Jean-Henry Morin
Jolita Ralyté
Mehdi Snene (Eds.)

LNBIP 53

Exploring Services Science

First International Conference, IESS 2010
Geneva, Switzerland, February 2010
Revised Papers

Springer

Lecture Notes in Business Information Processing 53

Jean-Henry Morin   Jolita Ralyté
Mehdi Snene (Eds.)

Exploring Services Science

First International Conference, IESS 2010
Geneva, Switzerland, February 17-19, 2010
Revised Papers

Springer

Volume Editors

Jean-Henry Morin
University of Geneva
CUI
Batelle - bâtiment A
7, route de Drize, 1227 Carouge
Switzerland
E-mail: Jean-Henry.Morin@unige.ch

Jolita Ralyté
University of Geneva
CUI
Batelle - bâtiment A
7, route de Drize, 1227 Carouge
Switzerland
E-mail: Jolita.Ralyte@unige.ch

Mehdi Snene
University of Geneva
CUI
Batelle - bâtiment A
7, route de Drize, 1227 Carouge
Switzerland
E-mail: Mehdi.Snene@unige.ch

Library of Congress Control Number: 2010929776

ACM Computing Classification (1998): J.1, H.4.1, H.3.5, D.2

ISSN 1865-1348
ISBN-10 3-642-14318-0 Springer Berlin Heidelberg New York
ISBN-13 978-3-642-14318-2 Springer Berlin Heidelberg New York

springer.com

Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper SPIN: 06/3180 5 4 3 2 1 0

Preface

The discipline of Services Science, introduced by IBM in 2002, has emerged and matured in a true transdisciplinary atmosphere. Encompassing disciplines not only in management and engineering, it also draws from disciplines such as social and cognitive sciences, law, ethics, economics etc. to address the theoretical and practical aspects of the challenging services industry and its economy.

Services Science leverages methods, results and knowledge stemming from these disciplines towards the development of its own concepts, methods, techniques and approaches thus creating the basis for true trans-disciplinary gatherings and the production of transdisciplinary results. Services Science is building a concrete framework for transdisciplinary purposes.

IESS1.0 – the First International Conference on Exploring Services Science – was the first international conference held in Europe in this domain. The conference took place during February 17–19, 2010 in Geneva, Switzerland. The goal of the conference was to build upon the growing community to further study and understand this emerging discipline. Academics, researchers and practitioners of all disciplines were invited to contribute their results and approaches to Services Science in a transdisciplinary setting. In order to achieve the best possible mix of disciplines and their representation, the conference call for papers was structured around transdisciplinary service research topics including service innovation, service exploration, service design, service engineering, and service sustainability, and around more disciplinary oriented service contexts such as: sectors and services, IT and services, foundations of services science, and governance and management.

The 27 papers included in this volume were carefully selected by the International Program Committee out of 42 submissions; 19 full papers and 8 short papers were presented during the conference. Given the novelty of the domain of Services Science we would like to acknowledge and thank all the reviewers for their valuable and professional work in crafting the program of this first conference.

The conference featured the keynote presentation of Diem Ho from IBM on "Exploring Service Science in our Current Socioeconomic Environment." Before the conference, a half-day Societal Forum was held and addressed issues in the areas of regulatory compliance and initiatives in eGovernment. Next year's conference is planned to take place in Geneva for its second edition (IESS 1.1), during February 16–18, 2011. As discussed and presented during the conference, the format will change towards an open access and a creative commons licensing policy. The submission process is also evolving towards an open submission process geared at establishing conversations between authors and reviewers. More information will be available on the IESS website.

We would like to thank all the participants and the organizers for their valuable contributions. In particular the Conference Chairs: Eric Dubois (Centre Henri Tudor, Luxembourg), Dimitri Konstantas and Michel Léonard (University of Geneva,

Switzerland); the Organizing Committee: Jean-Henry Morin, Jolita Ralyté, Mehdi Snene (University of Geneva), Yves Pigneur and Thibault Estier (HEC Lausanne), and all the volunteers: Marie-France Culebras, Aziz Khadraoui, Laurent Moccozet, Mélanie Montagnol, Wanda Opprecht, Jean-Marc Seigneur, Xavier Titi, Alfredo Villalba Castro, Hikari Watanabe, Anastasiya Yurchyshyna (University of Geneva).

We wish you a pleasant reading and a fruitful use of these research results in your research and applications.

April 2010

Jean-Henry Morin
Jolita Ralyté
Mehdi Snene

Organization

Conference Chairs

Eric Dubois	Centre Henri Tudor, Luxembourg
Dimitri Konstantas	University of Geneva, Switzerland
Michel Léonard	University of Geneva, Switzerland

Organizing Committee

Jean-Henry Morin	University of Geneva, Switzerland
Jolita Ralyté	University of Geneva, Switzerland
Mehdi Snene	University of Geneva, Switzerland
Yves Pigneur	HEC, University of Lausanne, Switzerland
Thibault Estier	HEC, University of Lausanne, Switzerland

Program Committee

Antonia Albani	Delft University of Technology, The Netherlands
Thecle Alix	University of Bordeaux, France
Pere Botella	UPC, Barcelona, Spain
Nuria Castell	UPC, Barcelona, Spain
Eric Dubois	Centre Henri Tudor, Luxembourg
Thibault Estier	University of Lausanne, Switzerland
Joao Falcão e Cunha	University of Porto, Portugal
Xavier Franch	UPC, Barcelona, Spain
Gilles Halin	ENSA University of Nancy, France
Petra Hocová	Masarykova University of Brno, Czech Republic
Dimitri Konstantas	University of Geneva, Switzerland
Patricia Lago	Free University of Amsterdam, The Netherlands
Michel Léonard	University of Geneva, Switzerland
Kelly Lyons	University of Toronto, Canada
Jean-Henry Morin	University of Geneva, Switzerland
Andreas Opdahl	University of Bergen, Norway
Oscar Pastor	Valencia University of Technology, Spain
Barbara Pernici	Politecnico di Milano, Italy
Yves Pigneur	University of Lausanne, Switzerland
Jolita Ralyté	University of Geneva, Switzerland
Ruth Raventos	Universitat Politècnica de Catalunya, Spain
Gil Regev	EPFL, Lausanne, Switzerland
Gerhard Satzger	Karlsruhe Service Research Ins., Germany

Table of Contents

Towards a Model for Measuring Customer Intimacy in B2B Services

François Habryn[1], Benjamin Blau[1], Gerhard Satzger[1], and Bernhard Kölmel[2]

[1] Karlsruhe Service Research Institute
firstname.name@kit.edu
[2] CAS AG
bernhard.koelmel@cas.de

Abstract. This paper proposes an approach for evaluating the relationship with a customer, leading to the creation of a Customer Intimacy Grade (CIG), across multiple levels of granularity: employee, team, business unit and whole organization. Our approach focuses on B2B service organizations which provide their customers with complex solutions and whose relationship with the customer is distributed among multiple employees and across different business units. The suggested approach should improve the systematic analysis of customer intimacy in organizations, leverage the customer knowledge scattered throughout the organization and enable benchmarking and focused investments in customer relationships.

Keywords: Customer Intimacy, Social Network, Organization, B2B Services, Service Relationships, Customer Relationship Management.

1 Introduction

In a demand driven and service-centric market, where companies face ever increasing competition, leveraging business relationships to achieve a competitive advantage is a key business strategy [1]. The modern perspective on services defines a service as the application of knowledge and expertise for the benefit of another entity [2]. This view does not separate the creation of value by a provider from its destruction by the consumer [3], but rather emphasizes the notion of co-creation of value between supplier and customer. In order for a company to remain competitive, the company must involve the customer in the value creation process [3].

Building on a similar idea, Treacy and Wiersema have developed a concept called *customer intimacy* [4], and they argue that it is one of three value disciplines, together with product leadership and operational excellence, that leads to market leadership. They define customer intimacy as "segmenting and tailoring offerings to precisely match the need of customers". Deep customer knowledge and detailed insights about the client´s underlying processes form the backbone of every customer intimacy organization. In addition, customer intimacy is characterized by the ability to respond quickly to almost any customer need, from customizing a product to fulfilling a

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 1–14, 2010.

special request. It therefore requires the appropriate degree of operational flexibility [5]. Customer intimacy is a complex construct, and even though several metrics have been conceived in the field of Customer Relationship Management [6], most companies struggle to quantify and proactively manage the degree of intimacy that they have established with their customers.

Currently there are only a few models available for measuring customer intimacy which, however, do not lend themselves to easy operationalization [7][1][8]. Even though some models do consider the service dimension [9][10], they particularly do not consider the co-creation view on services [3].

Our contribution of our research-in-progress paper is threefold. First, we provide a novel approach for measuring the degree of intimacy established with a customer, leading to a performance indicator which we will call the Customer Intimacy Grade (CIG). The CIG yields several benefits, such as giving access to an overview of the relationships with customers, and enabling benchmarking intimacy grades in order to systematically improve customer relationship processes. The originality of our model is that it focuses on the particular challenges of large B2B service organizations which are *(i)* the delivery of complex solutions that include multiple products and services, and *(ii)* the knowledge exchange between multiple business units within an organization. Second, we provide an illustrative case study which demonstrates the applicability and the added-value of the CIG measurement. With respect to the realization of our approach by means of an information system, we thirdly sketch a possible implementation of our CIG model.

The remainder of this article is organized as follows. In Section 2, we provide an overview of related work. Section 3 elaborates on the model that we propose for evaluating the Customer Intimacy Grade and discusses its implementation. We summarize our findings in Section 4 and outline future activities in this field of research.

2 Related Work

The original definition of customer intimacy presented above – to taylor and shape products and services to fit an increasingly fine definition of the customer [4] – considers the creation of customer intimacy between two organizations at the enterprise level. A major part of the existing literature is based on this definition, but we have also found some models emphasizing the employee´s perspective. This section covers previous approaches illustrating both the individual and organizational perspectives, and establishes the link to the concept of Customer Relationship Management.

Cuganesan examines the use of accounting numbers to calculate customer intimacy [11]. He suggests two modes of calculation: a sales calculation approach and a numeric calculation approach. These approaches are essentially focused on market intelligence data and customer penetration, and they are illustrated with a case study describing the complexity of evaluating customer intimacy for an organization in the financial services industry.

In a balance scorecard evaluation, Niven proposes five attributes which can be developed in order to measure customer intimacy [12]. These are customer knowledge, solutions offered, penetration, culture of driving client success, and relationships for the long term. The operationalization or detailed implementation of these attributes however remains open.

Kaplan suggests that for a differentiated customer intimacy strategy to succeed, the value created by the differentiation - measured by higher margins and higher sales volumes - has to exceed the cost of creating and delivering customized features and services [7]. Based on their time driven activity based costing, Kaplan and Anderson suggest a model to evaluate customer profitability [13]; the model, however, is not specific to companies pursuing a customer intimacy strategy.

An executive brief [9] suggests that services provide the opportunity for industrial companies to significantly deepen the level of customer intimacy and increase customer control, but it does not explain how to evaluate this level of customer intimacy, and, thus, how to measure the improvement through the added services.

Potgieter and Roodt provide a model in which they consider customer intimacy from the internal perspective and they conceive a questionnaire for the assessment of the customer intimacy culture of an organization [8]. This questionnaire was validated by an empirical study in a company from the entertainment industry. Their approach does not consider the actual intimacy achieved with individual customers, but the ability of an organization, and more specifically its cultural aspects, to support a customer intimacy strategy.

Tuominen and Rajala provide a six-layer approach for evaluating customer intimacy[1]: they differentiate whether the organization (1) was involved in the customer's planning process, (2) involved customers in their planning process, (3) partnered and jointly planned with customers, (4) aligned each other's operating processes, (5) designed operational interfaces, and (6) formalized the system of joint decision making. They use this scale to correlate the degree of customer intimacy with the internal market intelligence capability of the organization, so called market orientation. They recognize the importance of partnership and collaboration in the development of a customer intimacy strategy. However, only a few details are provided on how to actually measure these layers that merely focus on the organizational level.

Abraham emphasizes the importance of the relationships between employees. He defines customer intimacy as the formal or informal set of relationships established between supplier and customer, with a diverse array of partners, from corporate leadership to functional leadership (engineering, marketing, operations, maintenance, or service) and end-users of products or services [14]. These dynamic relationships provide multiple points and frequency of contacts between the company and its customer, as well as multiple points of view about the relationship and its benefits to both parties. According to his work, increasing customer intimacy can be achieved by improving the attitude of the employees dealing with the customer.

Yim and al. propose a model in which they consider both the "customer-staff" and "customer-firm" interactions in parallel. They define intimacy as the bondedness and connectedness of a relationship between two individuals and investigate how intimacy and passion can enrich customer service interactions and impact the "customer-firm" relationship [10].

The vast Customer Relationship Management (CRM) literature aims at improving the overall quality of the relationship with the customer as it should provide a seamless integration of every area of business that touches the customer, but several studies reveal the challenges of delivering business benefits out of CRM implementations [15]. Ballou states that "the old customer relationship management agenda as a bandage should now be replaced with the new agenda of customer intimacy, that is, to make customers feel good whenever they make contact with your company." (cited by [10]). CRM systems provide many key performance indicators such as customer satisfaction, customer value, or sales performance, but these are focused on the outcomes and do not do not provide the ability to evaluate the degree of intimacy.

3 A Model for Measuring Customer Intimacy

Many different aspects should be considered when developing a model to measure the degree of intimacy between a company and its customers. Liljander and Strandvik identified within their service relationship quality model that some of these aspects are at the organization level, while others are at the individual level [16]. Based on this premise, and in order to achieve the benefits outlined in Section 3, our model intends to include a calculation of the customer intimacy grade (CIG) for both the organizational and individual levels. The organization levels can be a team, a business unit or the entire enterprise.

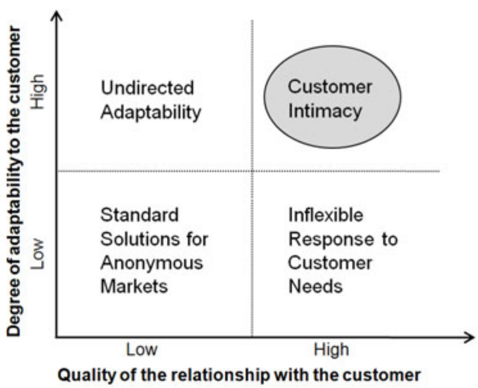

Fig. 1. The two dimensions of customer intimacy

However, as presented in Section 2, customer intimacy is not only about having a high quality relationship with a customer: it is also about how an organization and its members are able to leverage the knowledge acquired through this relationship in order to shape the offering and to achieve a competitive advantage. Therefore, we have represented customer intimacy on the following two-dimensional diagram (ref. Fig. 1). The x-Axis represents the quality of the relationship with the customer and the mutual willingness to create a partnership, while the y-Axis represents the ability to leverage this relationship and to adapt the offering in order to better fulfill the individual needs of the customer, and thus to create a competitive advantage. Customer intimacy exists when both the relationship with the customer (x-Axis) and the ability to adapt to the customer (y-Axis) are high.

There are multiple elements of evidence which prove that a service provider has reached a certain level of customer intimacy with specific customers, such as the evolution of the relationship into a longer term partnership, the access to customer information systems, a high frequency of interaction, the successful completion of joint activities, or the mutual involvement of top level management. Each of these indicators represents some valuable input for the CIG calculation. Our methodology targets to identify these *relevant elements of evidence* as well as to aggregate them into quantitative CIGs.

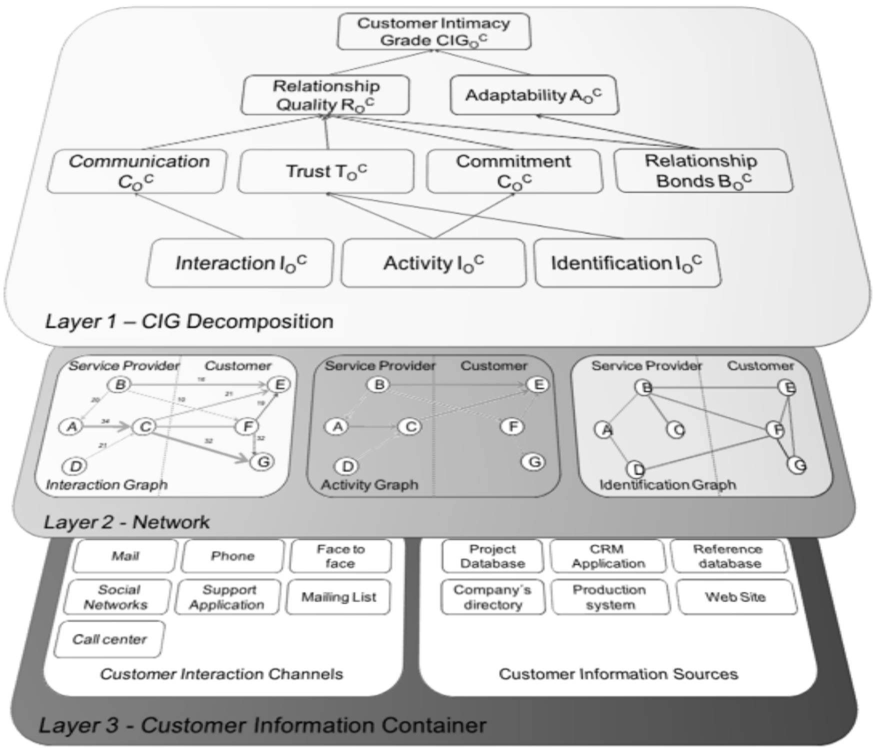

Fig. 2. Overall Customer Intimacy Grade (CIG) Calculation Model

The diagram depicted in Fig. 2 illustrates the CIG calculation model. It consists of three main layers. The first layer is the *CIG decomposition* into individual concepts as described in the literature. This enables us later on to compose CIGs out of measurable and quantifiable parameters. The second layer, which we call the *network layer*, is a graph-based representation of the components that constitute customer intimacy at the organizational and individual levels. Finally, the third layer, i.e. the *customer information container*, holds the underlying hard data - the "evidence of intimacy".

In the remainder of this section, we will detail the first layer and describe the CIG decomposition. Furthermore, we propose a concept to measure the individual components and aggregate them towards a higher level CIG. We provide a simple example to illustrate the application of the idea. Finally, we outline the intended implementation of the approach proposed.

3.1 The CIG Decomposition

As explained in the introduction of this chapter, CIG depends both on the *relationship quality* and on the *degree of adaptability*. In the following, the underlying concepts (depicted in Fig. 2) are identified from the literature and put into context. The notation in Fig. 2 is following: each CIG component is specified with two indices. The lower index represents the entity in the service provider organization and the upper index represents the entity in the customer organization. For instance, CIG_O^C represents the Customer Intimacy Grade between the organization O inside the service provider and the customer C.

Let us first focus on *relationship quality*. Many studies which evaluate the constituents of a relationship in a commercial setting are already available [17][18]. We base our evaluation on the recent work from Richard [15] because it focuses on B2B service relationships. In its evaluation of the impact of Customer Relationship Management on B2B relationships, Richard identifies a mean to evaluate the relationship quality along three main criteria: *communication*, *commitment* and *trust*. [15]

Based on his literature review, Richard finds that *communication* is used to initiate and build relationships: mediate ideas, thoughts and feelings, transfer information, solve problems and simply connect people [15]. Mohr and Sohi suggest that communication quality is a function of completeness, credibility, accuracy, timeliness and adequacy of communication flows [19]. Therefore, the first assumption of our model is that the *interactions* between the employees of the provider and the customer contain elements of evidence of the *communication quality*.

Trust has been conceptualized in the literature as having "confidence in an exchange partner's reliability and integrity" [20]. As this is a complex construct, Sako developed it along three dimensions: contractual trust, goodwill trust and competence trust [21]. Goodwill trust should be interpreted as a mutual commitment and support to each other, including confidence that the partners will not try to take an unfair advantage against each other. Competence trust has been defined as the belief that the partner has the ability, technical knowledge, expertise and capability to perform his role [21]. Our second assumption is that goodwill trust and competence trust increase when the service provider and the customer already have a common history and have worked jointly on successful activities. Therefore *activities* are elements of evidence for the degree of *trust*. In addition, *identification*, which is a process of self-categorization with respect to others, impacts the perceived proximity [22] and influences trust because of the feeling of belonging to the same group [23]. Thus, our third assumption is that *identification* is also an element of evidence of *trust*.

Commitment was defined by Andersan and Weitz as a desire to develop a stable relationship, a willingness to make short-term sacrifices to maintain the relationship, and a confidence in the stability of the relationship [24]. This is translated at the individual level into a readiness to help the customer when he has some issues, in showing some flexibility when this is needed by the customer, and a quest for the best long-term solution from the customer´s perspective and not from the provider´s perspective on the short term. Along with other criteria that will be defined in the future, the activities between the customer and the provider are also elements of evidence for commitment.

The second constituent of the Customer Intimacy Grade, according to the definition of customer intimacy from [4] is the demonstration that service providers and its employees actually adapted and tailored their solutions to fit exactly the need of the customer, summarized as *adaptability* in our CIG calculation model. *Adaptability* is one of four cultural traits of effective organizations according to Denison: "Adaptable organizations are driven by their customers, take risks and learn from their mistakes (…) they are improving the organizations' collective abilities to provide value for their customers [25]." This definition confirms that several elements of evidence of adaptability to a customer can be found, at both the organizational and individual levels. Liljander and Strandvik, in their Service Relationship Quality Model, identified ten types of bonds that enable a characterization of the relationship between a service provider and its customer [16]. In our approach we consider the elements of evidence of adaptability which are mainly contained in the following bonds: legal, economic, technological, geographical, knowledge-related, social types.

3.2 Network and Customer Information Container Layers

As mentioned previously, our intent is to calculate Customer Intimacy Grades at both the organization and the individual levels. The model provides a customizable aggregation of the individual CIG in order to obtain the CIG of a team, a business units and the whole organization. Fig. 3 highlights the possible CIG calculations.

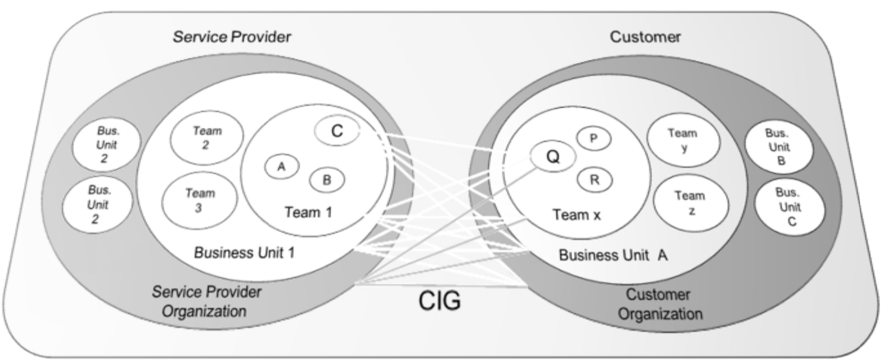

Fig. 3. Different CIG Calculation options

The CIG calculation in our model is based on the three functions interaction, activity and identity. In order to model the various CIG aggregation possibilities, we apply concepts from graph theory. We have defined three graphs Interactions G_{In}, Activities G_A and Identification G_{Id}. In the three graphs, the nodes represent the n employees and formally belong to the set $V = \{v_{1,\ldots,}v_n\} \in V$. V can be divided in two subsets V_C and V_P, depending whether the employee belongs to the customer´s C or to the provider´s P organization. In order to support the multiple aggregation levels represented by the teams and business units, additional subsets can be defined inside the provider and customer groups ($V_{Cx} \subset V_C$; $V_{Px} \subset V_P$).

The existence of an edge $e_{i,j}$ between two nodes v_i and v_j indicates that two employees already interacted with each other, completed some "adding value" activities together, or identified some perceived similarities. The set of edges E^G includes all the edges within a graph G. Our focus is on the subset $E^G{}_{CP}$ which contains the edges that have one node in the provider group, and the other in the customer group $E^G{}_{CP}=\{ e_{x,y} \mid x \in V_C ; y \in V_P \}$. The weight of an edge $w_{i,j}$ represents the amount of interactions, the amount of shared activities and the degree of identification between two employees v_i and v_j. In order to calculate these different weights, we use the elements of evidence which are available within the third layer "Customer Information Container" (ref. Fig. 3). Each piece of information added to these containers potentially contains some evidence that the intimacy has been modified, like a new contract or a new project, and lead to a modification of the CIG value. The aggregation mechanisms for the different factors represent one of our main fields of study.

We have described how to create the three graphs and how to weight the edges. In order to calculate the CIG out of these graphs we use the concept of centrality [26]. The centrality of a node may be determined by reference to any of three different structural attributes of that node: its degree, its closeness or its betweenness. The degree centrality $C_D(i)$ of a node i is defined as the number of its in- and outbound edges divided by the total number of potential nodes adjacent to i. This is an index of its potential *communication* activity. The closeness centrality $C_C(i)$ of a node i is defined as the inverse of the sum of the weights of the edges incident upon this node: $C_C(i)^{-1} = \sum_{j=1}^{n} w_{i,j}$. This is an index of efficiency. The betweenness centrality $C_B(i)$ of a node i depends on the the number of node pairs j and k for whom i is situated on the shortest path (also called "geodesic") [27]:

$C_{B(i)} = \frac{2}{(n-1)(n-2)} \sum_{j<k\ (j\neq i\ k\neq i)} \frac{\tau_{jk}^{i}(g)}{\tau_{jk}(g)}$ where $\tau_{jk}(g)$ is the number of geodesics between j and k, and $\tau_{jk}^{i}(g)$ indicates the number of shortest paths between j and k that go through i; the fraction $\frac{\tau_{jk}^{i}(g)}{\tau_{jk}(g)}$ is replaced by zero, when $\tau_{jk}(g) = 0$. These metrics are defined at the node level, thus providing us with the ability to measure the CIG at the individual level. One advantage of the centrality concept is that it also provides a formalization of aggregation of these three metrics along multiple nodes. We intend to use the aggregation formulas described in [27] in order to calculate the CIG for a team, a business unit or the entire organization. The Table 1 summarizes the three graphs and our interpretation of the three types of centrality in the context of CIG calculation.

Table 1. CIG Graphs Properties

Graph	Interaction Graph G_{In}	Activity Graph G_A	Identity Graph G_{Id}
Objective	Representation of the established contacts	Representation of the past "adding value" activities (e.g. completing a project, solving a problem, selling a new solution or renewing a contract)	Representation of the perceived similarities
CIG Impact	Communication	Trust and Commitment	Trust
Weight w	aggregation based on all interactions between two employees, their frequency and quality	aggregation based on activity duration, impact for the customer and type of activity	Aggregation based perceived similarity factors (e.g. social, geographical, cultural)
Degree Centrality $C_D(v)$	Number of contacts in the customer (resp. provider) organization	Number of qualitative relationships	Not applicable
Closeness Centrality $C_C(v)$	Ease of the communication	Intensity of the relationship	-
Betweenness Centrality $C_B(v)$	Importance and implicit power of this employee for the overall communication	Degree of involvement in the overall activities with the customer	Ongoing research

3.3 Illustrative Case Study

The following example is inspired by a real scenario in a large B2B IT Services provider. Its purpose is to illustrate our overall concept only, not yet, though, to provide a "validated" CIG value. Let us consider a service provider P and a customer company C. We will now illustrate the benefits of our model along a sequence of events that involve employees from both companies. These events and their impact on the CIG are described in Table 2. The actual CIG calculation will be described in detail for the event 1 only, due to space reasons.

Event 1 Calculation.
The aggregation formula still needs to be refined and investigated. For the purpose of illustrating this example, we take the following assumptions:

- one Project Month has a value of 20 on the activity graph.
- a phone call and an email have a value of 1 on the interaction graph.
- a face to face meeting has a value of 3 on the interaction graph.
- a perceived similarity has a value of 5 on the identity graph.
- an adaptation of the offering has a value of 10 for the adaptability.

Table 2. Case Study Sequence of Events

Event	Event description	Impact on CIG
0	There are no contacts between P and C and there were never any joint activities between employees from P and C.	The CIG is nil
1	P recruits the employee P_1 in the business unit BU_1. P_1 worked as a consultant for the customer C last year for three months and he knows two people C_1 and C_2 there - and worked specifically with C_1.	The entry of this information in the database results in an increase of $CIG_{P_1}^{C}$, $CIG_{BU_1}^{C}$ and CIG_{P}^{C}
2	The employee P_2 in the business unit BU_2 tries to get in contact with C, but so far his "cold calls" were not successful. He is notified that the CIG of P with C has increased and sees that P_1 has a positive CIG with C. He contacts P_2 and asks him to provide him with some information on C. During the discussion P_2 learns that that C might be interested in a solution provided by the business unit 2 and he gets some information on C´s purchasing behavior	No impact on CIG
3	With the help of P_1, P_2 organizes a meeting with three employees from C: C_1 C_2 and C_3. There are still no "adding value" activities between C and P but the degree of interaction between C and P has increased.	This meetings leads to the creation of a small CIG between P_2 and C_1, C_2, and C_3 and thus between BU_2 and C. Also P_2 has increased his CIG as he met C_1 and C_2 again.
4	This meeting has led to a preparation of service contract between BU_2 and C. During the design phase of the service employees from P and C get to know each other and C shares some knowledge about their challenges to P.	The interactions and joint activities between employees from P and C lead to a significant increase of the different CIG
5	The resulting service offering includes n modifications to the standard offering in order to fulfill C´s requirement	The integration of the customer challenges in the design phase leads to an increase of the adaptability and thus of $CIG_{BU_1}^{C}$ and CIG_{P}^{C}
6	The director of BU_2 has launched a new initiative for improving the communication with the customers. He would like to evaluate the impact of this change on the various customers.	The director can use the CIG and more specifically the communication part in order to evaluate the impact
7	The CEO wants to know in which accounts he should invest more and to know how to reorganize his team in regard to the strategic accounts	He can use the CIG to evaluate the relationship of his employees with the different customers

As presented in Table 2, before event #3 occurs, only P_2 was in contact with C. He had a three month project, resulting to an activity value of 60 ($w_{P_1C}^{A} = 60$), a very significant amount of phone calls, mails and meetings with C_1 and C_2: $w_{P_1C_1}^{In} = 60$ and $w_{P_1C_2}^{In} = 70$. He perceived six similarities with C_1 and 3 with C_2: $w_{P_1C_1}^{Id} = 30$, $w_{P_1C_1}^{Id} = 15$. This results in the following graphs (ref Fig. 4).

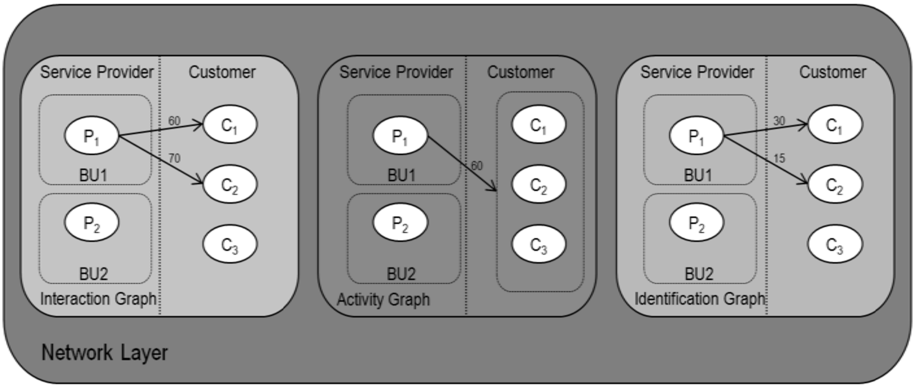

Fig. 4. Network Layer for event 1

In order to calculate the betweenness centrality we assume that there are 10 employees in both the service provider and the customer organization.

Table 3. Centrality measures for P_1 for event 1

Graph	Interaction Graph G_{In}	Activity Graph G_A	Identity Graph G_{Id}
Degree Centrality $C_D(P_1)$	0,105	0,052	0,105
Closeness Centrality $C_C(P_1)$	$7{,}6 * 10^{-3}$	$16{,}6 * 10^{-3}$	$22{,}2 * 10^{-3}$
Betweenness Centrality $C_B(P_1)$	1	1	1

The next step is to aggregate this centrality indicators into a meaningful Customer Intimacy Grade. Since our research on the potential aggregation mechanism is not completed, we cannot yet provide the CIG indicator. Afterwards, we would also calculate the centrality metrics for the business units BU_1, BU_2 and for the provider P in order to obtain the CIG grade at these different levels.

3.4 Realization

As outlined in Section 1, the ultimate objective of the model depicted in Fig. 2 is to quantify CIGs. These could then be used to create, visualize and exploit customer-centric networks as well as to support investment decisions into strengthening customer intimacy. To that end, three steps have to be taken to implement a CIG calculation and monitoring tool that can successfully be applied in business practice: data sourcing, operationalization of CIG constructs, and model validation.

Data sourcing. The basis of hard data supporting the individual components of customer intimacy has to be captured from existing Enterprise Information Systems and be fed into an aggregation tool. Customer Intimacy events (cp. Fig. 5) are triggered by the change of relevant information in one or more of the underlying data elements and are incorporated into revised CIG values. The information related to interactions and joint activities can be found in two different types of sources: the customer information channels and the customer information sources. The customer interaction channels are all the media that a company and its employees use in order to communicate and interact with its customer on an individual basis. This includes for example email, phone calls, face to face meetings, social networks, call-center applications, etc. Marketing messages addressed to a fairly small number of customers would be included, if they include references to the individual assessment, while mass-media communications would not be taken into consideration. The customer information sources are all the information repositories in which tacit or explicit knowledge about the customer has been reported such as project databases, CRM systems, production systems, etc.

