaluate the total service by means of assigning value to each of the components.

4 The application warehouse service

4.1 Company information

The warehouse supplier investigated is one of the world's leading actors in the forklift truck industry, and has been active in the business for over 50 years. Today, the company's products are actively marketed in over 70 countries, worldwide. The warehouse supplier has already taken extensive actions towards a change from just producing and selling forklift

[1] For more information about the Service Explorer program, please contact professor Yoshiki Shimomura (yoshiki-shimomura@center.tmu.ac.jp)

trucks towards providing warehouse service – or as the company likes to say, "***Don't buy trucks! Remember - you don't have to own a truck to use it!***" The Company's business concept is to *anticipate customer needs and deliver solutions for efficient materials handling*. With cost effective *products and services*, the company aims to provide its customers with trouble-free material handling operations worldwide. Their vision is to: provide the best quality in the warehouse truck industry; have a very strong brand name; have a product range on par with the best in our industry (in performance/features); and finally, to have a decentralized organization with deeply delegated responsibilities.

As highlighted in the company's business concept, the focus has already shifted from just selling products to providing the customer with warehouse service. In short, their ambition is to provide the right truck for the customer-defined application with the right power pack – delivered fast – and with each truck fully supported though their own service system in order to ensure maximum productivity for the customer. To do so, the company has developed different rental solutions. The benefits for the customer with these rental solutions, as highlighted by the company, are that they provide the customer with a flexible solution that can be adjusted depending on the customer capacity needs. These solutions also help the customer to avoid the uncertainty of forklift truck running costs, as well as eliminating the need to tie up capital, which could be better used in other areas of a customer's business. Examples of different offers within a rental solution are:

- A rapid response to ensure that the customer's operations keep running
- Guaranteed performance levels with a money-back commitment
- Total support from the company's service organization with rapid and guaranteed response times
- Full range of equipment specifications available – over 8,000 machines including counterbalance trucks
- The ability to change or upgrade equipment without additional cost, subject to 3 months' notice
- The ability to return equipment if it is no longer required without additional cost, subject to 3 months' notice
- The option of including a truck driver as part of the rental agreement

4.2 Modelling the warehouse service

Based on the empirical data collection, the service agents which participate in the warehouse service were defined: the part of the company that produced new forklift trucks, the part of the company that remanufactured used forklift trucks, the sales department and the remanufacturing for used forklift trucks and the warehouse customer (see figure 2).

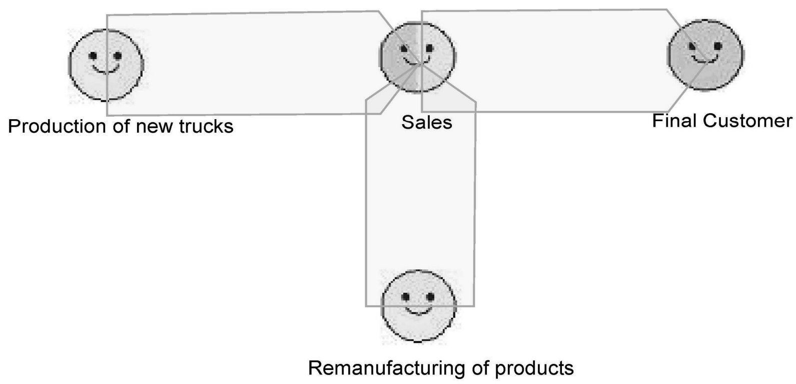


Figure 3. The flow model of the warehouse service.

As the second step, the RSPs of the warehouse were deployed. Altogether, four RSPs were deployed: "cost for warehousing", "time for delivery", "capacity change" and "function availability". One of the deployed RSPs is described in figure 4. The third step was to develop and define the function structures for each RSP. Figure 4 illustrates a life-cycle perspective where different RSPs (cost for warehousing, time for delivery, capacity change and function availability) influence the warehouse service.

Figure 5 describes a view model of the *time to delivery* RSP, while figure 6 shows how the same view model looks like in the Service Explorer software. The Service Explorer software supports the task to keep all interrelations and connections between different functions correct.

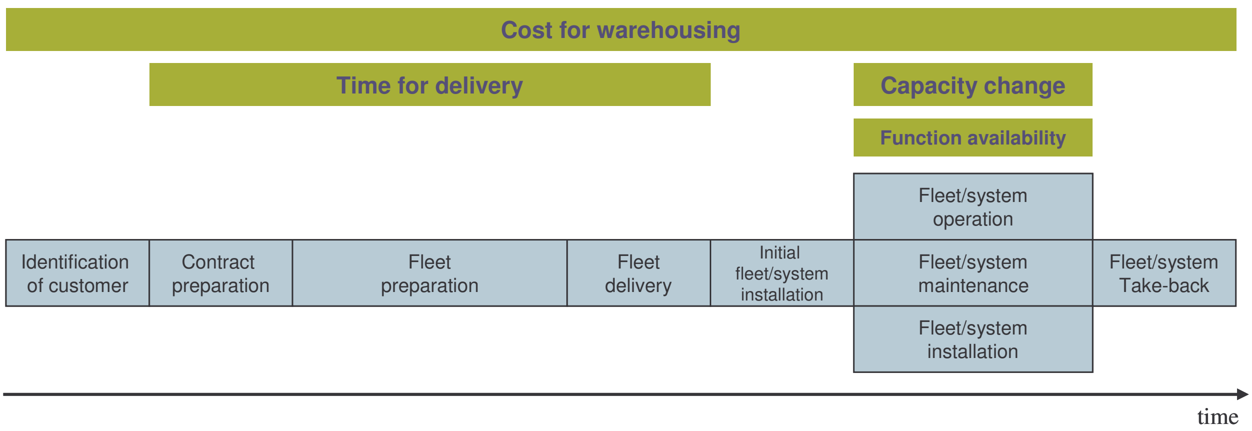


Figure 4. A time line model for when different RSPs (cost for warehousing, time for delivery, capacity change and function availability) influence the warehouse service.

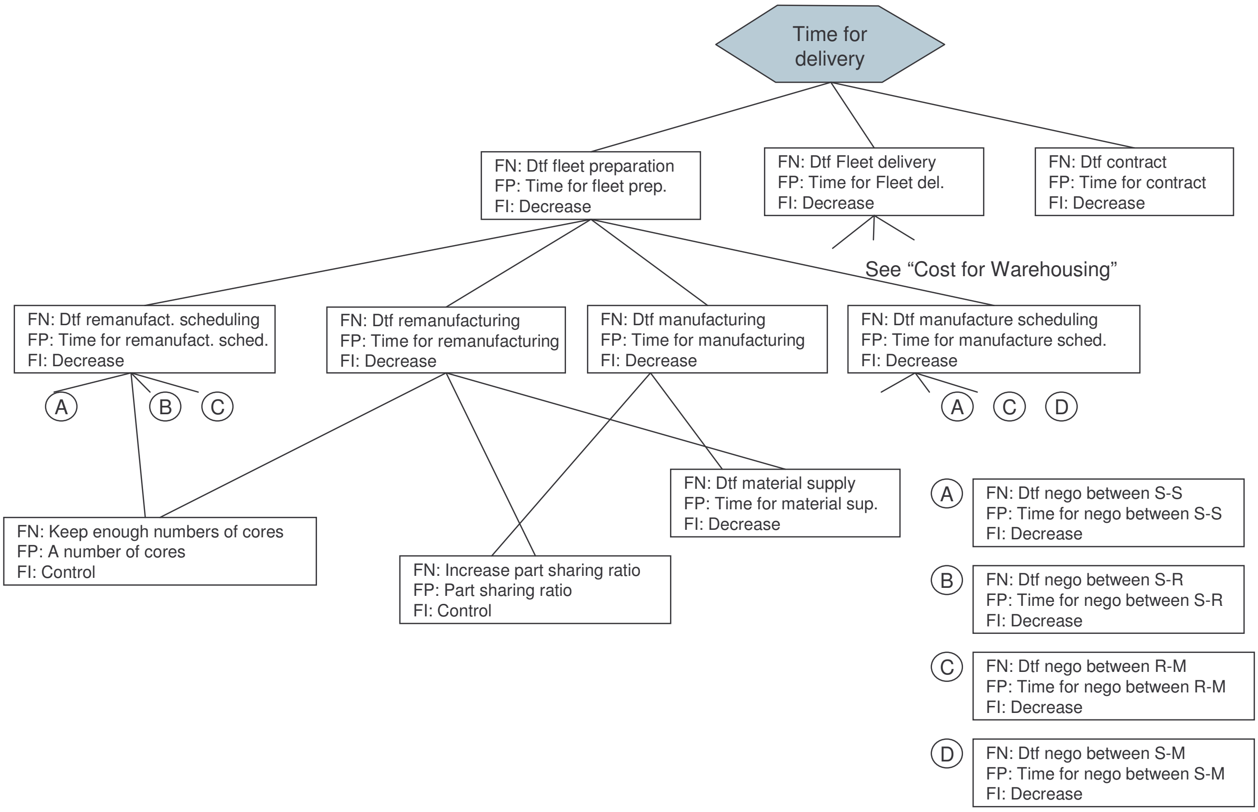


Figure 5. The view model for the "time for delivery" RSP.