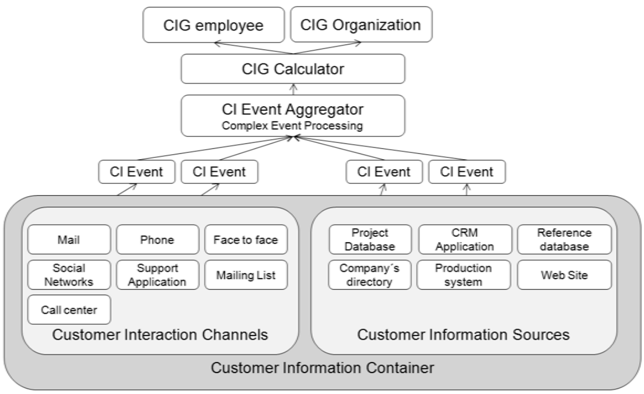

Fig. 5. CIG calculation architecture

Operationalization of CIG constructs. Based on future field work, the relative importance of individual data elements and the CI events triggered by them have to be quantified (so far artificially assumed in the case study). The model's calibration can either be done bottom-up or top down. The bottom-up approach intents to survey industry experts based on the evidence that individual elements provide for customer intimacy and to aggregate them using evidence-theoretical or similar approaches [28]. Alternatively, top down approaches capture the customer intimacy assessments of industry experts in certain situations. This again could be achieved via two options: an explicit approach would require respondents to assess a CIG directly and then – based on a number of data sets – enable a best fit approximation of the relative importance via a statistical analysis of variance. On the contrary, an implicit approach would have respondents compare customer intimacy for sets of two individuals or organizations and derive the relative importance of data elements via conjoint analyses.

Model validation. Finally, the calibrated model has to be applied to business situations and tested for the perceived usability of the approach. The cooperation with CAS Software AG in Karlsruhe, a provider of CRM and enterprise information management systems enables the prototypical implementation and subsequent testing with selected customers.

4 Conclusion

This paper presents a novel approach for measuring the degree of intimacy established with a customer, leading to a performance indicator called the Customer Intimacy Grade (CIG). Built upon three layers, this model provides the capability to quantify the CIG at the individual and organizational level. In the first layer, the CIG is decomposed into meaningful indicators. In the second layer we apply concepts from graph theory in order to derive these indicators. Finally, in the third layer the customer information sources that contain individual evidences of customer intimacy are represented.

In an illustrative case study, we demonstrated the applicability and business benefits of this model, such as giving access to an overview of the relationships with customers, supporting the exchange of customer knowledge between different business units, and benchmarking intimacy grades in order to improve customer relationship processes.

Our research embodies a promising approach to measure customer intimacy across business boundaries and to equip service providers with a meaningful quantitative CIG indicator. Nevertheless, further research has to be done to fully evaluate the models indicators, metrics and aggregation operations. On the first layer, the weight of the different components must be specified, and it should be investigated whether additional components should be included by means of qualitative research methods. Conducting expert surveys, we furthermore need to specify how to leverage the multiple centrality indicators in order to represent the CIG of an employee, a team or a business unit. On the third layer, we will work in close cooperation with the company CAS AG in order to determine the most relevant and most accessible sources of customer intimacy evidence in existing enterprise information systems to leverage their full potential. In summary, the first results are promising and substantiate our contribution beyond today's approaches to holistically evaluate customer intimacy across individual and organizational boundaries.

References

[1] Tuominen, M., Rajala, A., Mo, K.: Market-driving versus market-driven: Divergent roles of market orientation in business relationships. Industrial Marketing Management 33, 207–217 (2004)

[2] Vargo, S.L., Lusch, R.F.: Evolving to a New Dominant Logic for Marketing. Journal of Marketing 68, 1–17 (2004)

[3] Vargo, S.L., Lusch, R.F.: Why "service"? Journal of the Academy of Marketing Science 36, 25–38 (2008)

[4] Treacy, M., Wiersema, F.: Customer intimacy and other value discipline. Harvard Business Review (1993)

[5] Gubman, E.L.: Aligning People Strategies with Customer Value. Compensation & Benefits Review 27, 15–22 (1995)

[6] Kellen, V.: CRM Measurement Frameworks, pp. 1–37 (2002)

[7] Kaplan, R.: A Balanced Scorecard Approach To Measure Customer Profitability (2005)

[8] Potgieter, A., Roodt, G.: Measuring a customer intimacy culture in a value discipline context. SA Journal of Human Resource Management 2, 25–31 (2004)

[9] Industry Directions and IBM, Increasing Customer Intimacy, Value-Add and Profits Through Expanded Services, pp. 1–7 (2006)
[10] Yim, C.K., Tse, D.K., Chan, K.W.: Strengthening Customer Loyalty Through Intimacy and Passion: Roles of Customer–Firm Affection and Customer–Staff Relationships in Services. Journal of Marketing Research 45, 741–756 (2008)
[11] Cuganesan, S.: Calculating customer intimacy: Accounting numbers in a sales and marketing department. Accounting, Auditing & Accountability Journal 21, 78–103 (2008)
[12] Niven, P.R.: Balanced Scorecard Step-by-Step: Maximizing Performance and Maintaining Results. Wiley, Chichester (2002)
[13] Kaplan, R., Anderson, S.R.: Time-Driven Activity-Based Costing: A Simpler and More Powerful Path to Higher Profits. Harvard Business School Press, Boston (2007)
[14] Abraham, G.A.: Profit Power of Customer Intimacy: Deliver Top Line Revenue and Earnings Growth (2006)
[15] Richard, J.E.: The Impact of Customer Relationship Management (CRM) Technology on Business-to-Business Customer Relationships. Victoria University of Wellington (2008)
[16] Liljander, V., Strandvik, T.: The Nature of relationships in services. Advances in Service Marketing and Management 4, 143 (1995)
[17] Bove, L.: Customer relationships with service personnel: do we measure closeness, quality or strength? Journal of Business Research 54, 189–197 (2001)
[18] Barnes, J.G.: Closeness, strength, and satisfaction: Examining the nature of relationships between providers of financial services and their retail customers. Psychology and Marketing 14, 765–790 (1997)
[19] Mohr, J., Sohi, R.: Communication flows in distribution channels: Impact on assessments of communication quality and satisfaction. Journal of Retailing 71, 393–416 (1995)
[20] Morgan, R.M., Hunt, S.D.: The Commitment-Trust Theory of Relationship Marketing. The Journal of Marketing 58, 20–38 (1994)
[21] Sako, M.: Prices, quality, and trust: inter-firm relations in Britain and Japan (1992)
[22] Wilson, J.M., Boyer O'Leary, M., Metiu, a., Jett, Q.R.: Perceived Proximity in Virtual Work: Explaining the Paradox of Far-but-Close. Organization Studies 29, 979–1002 (2008)
[23] Hogg, M.A.: Social Identity and the Group Context of Trust: Managing Risk and Building Trust through Belonging. In: Siegrist, M., Earle, T.C., Gutsche, H. (eds.) Trust in cooperative risk management: uncertainty and scepticism in the public mind, pp. 51–72 (2007)
[24] Anderson, E., Weitz, B.: The Use of Pledges to Build and Sustain Commitment in Distribution Channels. Journal of Marketing Research 24, 18–34 (1992)
[25] Denison, D.: Corporate Culture and Organizational Effectiveness: Is Asia Different From the Rest of the World? Organizational Dynamics 33, 98–109 (2004)
[26] Freeman, L.: Centrality in social networks conceptual clarification. Social Networks 1, 215–239 (1979)
[27] Buechel, B., Buskens, V.: The Dynamics of Closeness and Betweenness (2008)
[28] Shafer, G.: Mathematical Theory of Evidence. Princeton Univ. Press, Princeton (1976)

Usage-Centered Design of Adaptable Visualization Services: Application to Cooperation Support Services System in the AEC Sector

Sylvain Kubicki[1] and Gilles Halin[2]

[1] Public Research Centre Henri Tudor
29, av. J.F. Kennedy, L-1855 Luxembourg-Kirchberg, Luxembourg
sylvain.kubicki@tudor.lu
[2] Research Centre in Architecture and Engineering
2, rue Bastien Lepage, 54001 Nancy, France
gilles.halin@crai.archi.fr

Abstract. In the Architecture, Engineering and Construction sector (AEC) co-operation between actors is essential for project success. The analysis of the co-operation context enables the identification of the "usages" carried out by each actor of a construction project when cooperating with others. It constitutes an important issue in highly collaborative domains. This article suggests a usage-centered process to design Adaptable Visualization Services. A Model-Driven Engineering lets us to describe usages, visualization services, business services and business domain and to define the relationships between their concepts. This method, inspired from UI design methods from software engineering or HCI domains, is integrated in an innovative service design process which guides the visualization services discovery, specification, development and appropriation by the end-users.

Keywords: Visualization service, Service design, Usage-centered design, Model-driven approach, Construction sector.

1 Introduction

Computer-based information systems supporting the cooperative activities in the AEC[1] sector are emerging, and most of large projects use them to improve communication between stakeholders. These "large projects" are different from the other ones by their scale, i.e. large surface to build, great budget… The organization of the actors involved in these projects aims to make uniform the methods of work, the resources management, the sharing of documents, or the planning of tasks. In most cases, "custom-made" software solutions are implemented and are used efficiently in the framework of these contexts of durable cooperation between organizations. However such standardized methods are not common in AEC industry projects, which always differ

[1] AEC stands for Architecture, Engineering and Construction sector, and describes the economic sector of construction, its related actors, methods, and services.

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 15–29, 2010.

in terms of buildings to be designed, constitutions of the teams of actors or communication methods to be used.

The concept of “cooperation context” helps us to deal with this complexity. The cooperation context of a project is always specific and it conceptually represents the actors involved in the project, the activities and the tasks that they perform, the documents that they use, and the objects that they design and then execute. Each stakeholder is only involved in a limited area of the cooperation context.

In such situations, if the composition of IT services is a well-delimited issue, it is not really the case for the visualization of information in a service system. Therefore, we develop the concept of “visualization service” in order to take into account such requirements in service systems developments. Our main hypothesis is that visualization services implemented in user interfaces of services systems have to fit usage of actors who have specific practices according to their roles in an activity.

Our approach focuses on the design and appropriation of new IT services (both Business Services and Visualization Services) to support cooperative activities in AEC. As the improvement and the change of work methods takes time, there are clear opportunities for service-science based innovation. From its past experiences, the Public Research Centre Henri Tudor (CRPHT) has defined a so-called S2IP (Sustainable Service Innovation Process). S2IP supports a networked and open innovation approach [1] based on the identification of a networked value constellation [2] making sustainable this innovation. A close relationship with research institutes (in this case the MAP-CRAI laboratory) enables the transfer/application of research results. In this paper we illustrate how the S2IP can be applied to the usage-centered design of adaptable visualization services.

The part 2 presents the service-based innovation applied in the AEC industry and defines the issue of adaptation to particular users’ requirements. Then a state-of-the-art related to usage-centered and adaptivity approaches is presented in order to introduce our understanding of visualization services (part 3). We suggest a process for supporting the design of usage-centered visualization services, based on a Model-Driven Engineering approach (part 4). Finally an example of visualization services design based on the proposed process is developed (part 5).

2 Service-Based Innovation in the AEC Sector Context

2.1 Challenges in AEC Cooperative Activities

AEC projects involve temporarily teams of heterogeneous actors (architects, engineers, contractors, material providers, etc.) able to respond to the customer’s requirements (i.e. architectural program). Each of these heterogeneous firms has its own internal processes, methods and IT infrastructures. Addressing team coordination support in AEC implies to take into account the specificities of the activity in this sector. They are related to the actors’ organizations (i.e. short-lived and heterogeneous teams), the low-predictable nature of the activities, the “prototype” character of each building project and the flexible processes of document exchanges. Through a “computer support” point of view we notice that 1) existing IT tools are often “single business” oriented, 2) they present a lack of interoperability and 3) these tools only offer partial representations of the cooperation context to their users.

In this specific context our approach focuses on the design and appropriation of new IT services and visualizations to support cooperative activities in AEC. The basic hypothesis of our previous works is that new tools supporting cooperation have to take into account these specificities. They also have to be able to be interfaced with existing tools in order to strengthen their usefulness for the users. Finally, appropriation by the end-users has to be taken into account in order to ensure that the practitioners will feel the value-added of the proposed services.

The particular research project described in this article emphasizes on user experience of groupware-oriented services systems. The issue that we suggest to address is related to appropriation of innovative technology through improved user experience and related Human-Computer Interfaces. In Luxembourg, the Public Research Centre Henri Tudor (CRPHT) has been engaged in several R&D projects, most of them in a PPP (Public/Private Partnership) approach with different stakeholders active in the sector as well as with the CRTI-B[2], the national professional association promoting new usages of ICT in the construction sector and its associated standards. These projects have resulted in several demonstrators and prototypes [1, 2]. Demonstrators of IT-based Business Services are clearly important in a global innovation process. However such demonstrators are not sufficient to ensure sustainability of a service-based innovation. In our work they are part of a larger innovation process called S2IP.

2.2 A Sustainable Service Innovation Process for the Design of Business Services

An innovation process called “Sustainable Service Innovation Process” (S2IP) has been defined by CRPHT[3] and applied as an innovation management process targeting the support to innovation in services within open partnerships with targeted beneficiaries [3]. This process is based on a participatory and collaborative innovation approach in order to sustain deep involvement of the network’s actors in the development of innovation services. This view is in line with the new research domain of Service Science [3]. The overall structure of S2IP is depicted in Fig. 1.

1. *Service value* firstly aims at identifying business opportunities for new service innovation.
2. *Service design and engineering* is associated with the definition of the service not only in terms of its business functional objectives but also in terms of all its required qualities.
3. *Service promotion*. Once the service contract has been validated by early adopters, it is important to promote the service to other potentially interested parties.
4. *Service management* consists of defining and providing tools that can be used by those that will deploy the service for checking and measuring the correctness of its implementation.
5. *Service capitalization*. Once a services system is deployed within a sector or organizations, it is necessary to collect feedbacks in order to define the possible evolution of the service.

---

[2] The Resource Centre for Technologies and Innovation in Construction (CRTI-B) is a standardization body involving all the representative building trades in Luxembourg. `http://www.crtib.lu`

[3] CRPHT is an RTO (a public Research and Technology Organization) according to the EARTO terminology (www.earto.org).

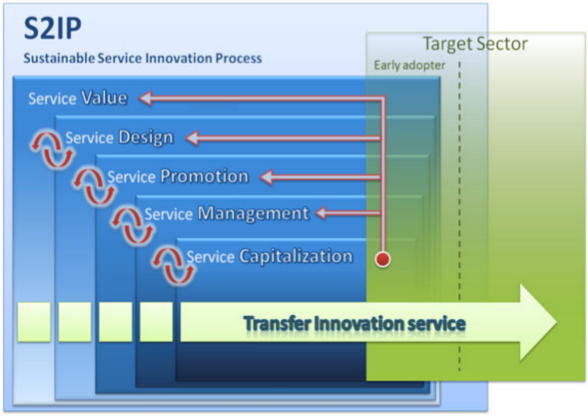

Fig. 1. The S2IP Innovation Process

These activities related to service innovation have been deployed in research projects targeting the design of business services aiming to improve cooperation activities in construction projects. The targeted sector has been deeply involved in the design process through a close partnership with CRTI-B. Two sets of business services supporting construction activities have already been designed and are being transferred to the sector [4]. While experimenting these business services in 5 real pilot-projects situations we have been able to appreciate, modify and finally validate the resulting business services [5].

But experiments also revealed that the Human-Computer Interfaces (HCI) provided with the business services shown their limits. Indeed many experimenters suggested improvements or particular requirements related to their individual needs: their own *usages*. Some examples are given below:

- When consulting the project's documents, the architects coordinating exchanges of documents need to track which documents are new ones in order to check their conformity, whereas contractors prefer to search for a specific document related to their current activity on the construction site,
- Coordinators of construction activity require a rapid view of coordination-related documents such as meeting reports and construction planning, whereas architects prefer to rapidly visualize new plans,
- Engineers want to obtain rapidly a specific view of the validation tasks they have to perform, whereas architects prefer to visualize every validation tasks pending in the project documents.

This feedback gathered during business services experiments differs from our initial aim, which was related to diffusing the designed business services. It shows that if cooperation necessary remains on setting up a cooperative work context (i.e. what working practices will be setup in a cooperative situation, at the group level?), the specific requirements of each type of actor of the construction projects have also to be specifically addressed by the services.

In this paper we develop the concept of "adaptable visualization service" in order to take into account such requirements in service systems developments. The design of such kind of service has to consider the particular needs of the users of a service system, which generate particular usages and associated requirements in terms of information visualization.

3 Usage-Centered Approach, Adaptivity and Visualization Services

Our main hypothesis is that visualization modes implemented in Human-Computer Interfaces of IT services have to fit usage of actors who have specific practices according to their role in an activity. Usages differ from traditional user profiles in context-aware computing by increasing its acceptance with:

- Organizational and operational roles of a project's actor in a particular cooperative situation,
- Particular requirements generated by the available business services in the collective project.

Therefore visualization techniques of project context could be designed according to the usages. They can be identified as an "adaptable visualization service" which could be chosen, integrated and used by the actors to perform their activity inside a project.

3.1 Usage Centered vs. User-Centered Design of HCI

The usage-centered engineering has been introduced by Constantine and Lookwood [6] to develop software that support all the tasks that users have to accomplish. This method suggests a systematic process using abstract models to guide user-interface designers. The originality of this approach is to combine and adapt requirement analysis models that come from the software engineering domain. The usage-centered design is proposed as an alternative to user-centered design which relies on three main techniques: user studies (to identify the users' need), rapid prototyping (to get user feedback), and usability testing (to identify usability problems) [7]. The differences between usage-centered design and user-centered design [7] is that the focus is not users but usage, i.e. the tasks intended by users and how these are accomplished. The major difference stays in the process: in the user-centered design the process is a sequence of approximations where the final solution emerges through repetitive cycles of trial design and user's feedback; in the usage-centered design, the process takes the form of an integrated concurrent engineering process which produces an incremental design described by interconnected models from which a final visual and interaction design are obtained by transformations. Then the usage-centered design can be assimilate to an MDE approach as those emerging currently in the HCI domain [8].

The usage-centered design method is based on three principal abstract models which guide the process (role model, task model, and content model) and two surrounded models (domain model and the operational model) (c.f. Fig. 2).

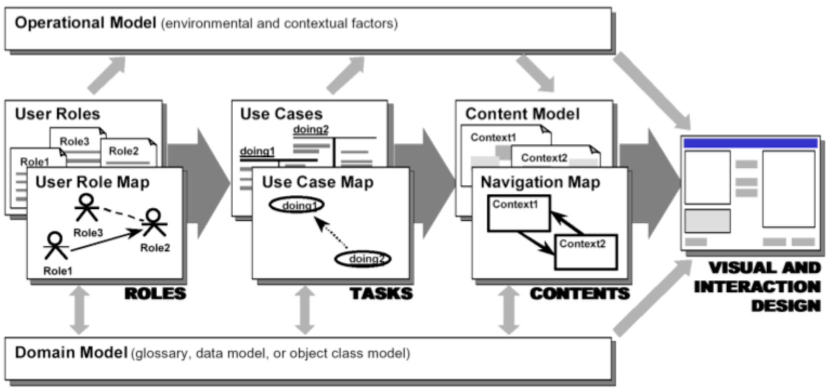

Fig. 2. The models used in the usage-centered design method (extracted from [9])

This approach which is made for define the user interfaces of a specific software related to particular needs, has the originality to define a set of models to describe incrementally the future UI. But, when the forms of visualization can be variable and interchangeable according to the role of different actors and also to the context of use, this method becomes inappropriate according to the many forms of UI that has to be studied and defined.

The adaptation of the interface to the context of use is a very active domain of research and stimulated by the growing needs in pervasive computer applications.

3.2 Adaptable versus Adaptive User Interface

The expansion of pervasive applications and user mobility has generated new user needs. Personal digital assistants, mobile phones, and modern communication devices are now used to realize many user activities. Many applications become mobile by proposing the same functionalities as those presents in versions used in desktop computer. The mobile application, and particularly its user interface, must be adapted to the context of use. Usually, in software engineering, the adaptation of an interactive application to different contexts of use requires costly redesigns of the user interface (UI) and a difficult maintenance of the different versions.

In HCI, the adaptation of an interface is characterized by two properties: adaptability and adaptivity. While adaptability refers to the ability of an interface to be modified by users, adaptivity refers to its ability to change without explicit intervention of users. By analogy with the plasticity of a substance or entity, UI plasticity is also defined as its the capacity to adapt to the context of use while preserving its usability [10]. Thus, plasticity appears as a form of adaptivity and the associated design methods are emergent and innovative. The objective of plastic UI design approaches, by opposition of those used in software engineering domain, is “to design once and generate many times”.

So, they identify different contexts of use (target) and design, for each target, the user interface elements that may evolve according to the context alterations in order to preserve the usability. In these approaches the context of use is described by three aspects: user, platform and environment. The user aspect denotes the characteristics of the archetypal person who is intended to use the interactive system. The environment aspect includes elements that characterize the physical places where the interaction will take place. Finally the platform aspect describes the physical and software resource that bind together the physical environment with the digital world [8].

By reusing the concepts and method of MDE of software engineering, the latest approaches offer a set of models describing different aspects of both the context of use but also the usability, the domain, the tasks, the workspaces, …[11]. All models obtained from dedicated meta-models are then "mapped" and bound by rules of transformation. Thus, when in an user interface described by these models, an element of the context changes the interactive system tries to restore a sort of "stability" by maintaining consistency introduced in the models.

The principal interest of this type of approach is the exhaustiveness of models to be considered to design plastic UI and the application in the definition of the USIXML language allowing designer to aboard the description of an UI with many levels[12]. But these approaches have been used in applications with simple user interface and low functional coverage (home heating control, slides viewer, a web tourism site [8]) and in individual activity situations. Indeed, when the activity is collective, another context has to be taken into account: it is the one of the actor in the activity: its role, its competencies. Relatively to this context, each actor is faced with particular situations that he needs to understand by building his point of view on the collective activity in which he participates. In our approach, we consider a point of view as a set of visualization modes adapted to different usage existing around the collective activity. The definition of a viewpoint is then a choice among a set of adaptable visualization services offered by a service system, which mediatizes the collective activity.

3.3 Visualization Services

Visualization services (VS) allow users to visualize a collection of information by using a remote service offering added value in interpreting the information represented. The visualization in the form of services is often dedicated to a particular scientific domain. It is based on the same principle, as other forms of more business-oriented services, of the classical SOA approaches: loose coupling, reusability, evolutivity by composing services. VS are used in areas where the interpretation of a large volume of data is a critical need as medicine [13] or network security [14]. VSs can also be enough general to be used in many particular situations (information search, management decision, diagnosis...) in individual or collective visualization activities [15].

Such services are typically designed around the concept of “dataflow” or “pipeline” which define a series of steps building the visualization from a data set. In the sequence of processing steps, raw data are first filtered, then transformed to a geometric representation and finally this geometry rendered as an graphic/image [16]. Recent approaches based on "services" propose to distribute each step, in the form of dedicated services, across the grid [15]. In literature, method descriptions are particularly oriented on explaining the distributed architectures implementing the pipeline. Just a few papers deal with implementing service design. In this area, the MDE approaches and the adaptable visualization services design are emerging. One of these emerging methods proposes to design adaptable visualization services (AVS) [14]. This method allows different actors to visualize the same information with different points of view by combining different forms of visualization. Three layers (or models) composed the method: "*i) language layer, ii) visualization methods layer, iii) transformation layer* "[14]. Even if this method does not fit exactly into an MDE approach, it remains interesting in its objective to give each actor of a collective activity (here the security management of networks) the possibility to adapt the visualization to his need and to propose a method to describe and add new visualization services.

The choice of adaptable visualization services in a collective activity of visualization is recent. Its extension to the visualization of cooperative context information is certainly innovative. It consists in offering to each actor of a collective activity (e.g. a construction project) the ability to select and organize visualization services as a multi-view user interface to build his appropriate visualization of the cooperative context. The method we propose focuses on a usage-centered design of these adaptable visualization services where the business component is essential.

4 Towards a Usage-Centered Design of Adaptable Visualization Services Based on MDE

As usages are numerous, we have to choose a generic method to describe and implement them as IT services in a service system. We aim to consider usages to guide the business services and visualization services design. Model-driven engineering (MDE) approach allows us to consolidate the three concepts in relationship (Fig. 3): domain targeted (which one guarantees sector fitting), business service, and visualization service. MDE recommends the use of meta-models to define domain specific languages. The following parts described basic concepts of our meta-models.

4.1 Usage Metamodel

In our preliminary approaches, usages are identified through the following questions (Table 1): *who* performs it?, *how* is the usage performed?, *where* is it performed?, *when*? and *what*?

This approach is derived from domain-specific collective work practices which generate themselves particular requirements for each actor of a collective activity, depending on his role or his particular responsibilities in the project Usages are defined independently of any existing IT service or groupware functionality. In this sense it differs from the definition of "use cases" in UML or task models in HCI while concepts are closed.

Table 1. Usages attributes

Usage's attribute type	**Usage's attribute name**	***Related to***
Who?	Usage's name	*Actor's role and cooperative situation characteristics*
	Role concerned (project's actor)	*Related to the AEC Business domain*
How?	Business task in which context the usage is performed	*Related to the AEC Business domain and to the Business Process of a Business Service*
What?	Main concept required, Sub-concepts required to perform the usage	*Related to the AEC Business Domain*
What?	Information quantity	*Related to the AEC Business Domain*
When?	Usage Frequency	*Related to the AEC Business Domain*
Where? When?	Context of application of the usage (location, time, device)	*Provided by the Business Service*

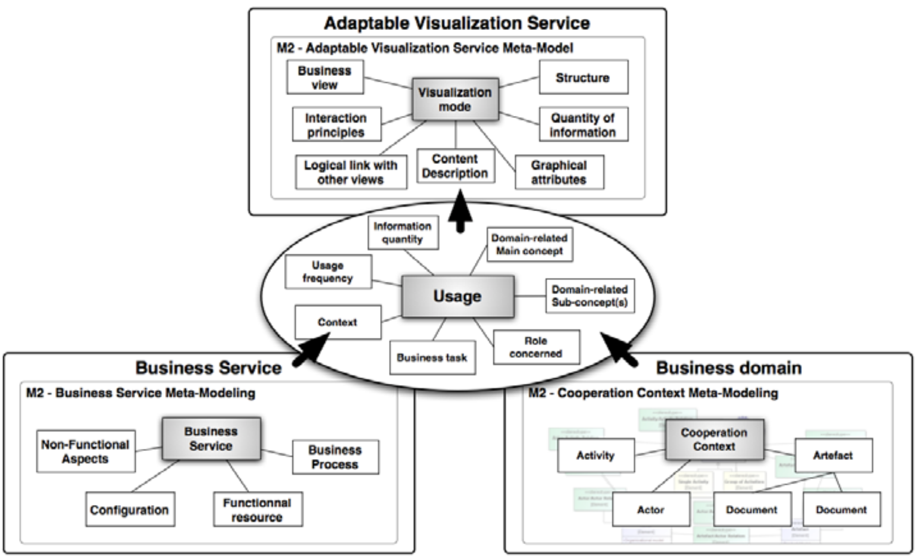

Fig. 3. Usage-centered Model infrastructure dedicated to adaptable visualization service design

4.2 AEC Domain Metamodel

The usage modeling refers to some specific concepts from a particular context of cooperation in the AEC domain, especially to precise the "what" and the "who?" questions. To describe these particular context models, we have defined a Cooperation Context Meta-Model (CCMM), which characterizes the cooperative activity at a high level of abstraction. CCMM strengthens the relationships existing between the elements of cooperation (actors, activities and artifacts).

4.3 Business Service Metamodel

Business services represent all the possible activities inside a project, it provides the *how?, where?* and *when?* questions in the usage definition (§ 4.1). The description of business services requires to use the same modeling framework to guarantee the alignment between the concepts introduced at each modeling level. The Business Service Metamodel describes business services aspects: functional and non functional resources, elements related to services' configuration (execution process) and the attached business process. This approach is inspired from other works such as the ones of IBM [17]. The metaconcept matching between metamodels enables to design business services adapted to specific domain cooperation contexts by using domain concepts when configuring the business service (service model level).

4.4 Visualization Service (VS) Metamodel

These previous works on domain modeling (§4.2) and the ongoing works on usage (§4.1) and business service (§4.3) modeling target the design of adaptable visualization services (AVS) for particular usages in AEC. The definition of usage aims at better understanding the business services and concept domains that are needed in visualization of particular situation. The challenge is to improve information display for each user's usage. We suggest defining a metamodel of the adaptable visualization services in order to describe AVSs used in groupware services and to enable their use in UI adaptation and configuration. The description of visualization techniques aims at defining their capability in terms of information visualization, on the basis of the relevant literature in the field [18, 19, 20]. At this time, the following attributes have been identified:

- Structure of the visualization technique: this attribute is related to the structure of data representation (hierarchical, concentric, and linear…).
- Quantity of information displayable: display of data (high quantity of unit data, proportion of heterogeneous data…).
- Graphical attributes: what graphic means are used in the technique in the manner of Bertin's encoding mechanisms?
- Content description: what domain-specific content is represented in the User Interface?
- Logical link with other visualization techniques: describes how a visualization service can be coupled to another.
- Interaction principles: clickable elements, such as user buttons, pop-up menus…
- Business view: is the visualization technique well known in a specific domain? This attribute is important because it helps to determine the impact of training/adaptation periods required by the users.

4.5 S2IP-Based Adaptable Visualization Service Design Process

The sections above highlight the high interrelation between usages, domain and business services concepts in the process of designing Adaptable Visualization Services for a particular domain. Such innovation projects have to be rigorously performed.

Then consolidating the design process, such as S2IP applied in Business Service Design, makes sense. The major challenge in AVS design process consists in identifying *possible visualization services applicable in particular usages*. From our model-based approach description, we retain the necessary "mapping" between usage, domain and Business Service attributes on the one side, and Visualization Service attributes on the other side. The main challenge is to map the concepts of usages to the ones of Visualization Services such as shown in Fig. 4.

This basic mapping between usages and visualization techniques is the core of the suggested Adaptable Visualization Services design process.

Visualization Services design is a process that has to closely involve target-domain practitioners, in a networked innovation approach. Therefore we formulate the hypothesis that S2IP (§2.2) could guide this process. The identification of the research and innovation activities described above could be linked with the aim of two S2IP processes: 1) service value and business strategy and 2) service design and engineering.

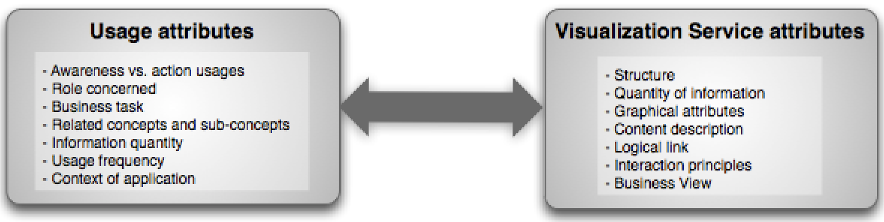

Fig. 4. Mapping Usage attributes to Visualization Service attributes

5 Example of Visualization Services Design

We carried a first experiment aiming at designing visualization services on the basis of usages that we identified with practitioners. This research work helped us to consolidate the design process (§4.5) and led to the development of four visualization services integrated in a prototype application [21].

Usages related to the role of "architect" have been identified. The approach was based on the existing best practices related to document management (§ 2.2). We distinguished between two types of usages: the ones related to the understanding of the state of the cooperative context (i.e. *awareness usages*) and the others related to the specific actions the role has to perform (i.e. *action usages*).

These usages have then been described according to the defined metamodel (concepts presented in Table 1). If we analyze one example: "searching a document", this usage has been described as follows (Table 2).

A first set of 37 architect-specific usages has been identified. In a second stage we have setup an experiment protocol in order to validate their usefulness with practitioners. Interviews have been carried out aiming at verifying qualitative aspects of usages (are they really useful) and quantitative aspects (among the 37 usages, what are the preferred ones?).

Table 2. Example of usage attributes

Usage's attribute name	**Example**
Usage's name	"*Searching for specific documents in order to check their consistency with main architectural plans or find past decisions.*"
Role concerned (project's actor)	Architect
Business task in which context the usage is performed	Coordination of exchanges.
Main concept required, Sub-concepts required to perform the usage	Document (its name). Type of the document, author (sub-concept).
Information quantity	Search among a big quantity of documents.
Usage Frequency	Quite rare.
Context of application of the usage (location, time, device)	At the office, on a Personal Computer.

Once some visualization techniques were described, we tried to find a logical manner to associate them with usages. Attributes of usages were compared to attributes of visualization services. Two usages have been selected, and for each one, two visualization services have been selected (Table 3).

Table 3. Sets of usages and visualization services of the example

Usage name	**Adaptable Visualization service**
Searching for specific documents in order to check their consistency with main architectural plans or find past decisions.	Treemap + Coverflow
	Table (chart)
Consulting project requests in order to validate it or comment the documents.	Gantt timeline
	Relational graph

The visualization services have been described according to the AVS metamodel concepts (§4.4). The Table 4 presents the description of the "treemap" visualization service according to this metamodel.

The two usages and their related four visualization services have been implemented in a demonstrator prototype called E.V.A. (Experimental Visualization Application). The Fig. 5 shows the E.V.A. interface[4]. A basic selection of a usage and a particular visualization enables the user to test it.

The final part of this visualization services design example is related to the validation of the proposition. As usages were previously validated with practitioners (see above) we had a first assessment of their utility. A second experiment stage led us to test the Visualization Service implemented with users. The process relied on testing tasks performed by users and a final questionnaire/discussion to gather qualitative feedback. 17 users performed the experiment and provide us interesting results. In our example, treemap + coverflow AVS appeared useful to search among big quantity of documents. Training period seems to be relatively brief, once the principle is

[4] E.V.A. prototype has been developed as a Rich Internet Application (RIA), based on the FLEX framework.