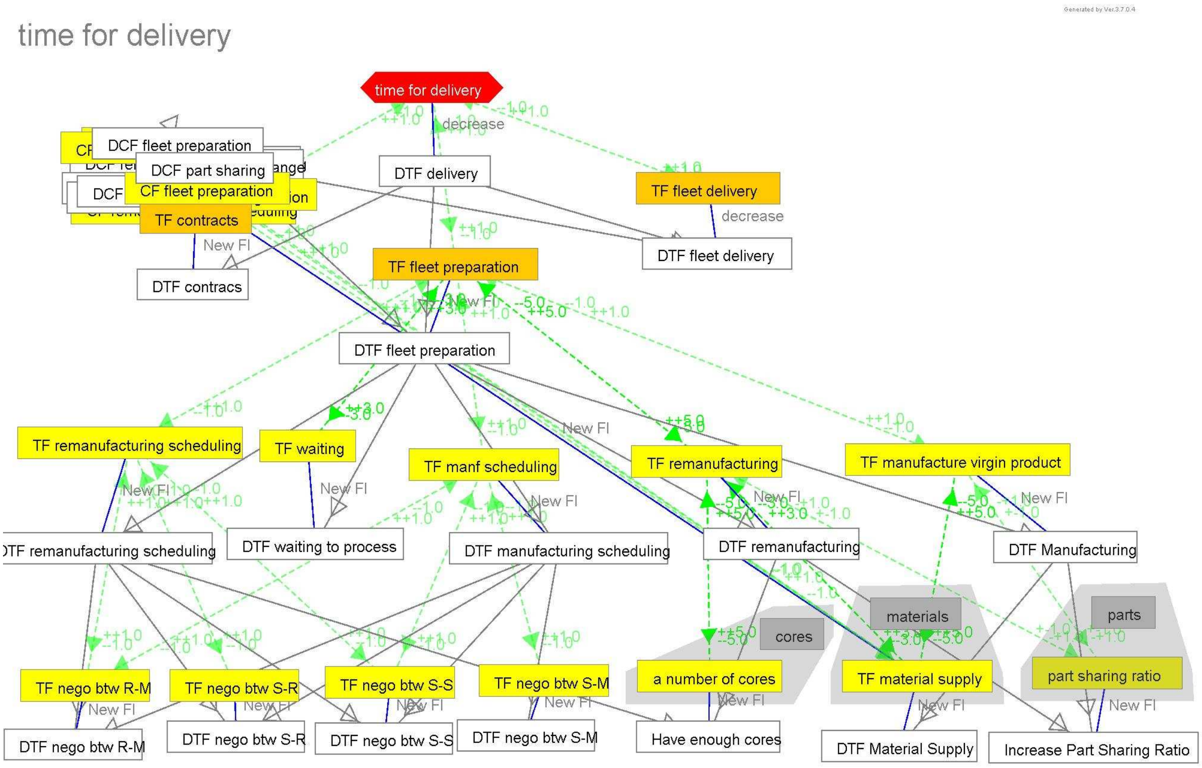


Figure 6. A Screenshot from the Service Explorer program of the view model for the "time for delivery".

To verify the accuracy of the described models, all models were presented for warehouse company personnel, who were able to give feedback before the evaluation, which is explained in the following section.

4.3 Evaluation of the warehouse service

The evaluation followed the procedure described in the Service Explorer manual[2]. All steps are not described in this paper. One important step in the validation was using the warehouse customers' validations of the different RSPs. To obtain this information, a questionnaire, as described in the method chapter, was sent out. Table 1 presents the questionnaire's categorized lists of requirements and the respondents' aggregated validation of each of them. The validation was made from 0 to 5, where 0 denoted unimportant and 5 very important. Highest valid was "reliability in fleet delivery", "making the logistics operation more efficient" and "confidence for the service providers regarding quality of the provided logistic system".

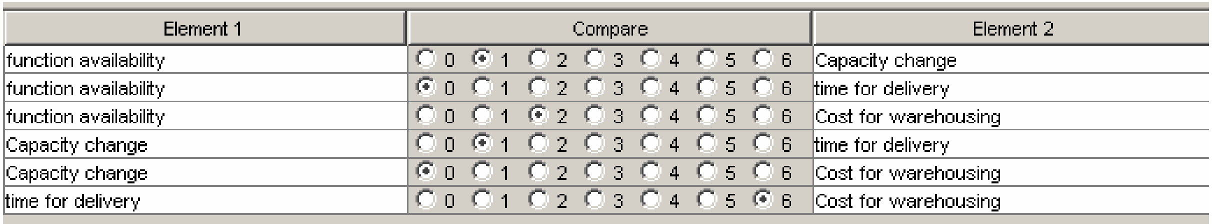
Table 1. Warehouse customers' requirements on the service. A "fleet" refers to a set of equipment such as forklift trucks prepared to meet user needs. The validation was made from 0 to 5, where 0 was unimportant and 5 was very important.

1. Basic requirements	**Validation**
Making the logistics operation more efficient	3,71
Confidence for your service provider regarding quality of the provided logistic system	3,43
Your logistic systems influence on your ability to provide your customers needs	3,14
Importance of the logistic system for your companies other operations, e.g. production	1,86
Improving your company's environmental image by using this service dematerialization	2,33
Low price for the logistic service	1,57
Predictable price for the logistic service	2,17
Possibility to get rid of the responsibility of the devices for the logistics operation	1,00
2. Contract preparation	
Fast validation of logistic needs	1,86
Short time for making contract proposal	1,71
3. Fleet delivery and installation	
Short time between signing the contract and the fleet delivery	1,86
Reliability in fleet delivery	4,00
Fast fleet system installation	2,43
4. Fleet system operation, maintenance and reinstallation	
Frequent validation of your logistic needs	1,29
Flexible fleet system configuration	2,86
Fast time for upgrading fleet system configuration	2,43
Low energy usage during logistic operation	1,86
Fast support	2,71
Accurate support	3,00
Environmental benefits of the logistics service operation	1,57
Easy error reporting	2,43
Fast error reporting	2,86
Fast corrections of malfunctions	3,57
Easy detection of malfunctions	3,14
Fast detection of malfunctions	3,29
Short time for getting spare parts	3,57

[2] Shimomura Laboratory (2004), Service Explorer Ver.3.7.0.4 Manual. Shimomura Laboratory at Research into Artifacts, Center for Engineering (RACE), University of Tokyo.

5. Fleet system tack-back	
Fast take-back of previously used devices, such as old trucks and batteries	1,29
Possibility to get rid of/sell used logistic equipment	1,57

The customers' validations were then transferred into an analytic hierarchy process (AHP) list [20]. The AHP list is used to judge the different RSP's relative importance (see figure 7). However, the AHP list input data have also been influenced and modified based on the interview with the warehouse company's Swedish CEO's discussion about warehouse customers behavior and their validation of different functions. For example, the CEO's experience concerning the reliability in fleet delivery is not as high ranked as the questionnaire indicated.



Element 1	Compare	Element 2
function availability	○ 0 ◉ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6	Capacity change
function availability	◉ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6	time for delivery
function availability	○ 0 ○ 1 ◉ 2 ○ 3 ○ 4 ○ 5 ○ 6	Cost for warehousing
Capacity change	○ 0 ◉ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6	time for delivery
Capacity change	◉ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6	Cost for warehousing
time for delivery	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ◉ 6	Cost for warehousing

Figure 7. An example of an AHP list for the RSPs.

The result from the validation using Service Explorer is that "function availability" is considered by the warehouse customer to be the most important issue. The most important function to improve and have control over (including its sub-functions) is that which controls the time for reaction on malfunctions.

5 Discussion and Conclusion

The service modeling method is appropriate to describe the actual service including the activities of the related service agents. The modeling method provides a transparent description of the investigated service. This enables and facilitates the work to get an attuned understanding and picture among the people that work with the service, something that facilitates the internal and external communication. It is also a method which provides service designers the structured information of the service and opportunities to explore improvement ideas and find new combinations between functions that can be used to solve a problem.

In addition, the service evaluation method offers the improvement focus with numerical importance values. This helps the designers to find and compare the best solutions. The service can be evaluated not only from one receiver's perspective, but also from the perspective of the multi-agents.

This research has found that Service Explorer is a useful means to handle and facilitate the structure of the data and support the evaluation of the different RSPs. Considering the fact that the tool is still a prototype, it provides great help and support. However, the tool still needs some improvement with regards to the service evaluator module of the tool. The service evaluator module is the newest and the least developed part of the tool, but still very powerful. The problem is that in the latter part of the evaluation, it is hard to get a good overview and to follow what one does. The lost overview is partly related to the high complexity and numerous relationships. This could be solved, for example, by taking away some of the inadequate information from the display.

6 Acknowledgement

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Mattias Lindahl
Institution/University: IKP/Linköping University
Department: Environmental Technology and Management
Address: SE-581 83 Linköping
Country: Sweden
Phone: +46 13 28 11 08
Fax: +46 13 28 11 01
E-mail: mattias.lindahl@ikp.liu.se