Table 4. Model of the treemap visualization service

Visualization service attributes	**Example**
Visualization service's name	Treemap
Structure of the visualization technique	Hierarchical structure.
Quantity of information displayable	Capability to represent high quantity of information, proportionally display of data.
Graphical attributes	Areas of variable sizes and colours.
Content description	Areas representing documents or sets of documents (e.g. by type)
Interaction principles	Filtering of document sets by selecting a colored area. Possible navigation within documents hierarchy (not mandatory).
Business view	No: consider a necessary training period.

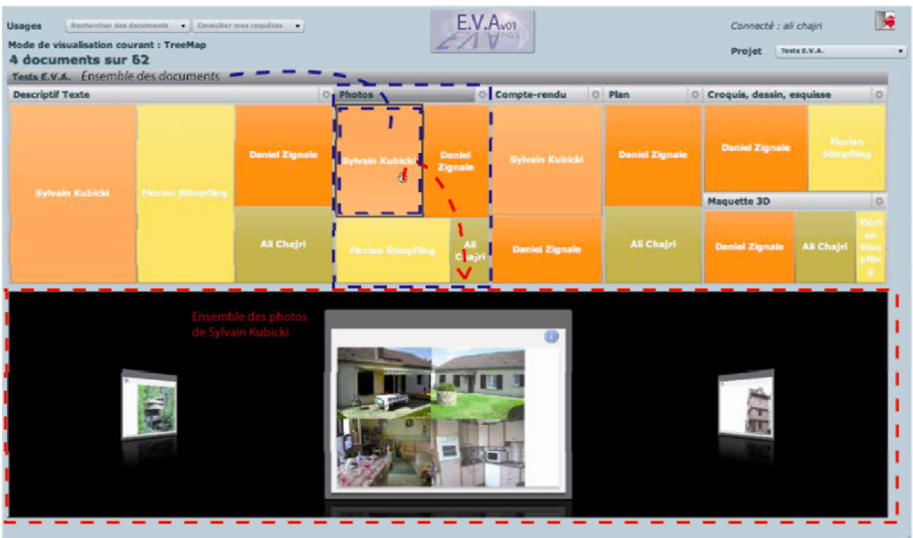

Fig. 5. Screenshot of the E.V.A. interface, showing Adaptable Visualization Services

explained. Therefore we concluded that it was well adapted to the corresponding usage. Further tests are however necessary to confirm these results.

6 Conclusion

The definition of adaptable visualization services (AVS) oriented by business usage in a particular domain requires a sustainable approach in which business actors must have a strong involvement. In this article, we have attempted to show how the innovation process S2IP, used in many CRPHT projects, associated with a MDE prospective approach of the MAP-CRAI, can be a guide to propose, design, implement and validate business services and AVS.

Currently, the process used in this method is related to the first two processes of the S2IP innovative process. Indeed the method is exploratory and three of the proposed meta-models (usage, business services and AVS) are still in a development state and require some testing and improvements. In the presented example, two modeled usages have guided the design of four AVS which have been validated by professionals. The definition of new usages and new AVS will allow us to refine the meta-models and their matching (mapping).

The realization of the final processes of S2IP (services promotion, management and capitalization) will require the definition of an integration tool of AVS like the mashup platforms of Web services [22, 23] based on a dedicated language, similar to EMML[5] that describes the integration. In our prospects, the definition of such a language will be built on the meta-models concepts and mapping, and it will describe the assembly and adaptation of the visualization services chosen by the platform user.

Acknowledgment

This article was supported by the Dest2Co project funded by the National Research Fund (FNR), Luxembourg.

References

1. Chesbrough, H.: The era of open innovation. MIT Sloan Management Review 44(3), 35–41 (2003)
2. Tapscott, D., Ticoll, D., Lowy, A.: Digital Capital: Harnessing the Power of Business Webs, London, UK (2000)
3. Chesbrough, H., Spohrer, J.: A research manifesto for services science. Communications of the ACM 49(7), 35–40 (2006)
4. Kubicki, S., Dubois, E., Halin, G., Guerriero, A.: Towards a Sustainable Services Innovation in the Construction Sector. In: van Eck, P., Gordijn, J., Wieringa, R. (eds.) CAiSE 2009. LNCS, vol. 5565, pp. 319–333. Springer, Heidelberg (2009)
5. Kubicki, S., Guerriero, A., Johannsen, L.: A Service-Based Innovation Process for Improving Cooperative Practices in AEC. ITCon - Journal of Information Technology in Construction 14, 654–673 (2009)
6. Constantine, L.L., Lockwood, L.A.: Software for Use: A Practical Guide to the Models and Methods of Usage-Centered Design, Inc. Addison-Wesley Educational Publishers, Reading (1999)
7. Constantine, L., Lockwood, L.: Usage-centered engineering for Web applications. IEEE Software (2002)
8. Coutaz, J., Galvary, G.: HCI and Software Engineering: Designing for User Interface Plasticity. In: Sears, A., Jacko, J. (eds.) The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications. Taylor & Francis Press, Abington (2008)
9. Karner, H., Droschl, G.: Usage-centered interface design for knowledge management software. Journal of Universal Computer Science 8(6), 634–643 (2002)

[5] EMML : Enterprise Mashup Markup Language, `http://www.openmashup.org/omadocs/v1.0/index.html`

10. Thevenin, D., Coutaz, J.: Plasticity of user interfaces: Framework and research agenda. In: INTERACT 1999. 13th International Conference on Human-Computer Interaction, Edinburgh, UK, August 30-September 3, 1999, pp. 110–117 (1999)
11. Sottet, J., Calvary, G., Favre, J., Coutaz, J.: Towards Mapping and Model Transformation for Consistency of Plastic User Interfaces. In: CHI 2006. Workshop on The Many Faces of Consistency in Cross-Platform Design, Montreal, Canada (2006)
12. Limbourg, Q., Vanderdonckt, J., Michotte, B.: USIXML: A language supporting multipath development of user interfaces. In: Bastide, R., Palanque, P., Roth, J. (eds.) DSV-IS 2004 and EHCI 2004. LNCS, vol. 3425, pp. 200–220. Springer, Heidelberg (2005)
13. Blazona, B., Mihajlovic, Z.: Visualization service based on web services. Journal of Computing and Information Technology (2007)
14. Hocová, P., Dymácek, T., Kintr, M.: Adaptable visualization service: through uniformity towards sustainability. In: First International Workshop on Model Driven Interoperability for Sustainable Information Systems (MDISIS 2008) held in conjunction with the CAiSE 2008 Conference, Montpellier, France (2008)
15. Li, F., Gong, B., Xing, C., Ma, Y.: Dynamic Visualization Service Deployment in Grid Scientific Workflow. In: Grid and Cooperative Computing (2008)
16. Haber, R.B., McNabb, D.A.: Visualization Idioms: A Conceptual Model for Scientific Visualization Systems. Visualization in Scientific Computing, 1–2 (1990)
17. Zimmermann, O., Schlimm, N., Waller, G., Pestel, M.: Analysis and Design Techniques for Service-Oriented Development and Integration. GI Jahrestagung, pp. 606–611 (2005)
18. Mazza, R.: Introduction to Information Visualization. Springer, London (2009)
19. Bertin, J.: Semiology of Graphics. The University of Wisconsin Press (1967)
20. Spence, R.: Information Visualization. Design for Interaction. Prentice Hall, Essex (2001)
21. Zignale, D.: Adapter des modes de visualisation à des besoins métiers. Application aux outils informatiques d'échange de documents dans les projets de construction. Master thesis. CRAI - Université Henri Poincaré, Nancy (2009)
22. Jhingran, A.: Enterprise information mashups: integrating information, simply. In: Proceeding of the 2nd international conference on Very large data bases VLDB, Seoul, Korea, pp. 3–4. ACM, New York (2006)
23. Ennals, R.J., Garofalakis, M.N.: MashMaker: mashups for the masses. In: Proceedings of the 2007 ACM SIGMOD international conference on Management of data, Beijing, China, pp. 1116–1118. ACM, New York (2007)

From End-User's Requirements to Web Services Retrieval: A Semantic and Intention-Driven Approach

Isabelle Mirbel and Pierre Crescenzo

Université de Nice Sophia-Antipolis
Laboratoire I3S (UNS/CNRS)
930 route des Colles
BP 145
F-06903 Sophia-Antipolis cedex
France
{Isabelle.Mirbel,Pierre.Crescenzo}@unice.fr

Abstract. In this paper, we present SATIS, a framework to derive Web Service specifications from end-user's requirements in order to operationalise business processes in the context of a specific application domain. The aim of SATIS is to provide to neuroscientists, which are not familiar with computer science, a complete solution to easily find a set of Web Services to implement an image processing pipeline. More precisely, our framework offers the capability to capture high-level end-user's requirements in an iterative and incremental way and to turn them into queries to retrieve Web Services description. The whole framework relies on reusable and combinable elements which can be shared out by a community of users sharing some interest or problems for a given topic. In our approach, we adopt Web semantic languages and models as a unified framework to deal with end-user's requirements and Web Service descriptions in order to take advantage of their reasoning and traceability capabilities.

Keywords: Web Services, Semantic Web, Intentional Modeling, Rules, Reuse.

1 Introduction

Service-oriented computing is a paradigm relying on services as atomic constructs to support the development and easy composition of distributed applications. Application components are assembled with little efforts into workflows of services loosely coupled to operationalise flexible and dynamic business processes. Searching for the relevant Web Services to operationalise a particular business process is one of the challenges of the service-oriented computing area. At present, in the process of searching for Web Services, it is assumed that user's goals have already been identified, captured, specified and formalised in a suitable model to easily find the relevant services. Or it is considered that users,

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 30–44, 2010.

which often are specialists of their domain, are also computer scientists or at least connoisseurs of Web Services. These hypotheses are generally too strong to be reasonable.

In this context, the SATIS (*Semantically AnnotaTed Intentions for Services*) project's ambition is to allow final users to express their intentions (or goals) and strategies (to achieve their intentions) in a high-level language, and to support the selection of a set of Web Service descriptions which could respond to the users' needs. But this problem is complex and cannot be solved in a general approach. Therefore, we focus on an application domain where domain knowledge and service descriptions (semantic Web Services) are available. The aim of SATIS is to provide to neuroscientists, which are not familiar with computer science, a complete solution to easily find a set of Web Services to implement an image processing pipeline.

Indeed, our purpose is to give at users disposal some useful dedicated reusable fragments of know-how to help them to implement their business goals with Web Services. Therefore, our approach relies on high-level business-oriented activity specification with the help of an intentional model in order to derive Web Service description from this high-level specification. We also focus on a community of users sharing some interest or problems for a given topic inside the business domain.

Our work belongs to the family of goal-based service retrieval approaches. These approaches ([23,24,25,2]) aim at specifying the goals which have to be satisfied by the retrieved services. In these proposals, different models are provided to specify goals without addressing the problem of how to capture them. On the contrary, our aim is to provide means to assist final users in querying the Web Service registry to find Web Services to operationalise a business process. The GODO approach [8] also addresses this issue by proposing models and tools to capture user's goals with the help of an ontology or in natural language. As in [10], we propose an incremental process to refine users' requirements in order to specify the features required for the Web Services under retrieval. Our approach distinguishes itself from [10] by the fact that we rely on semantic Web models and techniques to enrich the goal (or intention) specification, in order to provide reasoning and explanation capabilities.

With regards to approaches dealing with ontology-based service discovery [12], and more precisely OWL-S based approaches (as we are relying on OWL-S with regards to Web Service descriptions), capability matching algorithms [11] exploiting service profile descriptions have been proposed. Matchmaking algorithms [15] comparing state transformations described in the query to the ones provided in the descriptions have also been proposed. All these algorithms mainly exploit features of subsumption relationships. Ranking mechanisms have also been provided [1]. Our approach distinguishes itself from these works by the fact that our focus is on providing means to assist final users in authoring queries (more than rendering them). In other words, we are interested in the upstream process of deriving queries from final users requirements. Moreover, our concern is also on how to annotate such queries in order to support their capitalisation and sharing among a community of users.

Beyond an alternative way to search for Web Services, we provide means to capitalise know-how about Web Service search procedures themselves. Another novelty of our approach is to operationalise goals by rules in order to promote both mutualisation of high-level intentional specification and cross-fertilisation of know-how about Web Services search procedures among the community members.

The paper is organised as follows. First we give an overview of our SATIS approach in section 2. Then, in section 3, we detail the authoring process proposed in SATIS and how the authored search procedure is rendered in section 4. Next, we explain in section 5 how the framework is used by the different actors interacting in a neurosciences community of users. Finally, we conclude and give some perspectives.

2 SATIS Approach

The aim of our approach is to provide to neuroscientists, which are not familiar with computer science, a complete solution to easily find a set of Web Services to implement an image processing pipeline. The focus of this proposal is on how to search and retrieve Web Services descriptions from end-user's requirements. Indeed we provide support to retrieve an organised set of Web Service descriptions suitable to operationalise an image processing pipeline as specified by a neuroscientist (final user).

As we are interested by high-level end-user's requirements, we rely on a dedicated graphical notation to capture and specify them. In the context of a neuroscientists community, these requirements deal with image analysis pipelines. Different business process modeling formalisms have been proposed in the literature [13]. Decision-oriented models are semantically more powerful than the other process models because they explain not only how the process proceeds but also why. Their enactment guides the decision making process that shapes the process, and helps reasoning about the rationale [13]. Our approach is based on the adaptation of such a decision-oriented model called the map model [21]. This intentional process modeling formalism allows final users (neuroscientists) to define their image analysis pipeline by describing intermediate *intentions* (*i.e.* goals and subgoals to be satisfied through the processing chain) and *strategies* (*i.e.* means to reach goals).

As we are interested by the end-user's point of view on the processing pipeline to be operationalised by Web Services, we don't want him/her to explicitly specify the Web Service(s) s/he is interested in but the intention(s) s/he wants to satisfy by rendering Web Service(s). Moreover, we don't want to explicitly associate Web Service descriptions to *high-level end-user's intentional requirements*. In our framework, end-users associate queries to their requirements. Indeed, queries allow end-users to specify *generic Web Service descriptions*. For instance, in a neuroscientist community, by looking for a Web Service which takes as input an image and provides as output a debiased image, the end-user specifies the kind of Web Service s/he is interested in without explicitly refering to one specific

Web Service. By doing so, we assume a loosely coupling between high-level end-user's intentional requirements on one hand and Web Services descriptions on the other hand: if new Web Service descriptions are added inside the community Web Service registry, they can be retrieved to operationalise a high-level end-user's intentional requirement even if the requirement has been specified before the availability of the Web Services under consideration; and if Web Service descriptions are removed from the community Web Service registry, the high-level end-user's intentional requirements that they satisfied are still valid and may be operationalised by other available Web Services. Web Services are dynamically selected when rendering queries associated to high-level end-user's intentional requirements.

In our approach, we also adopt Web semantic languages and models as a unified framework to deal with (i) high-level end-user's intentional requirements, (ii) generic Web Service descriptions and (iii) Web Service descriptions themselves. With regards to high-level end-user's intentional requirements, we adapted the map model [21] to our concern and gathered its concepts and relationships into an RDFS [20] ontology dedicated to the representation of intentional processes: the map ontology [5]. As a result, intentional processes annotated with concepts and relationships from this ontology can be shared and exploited by reasoning on their representations. We also consider semantic *Web Service descriptions* specified with the help of the OWL-S ontology [14]. And finally, *generic Web Service descriptions* are specified with the help of the W3C standard query language for RDF [19] annotations: SPARQL [22]. Generic Web Service descriptions are formalised into graph patterns over Web Services descriptions. Indeed, our approach relies on three ontologies: The map ontology we proposed [5], the OWL-S ontology [14] and a domain ontology (in our case an ontology describing medical images and medical image processing dedicated to the neuroscience domain).

Knowledge capitalisation, management and dissemination inside a community of members may be supported by a collective memory, that is to say an explicit, disembodied and persistent representation of the community knowledge in order to facilitate access, sharing and reuse [6]. In semantic collective memories, resources are indexed by semantic annotations in order to explicit and formalise their informative content. Information retrieval inside the collective memory relies on the formal manipulation of these annotations and is guided by ontologies. In SATIS, we are dealing with annotations about Web Service descriptions, generic Web Service descriptions and high-level end-user's intentional requirements. We are exploiting reasoning and traceability capabilities of semantic Web models and languages to provide dedicated search, sharing and reuse means to improve collaboration inside a community of neuroscientists. Beyond a way to retrieve Web Services, our approach aims at providing means to promote mutualisation of high-level end-user's intentional requirements and cross fertilisation of know-how about how to operationalise image processing pipelines among the community members. Our proposal may be compared to case based reasoning approaches in that it provides means to identify relevant Web Service descriptions (solutions) corresponding to new high-level end-user's intentional requirements (problems) based on Web Service descriptions (solutions) identified for similar requirements (problems). Indeed high-level end-user's intentional requirements are considered as problem descriptions and Web Service descriptions are considered as solutions. generic Web Service descriptions as well as subgoals and strategies elicited to specify high-level end-user's intentional requirements are considered as intermediary knowledge on which to reason to reduce the gap between high-level end-user's intentional requirements and Web Service descriptions thus providing solutions to problems that is to say proposing Web Services to implement an image processing pipeline.

Indeed, we address the issue about how to retrieve Web Service descriptions from high-level end-user's intentional requirements by providing means to reuse existing knowledge about relevant Web Services to operationalise high-level end-user's requirements inside the scope of a community of users.

3 SATIS Authoring Process

In SATIS, search procedure authoring is supported by a three steps process: (i) high-level end-user's intentional requirements elicitation, (ii) requirements and generic Web Service description formalisation and (iii) fragment definition. During this process, the map model [21] helps to capture high-level end-user's intentional requirements. The map ontology, the domain ontology and the OWL-S ontology are used to formalise the high-level end-user's intentional requirements and to specify associated generic Web Service descriptions. RDF annotations representing high-level end-user's intentional requirements and SPARQL queries formalizing generic Web Service descriptions are then grouped into rules considered as reusable fragments.

3.1 Elicitation Step

Figure 1 shows an example of high-level end-user's intentional requirement dealing with tissue and lesion classification. It is specified with the help of the map model [21]. According to [21], a map is a process model in which an ordering of *intentions* and *strategies* has been included. In our case, we focus on image processing intentions and image processing strategies. A map is a labeled directed graph with intentions as nodes and strategies as edges between intentions. An image processing intention is a goal that can be achieved by following a strategy. An intention expresses what is wanted, a state or a result that is expected to be reached disregarding considerations about who, when and where. There are two distinct intentions that represent the intentions to start and to stop the process. A map consists of a number of sections each of which is a triple (source intention, target intention, strategy). A strategy characterises the flow from the source intention to the target intention and the way the target intention can be achieved. A map contains a finite number of paths from its start intention to its stop intention, each of them prescribing a way to achieve the goal of the image processing pipeline under consideration. Indeed, it is at runtime, when an intention

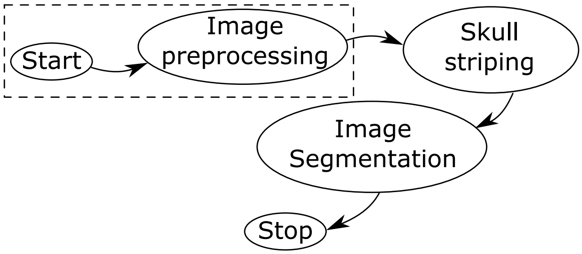

Fig. 1. Example of high-level end-user's intentional requirement

is satisfied, that one target intention and one strategy are chosen (among all the target intention and strategies available from the current intention), depending on the context of the process at runtime.

In figure 1, we can see 3 main intentions: `Image preprocessing`, `Skull striping` and `Image segmentation`. Between the intentions, we discover strategies. Strategies define the way to pass from an intention to a next one. There can be many strategies which link up the same intentions (for instance to indicate which (kind of) algorithm is used to achieve the target intention). Indeed, in a map, each set which is made up by a source intention, a strategy and a target intention is a *section* of the map. An example of section has been highlighted with a doted line in figure 1. Let's precise that a map is neither a state diagram, because there is no data structure, no object, and no assigned value, nor an activity diagram, because there is always a strong context for each section of the map: its source intention and its strategy. We can attach more information to this kind of schema (in order to help the user of the map to choose the adequate strategy, for example), but this is not the goal of this paper to fully describe the map model.

The aim of such a modeling is to capture high-level end-user's intentional requirement in order to turn them into generic Web Service description to search for available Web Services to implement the image processing pipeline under consideration. Indeed, high-level end-user's intentional requirement may need to be further refined to be transformable into generic Web Service description. For instance, in the example of figure 1, additional specification would be useful to understand what kinds of generic Web Service descriptions are suitable to search for Web Services implementing image preprocessing. Therefore, each section of a map may be refined into another map describing more in detail how to reach the target intention of the section under consideration. Figure 2 shows an example of map refining the section highlighted in Figure 1. In this map, different ways (*i.e.* different paths) to achieve the target preprocessing intention are provided.

At the refinement level presented in figure 2, it is now possible to associate generic Web Service descriptions to map sections in order to specify how to retrieve Web Service description implementing the section target intention. For instance, a query searching for Web Service descriptions which have an image as input, and an image qualified as debiased as well as a bias field as outputs aims

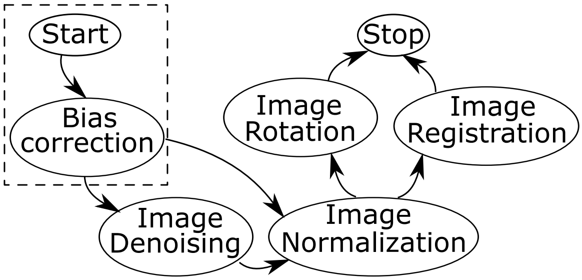

Fig. 2. Example of requirement refinement

at retrieving Web Service descriptions corresponding to the section highlighted in figure 2.

3.2 Formalisation Step

The second step of the authoring process is devoted to the formalisation of the intentions and strategies elicited during the previous step, as well as the generic Web Service descriptions associated to the most refined map sections. Intentions and strategies are formalised by using verbs, objects and manners from the domain ontology. Indeed, during the elicitation step, end-users think in terms of goals and means to reach goals while in the formalisation step, they try to formalise through domain concepts how to qualify goals and strategies elicited in the previous step.

To further formalise map elements, we rely on [16,17] proposal, which has already proved to be useful to formalise goals [18,9,21]. According to [16,17], an intention statement is characterised by a verb and some parameters which play specific roles with respect to the verb. Among the parameters, there is the object on which the action described by the verb is processed. We gathered the concepts and relationships of the map model and this further formalisation into an RDFS [20] ontology dedicated to the representation of intentional processes: the map ontology [5]. *Intention*, *Strategy*, *Verb*, *Object* and *Manner* are examples of concepts provided in this ontology.

The mappings between the domain ontology and the map ontology are automatically created when concepts of the domain ontology are selected to formalise map content. Domain concepts are then considered as instances of *Verb*, *Object* and *Manner*. Let us consider again the map depicted in figure 2. Intention `Bias correction` is described by `Debiasing`, instance of *Verb*, and `Image`, instance of *Object*. With regards to strategies, up to now we only consider one strategy between a source and a target intentions. So far, we did not qualify strategies by binding them to domain concepts. In the future, we plan to extend our Web Service annotation model with quality of service (QoS) information and to qualify map strategies by QoS domain concepts considered as instances of class *Manner*.

By using the map and the domain ontologies, a common vocabulary is used by the different members of the community contributing to support know-how sharing and cross fertilisation.

In SATIS, we assume Web Service descriptions are expressed in OWL-S. In our current scenarios, we only use the profile and the grounding of OWL-S as well as the input and output specifications in the process description. We enrich OWL-S description by considering Web Service OWL-S description elements (as input and output parameters for example) as instances of domain concepts. Thanks to this additional instantiation of domain concepts, it makes it possible to reason on OWL-S description element types to retrieve for instance subclasses of concepts we are interested in.

Generic Web Service descriptions are expressed as SPARQL queries among the Web Service descriptions expressed in OWL-S. The following query, where namespace `process` refers to the OWL-S process ontology and namespace `dom` refers to a domain ontology, is an example of generic Web Service description to retrieve debiasing Web Service description.

```
prefix dom: <http://.../dom-onto#>
prefix process: <http://.../Process.owl#>
select ?service
where
{
    ?service process:hasInput ?r1
    filter(?r1 =: dom:Image)
    ?service process:hasOutput ?r2
    filter (?r2 <=: dom:DebiasedImage)
    ?service process:hasOutput ?r3
    filter (?r3 <=: dom:BiasField)
}
```

In this example, we are looking for Web Services which OWL-S description indicates that the Web Service under consideration requires a parameter instance of the `Image` concept from the domain ontology as input and two parameters, instances of concepts (or sub-concepts) of `DebiasedImage` and `BiasField` as output.

3.3 Fragmentation Step

In SATIS, the process consisting in retrieving Web Services descriptions from high-level end-user's intentional requirements about image processing pipelines is viewed as a set of loosely coupled fragments expressed at different levels of granularity. A fragment is an autonomous and coherent part of a search process supporting the operationalisation of part of an image processing pipeline by Web Services. Such a modular view of the process aiming at retrieving Web Service descriptions from high-level end-user's intentional requirements favours their adaptation and extension. Moreover, this view permits to reuse fragments authored to deal with a specific high-level end-user's image processing pipeline in the building of other pipelines.

The fragment body captures guidelines that can be considered as autonomous and reusable. The fragment signature captures the reuse context in which the fragment can be applied.

For us, a guideline embodies know-how about how to achieve an intention in a given situation. We distinguish two types of guidelines: intentional and operational guidelines. Intentional guidelines capture high-level end-user's intentional requirements which have to be refined into more specific requirements. Operational guidelines capture generic Web Service description.

Map formalisations and SPARQL queries respectively constitute the body of intentional and operational reusable fragments. The fragment signature characterises the fragment content and let the other members of the community understand in which situation the fragment may be useful. A fragment signature is specified by a map section. The target intention of the section indicates the goal of the reusable fragment and the source intention as well as the strategy specify the reuse situation in which the fragment is suitable. The section highlighted in figure 1 is an example of signature for an intentional fragment which body is the map presented in figure 2. The section highlighted in figure 2 is an example of signature for an operational fragment which body is the query presented in section 3.2.

Indeed in SATIS, fragments are implemented by backward chaining rules, which conclusions represent signatures of fragments and which premises represent bodies of fragments (either operational or intentional guidelines). We call a rule *concrete* or *abstract* depending on whether its premise encapsulates operational or intentional guidelines.

These rules are implemented as SPARQL construct queries. The CONSTRUCT part is interpreted as the head of the rule, the consequent that is proved. The WHERE part is interpreted as the body, the condition that makes the head proved. When considered recursively, a set of SPARQL construct queries can be seen as a set of rules processed in backward chaining.

The following rule, where namespace `map` refers to the map ontology, namespace `process` refers to the OWL-S ontology and namespace `dom` refers to a domain ontology, is an example of concrete rule implementing an operational fragment aiming at retrieving debiasing Web Services.

```
<rule rdf:ID="rule-c2">
<rule:value>
prefix dom: <http://.../dom-onto#>
prefix map: <http://.../map-onto#>
prefix process: <http://.../Process.owl#>
construct
{
        _:s map:hasStrategy _:g
        _:g map:hasParameter map:AnyParameter
        _:s map:hasSource _:o
        _:o map:hasObject map:AnyObject
        _:o map:hasVerb map:AnyVerb
        _:s map:hasTarget _:i
```

```
        _:i map:hasObject dom:Image
        _:i map:hasVerb dom:Debiasing
        _:s map:hasResource ?service
}
where
{
    ?service process:hasInput ?r1
    filter(?r1 =: dom:Image)
    ?service process:hasOutput ?r2
    filter (?r2 <=: dom:DebiasedImage)
    ?service process:hasOutput ?r3
    filter (?r3 <=: dom:BiasField)
}
pragma {cos:server cos:query true}
</rule:value>
</rule>
```

In the WHERE part of the rule, we recognise the query previously presented in this paper. In the CONSTRUCT part of the rule, a graph pattern corresponding to the map section to build if Web Service descriptions are found in the community Web Services registry is specified. This graph pattern specifies the fact that no specific strategy and no specific source intention is required to achieve the target intention (concepts `map:AnyParameter`, `map:AnyObject` and `map:AnyVerb` are used in the specification). It also indicates that target intention is formalised by the object `dom:Image` and the verb `dom:Debiasing`. The retrieved Web Service descriptions are associated to the newly built map section through the `hasResource` property.

Thanks to SATIS three steps authoring process, high-level end-user's intentional requirements are capitalised inside the community semantic memory in order to be reused during the rendering process that will be detailed in the following section.

4 SATIS Rendering Process

The *rendering step* is supported by backward chaining among rules and matching with the Web Service descriptions. We rely on a semantic engine for both backward chaining on the SATIS knowledge base of rules implementing the reusable fragments and matching with the knowledge base of OWL-S Web Service descriptions. During the rendering step, high-level end-user's intentional requirements are dynamically created when needed all along the backward chaining process, as temporarily subgoals, until Web Service descriptions are found to match all the sub-goals and therefore the general goal of the high-level end-user's intentional requirement. As a result, a community member looking for solutions to operationalise an image processing pipeline will take advantage of all the rules and all the Web Service descriptions stored in the community semantic memory at the time of his/her search. This memory may evolve over the time and therefore the Web Service descriptions retrieved by using a rule may vary as well.

Let's clarify that the result is composed of descriptions of candidate Web Services, and not by Web Services themselves. The invocation of the selected (among the candidates) Web Services is out of the scope of this work. When rendering a Web Service descriptions search process, a set of candidate Web Services (alternatives) is associated to each goal or subgoal elicited during the specification of the image processing pipeline. So, the result of the rendering is a sequence of sets of candidate Web Services. But as the formalism we choose to model image processing pipeline, the map model [21], allows to specify several way to achieve an intention, the result of the rendering step may be composed of several sequences of sets of candidate Web Services.

5 Improving Collaboration among Community Members

One of the main objectives of SATIS is to support neuroscientists when looking for Web Services to operationalise their image processing pipeline. In this section we will first discuss the role of the different actors involved in the neuroscience community and then describe the different means we provide to support neuroscientists tasks.

Three core actors are identified in our framework: the *service designer*, the *process modeling expert* and the *domain expert*. In a neuroscientists community, computer scientists play the roles of *service designer* and *process modeling expert* while neuroscientists play the role of *domain expert*.

The service designer is in charge of promoting the Web Services available in the community Web Service registry. Therefore, when s/he wants to advertise a new kind of Web Service in the neuroscientists community, in addition to adding the Web Service description in the community Web Service registry, s/he writes a generic Web Service description and associates to it high-level end-user's intentional requirements to promote the services s/he is in charge from the end-user's point of view (that is to say in a non computer scientists language, as OWL-S is). The service designer is in charge of authoring atomic reusable fragments.

The process modeling expert is in charge of populating the community semantic memory with reusable fragments to help domain experts to (i) specify the image processing pipelines for which they are looking for Web Services and (ii) search for Web Service descriptions to operationalise the image processing pipelines they are interested in. Indeed, s/he provides reusable fragments useful in different image processing pipelines. Basic processes, as for instance intensity corrections, common to several image analysis pipelines, are examples of such basic fragments. Therefore, s/he may look at the fragments provided by the service designer with the aim of aggregating some of them into basic image processing pipelines. For instance, if `Image debiasing`, `Image denoising`, `Image normalisation` and `Image registration` Web Service descriptions are provided in the community Web Service registry (and associated fragments provided in the community semantic memory) at some point, the process modeling expert may put them together into a basic `Image preprocessing` pipeline. S/he may also identify recurrent needs when supporting domain experts in their authoring task and therefore provide adequate basic fragments for image processing pipelines. The process modeling expert may therefore write abstract rules. If concrete rules about generic Web Service descriptions corresponding to image processing subgoals are already available, the process modeling expert only writes the abstract rules. Otherwise, s/he is also in charge of writing the associated concrete rules.

Finally, the domain expert (or final user) is searching for Web Service descriptions to operationalise an image processing pipeline s/he is interested in. Therefore, s/he may first look in the community semantic memory if some existing rules already deal with the main intention s/he is interested in. If another member of the community already authored an image processing pipeline achieving the same high-level goal, s/he may reuse it as is. The goal under consideration may also be covered by a larger image processing pipeline specified through a set of rules already stored in the community semantic memory and corresponds to one of the subgoals of the larger pipeline. In this case also, existing rules can be reused as is and the rendering step to operationalise the image processing pipeline under consideration performed on the current semantic community memory content. If no high-level end-user's intentional requirements are already available, the domain expert specifies the image processing pipeline under consideration with the help of the process modeling expert. Indeed, abstract rules have to be written. Then, for each subsection identified in the high-level abstract rule, the domain expert may search for existing rules supporting their operationalisation. If it is the case, then s/he can decide to rely on them and stop the authoring process. Otherwise, s/he may prefer to provide his/her own way to operationalise the subgoals. By doing so, the domain expert enriches the semantic community memory with alternative ways to operationalise already registered goals. This will result in enriching the operationalisation means of the image processing pipelines already formalised into rules stored in the semantic community repository. In fact, when someone else looking for the subgoals under consideration will perform a rendering process, if his/her image processing pipeline relies on the achievement of a target intention for which a new operationalisation means has been provided, the backward chaining engine will exploit the rules previously stored in the semantic community repository as well as the new ones, increasing the number of ways to find suitable Web Service descriptions. Each time the domain expert, with the help of the process modeling expert, decides to provide new ways to operationalise a map section, s/he has to select the right level of specification of the fragment signature, in order to allow the reuse of the fragment under construction outside of the scope of the image processing pipeline under consideration.

From a more general point of view, domain and process modeling experts mainly provide intentional fragments: Domain experts focus on high-level intentional fragments, close to the image processing pipelines they want to operationalise. Process modeling experts focus on low level intentional fragments, that is to say fragments operationalising basic image processing pipelines. And service designers mainly focus on providing operational fragments to promote existing Web Services. But domain and process modeling experts may also provide operational fragments to specify their requirements in term of services. And the service designers may also provide intentional fragments in order to show examples of use of available Web Services inside the scope of more complex examples of image processing pipelines. By relying on a rule-based specification to retrieve Web Service descriptions and by providing distinct and dedicated modeling techniques to both service designers and service final-users as well as mapping mechanisms between them, we assist the bidirectional collaboration between neuroscientists and computer scientists inside the community.

An important objective of the SATIS project is to provide to domain experts means to better understand what are the characteristics of the available services and how to use them in the scope of the image processing pipeline they are interested in. We support this aim by several means:

- Requirements about Web Services are described in terms of intentions and strategies that is to say a vocabulary familiar to the domain expert, making the understanding of the a Web Service purpose easier to understand by domain experts.
- The SATIS approach relies on a controlled vocabulary (domain ontology) to qualify Web Services as well as requirements, this way reducing the diversity in the labeling, especially in Web Services descriptions elements.
- We propose to specify required Web Service functionalities in terms of queries (*i.e.* generic Web Service descriptions) instead of traditional Web Service descriptions in order to provide an abstraction level supporting the categorisation of available Web Services and this way an easier understanding of the content of the registry by domain experts.
- In our approach we clearly distinguish an authoring step and a rendering step:
  - During the authoring step, the focus is on the elicitation of the search procedure. The domain experts think in terms of intentions and strategies (and not in terms of services). His/her search procedure is fully described, eventually with the help of the fragments already present in the community semantic memory.
  - During the rendering step, it is the system (and not the domain expert) which tries to find Web Services corresponding to the requirements specified by the experts (by proving goals and sub-goals). Indeed, the experts don't need at all to know the content of the registry. A pertinent subset of it will be extracted by the system and shown to the experts.
- And finally, SATIS relies on a rule based approach which doesn't show to the domain expert the full set of rules exploited by the backward chaining engine to satisfy the user requirements. When rendering a search procedure, the domain expert only selects the intention characterizing his/her image processing pipeline and the system will search for the rules to use. A set of Web Services descriptions is given to the domain expert as result. But the complexity and the number of rules used to get the solution are hidden to the domain expert.

6 Conclusion

In this paper, we presented SATIS, a framework to derive Web Service specifications from end-user's requirements in order to operationalise business processes in the context of a specific application domain. More precisely, our framework offers the capability to capture high-level end-user's requirements in an iterative and incremental way and to turn them into queries to retrieve Web Services descriptions. The whole framework relies in reusable and combinable elements which can be shared out inside the scope of a community of users. In our approach, we adopt Web semantic languages and models as a unified framework to deal with (i) high-level end-user's intentional requirements, (ii) generic Web Service descriptions and (iii) Web Service descriptions themselves. SATIS aims at supporting collaboration among the members of a neuroscience community by contributing to both mutualisation of high-level intentional specification and cross-fertilisation of know-how about Web Services search procedures among the community members.

Future works will first focus on adapting our model to CORESE [7,3], a semantic Web search engine including a backward chaining mechanism in order to test our approach on examples of image processing pipelines. We also plan to develop software tools in order to automate the main tedious steps, like the transformation of the map specification into SPARQL rules and to test our approach in the context of a neuroscientist community. We also have in mind to enrich the formalisation step by taking into account additional information in order, for instance, to derive criteria related to quality of services. Indeed, we plan to extend our Web Service annotation model with quality of service (QoS) information and to qualify map strategies by QoS domain concepts. And we will also concentrate on providing query patterns to help experts writing generic Web Service descriptions.

References

1. Benatallah, B., Hacid, M.S., Rey, C., Toumani, F.: Request rewriting-based Web Service discovery. In: Fensel, D., Sycara, K., Mylopoulos, J. (eds.) ISWC 2003. LNCS, vol. 2870, pp. 242–257. Springer, Heidelberg (2003)
2. Bonino da Silva Santos, L.O., Ferreira Pires, L., van Sinderen, M.J.: A Goal-Based Framework for Dynamic Service Discovery and Composition. In: International Workshop on Architectures, Concepts and Technologies for Service Oriented Computing, Porto, Portugal, July 2008, pp. 67–78 (2008)
3. Corby, O., Dieng-Kuntz, R., Faron-Zucker, C.: Querying the semantic Web with the CORESE search engine. In: 16th European Conference on Artificial Intelligence (ECAI/PAIS), Valencia, Spain, pp. 705–709 (2008)
4. Corby, O., Dieng-Kuntz, R., Faron-Zucker, C., Gandon, F.: Searching the Semantic Web: Approximate Query Processing based on Ontologies. IEEE Intelligent Systems Journal 21(1) (2006)
5. Corby, O., Faron-Zucker, C., Mirbel, I.: Implementation of intention-driven search processes by SPARQL queries. In: 11th International Conference on Enterprise Information Systems (ICEIS), Milan, Italy (2009)

6. Dieng, R., Corby, O., Gandon, F., Giboin, A., Golebiowska, J., Matta, N., Ribière, M.: Knowledge management: Méthodes et outils pour la gestion des connaissances, dunod (2005)
7. Edelweiss Team of INRIA Sophia-Antipolis, CORESE: COnceptual REsource Search Engine (2009), http://www-sop.inria.fr/edelweiss/software/corese/
8. Gomez, J.M., Rico, M., Garcia-Sanchez, F.: GODO: Goal Oriented Discovery for Semantic Web Services. In: Cruz, I., Decker, S., Allemang, D., Preist, C., Schwabe, D., Mika, P., Uschold, M., Aroyo, L.M. (eds.) ISWC 2006. LNCS, vol. 4273. Springer, Heidelberg (2006)
9. Guzelian, G.: Modelisation et specification de composants réutilisables pour la conception de systèmes d'information. PhD thesis, Université Aix Marseille (2007)
10. Kaabi, R.S.: Une approche méthodologique pour la modélisation intentionnelle de services et leur opérationnalisation. PhD Thesis, Université Paris I Sorbonne (February 2007)
11. Li, L., Horrocks, I.: A Software Framework for Matchmaking Based on Semantic Web Technology. International Journal of Electronic Commerce 8(4), 39–60 (2004)
12. Martin, D., Burnstein, M., McDermott, D., McIlraith, S., Paolucci, M., Sycara, K., McGuinness, D.L., Sirin, E., Srinivasan, N.: Bringing Semantics to Web Services with OWL-S. World Wide Web 10, 243–277 (2007)
13. Nurcan, S., Edme, M.H.: Intention-driven modeling for flexible workflow applications. Journal of Software Process: Improvement and Practice 10(4) (2005)
14. OWL-S Coalition, OWL-S Specification, http://www.ai.sri.com/daml/services/owl-s/1.2
15. Paolucci, M., Kawamura, T., Payne, T.R., Sycara, K.: Semantic Matching of Web Services Capabilities. In: Horrocks, I., Hendler, J. (eds.) ISWC 2002. LNCS, vol. 2342, p. 333. Springer, Heidelberg (2002)
16. Prat, N.: Goal formalization and classification for requirements engineering. In: Third International Workshop on Requirements Engineering: Foundations of Software Quality (REFSQ), Barcelona, Spain (1997)
17. Prat, N.: Réutilisation de la trace par apprentissage dans un environnement pour l'ingénierie des processus. PhdThesis, Université Paris I - Sorbonne (1999)
18. Ralyt, J.: Ingénierie des méthodes à base de composants. PhD thesis, Université Paris I - Sorbonne (2001)
19. W3C, RDF: Resource Description Framework (2009), http://www.w3.org/RDF/
20. W3C, RDF Vocabulary Description Language 1.0: RDF Schema (2004), http://www.w3.org/TR/rdf-schema/
21. Rolland, C.: Conceptual Modelling in Information Systems Engineering. Springer, Heidelberg (2007)
22. W3C, SPARQL Query Language for RDF, W3C Recommendation (2008), http://www.w3.org/TR/rdf-sparql-query/
23. Stollberg, M., Norton, B.: A Refined Goal Model for Semantic Web Services. In: Second International Conference on Internet and Web Applications and Services, ICIW 2007 (2007)
24. Vukovic, M., Robinson, P.: GoalMorph: Partial Goal Satisfaction for Flexible Service Composition. In: International Conference on Next Generation Web Services Practices (2005)
25. Zhang, K., Li, Q., Sui, Q.: A Goal-driven Approach of Service Composition for Pervasive Computing. In: 1st International Symposium on Pervasive Computing and Applications, August 2006, pp. 593–598 (2006)

Lean Manufacturing in Public Services: Prospects for Value Creation

Ayham Jaaron and Chris Backhouse

Wolfson School of Mechanical and Manufacturing Engineering,
Loughborough University, Leicestershire, LE11 3TU, UK
{A.A.M.Jaaron,C.J.Backhouse}@lboro.ac.uk
http://www.lboro.ac.uk

Abstract. The purpose of this paper is to investigate the utilization of lean manufacturing systems in public service operations for potential added value. A case study of lean manufacturing implementation at a UK city council was carried out using in-depth interviews with key personnel coupled with documents collection. The Organizational Commitment Questionnaire (OCQ) was administered among front-line employees. Results show that lean manufacturing systems could create significant added value to the business and employees. A strong relationship was demonstrated between the lean manufacturing implementation and the affective commitment level of employees. This paper is one of a few studies that demonstrate the applicability of manufacturing systems in other settings and that they can generate significant added value for the service department and its employees.

Keywords: Public services, Lean manufacturing, Affective commitment, Service delivery.

1 Introduction

Managers in many organizations are often constrained to ineffective courses of action in call centre projects which fail to achieve a satisfactory level of service quality [1]. In many occasions, the ineffective call centres project implementation and management is a result of the inappropriate use of Key Performance Indicators (KPIs). This is due to the excessive focus on statistics to satisfy targets [2]. This causes the system to hide many repetitive tasks and procedures that are considered as waste. The waste present in the service system makes the service process sluggish and time consuming which in turns harms the customer service level and dissipates monetary resources. Furthermore, studies on call centre management practices and environment have revealed that there is a tendency to focus on efficiency (volume of calls handled) rather than effectiveness (service quality and customer orientation) [3]. In other words there is a focus on quantity rather than quality [4] [5]. This focus on quantity explains such issues as inflexibility, sluggish response procedures, stifling of employees human qualities, and increased stress on employees [6].

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 45–57, 2010.

However, service departments have to achieve targets if the parent organization is to maintain their support [2]. Due to the current economical pressures, public services must include a demonstration for Value For Money (VFM) for the operations and services they run. This is a challenge for managers with the need that substantial cashable efficiency savings will be required, ideally without impacting upon service performance. This resulted in a quest for ways to achieve savings through the application of transformational reviews of systems and managerial regimes.

Nowadays, lean manufacturing systems are widely used in many manufacturing industries around the globe, they have also witnessed acceptance from service industries [7] as a possible strategy to face increasing customer expectations and intensive economical pressures for reduced costs. Several studies have emerged in this regard to investigate the lean manufacturing approach use in service departments. For instance, Levitt [8] argued that service departments could achieve significant benefits from adopting the principles of lean manufacturing. Similarly, Bowen and Youngdahl [9] made the case, on the basis of Levitt [8] work, that service departments must continue their endeavour to adopt manufacturing production models. They argued that the lean manufacturing approach to services has reduced non-value added from service processes while acheiving customer focus. However, these studies, like many others, have failed to link this adoption of lean manufacturing with the effects on employees affective commitment and their role in creating a high quality service.

This paper aims to explain the gradual shift in management thinking in public sector service departments towards adopting manufacturing models as a substitute for traditional functional specialization. It investigates the impact of the lean manufacturing systems on the added value to the public services departments in terms of employees' affective commitment leveraging. In the following sections, the concepts of lean manufacturing are presented, the concept of affective commitment and both its prerequisites and significance on service quality are then discussed. This is followed by a description of the case study organization and data collection procedures. Finally, results are presented and conclusions discussed.

2 Lean Manufacturing and Service Operations

Lean manufacturing principles were introduced for the first time in Toyota Production System (TPS) as a comprehensive strategy for the elimination of waste from work operations [10]. The elimination of waste is achieved through the creation of value stream mapping of operations that deliver solutions and products in minimal time [11] [12]. Arguably, Sugimori et al. [13] was the first to discuss the TPS in the academia [14], they have introduced the two basic concepts that Toyota has recognised as the guiding principles for its new methodology. The first was the attaining of low cost production through waste elimination. The second is the utilisation of their workers capabilities to the utmost by treating them as human beings. In Sugimori et al.'s [13] own words: It (i.e. Toyota) has built up a system of respect for human. This respect was due to the companys belief that respecting human abilities and capabilities is where the competitive success lies. Workers were allowed to make decisions they found necessary for the work, such as stopping the line when a problem happens, make work changes, and make any improvement initiative to remove any waste found in the system. Lean manufacturing is also defined as the ability of the organization to do more work with less resources [11], thus reducing overall costs. It embraces a number of strategies that comprise the whole leanness philosophy, these are JIT (whereby products and parts are only produced when a customer demand is received), workers empowerment, zero inventory, team working, continuous improvement, value streams and quick system set-ups [15].

However, a gap seems to be present in service organizations between the management focus and that of front-line. While the premium interest of management in service organizations, similar to other types of organizations, is the cost, the one used at the customer interface level is of service quality and customer satisfaction [12]. To cover this gap of interest the management has to understand that as the service level increases the operating costs decrease. If the customer receives what he wants from the organization from the first contact created, then the customer is receiving a quality service with least-cost incurred by the organization, since the customer does not need to call again to get what he wants.

Service departments are typically exposed to a greater demand variety from the customer than are manufacturing departments [16]. In order for the service organization to absorb demand variety it needs an adaptive mechanism similar to that of a living organism that can adapt to the surrounding environment in order to function and thrive. Such an organic structure is typified by devolved decision making processes [17]. The characteristics of this approach are that jobs are wide in scope and employees are allowed to act on a variety of tasks, to learn and to build relationships with customers [18]. These tasks are not governed by rigid rules and procedures; the team shares the responsibility of the work. Hierarchy of control is not usually present thus allowing the team to identify the right person to solve a particular problem. Help desks, for example, are typically mechanistic structure units by the managerial systems they use. However they are outward-facing entities exposed to the ever-changing environment. The emphasis that mechanistic structures must be shielded from the environment strongly indicates that help desks must be given an organic face [6].

3 Affective Commitment Significance

Organizational commitment has emerged as a platform for the identification of the relationship between organizations and their individuals [19]. Mathieu and Zajac [20] have found that the concept of organizational commitment has taken two dimensions in empirical studies, some have described it as a consequence when linking it with work environment, role states and organizational structures, others have described it as an antecedent when linking it with turnover, absenteeism and personal behaviour. In the review of literature, organizational commitment has been defined as the employee's psychological attachment to the organization [21] [22]. Allen and Meyer [23] argued that organizational commitment has three different components. First, affective commitment where the person strongly identifies with the goals of the organization and desires to remain a part of it because he wants to do so. Second, continuance commitment where the employee commits to an organization because of the high cost associated with leaving the organization. Third, normative commitment where the employee attaches himself to and remains a part of an organization that has invested resources in training or educating him.

Several studies have demonstrated that organizational commitment, job satisfaction and quality of service are interrelated [24] [25]. Affective commitment was found to be more effective than the other two components in influencing the service quality of customer-contact employees. The impact of affective commitment on service quality can be explained by understanding its antecedents [26] [27]. The antecedents encompass that if the organization provided the chance for its employees to fulfil their personal ambitions; desire of achievement, autonomy, and a sense of control on what the employees have, then employees are more likely to develop affective commitment with their employer. Affective commitment is also related to the employer ability to decentralize decisions making processes to be at the employees level, this gives employees a feeling of personal importance and value in the organization. Employees whose working experiences are rewarding and fulfill their own aspirations are more likely to develop affective commitment, and are ready to exert more effort on behalf of the organization to deliver high levels of service quality than those whose working experiences were less rewarding [28]. However, managerial practices and organizational structures conventionally implemented in call centres across the service industry can inhibit the development of a rewarding job experience for employees. This is due to standardised work procedures, monitored dialogue [29] [30], mechanisation of customer-employee contact and an emphasis on quantity statistics and targets over the quality of interaction [5] [31]. As a result employees possess reduced levels of affective commitment in such environment.

Ellis and Taylor [30] found that despite strident calls for new forms of organizational structures and management styles, managerial practices and organizational structures commonly implemented in call centres inhibit the development of a rewarding job experience for employees.The consequence is high employee turnover, low service quality and ultimately low customer satisfaction. However, it is argued in this paper that the concepts of lean manufacturing of respecting human capabilities and abilities, discussed earlier, play a major role in leveraging affective commitment of front-line employees. lean manufacturing this way provides employees with a sense of control on what they have, and gives them a feeling of personal importance and value in the organization. Due to these reasons employees working under the lean manufacturing principles are more likely to develop affective commitment with their organization [26].

In fact, affective commitment has a direct impact on organisational efforts for financial savings. This is due to the direct and indirect cost of employees turnover if they lack a sufficient level of affective commitment. Direct costs (i.e. quantifiable) include advertising and recruiting cost, interviewing cost, orientation or training cost, and employment application processing cost. While indirect costs (i.e. unquantifiable) include reduced quality assurance, increased sick time and decreased morale that is perceived as of invaluable effect on call centre environment and customer retention [32]. Furthermore, a highly affectively committed employee does exceptional job of delivering a quality service that retains customers [22] [28]. The longer the customer stays with the company, the more the profits gained would be. Customers who stay with the company for longer become accustomed to use the service more and thus profits increase [33].

4 Case Study

An independent case study was carried out in the Information and Communication Technologies (ICT) department of Stockport Council in England. The ICT Department has a help desk that supports more than 6000 customers across the council departments and related directorates for their hardware and software needs and IT problem solving. The help desk has a total of 18 employees working on phones and emails. There were two team leaders in the ICT help desk responsible for day to day operations of the work. In general, the work of the employees is very similar to call centre environment where customers call seeking information on how to solve IT problems or for technical support. The purpose of the help desk from customer perspective was to provide customer with IT support and systems he needs and will need to do his job effectively. In contrast, the purpose of the original system (before transformation) from employees perspective-derived from the management practices- is to do my task and meet the set targets. This mismatch of perceived purpose was identified as resulting in a sub-optimum solution.

It was recognized that Stockport Councils aspirations for moving from excellent to exceptional require a continuation in the improvement of both performance and the use of resources. Further, the governments expectations include local authorities identifying 3% cash releasing efficiency gains each year and demonstrating and embedding VFM in a more explicit manner. Therefore, it was likely that some form of step change will be necessary to meet in full the challenges that lie ahead. In response to the need for improvement initiatives the ICT department was a part of a strategic approach to achieving the improvements and efficiencies necessary to enable the council to demonstrate VFM in the delivery of its priority outcomes, through the transformation of business and service delivery processes and methods. The transformation programme followed lean manufacturing principles and covered all functions of the ICT department. The transformation programme progressed in three stages:

Stage 1: (Check) This stage started with demand analysis. A check team was recruited to perform this crucial stage of the programme. The check team collated information about what customers expect and want from the ICT help desk and what matters to them most. Data collated in this process enabled identification of the major demands coming into the area. A visual representation of each operation carried out in the help desk was developed as a flow chart. Identification of waste (actions not adding any value from the customers point of view) was then carried out. All processes classified as waste were marked in red on the process flow chart, and processes that add value from the customer point of view were marked in green.

Stage 2: (Redesign) The team redesigned the processes flow taking what have been learned in the check phase considering the customer wants and then mapping out the service of the future. The new design focused on minimizing non-value adding activities from a customer point of view. However, it was recognized that complete elimination of non-value adding activities from a customer point of view was never going to be possible. The new processes were tested, re-designed and re-tested again to make sure that customers get the best possible service before going live in the help desk.

Stage 3: (Roll-In) This stage covered implementation of the new model within the ICT help desk by a gradual rolling in of employees. As the check team progressed and the discussion was held about the roll-in of staff to this new way of working, it was key to continue the identification of appropriate training. To ensure sustainability of the new system design a comprehensive staff training needs were identified as they arose in the help desk.

The data was primarily collected through in-depth interviews and questionnaires conducted within the premises of Stockport Council, followed by documents gathering. 16 interviews in total were conducted in research site, 11 were front-line employees from the help desk, three middle managers from the ICT department and two senior managers one is holding the services director position and the other is the head of transformation. Thematic analysis [34] methods were employed to identify the main themes constituting the interviewee replies. This process consisted of a set of steps that allowed the generation of central themes. First, the research objectives along with the interview transcripts of this study were revised in order to identify general theoretical topics that could help generate a coding framework for the interview transcripts. A coding framework is a set of words or topics that are carefully selected to represent a general meaning of what has been said in the interviews segments [35]. Second, the interview transcripts were carefully revised again with the aim of dividing the text into meaningful parts to reduce the data. Every part was then given a code that belongs to a pre-defined criteria (i.e. specific word or topic). Third, after a signing a code for each text in the interviews, another revision was carried out to find codes with common themes. This way allowed for clustering text segments around specific themes that was used later for interpretations.

The 15-items Organizational Commitment Questionnaire (OCQ) was introduced by Porter et al. [36] to measure affective commitment, this was further shortened to a nine-items version. The shortened nine-items version was found to be more superior than the full 15-items version and more effective for measuring affective commitment [19]. Hence, the nine-items OCQ was administered in this study. It used an interval five options likert-type scale with the following anchors (strongly disagree, disagree, undecided, agree, and strongly agree). Documents were also collected through the head of transformation and services director. These comprised mainly reports about the nature of the project, progressed achieved and the project management plans.

5 Case Study Findings

The in-depth interviews conducted were focused on exploring employees working conditions under the new system and the impact that lean manufacturing has on service operations and managerial roles, the thematic analysis of the interviews generated the following central themes:

Theme 1- working experience: Employees indicated that they now enjoy wider scope of demand and authority to make decisions on phones. The team share responsibility of the work and informal channels of communication is encouraged to allow for a quicker transfer of knowledge between members. Employees now get correct information from customers that could deliver a better service without the need for repeating phone calls. Customers get what they want with the elimination of transfer from pillar to post. One employee is now dealing with the demand in a very efficient way with more time to speak to customer. Employees indicated that 85% of incoming phone calls are now dealt one stop. The management focus shifted from targets and statistics towards percentage of one stop calls and demand analysis. No phone calls recording was required and no pre-specified call durations were used. In addition, no scripts were used for employees to follow when talking to customers.

Theme 2- performance measurement: Employees are measured and evaluated on the basis of sticking to working principles of meeting customer demand. Team leaders log into the system to track each employee profile on daily basis to see the frequency of phone calls that have been met one stop, each employee is expected to handle at least 5 calls every day and complete them one stop. Employees commented that it is now possible to complete phone calls one stop due to the authority they have to make decisions and deliver the optimal solution required. In addition, The correct information collected from customers allowed for the precise identification of problems and thus a satisfactory solution to be provided.

Theme 3- departmental Integration value: Interviewees recognised communication between departments as important. However, they indicated that the functional specialization model created a silo between sections and departments as every department was viewed as a separate entity that should not interfere with the work of other departments, one manager stated we thought functional specialization was an efficient way to do the work but it was not...the system was frustrating and did not allow for open doors policy. Interviewees claimed that they have witnessed huge improvements in communication, formal and informal meetings at managers and departmental level. As a result, front-line employees were provided with quick feedback and support channels from other business units when needed to serve customers.

Theme 4- operational value: All managers regarded the following contributions as important tools to prove lean manufacturing principles value in public service departments: cutting down the waste in the service system that makes the service process sluggish and time consuming. Saving resources/money without cut in service. 85% of calls are done one stop by one employee for each call. lean manufacturing principles is the only model that works with the Human side to change the nature of work. Reduction in repeated calls and thus improved productivity and handling capacity. Systems clarity and transparency due to continuous demand analysis. Focus on customer services rather than maintaining the system.

Measuring Affective Commitment: The data collected from the nine-item OCQ questionnaire was analysed to examine how affectively committed the help desk employees were. Responses were sought from statements such as I talk up this council to my friends as a great organizations to work for and this council really inspires the best in me in the way of job performance. A total of 18 employees working at the help desk were available at the time of the questionnaire, all employees responded targeting a 100% response rate. Responses to the nine-items are averaged to obtain a single score for each item; the standard deviation for each item was also calculated see Table 1. An overall mean for the nine items of 3.77 was achieved. This provided a clear indication of fairly high affective commitment level among employees in the Help Desk, where a return of 3.0 would indicate a neutral level of affective commitment and where values of 3.5 are typical in many organisations. A summary of the results is shown in Fig 1.

6 Analysis and Discussion

The traditional help desk environment represents the latest form of Taylorist principle as it is a common trend in help desks globally to practice high levels of monitoring over their employees [37]. However, the results of interviews conducted with front-line employees at the help desk have shown that the implementation of lean manufacturing principles has delivered numerous improvements. Employees under the new system are no longer restricted to repetitive job handling procedures or target achieving dilemma, they are empowered to do the job in the best way they see is vital to satisfy customer needs. Hence, employees have opportunities to develop their working skills by handling a wide range of challenging demands on daily basis. Their performance is evaluated on their ability to help the customer solve his problem from the first interaction without the need for the customer to call again. Further, employees operate as a team that shares the work responsibility; an employee can seek support from a more skilled colleague to solve a customer problem while on phone. Obviously, employees working in this environment have a feeling of belonging and ownership of the workplace, they have the freedom to make decisions to provide a high

Table 1. Mean and Standard Deviation for Affective Commitment Questionnaire

Item	**No.**	**Min.**	**Max.**	**Mean**	**Std. deviation**
Q1: I am willing to put great deal of effort beyond that normally expected to this company be successful.	18	3.00	5.00	4.0588	.8726
Q2: I talk up this company to my friends as a great organization to work for.	18	2.00	5.00	3.8125	1.0740
Q3: I would accept almost any type of job assignment in order to keep working for this company.	18	1.00	4.00	2.9375	1.0289
Q4: I find that my values and this company's Values are very similar.	18	2.00	5.00	3.8125	1.0178
Q5: I am proud to tell others that I am part of this company.	18	2.00	5.00	3.8750	1.1143
Q6: This company really inspires the best in me in the way of job Performance.	18	1.00	4.00	3.6250	1.0416
Q7: I am extremely glad I chose this company to work for over others I was considering at the time I joined.	18	2.00	5.00	4.0000	1.0226
Q8: I really care about the fate of this company.	18	3.00	5.00	4.2500	0.7859
Q9: For me, this is the best of all companies for which to work	18	2.00	5.00	3.5625	1.0431
Overall mean				**3.77**	
Internal Reliability (coefficient α)				**0.94**	

quality service at relatively shorter time, and they enjoy the open channels of communication between themselves as well as other departments. When linking these job characteristics and environment offerings for employees with the antecedents of affective commitment discussed earlier, an expectation of high affective commitment level among employees can be concluded. The 9-item OCQ provided a value of 3.77 for the affective commitment level among employees that indeed proved the value-added to front-line employees life in the help desk in terms of work experience and personal achievements. The results achieved from interviews have indicated that lean manufacturing principles has provided clarity on the system due to the continuous demand analysis performed, this helped managers to identify potential problems in the services offered and thus the immediate corrective measures to be taken. Lean manufacturing principles

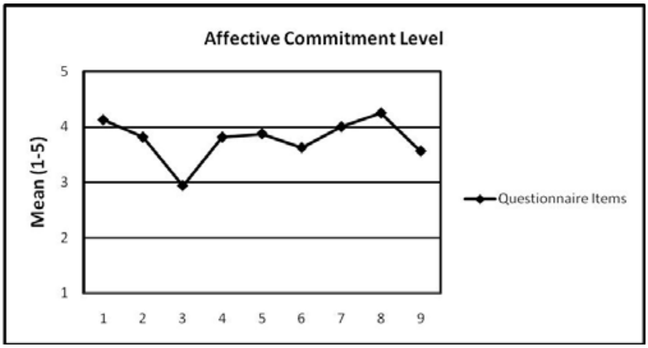

Fig. 1. Affective commitment of help desk staff

were found to eliminate the waste in operations that helped managers to achieve automatic productivity and capacity improvements. Customers do not need to call again which allowed employees to handle more demands in an efficient way without cut in service, and eventually reduce resources consumption and overall costs. Further, the creation of a committed front-line employees in the help desk has significantly resulted in reducing the burden of managing people behaviour in the help desk as the general moral system of the workplace controls the human resources behaviour and not the traditional top-down hierarchy. Apparently, the affective commitment of employees accompanied with system waste elimination created a difference for the customer experience and added-value to the service encounter, no unproductive processes are used anymore and employees are willing to exert more effort on behalf of their organization to deliver excellent service.

Employees can provide a fast service even though the customers may be misunderstood and their information incorrectly entered [38]. Thus, business resources can be lost due to poor service delivery. Interviews with managers have identified that lean manufacturing principles have provided workplace with a relaxed environment without the need to stick to a pre-specified time allowance, this inevitably helped improve solution delivery processes, prevented calls repetition, and eventually allowed for resources savings. Another significant dimension of interest is the departmental integration. Open channels of communication between the ICT help desk and other departments affected by its work were established. Formal and informal communication at managers level allowed for significant information sharing. Further, lean manufacturing principles made it possible for management to identify the opportunities for making cost savings and performance improvements in the short and medium term, both from a corporate and service perspective. The waste elimination element of the system was viewed as a resources saving activity that used to be a major cause for capacity reduction. In addition, lean manufacturing allowed the ICT help desk to do more with less, fewer people are required to do more job, an opportunity has aroused to remove some agency workers and save money.

7 Conclusion

The fundamental objective of this research has been to investigate the impact of lean manufacturing principles utilization in public sector service departments for potential added value to employees' workplace. In this context, lean manufacturing principles is based on designing service operation systems around customer demand instead of in functional hierarchies. Managers in public services are realizing the need to employ more innovative interventions to achieve financial savings and better performance. As a result a shift has been noticed recently in management thinking in public services to adopt systems engineering models utilized in manufacturing sector. This has occurred due to the economical and governmental pressures exerted on councils and public services to generate substantial cost reductions and efficiency savings.

The evidence from this research indicates that the utilization of lean manufacturing systems in the public service departments has a strong relationship with the level of affective commitment among front-line employees. It is concluded that the ability of front-line employees to control the work and be involved in decision making processes is a key factor for adding value to service departments and their employees.

References

1. McElhinney, D.: Concept of Entrapment and Decision-Making. Management Decision 43(2), 189–202 (2005)
2. Jaaron, A., Backhouse, C.: Affective Commitment Stimulation Through Systems Thinking. In: QUIS 11: Moving Forward with Service Quality International conference. Ingolstadt School of Management, Catholic University Eichstaett-Ingolstadt, Wolfsburg, Germany, pp. 291–299 (2009)
3. Dean, A.M.: Service Quality in Call Centres: Implications for Customer Loyalty. Managing Service Quality 12(6), 414–423 (2002)
4. Bain, P., Watson, A., Mulvey, G., Taylor, P., Gall, G.: Taylorism, Targets and the Pursuit of Quantity and Quality by Call Centre Management. New Technology, Work and Employment 17(3), 170–185 (2002)
5. Mahesh, V.S.: Improving Call Centre Agent Performance: A UK-India Study Based on the Agent Point of View. International Journal of Service Industry Management 17(2), 136–157 (2006)
6. Jaaron, A., Backhouse, C.: Systems Thinking for Call Centre Service design: Affective Commitment Implications in Manufacturing Enterprises. Working Paper, European Association for Research on Services (RESER) Publications (2009)
7. Robertson, M.: Application of Lean Production and Agile Manufacturing Concepts in A Telecommunications Environment. International Journal of Agile Management Systems 1(1), 14–17 (1999)
8. Levitt, T.: The Industrialisation of Service. Harvard Business Review 54(5), 32–43 (1976)
9. Bowen, D.E., Youngdahl, W.E.: "Lean" Service: in Defense of a Production-Line Approach. International Journal of Service Industry Management 9(3), 207–225 (1998)

10. Ohno, T.: Toyota Production System: Beyond Large-Scale Production. Porductivity Press, New York (1988)
11. Christopher, M.: Supply Chain Migration from Lean and Functional to Agile and Customised. Supply Chain Management: An International Journal 5(4), 206–213 (2000)
12. Busi, M.: Seeing the Value in Customer Service. White Paper, The centre for Business Process Outsourcing. University of Strathclyde, Glasgow (2005)
13. Sugimori, Y., Kusunoki, K., Cho, F., Uchikawa, S.: Toyota Production System and Kanban System Materialization of Just-In-Time and Respect-For-Human System. International Journal of Production Research 15(6), 553–564 (1977)
14. Wan, H., Chen, F.F.: A Leanness Measure of Manufacturing Systems for Quantifying Impacts of Lean Initiatives. International Journal of Production Research 46(23), 6567–6584 (2008)
15. Forrester, R.: Implications of Lean Manufacturing for Human Resource Strategy. Work Study 44(3), 20–24 (1995)
16. Seddon, J.: Freedom from Command and Control: A Better Way to Make the Work Work. Vanguard Education, Buckingham (2003)
17. Robey, D., Sales, C.A.: Designing Organization, 4th edn. McGraw-Hill/Irwin, USA (1994)
18. Seddon, J.: Freedom from Command and Control. Management Services. Enfield 49(2), 22–24 (2005)
19. Commeiras, N., Fournier, C.: Critical Evaluation of Porter et al.s Organizational Commitment Questionnaire: Implications for Researchers. The Journal of Personal Selling and Sales Management 21(3), 239–245 (2001)
20. Mathieu, J.E., Zajac, D.M.: A Review and Meta-Analysis of the Antecedents, Correlates, and Consequences of Organizational Commitment. Psychological Bulletin 108(2), 171–194 (1990)
21. Mowday, R.T., Steers, R.M., Porter, L.W.: The Measurement of Organizational Commitment. Journal of Vocational Behavior 14(2), 224–247 (1979)
22. Meyer, J.P., Allen, N.J.: A Three-Component Conceptualization of Organizational Commitment. Human Resources Management Review 1(1), 61–89 (1991)
23. Allen, N.J., Meyer, J.P.: The Measurement and Antecedents of Affective, Continuance and Normative Commitment to the Organization. Journal of Occupational Psychology 63(1), 1–18 (1990)
24. De Ruyter, K.: Commitment in Auditor-Client Relationships: Antecedents and Consequences. Accounting, Organizations and Society 24(1), 57–75 (1999)
25. Malhotra, N., Mukherjee, A.: The Relative Influence of Organizational Commitment and Job Satisfaction on Service Quality of Customer-Contact Employees in Banking Call Centres. Journal of Services Marketing 18(3), 162–174 (2004)
26. Mowday, R.T., Porter, L.W., Steers, R.M.: Employee-Organization Linkages: The Psychology of Commitment, Absenteeism, and Turnover. Academic Press, New York (1982)
27. Van Emmrik, Hetty, I.J., Sanders, K.: Mismatch in Working Hours and Affective Commitment: Differential Relationships for Distinct Employee Groups. Journal of Managerial Psychology 20(8), 712–726 (2005)
28. Mayer, J.P., Allen, N.J., Smith, C.A.: Commitment to Organizations and Occupations: Extension and Test of A Three- Component Conceptualization. Journal of Applied Psychology 78(4), 538–551 (1993)
29. Taylor, P., Mulvey, G., Hyman, J., Bain, P.: Work Organization, Control and the Experience of Work in Call Centres. Work, Employment and Society 16(1), 133–150 (2002)

30. Ellis, V., Taylor, P.: You Don't Know What You've Got Till it's Gone: Re-Contextualising the Origins, Development and Impact of the Call Centre. New Technology, Work and Employment 21(2), 107–122 (2006)
31. Varca, P.: Telephone Surveillance in Call Centres: Prescriptions for Reducing Strain. Managing Service Quality 16(3), 290–305 (2006)
32. Krenzelok, E.P., Dean, B.S.: The Cost of Employee Turnover to a Regional Poison Information Centre. Veterinary and Human Toxicology 36(1), 60–61 (1994)
33. Reichheld, F.F., Sasser, W.E.: Zero Defection: Quality Comes to Services. Harvard Business Review 68(5), 105–111 (1990)
34. Taylor, S.J., Bogdan, R.: Introduction to Qualitative Research Methods: The Search for Meanings. John Wiley and Sons, New York (1984)
35. Attride-Stirling, J.: Thematic Networks: An Analytic Tool for Qualitative Research. Qualitative Research 1(3), 385–405 (2001)
36. Porter, L.W., Steers, R.M., Boulian, P.V.: Organizational Commitment, Job-Satisfaction, and Turnover Among Psychiatric Technicians. Journal of Applied Psychology 59(5), 603–609 (1974)
37. Armistead, C., Kiely, J., Hole, L., Prescott, J.: An Exploration of Managerial Issues in Call Centres. Managing Service Quality 12(4), 246–256 (2002)
38. Cleveland, B.: Call Center Management On Fast Forward: Succeeding in Today's Dynamic Customer Contact Environment, 1st edn. ICMI Press, Annapolis (2006)

Determinants of Continuance Intention towards Self-service Innovation: A Case of Electronic Government Services

Shu-Lu Hsu[1], Huichich Wang[2], and Hersen Doong[1]

[1] Department of Management Information Systems, National Chiayi University, 580 Sinmin Rd., Chiayi 60054, Taiwan
slhsu@mail.ncyu.edu.tw, hsdoong@mail.ncyu.edu.tw
[2] Department of Information Management, National Chung Cheng University, 168 University Rd., Min-Hsiung, Chiayi 621, Taiwan
hcwang1@gmail.com

Abstract. Service science has attracted the attention of researchers from different disciplines and has become an increasing important issue. As service science was proposed to integrate people, management and technologies, the self-service innovation, such as electronic government (e-Government) services, have shown its unique implication in this field. To explore the determinants of continuance intention towards self-service innovation, this study utilizes psychological approaches, revealing how users' innovative style and involvement level may influence their continuance intentions towards innovative e-Government service. Based on psychological and marketing theories, this study proposed research propositions and provide useful insights for practical implications in terms of enhancing the execution performance via integrating the psychological approach into the pilot implementation strategy for self-service innovation.

Keywords: Service Sciences, Self-Service, Continuance intention.

1 Introduction

Service science is an emerging discipline that integrates the ongoing issues in different fields such as computer science, operations research, business strategy, management, and cognitive in the effort to develop the techniques requested for a service-dominated economy [27, 30]. Its multidisciplinary nature makes it extremely difficult to define what this discipline should look like [19]. A conceptual framework for service science building on market exchange processes is thus essential [23]. By revealing how people interact, innovate, evolve and learn the service systems, the service science has drawn upon and brought together the wisdom of marketing science in a way that is challenging and potentially transforming information communication technologies deliberation and practice.

The explosive expansion of self-service applications and Web-based services, for example, e-Government services, is a good instance showing such service innovations

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 58–64, 2010.

demands the presence of a user participating in the service manufacturing and delivery process [30]. As citizens and business are considered as the co-producers and participants in these processes, the government must have a profound understanding of their actual needs so as to (1) understand the value of creating a collaborative process between government and citizens/business and (2) bridge the front stage and back stage in innovative service design and implementation.

Indeed, e-Government innovation service was regarded to have transformed governments' capability to serve their citizens and businesses [4]. This phenomenon has been defined in a variety of ways. Means and Schneider [24] focused on the interrelationship and defined e-Government as "the relationships between governments, their customers (businesses, other governments, and citizens), and their suppliers by the use of electronic means". Brown and Brudney [8] highlighted the efficiency aspect and defined e-Government as the use of technology, especially Web-based applications, to enhance access to and efficiently deliver government information and services. These definitions were consistent to Spohrer et al.'s [34] proposition which asserted that the service system is a "value-coproduction configuration of people, technology, other internal and external service systems, and shared information". From the government perspective, e-Government is believed to be a cost-efficient channel that can enhance efficiency, improve effectiveness and reduce bureaucracy in government affairs [29]. Further, it will improve citizens/business interaction with government by empowering them to deal with government online at anytime while saving the hours spent in the paperwork, traveling to a government office, and waiting in line [31]. As such, building a successful e-Government has become a priority for governors' major administrative plans worldwide.

This study was designed to provide a psychological view that differs from existing self-service studies, which have mainly used perceptual approaches (e.g. perceived usefulness and perceived ease of use). It aims to reveal how self-service users' innovative style and involvement level may influence their continuance intentions towards innovative self service, i.e. e-Government service. Findings will help governors and researchers in designing practical e-Government implementation strategies.

2 Literature Review

Building e-Government (electronic government) has become an important global trend nowadays. American Society for Public Administration [1] defined e-Government as utilizing the Internet and the World-Wide-Web for delivering government information and services to business and citizens. Seeing the Internet as a cost-efficient channel for delivering self-services to the citizens [29], many governments in both developed and developing countries have committed billions of dollars to various e-Government initiatives. From the government perspective, e-Government is believed to be a cost-efficient channel that can enhance efficiency, improve effectiveness and reduce bureaucracy in government affairs [29]. Further, it will improve business/citizen interaction with government by empowering them to deal with government online at anytime while saving the hours spent in the paperwork, traveling to a government office, and waiting in line [31]. As such, building a successful e-Government self-service has become a priority for governors' major administrative plans worldwide. In fact, Gartner Group [16] has reported that government spending on the Internet and related network technologies had gone up to US$ 6.2 billion by 2005 from US$1.5 billion in 1999. However, despite all the hype revolving around e-Government, it has been argued that its promised benefits may continue to be an elusive dream in many cases.

Studies conducted in various countries, such as Switzerland [5], Canada [11], Australia [2] and the Netherlands [7], have reported that governmental agencies still face a high volume of contacts via traditional service channels, i.e. telephone and face-to-face. In other words, citizens apparently do not perceive the e-Government to be more convenient or useful than traditional channels. They thus prefer to request services either in person or via the telephone.

Such findings may reflect the fact that e-Government development has mainly been explored from a supply-side perspective, whilst the demand side, i.e. from the user's perspective, remains relatively unexplored [31]. Most existing e-Government literature is also being argued to be too theoretical in nature [10]. As service science is proposed to integrate people, management and technology, lacking the knowledge about how user will respond to an innovative self-service means losing the connection to one core component.

Having such a deficiency of knowledge, it is understandable that many countries have experienced difficulty in attaining any significant degree of success in their e-Government implementation because they do not understand users and their behaviors in the cyberspace. To resolve this problem, governments should recognize that even the best e-Government infrastructure cannot guarantee widespread adoption and usage; any e-Government initiative must therefore include the promotion of innovative services in its implementation. After all, the expected gains in efficiency, effectiveness or productivity of the e-Government technology cannot be realized if individual users do not accept these innovative services to fulfill their task needs in the first place [6].

2.1 Innovativeness

Innovativeness is "consumption of newness," a tendency to buy new products more often and more quickly than other people within the same market [25]. Individuals that are most likely to buy a new product after it is introduced into the marketplace are innovators [33] or market initiators [12]. In the adaption-innovation theory, Kirton [21] proposed that individuals characteristically exhibit one of two distinct cognitive styles of problem solving and decision-making: innovators or adaptors. Whilst extreme "innovators" tend to redefine and reconstitute both the problem and the context of its origin, extreme "adaptors" confine their problem-solving actions only within the frame of reference in which the problem is perceived to have arisen. Cognitive style is closely related to personality, whether it is conceptualized principally in terms of an underlying intrapersonal determinant of behavior or in terms of the regularity and consistency of behavior itself [13]. Clark and Goldsmith [9] asserted that determining the personality characteristics that influence innovators to purchase a new product early in the product life cycle is essential for the success of innovations.

Identifying innovators in service science fields is important because first, they are an important sales source for any business, as they use the product more frequently than other customers do [18]. Second, innovators are good sources of information regarding crucial insights into how customers view the new product, its positioning, features and other key marketing aspects [17]. Third, they are often heavily involved in the product field. That is, innovators find products, such as innovative self-services, that mean something special or important to them. Thus, if innovators like innovative self-services, they are more likely to spread favorable word-of-mouth about it, making it known to other users who are less involved with the innovative self-service. Less-involved citizens, while they may be less interested in innovative self-services, may seek the opinions of the innovators before they make a decision as to whether to adopt to innovative self-services or not. As such, understanding users' innovativeness level is essential to the successful implementation of innovative self-services.

2.2 Involvement

Involvement has played a significant role in behavior theories [36] and its impact on customers' responses to advertising, products, purchase decisions, brands and even technology has been widely discussed [22]. Involvement is the interest an individual finds in a product class: that is, the individual's perception of whether the product class meets his/her important values or goals [26]. Individuals with higher product involvement are likely to seek more information about brands and products [3], use more criteria when making a purchase decision, and form attitudes toward the product which are more resistant to change [28].

Personal involvement has been widely used to explain customer behaviors in interacting with new services in the e-marketplace, such as how personal involvement positively influences customers' Website purchase frequency [35] and how they respond to avatars and sales agents [20]. To a great extent, the adoption of innovative self-services is a type of customer behavior: users act as customers and the innovative self-service is the product. As such, involvement may provide good explanations of users' perceptions and behaviors toward an innovative self-service.

3 Research Propositions

Foxall [12] argued that individuals' choice is shaped by their innovativeness level [21] and involvement level [37]. Upon the interaction of these two psychological constructs, customers' purchase decision making can be categorized into four different types: complex buying, dissonance buying, habitual buying and variety seeking [13]. To confirm this proposition, Foxall has designed and conducted a series of studies to reveal the diversity of customers' adaptive-innovative personalities and their subsequent purchase frequency of health food/financial products, or their frequency of use of information technologies. For example, Foxall and Bhate [15] reported that both innovative cognitive style and a high level of personal involvement with computing are significantly related to the number of home computer software packages used by individuals. In another study, Foxall and Bhate [14] indicated that compared to less-involved innovators (high innovativeness), more-involved adaptors (low innovativeness) have significantly higher overall computer usage, frequency of computer use and number of software packages used. Further, these factors were also reported to be significantly higher among more-involved innovators than among less-involved innovators.

Exploring customers' decisions to adopt Internet purchase methods with a sample of 1,044 members randomly selected from a top international branding Website, Wang et al. [35] revealed that customers' underlying differences in innovativeness levels and involvement levels were associated with significant differences in their Website purchase frequency: more-involved adaptors were found to have the highest purchase frequency, followed by more-involved innovators, less-involved innovators, and less-involved adaptors. Further, customers' underlying differences in innovativeness levels and involvement levels were also associated with significant differences in their decision-making processes: different predictors were found to explain each segment's Website loyalty behavior. Foxall's [13] proposal of how these four segments differ in terms of their problem-solving and decision-making processes according to their style/involvement was empirically verified.

Building on the discussions above, this study argues that: To serve citizens, the government will promote the advantages of innovative e-Government self-services to citizens so as to facilitate their awareness and interests in using these services. In the long run, the contents and promotion strategies of e-Government self-services may stimulate different levels of continuance intentions toward e-Government self-services, resulting from differences in users' underlying innovativeness levels and involvement levels. Based on the previous research discussed above, this study proposes that:

- Proposition 1: There are positive relationship between users' involvement level and their innovative e-Government self-service usage frequency.
- Proposition 2: There are positive relationship between users' innovativeness level and their innovative e-Government self-service usage frequency.
- Proposition 3: Less-involved adaptors, less-involved innovators, more involved adaptors, and more-involved innovators differ in their continuance intention toward innovative e-Government self-services. More-involved adaptors have the highest level of continuance frequency toward innovative e-Government self-service.

4 Research Contribution

This study aims to reveal that: (1) whether those who initiate innovative e-Government self-service use earlier, i.e. innovators, or those who have reported higher involvement in the innovative e-Government self-service show a higher continuance intention toward this service: that is, who are the true supporters of innovative e-Government self-services in the long run. (2) whether users' psychological traits of innovativeness and involvement significantly shape their decisions toward innovative e-Government self-service usage: that is, whether the four segments differ significantly in their continuance intention toward innovative self-services.

In sum, the theoretical contribution of this paper is two-fold. First, it verifies and advances past studies in term of the profiles of innovators [32], Foxall's [12] proposition of the relationship between individual's cognitive style/involvement and their behavior, and Wang et al.'s [35] empirical results in a new and different service science context. Second, it proposed research propositions to explore users' behavior with a robust theoretical basis. As such, it not only expands the discipline of service science from a psychological perspective, but also provides fruitful and practical issues for governors and researchers.

As regards the managerial implications, this study may contribute to the initial operation of new innovative self-services, which has long been regarded as a difficult task. By showing that some users are more likely to accept the new innovative self-services faster and use these services more frequently than others, this study's findings can be well integrated into and enhance the effectiveness of the pilot implementation strategy, which has been recognized as one of the most useful implementation strategies in the realm of innovative e-Government self-service.

References

1. American Society for Public Administration. Benchmarking E-government: A Global Perspective. UN/ASPA, New York (2002)
2. Australian Government: Australians' Use of and Satisfaction with E-government Services. Commonwealth of Australia, Barton (2005)
3. Beatty, S.E., Smith, S.M.: External Search Effort: An Investigation Across Several Product Categories. Journal of Consumer Research 14, 83–95 (1987)
4. Bekkers, V.: E-government and the Emergence of Virtual Organizations in the Public Sector. Information Polity 8, 89–101 (2003)
5. Berner Fachhochschule, Unisys: E-Government Trendbarometer. Thalwil, Unisys (Schweiz) AG (2005)
6. Bhattacherjee, A., Sanford, C.: Influence Processes for Information Technology Acceptance: An Elaboration Likelihood Model. MIS Quarterly 30, 805–825 (2006)
7. Bongers, F., Holland, C., Vermaas, K., Vandeberg, R.: Burgers Aan Bod. In: Elektronische Overheidsdienstverlening in Het Perspectief Van De Vraagzijde. Utrecht, Dialogic (2004)
8. Brown, M.M., Brudney, J.L.: Achieving Advanced Electronic Government Services: An Examination of Obstacles and Implications from An International Perspective. In: National Public Management Research Conference, Bloomington (2001)
9. Clark, R.A., Goldsmith, R.E.: Interpersonal Influence and Consumer Innovativeness. International Journal of Consumer Studies 30, 34–43 (2006)
10. Devadoss, P.R., Pan, S.L., Huang, J.C.: Structurational Analysis of E-government Initiatives: A Case Study of SCO. Decision Support Systems 34, 253–269 (2003)
11. Erin Research: The Institute for Citizen-Centred Service Citizens. First 3 Research, Canada (2003)
12. Foxall, G.R.: Science and Interpretation in Consumer Research: A Radical Behaviourist Perspective. European Journal of Marketing 5, 6–99 (1995)
13. Foxall, G.R.: Consumer decision making process, level and style. In: Baker, M.J. (ed.) The Marketing Book, 5th edn. Butterworth-Heinemann, UK (2003)
14. Foxall, G.R., Bhate, S.: Cognitive Style, Personal Involvement and Situation as Determinants of Computer Use. Technovation 11, 183–199 (1991)
15. Foxall, G.R., Bhate, S.: Cognitive Style and Use-innovativeness for Applications Software in Home Computing: Implications for New Product Strategy. Technovation 13, 311–325 (1993)
16. Gartner Group for E-Government Spending, http://gartner11.gartnerweb.com/public/static/aboutgg/pressrel/pr041100a.html

17. Goldsmith, R.E.: Explaining and Predicting Consumer Intention to Purchase Over the Internet: An Exploratory Study. Journal of Marketing Theory and Practice 10, 22–28 (2002)
18. Goldsmith, R.E., Flynn, L.R.: Identifying Innovators in Consumer Product Markets. European Journal of Marketing 26, 42–55 (1992)
19. Glushko, R.J.: Designing a Service Science Discipline with Discipline. IBM Systems Journal 47, 15–27 (2008)
20. Holzwarth, M., Janiszewski, C., Neumann, M.M.: The Influence of Avatars on Online Consumer Shopping Behavior. Journal of Marketing 70, 19–36 (2006)
21. Kirton, M.: Adaptors and Innovators: A Description and Measure. Journal of Applied Psychology 61, 622–629 (1976)
22. Latour, M.S., Hanna, J.B., Miller, M.D., Pitts, R.E.: Consumer Involvement with Personal Computer Technology: A Multi-sample Analysis. American Business Review 20, 1–12 (2002)
23. Lusch, R.F., Vargo, S.L., Wessels, G.: Toward a Conceptual Foundation for Service Science: Contributions from Service-Dominant Logic. IBM Systems Journal 47, 5–14 (2008)
24. Means, G., Schneider, D.: The E-Business Revolution and the Design of 21st Century Companies and Markets. John Wiley & Sons Inc., New York (2000)
25. Midgley, D.F., Dowling, G.R.: Innovativeness: The Concept and Its Measurement. Journal of Consumer Research 4, 229–242 (1978)
26. Mittal, B., Lee, M.S.: A Causal Model of Consumer Involvement. Journal of Economic Psychology 10, 363–389 (1989)
27. Paulson, L.D.: Services Science: A New Field for Today's Economy. IEEE Computer 39, 18–21 (2006)
28. Petty, R.E., Cacioppo, J.T.: Issue Involvement as a Moderator of the Effects on Attitude of Advertising Content and Context. Advances in Consumer Research 8, 20–24 (1981)
29. Pieterson, W., van Dijk, J.: Channel Choice Determinants: An Exploration of the Factors that Determine the Choice of a Service Channel in Citizen Initiated Contacts. In: ACM International Conference Proceeding Series, vol. 228, pp. 173–182 (2007)
30. Pitkänen, O., Virtanen, P., Kemppinen, J.: Legal Research Topics in User-Centric Services. IBM Systems Journal 47, 143–152 (2008)
31. Reddick, C.G.: Citizen Interaction with E-government: from the streets to servers? Government Information Quarterly 22, 38–57 (2005)
32. Robertson, T.S., Myers, J.H.: Personality Correlates of Opinion Leadership and Innovative Buying Behavior. Journal of Marketing Research 6, 164–168 (1969)
33. Rogers, E.M.: Diffusion of Innovations. The Free Press, New York (2003)
34. Spohrer, J., Maglio, P.P., Bailey, J., Gruhl, D.: Steps Toward a Science of Service Systems. IEEE Computer 40, 71–77 (2007)
35. Wang, H.C., Pallister, J.G., Foxall, G.R.: Innovativeness and Involvement as Determinants of Website Loyalty: I. A Test of the Style/Involvement Model in the Context of Internet Buying. Technovation 26, 1357–1365 (2006)
36. Warrington, P., Shim, S.: An Empirical Investigation of the Relationship Between Product Involvement and Brand Commitment. Psychology and Marketing 17, 761–782 (2000)
37. Zaichkowsky, J.L.: The Personal Involvement: Reduction, Revision, and Application to Advertising. Journal of Advertising 23, 59–70 (1994)

A Service Science and Engineering Approach to Public Information Services in Exceptional Situations - Examples from Transport

Petra Hocová[1] and João Falcão e Cunha[2,3]

[1] Masaryk University, Faculty of Informatics
Botanická 68a
602 00 Brno, Czech Republic
qhocova@fi.muni.cz
http://kirlab.fi.muni.cz/

[2] Faculty of Engineering, University of Porto
Rua Dr. Roberto Frias
4200-465 Porto, Portugal
jfcunha@fe.up.pt

[3] OPT - Optimização e Planeamento de Transportes, S.A.
Rua Assis Vaz 27
4200-096 Porto, Portugal

Abstract. ITC based information services are widely used for providing or accessing information on a daily basis. In exceptional or emergency situations relevant information could be sent to citizens in order to elicit improved responses. There are examples of using mobile devices to reach users, e.g., in some countries, citizens have received text messages with relevant information about H1N1, such as a list of the main symptoms and a telephone number to call in case of emergency.

This paper proposes the *Contemplate* initial extension to the engineering CDIO process (conceive, design, implement and operate) and stresses out its iterative nature as a framework suitable for new service design, in our case for emergency or exceptional information services. Although the proposal is applicable in general, this paper uses examples from public transport in urban areas. Road works, congestion, and accidents are examples of undesirable influences on public transportation. Technologies such as GPS, mobile communication devices, databases, data mining and other approaches for profiling user activities with careful individual and social considerations could be used to improve the quality of service and quality of life in cities.

Keywords: Service science, service development framework, transportation, exceptional information services.

1 Introduction

Service Science, Management, and Engineering (SSME) has been proposed as a new study field required to face the challenges of the increased predominance

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 65–81, 2010.

of services in the world economy. According to [7] "there is a need for a new science of service systems, which aims to increase service innovation by applying scientific understanding, engineering discipline, and management practices to designing, improving, and scaling service systems".

There has been a wide range of research in SSME, in particular changing the focus of existing work from *product* to *service*. This shift is particularly visible in the marketing area, where the work of Lusch and Vargo (see for instance [6]) has been contributing to establish a service-dominant logic with concepts at the core of service science.

This paper acknowledges these efforts and proposes to apply the well known engineering process, based on CDIO (conceive, design, implement and operate, www.cdio.org), to the development of services. Given the experience of one of the authors in several projects in the public transport area, this work relies on examples of information services under exceptional situations related to transport. This seemed to us to be an area where new technologies that are being deployed could enable innovative services to be defined under demanding requirements. This paper can therefore be seen as a contribution towards bringing an engineering framework into the SSME field of study.

1.1 Context

Urban life is characterized by movements of people that follow daily, weekly and yearly patterns. When something goes wrong or when the situation does not follow the usual patterns it is usually difficult for people to know what is happening. Current technologies could help to overcome both the information gap and to provide useful alternatives in case they exist.

For instance, suppose you are in a train, metro or a bus and it stops for a few minutes or more time. Or suppose you are waiting for a bus, but there was an accident that will make it arrive over half an hour late at your bus stop. But other exceptional occurrences may involve special gatherings of people, say for a large concert, sport event, or political gathering.

Existing information and communication technologies can be used to identify relevant users in need of information and provide them with useful information. In some cases guidance can also be provided. For instance, in the case when a train breaks down, or there is a strike, affected users could receive information on alternative transport. To be acceptable to receive unusual information, some aspects must be taken into consideration. Some people may like to receive information, but others may see that as an intrusion. Therefore some careful steps must be taken in order to assure that such emergency information services are acceptable. If we could guarantee that information provided was always 100% accurate it would be simple to make such services available. But it is usually the case that does not happen.

Exceptional or emergency situations could be defined as situations that are not planned and that no forecasting system could determine accurately the place or time when they would occur. Depending on the type of situation, more precise definitions could be provided. For instance, in transportation, there are planned timetables, and there is a known distribution of variability. But no forecasting system can predict major accidents. Therefore, it could be defined that exceptional or emergency situations involve situations where users' plans would be affected over a certain time for instance, over thirty minutes.

The examples used in this work will assume such situations.

1.2 Relevant Technologies

There are three levels of technology involved in information services for exceptional situations:

- The delivery technology (e.g., mobile devices and networks);
- The technology to identify relevant information (e.g., GPS systems in buses and transit supervision systems that detect that a particular bus will be very likely to be 30 minutes late due to congestion or accident); and
- The technology to match information to users in relevant areas (e.g., data bases/data mining to determine that a particular group of users is likely to need such information in a particular area and time).

Although we could think of many technologies to be used for supporting public information services in exceptional situations, the most likely candidates will need to be available in such exceptional situations. Mobile devices and underlying systems, such as communication networks, will be the most interesting ones to consider. Framework services could be text messaging or mobile Internet. Large visible displays available in public places, including the TV networks or cable TV, or public speaker systems, including radio networks, could also be used. A mix of such channels or interfaces would be even more effective in many situations, although in many cases only one would be available or would reach the user or customer.

When inexpensive and widespread mobile devices with GPS and permanent Internet are available, information services may offer even more support in exceptional situations. Although it is already possible to identify the position of a cellular phone using cellular triangulation, telecommunication companies do not usually let that information be available except in emergency situations.

However widespread mobile devices are, we need also to find the appropriate information for each situation and for each user. In order to achieve this goal we can start both with data that characterizes users' patterns and relevant data to help them in those exceptional situations.

For instance, transport users have usually to validate their transport card, either when entering the transport system and/or when leaving it, leaving behind a rich history of transport behavior. In case of unusual events, for instance involving heavy delays in a particular route, users that are likely to be involved could be sent relevant information for other transport options. Section 2 and 3 will provide further details on this example.

An alternative to finding patterns in users' data would be to have the user cooperation. With appropriate information and publicity, some users could provide relevant information or demand information services. It could be thought of that a user may register to get relevant information on a particular route and wishes to receive updates on changes to that route, either planned in advance, or exceptional. Users could receive such information over the Internet, trough email, social networks (e.g.: Twitter, Facebook, Hi5), or messages in the mobile phones. A possibility would involve that each user could define a set of possibilities having to do with the channels to be used, and perhaps the timing and place (if the location of the user could be determined based on the position of the registered mobile device). But such registration process may be difficult to master for the large majority of people and even more difficult for irregular users. Unsolicited exceptional information must then be relevant and accurate, and of course it would be important that users may provide feedback, to improve the services or to make sure that they are removed from the service if they so wish.

Applying sound service science principles to the study of people, technology, and systems will be essential to select the appropriate technologies, develop the relevant services, always having in mind the needs of the users, both as individuals and as a social group with habits, rules, and laws. To develop the relevant services, an engineering discipline will be required and we propose to base this on the CDIO, conceive, design, implement and operate, process.

1.3 Main Foundations for the Proposed Framework: SSME and CDIO

The framework described in this paper is based on service science foundations, in particular SSME – Service Science Engineering and Management, as proposed by [9], and Service-Dominant Logic, as proposed by [6]. Moreover, it follows the engineering process approach that is currently used in many engineering schools as a basic reference, the CDIO™initiative (www.cdio.org).

According to [9], a service system is a "value–coproduction configuration of people, technology, other internal and external service systems, and shared information (such as language, processes, metrics, prices, policies, and laws)."

According to [6] "Advancing service science requires a service-centered conceptual foundation [...]. The primary tenets of service-dominant logic are: (1) the conceptualization of service as a process, rather than a unit of output; (2) a focus on dynamic resources, such as knowledge and skills, rather than static resources, such as natural resources; and (3) an understanding of value as a collaborative process between providers and customers, rather than what producers create and subsequently deliver to customers."

The CDIO™initiative is "an innovative educational framework for producing the next generation of engineers. It provides students with an education stressing engineering fundamentals set in the context of Conceiving – Designing – Implementing – Operating real–world systems and products. The CDIO™Initiative was developed with input from academics, industry, engineers and students. It is universally adaptable for all engineering schools." (www.cdio.org).

Although the original CDIO is targeted at "real-world systems and products", our work shows that it can also be adapted or applied to service systems, offering therefore a suitable process for the engineering and management of services, taking into consideration the service-centered conceptual foundation: service as a process, focus on dynamic resources, and value as a collaborative process.

CDIO is a simple, abstract, and multidisciplinary overview of the well known engineering approach. It related well with specific engineering process models and frameworks, such as the software process. The conceive stage includes requirements elicitation and systems specification, design includes architecture definition, implementation includes testing and deployment, and operation includes maintenance.

This paper proposes an improvement on CDIO, adding a *Contemplate* stage. Such stage is also considered under a service-dominant logic, keeping in mind that one is interested in *contemplating* the *service system.*

1.4 Relevant Aspects of Information Services on Exceptional Situations

Information services that may be used by a large number of people in exceptional situations must therefore be providing relevant value for the users in such exceptional situations. Such services have to rely on:

- knowledge from users' habits;
- use normal users' language;
- obey to regulations and local law;
- focus on very dynamic situations; and
- involve an ever improving collaborative process between providers and customers.

This is required to make sure that the service will adapt to the evolution of users' needs.

Moreover, a very sound business model must be underlying the services, from the beginning of the process.

As usual, testing ideas and concrete proposals, in all steps of the CDIO process, will be fundamental for developing relevant information services on exceptional situations. If exceptional situations are also critical, a good understanding of the risks involved in providing inaccurate information is also very important. For this purpose, users associations, relevant social groups and legal experts may need to be involved in the process. As will be seen in the next section the Contemplate extension to the CDIO process attempts to improve and focus on one of the stages. The stress on the iterative nature of the process is denoted by a loop, which is followed continuously and possibly many times during the whole service design process.

1.5 Organization of the Paper

In section 2 we present the proposed framework for public information service development, as an extension to CDIO, and in section 3 we introduce some examples of information services that may be used under exceptional situations involving public transport. Section 4 highlights some relevant conclusions that we have learned from thinking about the development process for such services, and indicates areas that will need further research in order to improve the overall framework.

2 The CCDIO Loop

In this section we propose an extension of the CDIO framework, the CCDIO loop - Contemplate–Conceive–Design–Implement–Operate (see Fig. 1). The individual stages will be discussed later in following subsections, but first we refer to various categories of new services. The CCDIO loop: it is a loop because after the 0 stage is reached, there is a new contemplate stage. In fact, contemplate can start after any CCDIO stage.

According to [1], there are several categories of new services. There are three categories dealing with already existing and stable services for a given provider. There are services so called *cost reductions,* which are basically already existing services or very similar to existing services offered at a lower price. A usage of existing services in different market segments or whole new markets is a category of *repositioning services.* Services that bring improvements in performance to current services and as such replace current services are seen as *improved services* (or *revisions to existing services*).

Another three categories focus on brand new services. A category of services which are *new to the world* represent such services which are seen by the customer as new and/or surprising. Often these services are a great challenge for the service provider. *New service lines* represent a category of services which are new for the provider, but customers/users can have a chance to experience them thanks to the offering of a different provider, often in the same space (e.g. locality or cyberspace). And there are of course *additions to existing service lines.*

One of the advantages of the CCDIO loop is that it covers all these categories and supports the overall process of new service development. It is possible to enter the loop at two stages, either in the contemplate–conceive sub-loop or within the operate loop. Depending on the entrance point, following the CCDIO loop is then more suitable for a brand new services or for improvements of already existing ones respectively. The objective of the framework is to make sure that all steps are followed when contemplating, conceiving, designing, implementing and operating information service systems. User validation and system testing are essential parts of this framework. Social validation is also required.

The CCDIO loop describes the process of a new public information service development with a five step iterative framework. The main steps are as follows: Contemplate–Conceive–Design–Implement–Operate.

Before we will describe every step in more detail in the following subsections, we would like to comment the framework as a whole. First, we would like to talk about the loop. It is important that the new service development follows a spiral loop, which leads to an improvement or even a complete new offering. The contemplating and conceiving phase are followed by designing a service leading

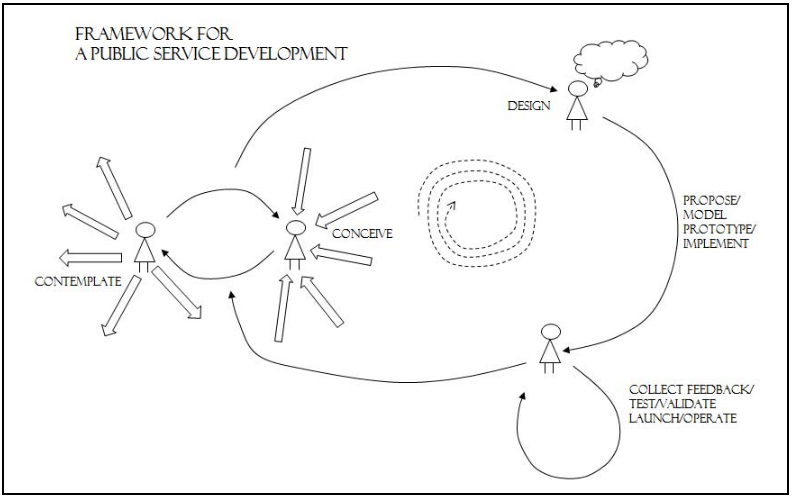

Fig. 1. CCDIO Framework for new public information service development

to a sound proposal. Collection of the feedback in some form is necessary for us to be able to contemplate and conceive again. Following the CCDIO loop again, we would go through redefining the initial ideas and possibly move to a service prototype with its testing and validation. Feedback will take us again to the phase of contemplating and conceiving. At this point, dependently on the success of previous loops and phases within the loops, the provider might be ready to implement the service and launch it.

To develop a new service, we need a sequence of steps, which need to be followed in a given order. For example, it does not make much sense to validate non–existing services or to prototype services without knowing and understanding the subject matter.

While designing a new service, it is very likely that we will have to handle vague information and learn new things on the way. Customers, who have to be involved into the service creation, can agree on the fact, that "something is missing" or "something could be done better", but sometimes to realize what is the good solution can require to go through the loop more than once.

The framework contains two sub-loops. One is the loop between contemplating and conceiving. Contemplating is more a passive activity of mapping the domain, while conceiving is more about active combination of possibilities and finding out interesting perspectives, helpful to the (potential) users of the service. These two phases are continuously switching until the provider believes it is time to come up with a solid design. A second sub-loop is at the stage of operating.

The framework serves as a simple conceptual lead not to omit some important issues. The proposed steps themselves are not surprising at all, but their usage according to the rules and the focus on the user had proved the usability of this framework and an example will be discussed further on.

In the following subsections we will describe the individual steps in more detail.

2.1 Contemplate

As Fig. 1 shows, this step is about searching around and looking for new or interesting incentives. This step is also about simple mapping of a situation. It gives us the overall picture of a domain, but also we should be aware of some important details.

When we are contemplating the landscape for a new public service (or an actual service improvement), we are trying to understand what is the particular domain about and what is possibly missing there. The questions which have to be asked are:

– What is the domain about? What is important the domain for the users (public)? What can bring the service/information closer to the user? How is the public served in exceptional situations?
– What are the boarders of the search? How far/deep we intend to go?
– What channels are used? Which channels are suitable for the users to spread the information according to given situation? ([8])
– What is missing? Is everything as we would expect when using the public service? Is it understandable?

To pass this phase successfully, we recommend using common practices and techniques of ethnographic research to collect data. We mention here an Internet or library search and interviews and/or questionnaires as the simplest ways of data collection. Social networks can be used as well to ask around friends or business partners to share their views. Another way of gaining the information and insights is use of crowdsourcing as it was used by IBM online jam session of university students on April, 2009, who were discussing the matters of the Smarter Planet ([3]).

Moreover, since public transportation is meant to be for the public, to get data to better understand the end users is the objective of this phase. Examples of large sources of data for later data mining and pattern searching result from photo and video recordings (as it was used e.g. in SAS airlines by Doblin Group (http://doblin.com). These sources are a channel for direct observations in real situations.

From the side of a mental effort this is activity (conceiving phase) that can be viewed as a more passive one and serve for orientation and positioning oneself in the domain.

We started the contemplating phase thinking about the domain of public transportation in Porto, Portugal, and about how transport information services could be improved. There are many providers of transportation but the overall service and also the service information is very dispersed. According to Service Aspect Star [5], we analyzed the situation from all seven perspectives - *Who: Agent – What: Outcome – Where : Location – When: Time – How much:*

Evaluation – Why: Rule – How: Process. The focus on every individual aspect helped us to find out a space for improvements of information services in Porto. One of the identified points was to handle exceptional situations in public transportation (referring to the aspect of time). During this phase important questions were identified:

Who: Which agents are going to be involved in exceptional situations?
Where and how: How can we reach them? Which relevant channels regarding their position can be used? What kind of rules we will use to decide the relevant channel?
How much: How are we going to build a business model capturing exceptional situations?

The aspects *Why: rules* and *What: Outcome* will be handled later depending on the answers to previous questions.

2.2 Conceive

The next phase Conceive can be considered as a more active one. It focuses on active selecting and sorting out the important information. The problem nowadays is that there is an information overload in nearly every domain and to select the right information is a demanding task. There are approaches which could be used in this phase to build upon the results from the previous contemplating phase. We would divide them into two sub-phases: a differentiation of patterns and a new ideas generating [2].

While trying to differentiate patterns, we focus on following questions:

– In the observed domain, are there any behavioral patterns of the agents? Which are the ones more obvious? Why are the patterns there? Do they signal positive acceptance of a service or do they express a common failure of actual service setting?
– Can we abstract from our domain to another one? Is there a domain with similar rules or patterns (even not related to the observed one)? Did we witness similar settings in another domain? Do the relationships between individual elements remind me of another domain?
– Do we have all the information needed or do we have to contemplate a bit more?

The conceiving phase enable us to have an insight into the domain and help us to deconstruct the domain elements to understand it more fully. To define new offerings, the techniques of generating new ideas are used. Except the ones mentioned in previous section (crowdsourcing, asking around, and other ethnographic techniques), we recommend to employ for instance storyboarding, mind mapping, brainstorming, or metaphorical thinking.

The information about public transportation in Porto region is fragmentary. Our analysis fully approved the following statement, in particular from the view of foreign visitors of the city. There are "[...] services offered by many different companies, as well as across the different functional units within a single company. These service "fragments" all add up to an experience that can be disjoined and exhausting. In addition to the fragmented experience any single problem along the way tends to be associated with the "major" service provider, fairly or unfairly. This is especially so when the service experience is poorly defined, with unclear boundaries of responsibility." [2]. New services integrating information of different means of transportation are being identified [4].

2.3 Design

The design process follows the sub-loop of contemplating and conceiving in the CCDIO loop. Within the designing process we typically set up new settings of elements and make them visible for other stakeholders of the designing process. In this phase we create the first proposals and/or prototypes and/or implementations based on findings from the previous phases. At this stage, the clear picture of the proposed solution should be finished, even though it will be most likely changed during the active feedback later on. In Porto, we are in the stage of a new service proposal. Nevertheless, some important issues were already decided. The location aspect (of the Service Aspect Star), defining the boundaries of the system, were set to the Porto metropolitan area. When identifying agents involved in the exceptional situations in public transportation, we identified the following groups:

a) *vehicles (buses, trains and metro trains)* - every bus is equipped by GPS and the information about its location is obtained real time in every few seconds, trains and metro trains are connected with the stations through radio to exchange the messages about the location and situation. Also, to enter the bus or the area of the metro, every user is obligated to swipe an electronic chip card through the reading device. The same obligation holds for transfers as well. Therefore, it is possible to follow up a direction of his/her movement, but not the whole trip, as the validation does not have to be done when leaving the transportation system;
b) *users of public transportation*, which are separated into three groups:
   i) *actual/present users* - these are traveling passengers or the ones expecting the arrival of the vehicle in a near future
   ii) *expected users* - these are such passengers, who usually travel at given time through given location
   iii) *past users* passengers, who used a given means of transportation in given time in the past

The users/customers are either identified by using the personal electronic chip card with pre–paid service, or not identified in case of using individual trip tickets. The service provider here is represented by drivers and other public transportation personnel.

The most common exceptional state in the public transportation is a delay of a vehicle. Such delay can be caused by accident ahead, heavy traffic on the streets or detours because of street work. The *primary need* of the user in such situation is to be informed about *what caused the delay.* The *secondary need* is to be informed about and offered some *possible solutions.* The needs are forming the design of the service. The possible location of the user is denoting a group of information channels.

The situation is pictured on Fig. 2. Let us say, there is an accident on the road ahead of the bus. The engine/information system, which receives the regular information about the bus location through the GPS, deduces a major discrepancy between the bus location schedule and the actual location of the bus. The information system follows the scenario for every user group.

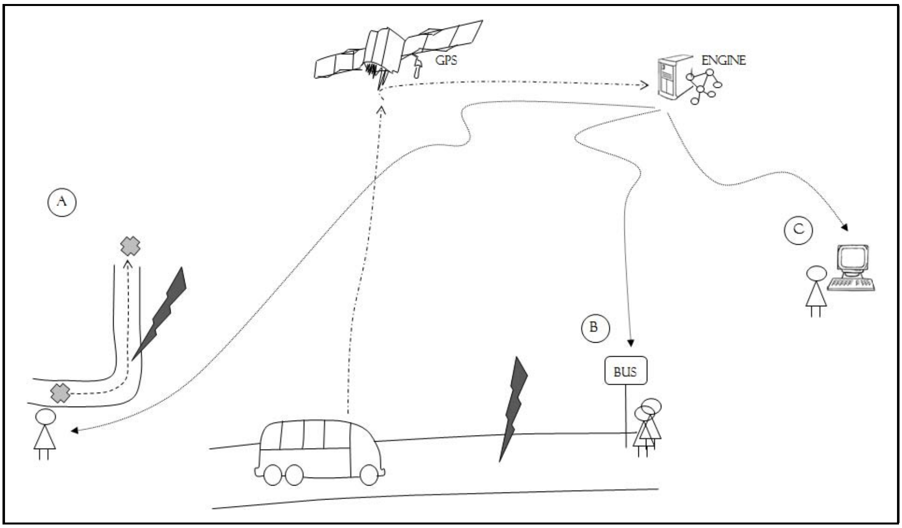

Fig. 2. Scenarios for agents of the system

i) *present users* - (case B on Fig. 2) two possible channels can be used to pass the information about the delay, its length and possible alternatives: either electronic information boards used on relevant stations, or a mobile network. A selection of subset of present users can be done based on behavioral patterns found in data of identified users;

ii) *expected users* - (case A on Fig. 2) two possible channels can be used to pass the information about the delay, its length and possible alternatives: either a mobile network or the Internet. Through a mobile network, we can reach the identified users, who are willing to receive such service, and according to their behavioral patterns are classified as expected users. An example of the pattern can be that the user, every work day validates her transport card at a certain bus stop in the critical time period and did not validate it yet.

The Internet offers also a few reasonable possibilities: the information will be shown on the home web page of the service provider, but can also be displayed through social networking platforms. For instance, a Facebook account of the public transportation company or a Twitter account for informing relations about new status. The relevance and individualization of the messages might be based on the information about identified users, but basically, this channel would be devoted more to all users (i.e., the identification does not play a role here);

iii) *past users* - (case C on Fig. 2) two possible channels in this case: a mobile network and the Internet. In the case of identified user, we would be looking for particular individuals who were traveling in a certain time through a certain location (for example in case of witness search or other case of identification of past passengers). The reasons for looking for past users may be very rare, but the way to reach both, identified and non-identified, users is analogical to the previous case. Privacy of information must be assured, and only statistical data may be collected.

The phase of design leads into the activities such is working on a proposal, modeling, prototyping or implementation of service which are under development. The crucial part of outputs of these activities has to be focused on possible business models.

2.4 Implement

Once we are clear on the design, i.e. with structure of individual elements and their relationships, with processes which need to be taken into account in given domain of proposed service, we are ready to work further on. These activities lead to proposals in the first stages of the service development and their further negotiations. In later stages (later, repeated pass through the CCDIO loop), models or prototypes are done. The last stage is devoted to the implementation and results in a working service.

The outputs (proposals, models, prototypes, implementations) have to cover the core needs identified in earlier stages of the development.

In Porto, we are now in the first or second cycle of the CCDIO loop, working on the sound proposal for the public transport companies based already on expressed needs and ideas of the (potential) users.

Exceptional situations are not happening very often and for assurance of later ease of the process, we have to start to think about modeling possibilities of these situations together with probability models to be able to test them as well later on. At the beginning, the model will not be very difficult since the agents - users - can have only very few states: not-traveling, traveling before transfer, and states referring to every transfer. The states of the vehicles can be at the beginning set to: at the bus stop, between bus stops, in a depot.

The communication channels were set in previous phases, but the communication protocol was not discussed yet. In this case, we mean the communication between the users and provider about their interest of this service. This activity is very closely linked to the business model. This service could be offered to volunteering customers/users, who would be willing to collaborate on improvements of initial versions. Later on, an improved service could perhaps be offered for a monthly payment. In Porto transportation domain, the hardware support is already available - GPS in the buses, radio in the trains and metro trains, SmsBus™- a real time service handling user requests about transport connections at particular bus stops and database of the trips of passengers. The new service could use current technologies in different ways.

2.5 Operate

The operate state covers few more actions, which precede to the final operating status - it is about the feedback and critical insights on usability and value added by the service. At this stage the main focus lays on involvement of the customers. The operation state provides a space for collaboration.

– Is the proposed output (proposal, model, prototype, and implementation) considered as useful and usable? Is the participation in this service comfortable (e.g. does it bother me that I am receiving text messages about road work once in a while?)
– Are there any new ways (new channels) to provide the service? By using them, is it possible to increase the "comfortability" of the service? Which variants were accepted as the best? Why?
– Do we still work on the satisfaction of the core needs? Do users use the service in the desired way or do they tend to use it differently? Why? Are all aspects of the Service Aspect Star covered?

3 Examples of Information Services in Exceptional Situations for Public Transport

There are many possibilities of information services that could be used when thinking about the proposed CCDIO framework.

We will describe three information services that could help people in unusual circumstances or exceptional situations and are therefore not to be used very often:

1. Information service for travelers that are likely to be affected by heavy transport delays;
2. Information service for people attending large gatherings and would benefit from public transport to go and leave;
3. Information service for travelers that are likely to be affected by strikes.

All these three services could of course be a unique overall service for exceptional situations. The range of people that would be potential recipients of the service may vary, and depending on the type of transport users different strategies may need to be followed in order to develop the services. Bringing them together would be beneficial from the point of view of public awareness.

Information services in exceptional situations could be just providing information on what is happening, but it would be more interesting if advice on alternatives is provided.

Example 2 above already seems to be indicating that alternative information on transport is provided, but perhaps just providing information on what is being offered or not offered could be valuable.

3.1 Example 1 - Information Service for Travelers That Are Likely to be Affected by Heavy Transport Delays

This was the example that has been mentioned in the paper. The service in the simple form could update targeted travelers about using routes that are suffering heavy delays due to unusual congestion or accidents.

It would be important to provide the user with advance information on the delay, but only in cases that such user is planning to use the affected transport service. Therefore the proposed information service must determine beforehand the likelihood that each customer will be using the transport service in the time frame and the area of the disruption. In general a time space boundary must be calculated and a set of people must be identified as the most likely recipients of the information service.

As mentioned in a previous section, users may have subscribed the exceptional information service, but more often automatic systems could be used to identify relevant users that would appreciate the information. In this later case, data collected from transport card validation (for instance) could be used to define user transport patterns. Such patterns could then be cross checked with the routes under heavy delay. Likely affected users would be sent messages to their mobile phones with warnings and perhaps alternative options for traveling and a number to call for help if required.

Occasional travelers, not registered, would be missing warnings as there were no patterns to be used. The information service could be improved if there were ways to identify those occasional travelers. For example, tourists that arrived recently in the area of the service would need an alternative approach. Perhaps when arriving to the city they are visiting they may be sent a message proposing a set of exceptional information services, including transport. Telecommunication companies are used to send text messages with information on tariffs for roaming customers or help line numbers. Tourists might be asked to register at the tourist information office for such services, when and if they buy a travel card. In order for the information to reach the mobile device, there is the need to associate a mobile phone with a travel card. Perhaps then recent card owners could be targeted with an initial exceptional message with details of transport information services.

This also raises the issue of language: information messages must be sent to users in their own language, or in a language that they understand.

3.2 Example 2 - Information Services for People Attending Large Gatherings

Using public transport is usually desirable from an environmental point of view. Events that attract very large numbers of people usually benefit from exceptional public transport offers that many people could use (instead of private/individual transport) if more information was available.

As with the previous example a mixture of previous registration and pattern mining could be used for spreading the service. In this case buying the ticket could be associated with registering for the service. With more advanced technologies, guidance could be provided at the event for the return transport availability, location and timetable. Cooperation from the organizers of the events and from the media that is publicizing it would also be highly desirable.

This information service could also involve in some degree example 1 as in those events traffic congestion would be likely.

3.3 Example 3 - Information Services on Strikes Affecting Large Number of Travelers

Transport related strikes are usually rare, but have a big impact on people moving through the system. Strikes in one mode of transport usually affect the other modes. For instance, a taxi strike will force a tourist arriving to the destination to use the public transport system, and vice versa.

The effectiveness of the information system would depend on how information is shared between the different players. For instance, arriving passengers to a particular airport could be warned beforehand of a strike in a particular mode of transport and receive specific information on where to find alternatives.

Strikes on public transport may be partial and then it would be important for customers to receive both update information on expected timetables or alternatives taking into consideration the available transport service.

Once again user registration and pattern mining could be used to define service targets in many situations.

3.4 Advances in Technologies and Social Perception

Advances in technologies, and changes in individual and social perception of its possibilities are critical for deploying these proposed information services. For instance it is possible with current technology to know the likely position of people using mobile devices, or making payments with electronic cards. With the expansion of mobile devices with GPS the accuracy will increase. However it is not acceptable that this information is used by the benefit of others, and therefore the access to such information is restricted to very few cases, usually having to do with emergency situations, e.g., determining the origin of calls to emergency numbers (112 in most of Europe, or 999 in the USA). Customers sometimes allow location to be used in some experimental projects.

Perhaps with high quality exceptional information services it would be possible to use such information for the benefit of the user.

4 Conclusions

The proposal presented in this paper resulted from conceptual work of applying the principles of service science, management, and engineering (SSME) when thinking about developing exceptional information services in public transport.

The focus of the proposal was in the engineering process, with the CCDIO framework: contemplate, conceive, design, implement and operate. CDIO is usually applied to product engineering, but this paper argues that it can also be applied to new service engineering.

The proposed framework needs to be validated with real service development, and we believe that the examples provided could be used for such validation. Applied research on user needs, user feedback and social acceptance seem to be important in early phases of a project involving exceptional information services.

In a concrete project, management aspects are also naturally relevant and an important issue to be considered would be business modeling for the services under study. These issues would need to be covered in all steps of the CCDIO process, and would be critically important for a sustainable service. A sound engineering service development process should also take into account those matters.

The proposed CCDIO approach is targeted at real-world service systems, instead of "real-world systems and products" as the original CDIO. Given that a service system is a "value-coproduction configuration of people, technology, other internal and external service systems, and shared information", it is a more complex system that traditional "real-world systems or products" that engineering targets. Therefore the proposed contemplate stage is addressing this "value-coproduction configuration", and therefore our CCDIO approach aligns well with SSME.

References

1. Booz, A., Hamilton: A New Product Management for the 1980's. Booz, Allen, and Hamilton, Inc., New York (1982)
2. Edvardsson, B., Gustafsson, A., Johnson, M.D., Sanden, B.: New Service Development and Innovation in the New Economy. Studenttliteratur AB, Lund (2002)
3. Jamming for a smarter planet, IBM Smarter Planet University Jam (April 21-24, 2009), http://download.boulder.ibm.com/ibmdl/pub/software/dw/university/-smartplanet/Jam_Report2009.pdf (retrieved September 1, 2009)
4. Hladik, P.: Internal Report on Public Transportation in Porto metropolitan area. Internal Report of OPT - Optimização e Planeamento de Transportes, Porto (September 2009)
5. Hocova, P.: INnovation & COoperation: Modeling the Reference Model of Service System for Supporting Cooperation. Masaryk University, Faculty of Informatics. PhD thesis (2010)
6. Lusch, R.F., Vargo, S.L., Wessels, G.: Toward a conceptual foundation for service science: Contributions from service-dominant logic. IBM Systems Journal, SSME - Service Science, Management, and Engineering 47(1), 5–14 (2008)

7. Maglio, P.P., Spohrer, J., Seidman, D.I., Ritsko, J.J.: Preface. IBM Systems Journal, SSME - Service Science, Management, and Engineering 47(1), 3–4 (2008)
8. Patricio, L., Fisk, R., Cunha, J.F.: Designing multi interface service experiences: the Service Experience Blueprint. Journal of Service Research 10(4), 318–334 (2008)
9. Spohrer, J., Maglio, P.P., Bailey, J., Gruhl, D.: Steps Toward a Science of Service Systems. IEEE Computer 40(1), 71–77 (2007)

Service Portfolio Design for Service Innovation Management: The Case of a Luxemburgish Research and Technology Organization

Pierre-Jean Barlatier, Jean-Charles Bernacconi, and Sandrine Reiter

Centre de Recherche Public Henri Tudor
29, Av. J. F. Kennedy, L-1855 Luxembourg
{pierre-jean.barlatier,jean-charles.bernacconi,
sandrine.reiter}@tudor.lu

Abstract. This paper examines the strategic management of service innovation capabilities within a Luxemburgish Research and Technology Organization (RTO). The authors propose to study the organizational design of this RTO through the lens of a conceptual model built on both literature and empirical-based relationships between new service development (NSD) and the management of resources and competencies mobilized by innovation capabilities. We highlight three key managerial functions for the design of an innovative organization able to propose new sustainable services. This research emphasizes the importance of the management of a service portfolio in order to ensure the coherence between NSD processes, markets and the resource base.

Keywords: New Service Development, Service Innovation, Service Portfolio, Research and Technology Organization.

1 Introduction

The rise of the Service Economy emphasizes the needs of designing new organizational forms and models that may support service innovation. From this perspective, with increased competition, accelerated changes of markets' needs and technology evolution, organizations have to generate continually new services [1; 2; 3]. Organizational capabilities to succeed in generating new services are seen as a vector of competitiveness, and research on New Service Development (NSD) as already shown positive relations with performance [4]. However, many service firms fail to identify and measure NSD processes they do have [3].

In this paper, we focus our attention on NSD processes issues within Research and Technology Organizations (RTO), in which innovation capabilities represent core competencies and are source of business, insofar as the main output of such organizations is a service innovation. From this perspective, we propose here an exploratory study of the articulation of the NSD process, the development of services innovation capabilities and resources, and the management of the services portfolio coherence. In order to do so, we define in this paper a service innovation management organizational structure dedicated to RTO as well as some related observed practices that may contribute to its effectiveness, taken from a study of a Luxemburgish RTO.

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 82–95, 2010.

2 Service Innovation Management Model

2.1 New Service Development Processes

Research on NSD models has begun by investigating principal new product development (NPD) models. These one were proposed in a linear and sequential perspective [5; 2]. But, as Stevens and Dimitriadis [6] have noticed, the validity of NPD models in the context of services remains to be demonstrated. Further to these works, some non-linear NSD frameworks were designed, with the hope to provide new fruitful insights by emphasizing interdependence on design and development in NSD as well as its cyclical aspects [7]. We propose here to follow up research carried by Froehle and Roth [7] on the non sequential and resource-based conception of NSD.

The NSD process has been analytically dissected and modeled by numerous researchers, from Shostack [8], who developed one of the earliest notable linear NSD models by deconstructing the process into ten discrete stages, to Johnson, Menor, Roth and Chase [9] who have synthesized previous NSD process research and have created a general four-stage NSD model involving the phases of design, analysis, development, and full launch.

However, even if NSD process activities appear as sequential, Froehle and Roth have noticed complementary nonlinear frameworks, “hoping to attain different perspectives and insights into the development of new services”, but “with few exceptions, one important element that has not been thoroughly developed is the resource base necessary for, and involved in, new service development” [7, pp.171-172].

2.2 NSD through the Resource-Based View Lens

Scholars agree that the Resource-Based View (RBV) takes its origins in the influential work of Penrose [10]. RBV basically states that competitive advantage comes from the bundle of resources that organizations hold and which have the following four attributes: rare, valuable, imperfectly imitable and without equivalent substitutes [11]. In other terms, this literature stream argues that differences in profitability among firms are related to differences in their resource architecture and the way these resources are deployed [10; 11; 12]. According to Gadrey, Gallouj and Weinstein [13] and Van Ark, Broersma and Den Hertog [14], performing a service involves setting a bundle of capabilities and human, technological, and organizational competencies. In the same vein, Froehle, Roth, Chase and Voss [15] insist on the strategic influence of appropriate (team-based) organizational structures, the NSD process design and the related Information Technology (IT) choices on the speed and effectiveness of NSD. From this perspective, we focus our attention on these three literature-based main strategic resources on NSD processes:

1. *The Importance of the Human Skills.* NSD processes are knowledge-intensive. From this perspective, human skills and intellectual resources constitute the firm’s human capital [11]. According to Froehle and Roth [7, p. 173]: “these resources include, but are not limited to, the educational, cultural, and experiential knowledge and skills contained within the firm’s employees”. Organizational knowledge comes fundamentally from individuals, and the transfer of know-how implies socialization processes, the connection of employees’ daily work experiences with opportunities for improvement and innovation [16].

2. *The Role of the Organizational Structure*. According to Miller [17], the most innovative firms rely on an adaptive, organic organizational structure that foster intensive collaboration as well as open and informal communication systems in order to introduce new products. The adoption of a flexible organizational structure develops cross-functional teamwork benefits and enhances knowledge and competencies combination perspectives, i.e. innovation capabilities [18; 19]. Froehle et al. [15] suggest that flexible organizational structure benefits comes more from this combination of knowledge and competencies, by generating a diversity of idea than from improved efficiency or reduced development time.
3. *Information Technologies as NSD Enabler*. IT plays a critical role for services, and has quickly become a crucial element of service firms [20]. As Froehle et al. [15, p. 6] have pointed out: "Advanced information technologies, such as groupware, intranets, and electronic commerce, help organizations direct, organize, and revitalize these flows of organizational knowledge, thereby creating better processes and better service products". IT benefits for NSD are twofold: (i) IT can raise organizational effectiveness in generating information efficiencies [21], by improving the initial base of knowledge to draw from when employees engage in problem-solving and decision-making; (ii) IT can foster collaboration and creativity in creating boundary-spanning information synergies. As a consequence, IT appears as an NSD enabler and speeds up the service development cycle.

2.3 Innovation Capabilities

From a resource-based view perspective, innovation capabilities are one of the major sources for the generation and the development of competitive advantage. As Schreyögg and Kliesch-Eberl [22] have noticed: "…a capability does not represent a single resource in the concert of other resources such as financial assets, technology, or manpower, but rather a distinctive and superior way of allocating resources" (p. 914). Hence we consider innovation capabilities as a collective and socially embedded high-order organizational capability to efficiently combine critical resources and assets (i.e. human skills, IT, and organizational design…) in order to successfully achieve NSD processes.

Finally, if this resource–process framework provides new fruitful insights to NSD management practices, it needs to be completed with resources-building and resources-regenerating competencies of the service portfolio as well, in order to be successful and viable in a long-term perspective. Hence, we propose in the Fig. 1 below a model of services innovation management that synthesize and articulates the previously studied elements.

This model clearly describes a dual perspective, in emphasizing first the close interactions between the NSD process, the service portfolio and the markets (and therefore the end-users). Indeed, organizational actors involved in NSD processes have strong interactions with end users and markets, in terms of co-design in the early stages of the NSD processes or in terms of co-valorization of the service output. Once the service is designed, it should be decontextualized and then adopt a generic form in order to be integrated in the organizational service portfolio. Therefore, this packaged service can be proposed to other markets and contexts, i.e. other end-users.

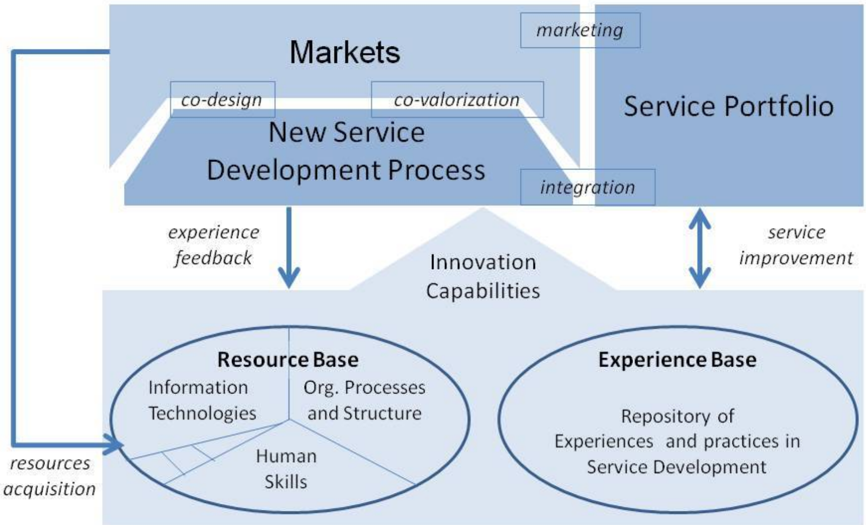

Fig. 1. Service Innovation Management Model

The second emphasis of the Fig. 1 lies on the interplay of the resource base and the experience base of the organization. Both actual and potential organizational resources and previous NSD experience are assets that are mobilized by innovation capabilities during NSD processes.

Moreover, this dual model points out interactions between the user-oriented perspective and the organizational-oriented perspective of the innovation processes. These interactions consist in a mutual enrichment based on experience feedbacks and service improvement processes.

In line with Froelhe and Roth's [7] conception about the importance of developing both process-oriented and resource-oriented practices for a firm in order to build a competitive advantge, we argue in this contribution that an organization that develops specific competencies in service portfolio management will enhance both its resources management practices and market-oriented activities. We propose in the next section to present an empirical illustration of these organizational issues of sustainable management of services innovation through the initiative of a Luxemburgish RTO. We focus first on the organizational design of the studied RTO that emphasize the importance of specific service management functions. We present in a second section the distinctive service portfolio management practices of this RTO.

3 Organizational Design of Sustainable Services Innovation RTOs: Evidence from the CITI

EARTO [23] defines RTOs as "specialized knowledge organizations dedicated to the development and transfer of science and technology to the benefit of the economy and society". The main mission of a RTO is therefore to provide research, development and innovation services both to private and public beneficiaries. The Centre de Recherche Public Henri Tudor (CRPHT) is the largest Luxemburgish RTO, founded in 1987, and has over 350 employees. The CRPHT has signed a performance contract with the Luxemburgish government that focus on two main strategic objectives. First, it carries out R&D activities in a collaborative way in order to improve and strengthen the innovation capabilities of private and public organizations. Second, it aims at being a recognized scientific actor in selected technological and scientific areas. The Centre for IT Innovation (CITI) as one CRPHT department, directly derived is mission from these two strategic objectives.

Luxembourg is one of the most service-led economies in the world in where more than 90% of the Growth Added Value is generated by service sector. In this context, the CITI has developed a strategy essentially based on Service Science to achieve its mission: to produce innovations and to design its organization in order to manage in a sustainable way a specific innovation mix.

CITI produces “Science-based innovation”. This essentially means (in the sense of Pavitt "Science-Based Industries" [24; 25]) that R&D workforce has to develop high level science and engineering skills in order to maintain strong links with academics. These links are essential to identify theory and methodological material to produce innovative solutions with partners. Therefore, solutions provided have to solve partners’ problems but also to address scientific issues. Service innovation within such a scientific context produces knowledge that is: (i) co-constructed and validated by end-users in an iterative process, and (ii) identified, shared and validated by the scientific community.

A first CITI function called Scientific and Technological Manager (STM) refers to the management of the six CITI Scientific and Technology Units (STU). These STU are constituted by researchers and structured by scientific background aiming to reinforce scientific networking. Researchers are then anchored in different backgrounds/disciplines (IT, economy, sociology, psychology, management…) that we can label “vertical diversity”. They are also developing jointly scientific, technological and market oriented skills that we can label “horizontal diversity”.

Managing this diversity/variety is crucial for new knowledge production but also for knowledge exploitation. So the main functions of STU are to maintain/capitalize existing knowledge but also to develop new ones. The diversity of competencies managed (from macroeconomics to software architecture design) strengthens the ability to co-design services based on human, organizational and/or technological competencies. From this perspective, STU represents CITI resource base as mentioned on Fig. 1.

Second, as the CITI aims to produce innovation in combining these previous types taking into account three main enablers (technology, organization and human), a function called Service Line Manager (SLM) has been implemented in order to create sustainable innovation.

Hence, seven Service Lines (SL) have been created to boost service-oriented strategies in increasing interdisciplinarity (combination of resources and competencies) and the ability to build coherent and value driven “suite” of integrated services proposed to different markets.

Third, as the CITI wants to bridge gaps between science, services and markets, in a service innovation approach which is demand or user driven, a third function has been proposed: the Strategic Program Manager (SPM). Eleven Strategic Programs (SP) organize sustainable innovation from an end-users' perspective. SP mainly addresses exploitation of knowledge and services for identified and implied beneficiaries, but can also develop new knowledge in an exploratory way in collaboration with end-users.

Finally the main challenges of service innovation for the CITI consist not only in the maintenance of an "assets" knowledge base but also in the effective design of a dynamic organization to deploy them. Hereafter, coordination and governance mechanisms have to be implemented in order to develop a competitive advantage creating new services, new competencies, new markets or partnerships.

In this context, the management of the CITI Service Portfolio appears has being critical in order to address these organizational issues.

4 Service Portfolio Design: A Proposition

A service line addresses a set of coherent services, which are described within a service portfolio. The SLM gathers services from their identification to their capitalisation in a coherent package and manages interactions within the 2 other dimensions of the service model: market, i.e. SPM, and resource base, i.e. the STM.

Within the portfolio, a service is described in a view that reflects on one hand the SLM's point of view and one the other hand its interactions with SPM and STM.

Integrating a service in the organizational portfolio consists, for the SLM, to describe it in its generic form. The description is seen as the first output of the NSD process and is mainly represented by the output it generates, the resources (human, technical and processes) it mobilises, and the activities which are performed.

Managing the interaction with the STM means focusing on resources needed to design, deploy, and innovate on the service: the "Service Assets".

Finally, considering the interaction with the market, SLM and SPM should interact in order to contextualize a generic service to a specific market. A generic service could be contextualized several times, according to the markets it addresses. This is represented in what we have called the service "contextualised level".

The next sections will present the service portfolio design around these three visions (generic level, assets and contextualization level) and our demonstration on two principles:

- The first one is that, each attribute that is defined to characterize a service within the portfolio is based on a question that should find an answer in order to have a complete vision of the service. Our presentation will then be based around these questions, and attributes definitions.
- The second one is to propose an illustration of our purpose on an example based on one service existing at the CITI "Skill foresight service".

The skill foresight service proposes to look forward and to foresight tomorrow key competencies. It aims at answering the question: What competencies are needed for a job or a given sector within 3 or 5 years?

All the attributes presented in the next sections have been defined according to the CITI needs and experience. They reflect the day to day concrete work of a SLM, and so have for the moment not been yet confronted to the existing literature. The model proposed here, results of the SLM work and which has been put in place in order to answer to the new constraints induce by the move of the CITI organization to service innovation management. This work is still running and thus some of the attributes proposed here will probably be adapted according to new emerging results and needs.

4.1 Service Line Core Business: "Service Generic Level"

Managing the service portfolio implies first of all, integrating services in their generic form. Regarding the SLM work at the CITI, It has been proposed to study the service generic level regarding 2 main points of view: What are the attributes need to define the service internally and what are the information needed to deliver it.

On one hand, all information needed for a SLM to define and present internally his services, are gathered and organized around the seven main following attributes.

Output*: What are the concrete results that a costumer can expect from this service?* Delivering a service relies, mainly, on qualitative and not quantitative outputs. However, in order to be able to sell this service, we should be able to demonstrate its value and so to give an overview of what the client can concretely expect. The way the service is delivered is not the purpose, only the concrete results are described here.

Type of action**:** *What is the nature of the delivered service?* A same service could be delivered in several ways depending on the client needs. We have classified this "type of action" within seven main categories describing the service delivery:

- Research: The service is adapted through research investment.
- Consulting: The service is delivered, as it is, in collaboration with the client.
- Operational: The service is delivered by the CITI without client participation.
- Labeling: The client has been certified on the service delivery.
- Training: A training can be dispensed to the client.
- Transfer: The whole service is transferred to the client, he will then be able to deliver by himself the service to its own client.
- Support: Ensure the maintenance of the service after its delivery.

Research partners: *Who are the specific partners, privileged partners on the market (potential customer) as well as at the research level?* Research partners are involved in the early stages of the NSD process in order to co-design and co-valorization the service. This attribute, point out the main (first) research partners who have been involved in this early stages of the NSD process.

Strategic human resources: *Which are the human resources that participate to the definition and the evolution of the service? Who can help writing a proposition for a customer?* Designing, deploying and delivering a service relies on internal human resources who are pointed out through this attribute, which is directly correlated to the STMs through the "human assets" attribute that will be described later in the paper.

Useful assets**:** *Which are the assets the service relies on?* As seen previously, in the RBV, service innovation relies on human capital as well as on technical and process assets. These assets are mostly scientific methodology coming from research, enhanced by technology. This attribute is once again, emphasize the interaction with STM, as these assets are produced within a scientific and technological units.

Service maturity**:** *Which is the maturity of the generic service at a given date?* Everybody agrees on the fact, giving an overview of the maturity of the service is mandatory. However further discussions are running in order to find a common maturity scale.

For the moment, we will give an indication on a 5 level scale, from 1: emerging service to 5: mature service. Has we will see later in the paper, this generic maturity level will be nuanced by a contextualised maturity level. A service always emerges from one given market, and is then always more mature on this market than on another one.

Development plan**:** *Which are the possible evolutions of the service in short and mid-term, with which partner, for which market?* The development plan intends to give an idea of the maturity gain expected at mid-term (1 or 2 years). It is, for the moment, described in a verbalized form, however, this seems to be too wide, and will be precise in the future. For example, information about the strategy that will be put in place in order to gain in maturity could be added.

Success story**:** *When available, which was the best deployment experience of the service?* A success story is a brief description of the best experience that could be used to promote the service. The client or partner who has been involved in this experience should be pointed out as a reference that can be contacted in order to give a feedback on his experience.

Table 1. Skill foresight service- generic level - research and definition

Output
A global report containing: The initial skill card of the study job. The evolution profile (determinant, evolutions scenario, action plan) that has been identified. The resulting skill card of the job describing new key competencies within 3 or 5 years
Type of Action
Research, Consulting, Training, Support
Research partner
Luxemburgish training organisms (Chambres patronale et salariale, ADEM, ABSI)
Strategic human resources
ADU, GMA, DHU, BME
Useful Asset
Skill card methodology guide, Skill card Interview guide, abiliticWeb tool (under development)
Service Maturity
In 2009 maturity level 4
Deployment plan
Actually the service is been developed within “la grande region” through an INTERREG Project. Objective end 2010, deploy the service in several European training organisms as well as develop a computer based tool to support the service. In 2011 maturity level 5
Success story
Muller&Wegener - Luxembourg – Work on the job “ Préparateur de commandes”

On the other hand, delivering a service, mainly consist in answering to the 2 following questions:

- How to explain quickly the service to one of your colleague?
- What are the modalities and the associate costs in terms of human resources, licenses, infrastructures?

And bring us to the definition of 2 corresponding attributes:

Technical description: The technical description will give an idea of how the service will really take place. The discourse does not intend to be commercial, but technical and will be used internally to describe how the service will technically take place and is complementary to "output".

Delivery options**:** SPM are mainly concerns by selling services on their market. In order to achieve this goal they should be able to estimate as precisely as possible the service cost. Identifying the service delivery options will enable this cost estimation. SLM will then precise how many man/day and additional cost (licences for example) that are necessary to deliver the service. According to "Revenue Model" the SPM will, on this base, be able to estimate the service delivery cost.

Table 2. Skill foresight service- generic level - Delivery

Technical description The skill foresight service proposes to look forward and to foresight tomorrow key competencies. The service aims at answering the question: What will be the competencies needed for a job, or a given sector within 3 or 5 years? The service is based on prospective theory and is decomposed into 3 main phases: Establishing the skill card of the job Establishing an evolution scenario Establishing the foresight skill card
Delivery options Several options - Option 1 : 21,75days o Initial Skill Card through individual interviews and validation in focus group o Evolution scenario based on 3 focus groups o Foresight skill card : based on one focus group o Final report - Option 2 : 19 days o Initial Skill Card based on Focus group o Evolution scenario based on 3 focus groups o Foresight skill card : based on one focus group o Final report - Option 3 : 16 days o Initial Skill Card based on Focus group o Evolution scenario based on 2 focus groups o Foresight skill card : based on one focus group o Final report

4.2 Assets: Coordination with Scientific and Technological Managers

As seen previously, within the service definition, SLM identifies resources (human, technical and process) used to design and deliver services. Within the Service Innovation management Model, these resources are at the organisation level managed by STM.

The STM manage resources, and should describe them, in order to allow the SLM to identify the one that are needed for his services, though 2 main attributes: Potential human resources and Potential non-human resources.

Potential human resources: *Who are the people who are able to work on the service? And what is their competencies level?* Human resources address collaborators who participate in the development or the delivery of the service. STM should go one step forward than the SLM, and give an idea of resources competencies domain and their expertise in the service. This will allow the SLM to identify the possible resource implication on the service.

Potential non-human resources: *What are the non-human resources (technical and process) that are useful for the service?* None human resources address any resources that are useful for the service definition and delivery. It could be technical or scientific resources such as methodology, software, training courses support, bibliography. The resource is described by its name, which is link to the non human assets within the generic level, a short description of the resource and where to find it.

Table 3. Skill foresight service- Assets

Potential human resources:
ADU: scientific coordinator, statistics, prospective theory…
GMA: research engineer, human resource…
DHU: research engineer, skill card expert, project manager…
BME: research engineer, jobs and skills expert…
***Potential none human resources*:**
- Skill card methodology guide: skill_card_guide.doc
- Skill card Interview guide: interview_guide.doc
- abiliticWeb tool (under development): user_guide_aviliticWebtool.pdf
- Training courses support: skill_foresight_methodology.ppt
- For each of these resources a description is given

4.3 Contextualization: The Market Link

The generic level described previously focuses on the SLM point of view. We have also seen that the asset level addresses the coordination within the SLM and the STM.

The SLM should also align the service portfolio according to markets needs (market pull). As a consequence, this interaction should also be represented within the portfolio which has been done through the “Service contextualisation” level.

First of all, for each market where the service can be commercialized, SLM and SPM should agree on a specialized service definition as well as main outputs specific to the market. These outputs and definition should focus only the specificity of the market and will answer to the following questions:

- What are the concrete results (specific to the market) that a costumer can expect from this service?
- What commercial discourse can we rely on in order to promote the service on the market?

Answering these questions will lead to the definition of ***Specific outputs*** that the service will deliver to the market as well as a ***Market specialized description*** which will present a commercial discourse available to promote the service outside the RTO.

Table 4. Skill foresight service "training organisms" - definition

Market specialized description
You are a training organism and you wonder « How to adapt, as soon as possible, my training courses contain to the market need ».   The skill foresight service is an innovative methodology that allows you to identify tomorrow key competencies and to adapt and valorize your training offer.   The service is adapted to your needs through a participative demarche involving professional of your domain.

Other attributes of the definition category intent to describe the market that the service would address. These attributes are mainly the responsibility of SPM and should give an overview of the market potential for the service to SLM and STM. These attributes are defined around the main questions that arise in order to define the potential of the service on the market.

The first 3 attributes intend to describe the market overview, in order to package the service and contextualize it to this specific market.

Market challenges*: Which challenge, activity or process the service would address?*
Main customers**:** *Which clients would be interested in using the service?*
Main competitors**:** *What are the service competitors on the market?*

Knowing a market means, first of all, been able to indentify challenges it should address. The attribute "market challenges" propose a selection of a subset of these challenges that the service could address. The goal is to collect, useful information in order to promote the service, to identify its possible developments and to customise it to the market.

Clients' identification is the second information that should be addressed, and more particularly those who could be interesting in the service and for whom it is valuable to promote it (Main customers). And finally, in order to have a market global vision, SPM should also focus on the competitors on the market, and adapt the service in order to propose innovation and different services than those already existing (Main competitors).

Communication means and supports**:** *What are the typical communication means and supports that can be activated in order to promote the service on the market?* This attribute intends to provide information in order to promote the service on the market and to capitalize on publications already published.

Market partners: *Which are the partners that you could relies on, in order to have a good comprehension of the market?* Describing market partners has the same function as "research partners" at the generic level, but focus, this time, on the market enablers. It presents partners who can help in developing and promoting the service on the market and mainly participate to the service sustainability.

Maturity on the market**:** *Which is the maturity of the service on your market?*

Development plan: *How to bring the service to contribute to the program development?*

As seen previously, the service maturity and development plan can be different from one market to another, At the generic level, the SLM estimate the service maturity, and associate development plan considering its design at the early stage of the NSD process (i.e. on one specific market). The SPM should then estimate the service maturity on its market as well as the possible development opportunities of the service on the market. These 2 attributes strongly influence the service deployment strategy on the market.

In the previous paragraphs, service opportunities for the market have been pointed out. SPM, in collaboration with SLM and STM, has now to identify the way it could be delivered. This identification relies on 3 attributes: service assets, support partners and income models.

Service Assets: *What are the assets (Human and non Human) that are specific to the market in order to be able to deliver the service?* Regarding one specific market, additional assets, that were not present at the generic level, will be needed. These additional resources are described here, by specifying only resources that were not mentioned at the generic level.

Support partners**:** *Which partners are associated to the service delivery on the market, for example SSII for a software on which the service relies on?* In order to be delivered a service sometime needs the support of external partner, like for example specific expertise on the market. These partners are described giving their references as well as their implication in the service delivery.

Income models: *How the final price will be calculated?* Which type of contract can you expect deliver for the service? Income models are directly link to the "type of service" and the "delivery options" defined within the generic level. It will define; according to the client and the type of service the income model that can be applied, from collaborative research to consultancy fees.

Table 5. Skill foresight service "training organisms" – delivery

Market challenge
Identifying future competencies, adapting training to client needs
Main customers
Training organisms within the "grande region", Human resources departments
Main competitors
Specialize human resources consultants working on skill card establishment ***Communication means and supports:***
Newspaper publication (example: "Tageblatt", "Le jeudi")
Scientific publication (example: ESSEC 2009)
Skill foresight leaflet (under construction)
Development plan:
Develop the maturity of the service in intra-enterprise mainly by reducing the cost for small and medium enterprises
Revenue models:
Collaborative research project, when specify to one specific context within a company, Consultancy model in other cases

As previously said, this work is the results of the SLM thinking on their day to day needs. It has been proposed at the CITI level and is still under revision. These attributes are now in a way of being proposed at the corporate level, i.e. within the whole CRP-Henri Tudor. The next step will be to adapt and validate this work according to the existing literature and to experts of the service science domain.

4 Conclusion

This paper presents the organizational design of a service portfolio used to leverage service innovation capabilities within a Luxemburgish RTO.

The design of such a service portfolio ensures the NSD processes coherence within the organization in guaranteeing the sustainability of innovative services.

The benefits of this management of this service portfolio are twofold: (i) it fosters interactions between the organization and the markets in order to increase services visibility for the clients (end-users) and (ii) to involve them in a co-design process. However, this research points out that interactions with the market are not the only prerequisite to support innovation design. Indeed, as NSD processes are also based on organizational resources (human, technical or processes), the service portfolio should also integrate and manage this issue.

Creating, through the service portfolio, these coherent links between NSD processes, markets and resource base will allow organizations to improve innovative sustainable services in a continuing process. However, the management of these links implies for the organization to refine its capitalization strategy that may leads to the empowerment of its service innovation capabilities.

References

1. de Brentani, U.: New industrial service development: Scenarios for success and failure. Journal of Business Research 32(2), 93–103 (1995)
2. Cooper, R.G., Easingwood, C.J., Edgett, S., Kleinschmidt, E.J., Storey, C.: What distinguishes the top performing new products in financial services? Journal of Product Innovation Management 11(4), 281–299 (1994)
3. Voss, C.A., Johnston, R., Silvestro, R., Fitzgerald, L., Brignall, T.J.: Measurement of innovation and design performance in services. Design Management Journal 3, 40–46 (Winter 1992)
4. Vermeulen, P.A.M., De Jong, J.P.J., O'Shaughnessy, K.C.: Identifying key determinants for new product productions and firm performance in small service firms. Services Industry Journal 25(5), 625–640 (2005)
5. Kline, L., Rosenberg, N.: An Overview of Innovation. In: Landau, R., Rosenberg, N. (eds.) The Positive Sum Strategy. National Academy Press, Washington (1986)
6. Stevens, E., Dimitriadis, S.: Managing the new service development process: towards a systemic model. European Journal of Marketing 39(1-2), 175–198 (2005)
7. Froehle, C.M., Roth, A.V.: A Resource-process framework of new service development. Production and Operations Management 16(2), 169–188 (2007)
8. Shostack, G.L.: Service Design in the operating environment. In: George, W.R., Marshall, C.E. (eds.) Developing New Services, pp. 27–43. American Marketing Association, Chicago (1984)

9. Johnson, S.P., Menor, L.J., Roth, A.V., Chase, R.B.: A critical evaluation of the new service development process. In: Fitzsimmons, J., Fitzsimmons, M. (eds.) New Service Development, pp. 1–32. Sage, Thousand Oaks (2000)
10. Penrose, E.: The Theory of the Growth of the Firm. Oxford University Press, New York (1959)
11. Barney, J.B.: Firms resources and sustained competitive advantage. Journal of Management 17(1), 99–120 (1991)
12. Wernerfelt, B.: A Resource-Based View of the Firm. Strategic Management Journal (5), 272–280 (1984)
13. Gadrey, J., Gallouj, F., Weinstein, O.: New modes of innovation – How services benefit industry. International Journal of Service Industry Management 6(3), 4–16 (1995)
14. Van Ark, B., Broersma, L., Den Hertog, P.: Service Innovation. In: Performance and Policy: A Review, Ministry of Economic Affairs. The Hague, Netherlands (2003)
15. Froehle, C.M., Roth, A.V., Chase, R.B., Voss, C.A.: Antecedents of new service development effectiveness. An exploratory examination of strategic operations choice. Journal of Service Research 3(1), 3–17 (2000)
16. Nonaka, I., Takeuchi, H.: The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation. Oxford University Press, London (1995)
17. Miller, D.: Configurations of Strategy and Structure: Towards a Synthesis. Strategic Management Journal 7, 233–249 (1986)
18. Nahapiet, J., Ghoshal, S.: Social capital, intellectual capital, and the organizational advantage. Academy of Management Review 23, 242–266 (1998)
19. Gallouj, F., Weinstein, O.: Innovation in services. Research Policy 26, 537–556 (1997)
20. Fitzsimmons, J.A., Fitzsimmons, M.J.: Service Management: Operations, Strategy, and Information Technology, 2nd edn. Irwin/McGraw Hill, Boston (1998)
21. Dewett, T., Jones, G.R.: The role of information technology in the organization: review, model, and assessment. Journal of Management 27, 313–346 (2001)
22. Schreyögg, G.E., Kliesch-Eberl, M.: How dynamic can organizational capabilities be? Towards a dual-Process model of capability dynamization. Strategic Management Journal (28), 913–933 (2007)
23. Please consult the following, `http://www.earto.org`
24. Pavitt, K.: Sectoral patterns of technical change – towards a taxonomy and a theory. Research Policy 13(6), 343–373 (1984)
25. Pavitt, K.: What we know about the strategic management of technology. California Management Review 32(3), 17–26 (1990)

Definition of a Description Language for Business Service Decomposition*

Lam-Son Lê, Aditya Ghose, and Evan Morrison

School of Computer Science and Software Engineering
Faculty of Informatics, University of Wollongong
New South Wales 2522, Australia
{lle,aditya,edm92}@uow.edu.au

Abstract. In the last few years, service-oriented computing has become an emerging research topic in response to the shift from product-oriented economy to service-oriented economy and the move from focusing on software/system development to addressing business-IT alignment. From an IT perspective, there is a proliferation of methods and languages for describing Web services. There has not been as much work in defining languages or ontologies for describing services from business perspectives.

In this paper, we analyze the landscape of service representation and discuss the needs of having a description language for business services. By leveraging existing work on describing service capabilities and properties, we define a specific description language that explicitly addresses the decomposition of business services and their non-functional properties. The language is defined both informally (as a list of descriptive concepts) and formally (by means of meta-modeling and declarative modeling).

Keywords: Service-Oriented Computing, Service Engineering, Strategic Alignment, Business-IT Alignment, Description Language, Metamodeling.

1 Introduction

In the past ten years, software and system modeling have become rapidly growing and high profile topics in the field of information systems. The proliferation of methods for modeling software and systems has expanded dramatically to many different paradigms, including: component-based software development, rapid application development, iterative and incremental development.

Currently, there are two emerging topics of interest: service-oriented computing and enterprise architectures, the focus has shifted from software and system development to the convergence of enterprises, organization and information systems. We deal with not only software and system development, but also the way they are exploited to make business more efficient and effective. Enterprise architecture deals with the alignment between business and Information Technology

* Funding of this research was provided by the Smart Services CRC Initiative http://www.smartservicescrc.com.au/

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 96–110, 2010.

(IT) in order to make the enterprise more competitive (e.g. more cost-effective, better client support) [13]. In service-oriented computing, the goal is to produce a more modular and loosely coupled organizational system, where changes within the organization is managed in a less risky fashion than more traditional major change systems [9].

From an IT perspective, there is a proliferation of methods and languages for representing Web services. There has not been as much work in defining languages or ontologies for describing high-level services from a business perspective. In a broader context, we need a new approach in describing the long-term strategy of an organization and the way it is aligned to high-level business services. There is a need to understand the degree of strategic alignment of a service portfolio to support service re-alignment in the face of changing strategic landscapes.

Motivated by the needs of describing business services from a pure business perspective, we define a specific description language that explicitly addresses the decomposition of business services and their non-functional properties. We base this work on existing work that established basic description for service capability and properties.

The remainder of this paper is structured as follows. Section 2 discusses the needs of a dedicated description language for business services and their decomposition. The description language that we propose for business services is defined in Section 3. Section 4 presents work related to the representation of business services. Section 5 ends the paper by drawing some conclusion remarks and discussing future work.

2 The Needs of Describing Business Services and Their Decomposition

In this section, we discuss why we need a specific description language for business services. Subsection 2.1 addresses the landscape of service representation within which the representation of business services is positioned. Subsection 2.2 describes an example that will be used for formulating the requirements of such a description language. Requirements of a description language for business services are presented in Subsection 2.3.

2.1 Representation of Services

Figure 1 illustrates a description continuum of strategy, goals, services and processes that would be necessary for describing an organization. This continuum has two ends that correspond to the specification and the operationalization of an organization. High-level specifications and long-term strategies appear to the left most side of the spectrum. The granular detail increase towards the right of the figure until operationalization of high-level specifications and strategies is achieved.

To the specification end of the continuum lay the modeling languages for strategy and goals. These modeling languages are used for capturing the vision and the requirements of an organization. Some research has been put forward in this area. The e3 Forces [11] proposes a framework for modeling 3 perspectives of an organization one of which is focused on business strategy modeling. In the InStAl method [16], strategy of an organization is represented in terms of strategic objectives and strategic goals with respect to the vision of the organization's stakeholder. Goal-oriented Requirement Language [19] supports goal-oriented reasoning by establishing correspondences between intentional elements (goal, softgoal, task, believe, resource) and non-intentional elements - which may be imported from an external model, in a scenario. Other researches on goal modeling include Tropos (an agent-oriented software development method based on goal-oriented requirements) [4], GOORE (a goal-oriented method for requirements elicitation) [14] and Lightswitch (definition of early requirements of an enterprise system) [12]. In our group, we are developing a specific method and an associated toolkit that enable the representation of business strategies and business services in a hierarchical approach as well as the alignment between them. This work, which, together with InStAl method [16] and e3 Forces [11], can be classified as Strategy Modeling Language (SML) as illustrated in Figure 1. While GRL primarily deals with goal modeling as the name suggests, SML nevertheless addresses a wider range of high-level strategy and requirements .

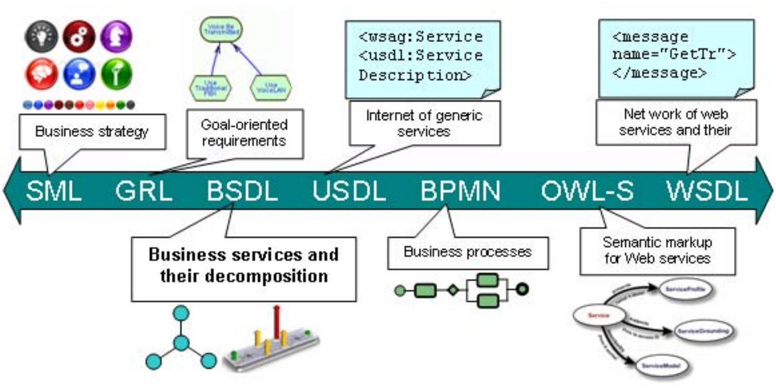

Fig. 1. Representation continuum of services with regard to strategy and goal modeling

Towards the operationalization end, there are different levels of service representation. Business services can be viewed as high-level implementation components that operationalize the organization's strategy. The business services can be decomposed (e.g. by subcontracting) and refined (e.g. by adding properties). This decomposition and refinement may result in a network of generic services that can be represented using Universal Service Description Language (USDL) [1] or Description of Service Capabilities and Properties (DSCP) [10]. A more technical description language such as Web Service Description Language[1] could be used when IT supports such as Web services are needed. OWL-S[2] provides an ontology for describing functionality of web services, how they can be used and how to interact with them.

In this paper, we propose a description language for business services and their decomposition that we call Business Service Description Language (BSDL). It establishes the missing link between GRL and USDL by taking into account service decomposition and looking at services at a higher level than other service description languages do.

It is worth noting Business Process Modeling Notation (BPMN) - the most popular modeling language for business processes [18]. In the representation continuum of Figure 1, BPMN is placed closer to the operationalization end than BSDL and USDL are. This can be judged in the way that business processes are regarded as instances of generic services and business services.

2.2 Motivation Example

Let us consider an example. A large-scale construction company called Bridge-Builder (BB) offers bridge construction as a service. The company can describe this service to their potential clients (e.g. government) as follows: the construction of bridge will be done in a cost-effective, schedule-manageable manner but the total cost and the construction schedule should be negotiated based on technical specification given by the client.

Before building a bridge, the BB company and their client would: (i) detail technical specification, (ii) negotiate schedule constraints and financial issues, (iii) elaborate penalty conditions that may be applied in case the schedular constrains or the technical requirements are not met. After having reached agreement on these details, the BB company would start this business by breaking down the service "Bridge Construction" they offer into four constituent services each of them can be subcontracted to other companies who specialize in a specific area (see Figure 2). The constituent services are

– pre-construction clearance: ground needed for building the bridge is cleared
– pillar construction: pillars of the bridge are constructed
– span construction: spans of the bridge are built
– lighting facility: lighting systems are equipped on the bridge

In Figure 2, each bubble stands for a business service. The text inside each bubble describes the name, schedule obligation and penalty for not meeting the schedule of the service being represented. The four thick arrows coming from the bubble in the center of the figure represent subcontracting.

There are several challenges in describing the "Bridge Construction" service and its decomposition. First, in addition to describing the main function of this

[1] W3C Web Service Description Language `http://www.w3.org/TR/wsdl`
[2] OWL-S: Semantic Markup for Web Services
`http://www.w3.org/Submission/OWL-S/`

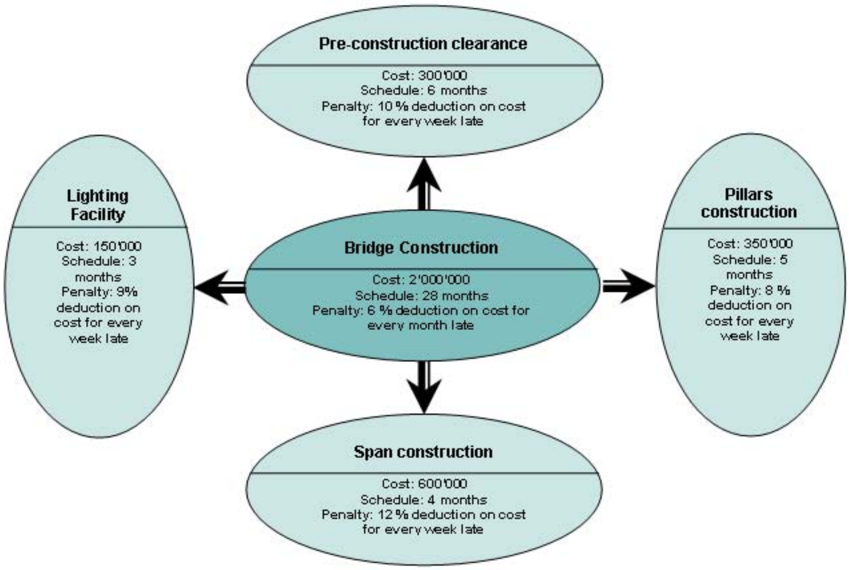

Fig. 2. Decomposition of the service "Bridge Construction" results in distributing its functional and non-functional properties into constituent services

service, we need to explicitly represent its *non-functional properties* including the costs, schedule, penalty as illustrated in Figure 2.

Second, as the the "Bridge Construction" service is decomposed into four *constituent* services, the same extent of description should be achieved for all of its constituent services.

Third, the company that offers one of the consistent services may decide to *further* subcontract, outsource or delegate part of its service, leading to additional service decomposition.

2.3 Description Language Requirements

The challenges pointed out in the previous subsection drive us to formulate the following requirements of a description language dedicated to the representation of business services and their decomposition.

1. **distribution**: functions and non-functional properties of a business service are distributed into constituent services
2. **decomposition**: a set of concepts that can explicitly describe how to break down business services
3. **uniformness**: the above abilities should uniformly be applied across the decomposition hierarchy of business services

In Section 3, we define a description language that addresses the requirements listed above. We call this language the Business Service Description Language (BSDL).

3 Business Service Description Language

This section first gives an informal definition of BSDL (Subsection 3.1). The BSDL is then formally defined by means of meta-modeling (Subsection 3.2).

3.1 Informal Definition of BSDL

The DSCP is a description language for business services [10]. This language addresses the description of both the functional aspect and non-functional properties of a business service. In our understanding, this work has the most detailed description of business services. We base our BDSL on this work[3], particularly in the representation of service capability whilst adding the decomposition of business services. We also take a different approach for formalizing our BSDL (see Subsection 3.2).

In DSCP [10], the functional aspect of business services is captured by service capabilities whilst the non-functional aspect is covered by service properties. We borrow these descriptive concepts while adding more concepts that describe the decomposition of business services and some non-functional properties. Table 1 summarizes the descriptive concepts defined in the BSDL. Each concept is defined in English and is classified either as basic, functional, non-functional, lexical or decomposition. Note that the added concepts are marked with star symbols (*) in this table.

3.2 Formal Definition of BSDL

Meta modeling is a popular approach for formally defining modeling and description languages. In this subsection, we present a meta-model that formally defines the BSDL. Typically, a meta-model has three elements: a diagram, description rules and sample instantiation. The diagram gives visual representation of the concepts defined in the description language being formalized by the meta-model. The diagram also visually shows relationships between these concepts as well as cardinalities and roles specified in the relationships. But diagrammatic representation is usually weak in capturing rules that a description language may have. We need a more formal means to represent the rules. The third element of a meta-model illustrates how instant models of the description language can be instantiated from the meta-model. The existence of this element is necessary to prove that the first element and the second element are consistent and the meta-model as a whole can be instantiated. A non-trivial sample instantiation is usually included in the meta-model for this purpose.

The DSCP [10] is formalized using Object Role Modeling (ORM) [5] - a visual conceptual data modeling technique with the advantage of being able to include a sample population directly in the ORM diagram that helps to validate the model and demonstrate how it is used. In this approach, ORM diagrams give visual representation of the concepts defined in DSCP. The way that ORM include the rules

[3] An online version of DSCP can be found at http://www.service-description.com

Table 1. The building blocks of BSDL are informally defined in English. Some of them are originated from DSCP [10]. The newly-defined building blocks are marked with *.

Concept	Group	Informal definition of element
Business Service	Basic	Represents a high-level service that is provided by a business entity (e.g. an enterprise, an organization, an individual).
Provider	Basic	Represent a business entity (e.g. an enterprise, an organization, an individual). A provider may not be a system that can operate without any human activities. A business service may be provided by more than one provider.
Requester	Basic	Represent a business entity (e.g. an enterprise, an organization, an individual) that requests a business service.
Capability	Functional	Represents the function of a business service does. A business service may have more than one capability.
Rule	Functional	Represents an effect or a pre-condition of a Capability. A capability may have multiple preconditions and effects.
Signature	Functional	Represents input or output of a Capability. A signature can be regarded as a set of parameters.
Parameter	Functional	Captures a piece of information or data that a business service consumes or produces.
Property	Non-functional	Generic non-functional property of a business service.
Obligation	Non-functional	Represents responsibility that both the requester and the provider of a business service must fulfill. An obligation is associated with a penalty.
*Schedule**	Non-functional	Represents an obligation that mandates the time-frame of a business service.
*Environment**	Non-functional	Represents an obligation that mandates how environment-friendly a business service should be.
Payment	Non-functional	Represents an obligation that mandates how the service requester pays the service providers.
Penalty	Non-functional	A non-functional property associated with an obligation. This property represents penalty applied when the associated obligation is not fulfilled.
Price	Non-functional	A non-functional property that represents the amount of money being charged for a business service from the providers perspective. It may be called costs from the requesters perspective.
Lexical Term	Lexical	Represents a lexical term used in describing capabilities and parameters of business services.
Verb	Lexical	Represents a verb used in describing capabilities of business services.
Noun Phrase	Lexical	Represents a noun or a noun phrase used in describing parameters of business services.
Case Description	Lexical	Used for describing attributes (e.g. topic, location) of a Capability.
Ontological Source	Lexical	Contains definition of lexical terms, case descriptions and rules.
*Decomposition**	Decomposition	Represents the manner in which a business service is broken down into a number of constituent services.
*Subcontracting**	Decomposition	A method of decomposing service by which an external service provider is contracted to perform part of a business service. The part that is subcontracted can be regarded as a constituent service.
*Outsourcing**	Decomposition	A method of decomposing service by which a third-party service provider (potentially be an oversea provider) is contracted to perform part of a business service.
*Co-sourcing**	Decomposition	A method of decomposing service by which some part of a business service is performed both by its provider and by some external provider.
*Delegation**	Decomposition	A method of decomposing service by which some part of a business service is assigned to another service provider, usualy a person.

dealing with cardinality and uniqueness of the DSCP concepts and some instant model in their diagrams is an advantage of this approach. However, it is not clear if ORM diagrams can express all kinds of rule defined for a description language.

The meta-modeling approach that we follow in formalizing the BSDL is to use a Unified Modeling Language (UML)[4] diagram and a declarative language based on the first order logic and the set theory called Alloy [2]. By using a declarative language that has capability of processing the first-order logic, we can formalize a wider range of rules than using a diagrammatic approach in ORM. Using UML to represent the meta-model also brings a benefit regarding the potential implementation of BSDL. The UML diagram of the BSDL meta-model can be imported to quickly build a project baseline in Eclipse Modeling Framework[5] - a popular development environment in research community.

Meta-model of BSDL. The way we build a meta-model for BSDL can be summarized as follows. The descriptive concepts of BSDL (see Table 1) are visually expressed in a UML class diagram. The diagram is complemented by a list of description rules (see Table 2) that define the well-formedness[6] of BSDL. The UML classes and the list of description rules are together formalized in Alloy code which allows verification using object-oriented syntax and the capability of processing in first-order logic. This is an advantage of this approach over using UML and a separate constraint language such as Object Constraint Language[7]. Another advantage is that the Alloy language comes with a tool that allows checking the consistency and helps in generating a sample instant model of the formalized meta-model.

Figure 3 is the UML diagram of the BSDL meta-model. Each BSDL descriptive concepts (that is listed in Table 1) is represented as a UML class. Each `Business Service` is connected to a `Requester` and one or more `Provider`(s) through UML composition relations that have the role names `serviceRequester` and `serviceProviders`, respectively. A `Decomposition` connects a decomposed `Business Service` via the `decomposedService` role name and one or more constituent `Business Service`(s) through the `constituentServices` role name. The `Decomposition` is an abstract class of four concrete classes each of which represents a specific decomposition method for business service.

A straightforward way of representing service decomposition is to use the well-known "Composite Pattern" [3]. This pattern is most suitable for situation where there is a clear distinction between leaf nodes and composite nodes. However, the `Business Service` in this meta-model plays both the role of a decomposed service and the role of constituent services. We cannot tell if a business service is no further decomposed in order to qualify as the leaf in the decomposition hierarchy. In addition, by representing the service decomposition as a

[4] UML Resource Page of Object Management Group http://www.uml.org

[5] Eclipse EMF homepage http://www.eclipse.org/modeling/emf/

[6] Well-formedness refers to the way that a model is structured in the fashion expected, which is typically specified in terms of rules that are called well-formedness rules.

[7] OCL Specification http://www.omg.org/technology/documents/formal/ocl.htm

UML class instead of a UML composite relation, we can enrich the meta-model by specializing it and adding attributes.

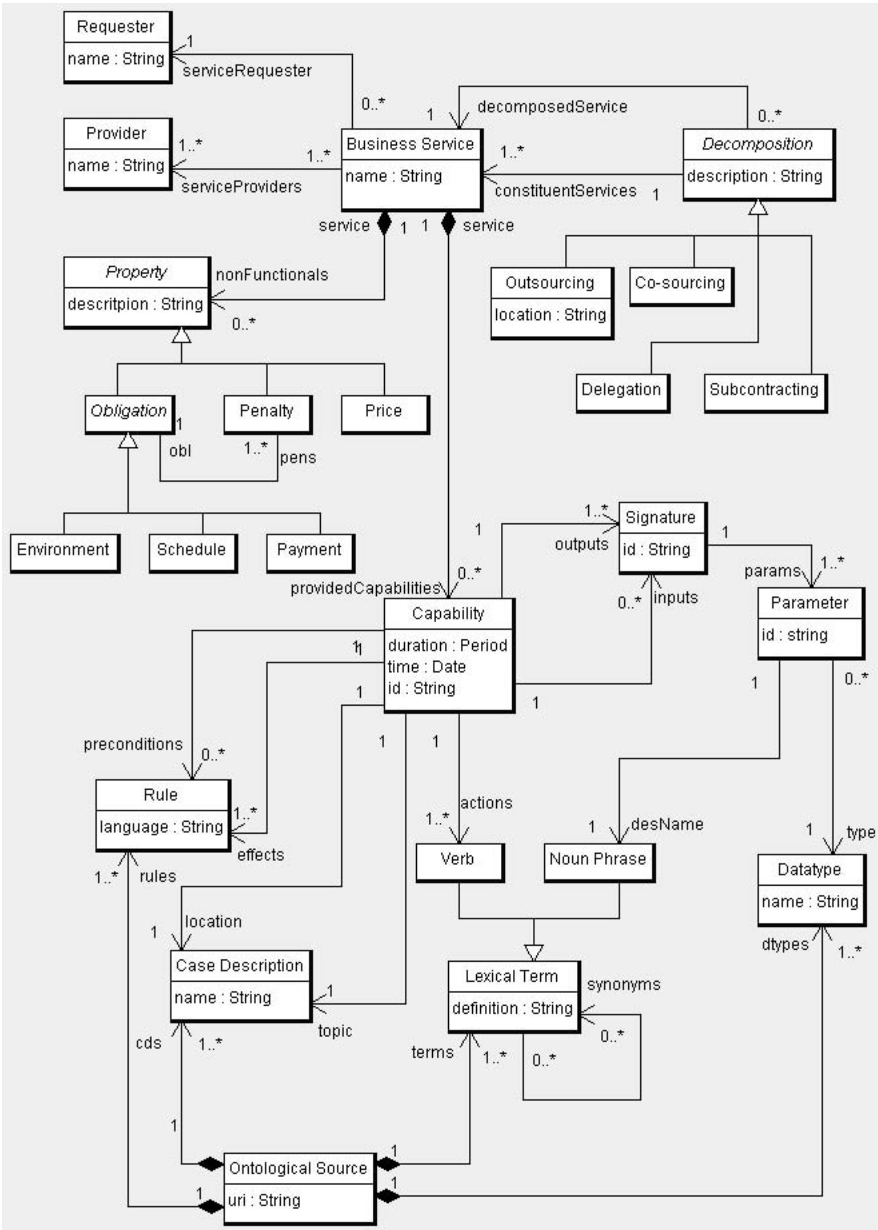

Fig. 3. The descriptive concepts of BSDL and the relationships between them can visually be expressed in a UML class diagram

`Property` is an abstract class that represents a generic non-functional property. This class is connected to the `Business Service` class through a role name called `nonFunctionals`. `Obligation`, `Penalty` and `Price` are subclasses of `Property`. Note that the classes `Obligation` and `Penalty` are connected by a UML association relation in accordance to the definition of the corresponding concepts given in Table 1.

The rest of the UML diagram is actually translated from the meta-model of DSCP [10] that was conceptualized using ORM [5]. Each `Business Service` is connected to some `Capability`(s) through a UML composition relation. A `Capability` is associated to `effects` and `preconditions` all of which are instances of `Rule`. A `Capability` is also associated to `inputs` and `outputs` that are actually instances of `Signature`. A `Capability` is lexically characterized by a `Verb`. A `Signature` has a number of `Parameter`(s) each of which has a `Datatype` and is lexically characterized by a `Noun Phrase`. Note that `Verb` and `Noun Phrase` are generalized into `Lexical Term`. All instances of `Rules`, `Lexical Term` and `Datatype` belong to an `Ontological Source`.

Table 2. Description rules constrain the way instances of BSDL building blocks are put together in a service description model

Rule	**Informal semantics**
Acyclic	There must be no cycle along the decomposition hierarchy of business services.
Mutual	For each business service, all properties and capabilities declared in it must take it as their sole service.
Uniqueness	The set of parameters of two different signatures must be different.
Same service	An obligation and corresponding penalties must be of the same business service.

The UML diagram of Figure 3 offers diagrammatic expressiveness for representing the BSDL descriptive concepts and their relationships but does not cover the well-formnedness of the whole BSDL model other than cardinalities of these relationships. However, the BSDL well-formedness is more than just about cardinality. For example, the decomposition hierachy of business services in BSDL is well-formed if it has no cycle. For this reason, we need a list of description rules that state how instances of BSDL descriptive concepts are put together to make a correct BSDL model. Table 2 lists the description rules of BSDL.

Formalization in Alloy. The UML diagram shown in Figure 3 and the list of well-formedness rules (Table 2) can be formalized together in single Alloy code. As the Alloy language offers an object-oriented syntax, we can translate the UML diagram to Alloy straightforwardly as follows

- A UML class is mapped to an Alloy signature (the `sig` keyword)
- A UML role name is mapped to an Alloy field (to be declared within an signature)

- The UML cardinalities `1`, `0..1`, `1..*` and `0..*` are mapped to the `one`, `lone`, `some` and `set` keywords of Alloy, respectively
- The UML generalization is mapped to the extension mechanism in Alloy with the `extends` keyword
- For the sake of simplicity, we can ignore UML attributes of which types are primitives (e.g. `Date`, `String`) because they are not referred to in the BSDL description rules.

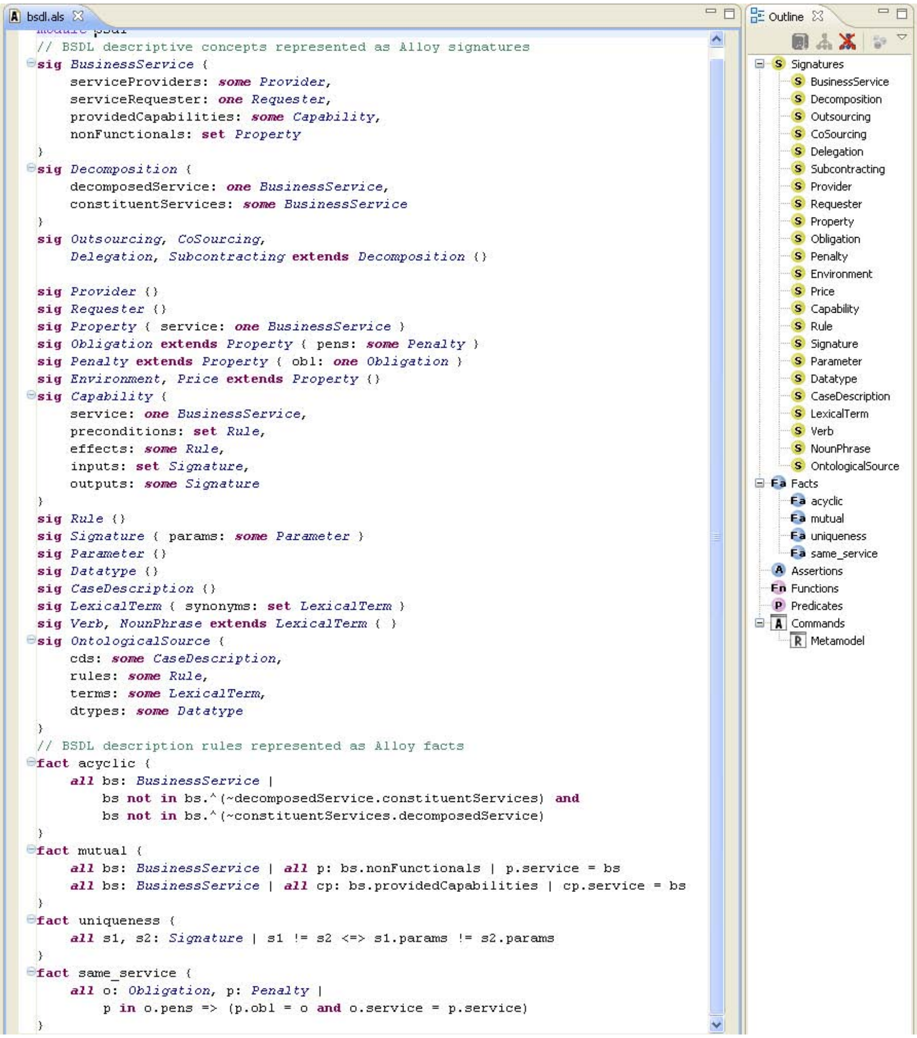

Fig. 4. The meta-model of BSDL is formalized in Alloy. Alloy signatures declare the building blocks while Alloy facts capture the description rules of BSDL.

Translating BSDL description rules to Alloy code can be done in two steps: write first-order logic [15] statements for the BSDL description rules before mapping these statements to Alloy facts (the `fact` keyword). For example, the *Acyclic* rule can be stated as: every business service is found neither the transitive closure of its parent service nor in the transitive closure of its constituent services. This statement is finally translated to the following Alloy formula

```
all bs: BusinessService |
        bs not in bs.^(~decomposedService.constituentServices) and
        bs not in bs.^(~constituentServices.decomposedService)
```

Figure 4 shows the Alloy code that formalizes the BSDL meta-model, including the descriptive concepts and the description rules. There are two panels in this figure. The panel to the left displays Alloy source code whilst its overview is shown in the panel to the right. Note that the names of signatures and fields in the Alloy code match those of the corresponding classes and role names in the UML diagram. Name matching is also observed between the BSDL description rules and the corresponding Alloy facts.

Consistency and Instantiation of the BSDL meta-model. To check the consistency of the Alloy code shown in Figure 4, we need to have it executed. The Alloy language is supported by a tool called Alloy Analyzer[8]. It is possible to add execution and instantiation commands to the code and run it on Alloy Analyzer. If the Alloy code is over-constrained (e.g if there is contradiction between Alloy facts declared in the code), the tool outputs a message notifying that the code is inconsistent and thus no instant model can be generated for it. Otherwise if the code can be instantiated, the tool generates and visualizes an instant model.

Figure 5 displays an instant model generated by the Alloy Analyzer tool. This instant model corresponds to the example presented in Subsection 2.2. In this figure, bubbles and rectangles represent instances of BSDL descriptive concepts. Note that there is text inside each of them. The text has two lines: one is the name of the BSDL descriptive concept, the other (wrapped by parentheses) is the name of the instance the bubble or rectangle represents.

4 Related Work

In this section, we relate the BSDL to existing work on service representation and management. SLA@SOI is a research and engineering project that can embed SLA-aware infrastructures into the service economy[9]. On of the key points of this project is to build an automated e-contracting framework that manages Service Level Agreement (SLA) for business services. However, a specific description language for business services and their decomposition is not addressed.

WSDL and BPEL4WS are dedicated for web services. Obviously, the properties defined in these languages are specific to web services. The decomposition of services can be represented via a mechanism called service invocation.

[8] Downloads and tutorials of this tool are available at `http://alloy.mit.edu/`

[9] SLA@SOI Project `http://sla-at-soi.eu/`

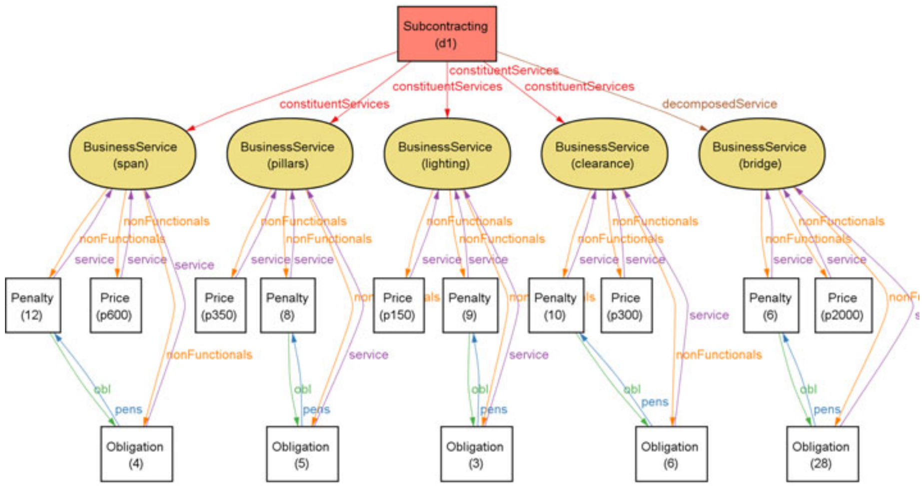

Fig. 5. The "Bridge Construction" example can be instantiated by Alloy Analyzer

The DSCP [10] on which our BSDL is based aims at modeling functional and non-functional properties of business services. To our best understanding, the range of service properties covered in this work is widest among those offered by research work on business service modeling. This work does not deal with the decomposition of business services. In USDL [1], services are considered as generic services that may or may not have technical aspect. Services are coupled from the standpoint of an internet of services. The decomposition of services are not addressed in USDL.

Various work on combining non-functional descriptions with service-oriented architecture has been undertaken. Wenting et. al. offer a weighted metric for service selection based on higher level non-functional goal models [7]. This work relies heavily on domain experts who provide preferences that can be combined to rank and rate the desires of each organization and aid in the decision process for service selection. This work is novel, providing a rank-based preference structure that can be used between higher level strategies and the correlation to services. It complements the work in [8] where a Quality of Service architecture for Web services has been described. The architecture proposed in [8] defines many descriptive terms for services that may be used in an general ontological service framework as well as the mechanics that may be used to incorporate a description language into a complete service provision framework by way of describing many non-functional attributes of services. These articles [7,8] do much in the way of formalizing the required language for service/strategy non-functional descriptions as well as providing implementation mechanisms that would allow services to invoke the ontology; however, the articles offer broad frameworks for representation of services. Key to the representation of services and the higher level business strategy is the vender selection problem[6,17]. In

[17], the authors expand on Weber's early work in vender selection criteria and methods. In this article Weber et. al. identify a series of qualities that a decision system for vender selection must have. They then describe a metric algorithm for the determination of optimal vender number selection. In [6], Kumar et. al. offer a fuzzy goal programming approach to the vender selection problem with multiple objectives, this work breaks down the task of selection using quantitative descriptions of constituent services. All of the aforementioned research does little in the way of framing the problem in a business domain. In this regard much work must be undertaken to resolve inconsistencies between the approaches described above to form a central body or language for describing the relationships between business service providers.

5 Conclusion

Service-oriented computing has become an emerging research topic in response to the shift from product-oriented economy to service-oriented economy and the move from focusing on software/system development to addressing business-IT alignment. In the standpoint of service-oriented computing, services are considered as main vehicle for the operation of an enterprise or organization. Describing services is essential for an organization. There exist description languages that are dedicated to either web services or generic services. From another perspective, describing goals and strategy are necessary for capturing the long-term vision of an organization. To fill in the gap between modeling high-level strategy and the technology-focused representation of services, we define a description language called BSDL from a pure business perspective. The language is dedicated to the representation of business services, in particular the decomposition and non-functional properties of business services.

Future work falls into three directions: (i) improvement of BSDL; (ii) alignment between business services and strategy; and (iii) evaluation. In the first direction, BSDL can be enhanced to cover a wider range of non-functional properties and to provide formal semantics (e.g. by means of first-order logic) for service capabilities and service decomposition. A more technical work is to represent the syntax of BSDL in some markup language. In the second direction, we target the modeling of long-term strategy of an organization and the strategic alignment of business services that the organization offers. The goal of this research is to be able to identify the strategic antecedents of every service and the service-level operationalization of every strategy. In our group, we have an ongoing project where we are developing a specific modeling language for strategic alignment and implementing a toolkit. The definition of BSDL presented in this paper is taken as a baseline for this project. In the third direction, BSDL will be evaluated together with the work on strategic alignment using case-studies provided by industrial partners that get involved in the multi-partner project funding this research.

References

1. Cardoso, J., Winkler, M., Voigt, K.: A service description language for the internet of services. In: Proceedings of First International Symposium on Services Science, Berlin, Germany, March 2009, pp. 1–10 (2009)
2. Jackson, D.: Alloy: a lightweight object modelling notation. ACM Transactions on Software Engineering and Methodology 11(2), 256–290 (2002)
3. Gamma, E., Helm, R., Johnson, R., Vlissides, J.: Design Patterns: Elements of Reusable Object-Oriented Software. Addison-Wesley, Reading (1995)
4. Giorgini, P., Kolp, M., Mylopoulos, J., Pistore, M.: The tropos methodology: An overview. In: Methodologies and Software Engineering for Agent Systems. Academic Press, London (2003)
5. Halpin, T.: Information Modeling and Relational Databases: from conceptual analysis to logical design. Morgan Kaufmann, San Diego (2001)
6. Kumar, M.: A fuzzy goal programming approach for vendor selection problem in a supply chain. Computers & Industrial Engineering 46(1), 69–85 (2004)
7. Ma, W., Liu, L., Xie, H., Zhang, H., Yin, J.: Preference model driven services selection. Advanced Information Systems Engineering 1, 216–230 (2009)
8. Maximilien, M., Singh, M.: A framework and ontology for dynamic web services selection. IEEE Internet Computing 8(5), 84–93 (2004)
9. Huhns, M.N., Singh, M.P.: Service-Oriented Computing: Semantics, Processes, Agents. Wiley, Chichester (2005)
10. O'Sullivan, J.: Towards a Precise Understanding of Service Properties. PhD thesis, Queensland University of Technology (2007)
11. Pijpers, V., Gordijn, J., Akkermans, H.: Business strategy-IT alignment in a multi-actor setting: a mobile e-service case. In: Proceedings of the 10th International Conference on Electronic Commerce. ACM, New York (2008)
12. Regev, G., Wegmann, A.: Defining Early IT System Requirements with Regulation Principles: The Lightswitch Approach. In: Proceedings of 12th IEEE International Conference on Requirements Engineering, USA, pp. 144–153 (2004)
13. Schekkerman, J.: How to Survive in the Jungle of Enterprise Architecture Framework: Creating or Choosing an Enterprise Architecture Framework. Trafford Publishing (2004)
14. Shibaoka, M., Kaiya, H., Saeki, M.: Goore: Goal-oriented and ontology driven requirements elicitation method. In: Hainaut, J.-L., Rundensteiner, E.A., Kirchberg, M., Bertolotto, M., Brochhausen, M., Chen, Y.-P.P., Cherfi, S.S.-S., Doerr, M., Han, H., Hartmann, S., Parsons, J., Poels, G., Rolland, C., Trujillo, J., Yu, E., Zimányie, E. (eds.) ER Workshops 2007. LNCS, vol. 4802, pp. 225–234. Springer, Heidelberg (2007)
15. Smullyan, R.M.: First-Order Logic. Dover Publications, New York (1995)
16. Thevenet, L.-H., Salinesi, C.: Aligning IS to Organization's Strategy: The InStAl Method. In: Krogstie, J., Opdahl, A.L., Sindre, G. (eds.) CAiSE 2007 and WES 2007. LNCS, vol. 4495, pp. 203–217. Springer, Heidelberg (2007)
17. Weber, C.A., Current, J., Desai, A.: An optimization approach to determining the number of vendors to employ. Supply Chain Management: An International Journal 5(2), 90–98 (2000)
18. White, S.A., Miers, D.: BPMN Modeling and Reference Guide. Future Strategies Inc. (2008)
19. Yu, E.S.K.: Towards modelling and reasoning support for early-phase requirements engineering. In: Proceedings of RE'97 - 3rd Int. Symp. on Requirements Engineering, pp. 226–235 (1997)

Can Software Architecture Review Methods Apply to Service Design?

Simon Field*

Glamorgan Business School, University of Glamorgan,
Pontypridd, Wales, United Kingdom and
Office for National Statistics, Newport, Wales, United Kingdom
simon.field@lefert.com

Abstract. Service design is a relatively new discipline, perhaps considered today to be more art than science. A chosen design may affect multiple stakeholders, and its impact may vary across multiple service attributes. It is often therefore difficult to determine whether one service design is preferable to another. This paper presents a review method derived from those adopted by software architects to evaluate competing software architectures. It suggests that the domain of service design shares some significant characteristics with that of software solution architecture, and proposes the adaptation and application of evaluation and review methods that have proved successful in the software solution architecture domain.

Keywords: Service evaluation, service quality, architecture.

1 Introduction

This paper proposes the application of evaluation methods that have been developed for assessing computer software architectures to the domain of service design. It takes as its starting point a definition of software architecture, and examines established methods and standards for describing software quality and evaluating software architectures.

Section 3 considers the domain of service evaluation with particular reference to the field of public services. It considers the complexity resulting from the multi-dimensional nature of impacts caused by changes to services, further compounded by the different perspectives of multiple stakeholders. It also examines the discipline of service design, highlighting the parallels between service design and software systems design that have been identified by numerous commentators.

Section 4 describes a proposed Service Architecture Review Method and accompanying Service Quality Attribute model, and the paper concludes with some suggestions regarding the future areas of research that may be opened up as a consequence of this work.

---

* The author is a DBA student at Glamorgan Business School and Chief Technology Officer at the Office for National Statistics. The research presented here has been sponsored by Public Service Management Wales and the Office for National Statistics.

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 111–124, 2010.

2 Software Architecture

The Software Engineering Institute at Carnegie Mellon University (SEI) has collected over sixty definitions of "Software Architecture", publishing them under "Modern", "Classic", "Bibliographic" and "Community" categories on its web site. The majority of these definitions come from the 1990's, the period when the concept of software architecture became widely discussed among the computer science community.

2.1 What Is Software Architecture?

A seminal work from this period is Software Architecture in Practice by Len Bass, Paul Clements and Rick Kazman[1], the first edition of which was published in 1998. It defines Software Architecture as follows:

"The software architecture of a program or computing system is the structure or structures of the system, which comprise software components, the externally visible properties of those components, and the relationship among them."

Whilst there is clearly not a single form of words that is universally accepted, this definition is widely quoted in associated literature, and lies towards the centre of the set of definitions collected by the SEI.

The authors highlight a number of implications of this definition. An architecture is an abstraction, defining a set of elements, but suppressing those details of the elements that do not relate to how they use, are used by, or interact with, other elements. The definition also implies that systems comprise more than one structure with critical relations between them. The authors suggest this in turn implies that all systems have an architecture, and that the external behaviour of the elements that comprise a system are part of that system's architecture.

The growth in complexity of software systems over time has led to recognition of the importance of abstraction as an aid to communication among the stakeholders of a system, especially during its specification and construction. A representation of the architecture becomes a lingua franca that all stakeholders can speak and understand, as well as serving as a technical "blueprint" for the system that is to be built, modified or analysed.

This growth has also led to increased interest in the relationship between the architecture of a system and the behaviour of that system. Since the architecture encapsulates the external behaviour of the components, it is a combination of those behaviours that will make up the external behaviour of the resulting system. It follows that different architectures can result in different behaviours that might be closer to, or further away from, the set of behaviours most desired by the stakeholders.

2.2 Software Quality

The IEEE Standard for a Software Quality Metrics Methodology describes software quality as "the degree to which software possesses a desired combination of attributes (e.g. reliability, interoperability)"[2]. ISO 9126 [3] is an international standard for evaluating software quality. Part one of the standard (ISO 9126-1) sets out a quality model which classifies software quality in a structured set of characteristics and sub-characteristics (see Table 1 below).

Table 1. ISO 9126-1 Software Quality Model

Characteristic	Sub-characteristic
Functionality	Suitability Accuracy Interoperability Security Functionality Compliance
Reliability	Maturity Fault Tolerance Recoverability Reliability Compliance
Usability	Understandability Learnability Operability Attractiveness Usability Compliance
Efficiency	Time Behaviour Resource Utilisation Efficiency Compliance
Maintainability	Analysability Changeability Stability Testability Maintainability Compliance
Portability	Adaptability Installability Co-existence Replaceability Portability Compliance

It is clear that both the IEEE standard and the ISO standard are referring to the same concepts when the former uses the term “attribute” and the latter uses the term “characteristic” (although the ISO standard uses both terms, and makes a clear and well argued distinction between them). The term “quality attribute” is in more common usage for this concept, even if the ISO standard's use of “quality characteristic” is more precise, and so the remainder of this paper will follow the majority in using the term “attribute”. Many more quality attributes have been proposed by others, with a catalogue of over sixty being listed in Wikipedia [4].

In Quality Attributes [5] a technical report from the Software Engineering Institute at Carnegie Mellon University, the authors introduce a generic taxonomy of software quality attributes, and propose “an attribute-based methodology for evaluating software architectures” which involves analysing the trade-off between quality attributes offered by different possible software architectures.

2.3 Software Evaluation

This proposal led to the development of Software Architecture Analysis Method (SAAM) (sometimes referred to as Scenario-Based Architecture Analysis Method) at the Software Engineering Institute, which was the first documented, widely promulgated architecture analysis method [6][7]. Further refinement led to the development and publication of Architecture Trade-Off Analysis Method (ATAM) [8]. Application of this method involves the development of a set of scenarios using a quality model as its basis, and analysing the different trade-offs between these offered by competing alternative architectures. SAAM spawned a number of extensions, and other evaluation methods include Scenario-Based Architecture Reengineering (SBAR) [9], Architecture Level Prediction of Software Maintenance (ALPSM) [10] and A Software Architecture Evaluation Method (SAEM) [11].

A comprehensive comparison of all methods is not possible within the scope of this paper, but a survey of methods published in IEEE Transactions on Software Engineering in 2002 concluded that ATAM is the most suitable method, based on criteria proposed by the authors [12]. A framework for comparing software architecture evaluation methods, published in 2004, also concluded that “only one method, ATAM, provides comprehensive process support” and judged ATAM to be the most mature of the eight methods considered [13].

The value of assessing different architectures lies in the high cost of changing a system once it has been developed. If a system fails to exhibit appropriate behaviour in a key quality attribute it is likely that an inappropriate software architecture has been selected. Correcting such a fault is often difficult, involving fundamental re-engineering of the solution.

Modern software development methods, such as Rational Unified Process [14] and DSDM Atern [15], place the development of the architecture of a system early in the life-cycle, prior to the more labour intensive activity of constructing the software. By conducting an evaluation of possible architectures at this early stage, a project is able to ensure that the most suitable architecture is chosen before most of the resources are committed to the project, increasing the likelihood of a successful project, and maximising the chances that the system will satisfy the wishes of the system's stakeholders.

ATAM involves an intensive review by a team of stakeholders, which might include its developers, the system's owner, some users, and those who will have responsibility for running, operating and maintaining the system. The review team collectively develops a set of scenarios that are placed in the context of the key quality attributes by creating a utility tree (where each leaf node is a scenario, and the branch nodes are quality attributes). The tree is then analysed for each architectural approach that is under consideration, uncovering risks, sensitivity points and trade-off points in the tree and deriving a view of the overall utility of each approach. A major benefit of this evaluation method is that the assessment of different architectural approaches is directly related to those quality attributes that are most important in the eyes of the stakeholders for the system under consideration. It reflects the “multi-attribute” nature of a system's behaviour and exposes the inevitable trade-offs between the different attributes for any one solution.

The Office for National Statistics has developed a variation of this method to conduct its own architecture reviews [16] which evaluates the risk of failing to reach desired goals for quality attributes instead of attempting to measure degrees of utility. The effect is similar, in that it exposes trade-offs between attributes, but ones expressed in terms of risk rather than utility.

The software architecture evaluation methods described above can be characterised as “pre-implementation” evaluations. They evaluate a design before that design has been implemented, and are used to select the most suitable design with the aim of reducing the risk that the eventual implementation fails to satisfy the expectations of its stakeholders.

3 Service Evaluation

The complexity of evaluating services has been the subject of much study, and it is beyond the scope of this paper to offer a comprehensive review of the relevant literature. However, it is interesting to note that a common theme that emerges from much of the literature is the complexity that arises from the multi-dimensional impact of making a change to a service. This section will focus mainly on the work of those exploring public service design and reform, but it is suggested that many of the issues highlighted in the public service arena are more widely applicable to other service industries.

In Evaluating public management reforms [17], the authors highlight the difficulties of evaluating public services and the effects of change. These difficulties relate to the multi-dimensional nature of the criteria, and the authors point out that this is a problem shared with, and stemming from, the difficulty of evaluating organisational performance [18]. This is further complicated by the perspectives that different stakeholders will bring.

The authors go on to consider two criteria that have been proposed by proponents of public choice reform: “efficiency” and “responsiveness”. These are each shown to be multi-dimensional with, for example, cost, quantity and quality all being potential dimensions of “efficiency”, and “responsiveness” being measurable from a variety of stakeholder perspectives [17]. They identify a third multi-dimensional criterion for evaluating public service reforms, “equity”.

In Excellence and Fairness [19], a paper that sets out the UK Government's approach to improving public services, four criteria are proposed for evaluating the extent to which public services can be considered “world class”: “delivering excellent outcomes”, “offering personalised approaches”, “being fair and equitable” and “offering good value for money”. No formal definition is offered, and whilst these criteria are expressed differently from the three mentioned in the previous paragraph, the examples given in the paper show that they are similar multi-dimensional criteria, and that they share many of the same constituent dimensions.

Evert Vedung [20] proposes a taxonomy of evaluation models that clearly illustrates the multi-dimensional nature of the problem facing service evaluators. Among its eleven evaluation models are models for goals, side-effects, stakeholder concerns, client concerns, productivity and efficiency measures.

In addition to the multi-dimensional criteria that might be used to judge a service reform, the service will have multiple stakeholders, each of whom may have a distinct perspective and different objectives for that service.

An example public service stakeholder model can be found in Beyond Boundaries: Citizen-Centred Local Services for Wales [21] (commonly known as “the Beecham review”), which examines the Citizen Model advocated in the Welsh Assembly Government's vision for public services, Making the Connections [22]. It includes the diagram given in Figure 1 below, representing the relationship of services with the public.

Fig. 1. The relationship of services to the public

Taken together with those involved in commissioning, designing and delivering services (only some of which are reflected in the above diagram), this is a starting point for creating a more complete and commonly accepted view of public service stakeholders. It is essentially the same set considered in Evaluating public management reforms [17].

Public services would appear to have a broader range of distinct stakeholders in comparison with those delivered by the private sector. For example, those who are accountable for the delivery of the service may be distinct from those who are responsible for its delivery, and those paying for the service (the source is often ultimately taxpayers' funds) are not necessarily the same as those who use or receive the service. However, in today's world of partnerships and outsourcing, many of these complexities are to be found in both the public and private sector, and so it is suggested that evaluations of all types of service need to consider multiple dimensional impacts from the perspectives of multiple stakeholders.

In the context of services, the term "evaluation" is controversial when applied to an examination of a service before its implementation. In Public Policy and Program Evaluation, the author insists that "evaluation is retrospective", and that "prospective appraisals (i.e., scrutinies of courses of action considered but not yet adopted even as prototypes), are not included in my definition" [20]. He argues that to include prospective (ex-ante) assessments in evaluation would be to allow the concept of evaluation to "become too diluted".

However, he does acknowledge that some leading theorists argue that prospective assessment (ex-ante assessment) does belong to evaluation [20]. Among them, Rossi, Lipsey and Freeman adopt a broader definition of "program evaluation". They include the design of the programme before its implementation among the five domains that may be assessed as part of an evaluation [23].

3.1 Service Quality Model

One service quality model that has been clearly defined and is in widespread use is *Servqual*. It was developed during the 1980s by Zeithaml, Parasuraman and Berry

[24] and is sometimes referred to as RATER, an acronym formed from the model's five dimension; Reliability, Assurance, Tangibles, Empathy and Responsiveness.

Servqual's conceptual model highlights the identification and measurement of five gaps:

1. Not knowing what customers expect (the gap between management's perceptions of customer expectations and actual customer expectations).
2. The wrong service (the gap between management's perceptions of customer expectations and the service quality specifications of the service provider).
3. The service performance gap (the gap between the specifications and actual service delivery).
4. When promises do not match delivery (the gap between service delivery and communications from the provider to the customer).
5. Customers' assessment of service quality (the gap between customer expectations and their perception of what they actually receive).

The focus of Servqual is on customer expectations and the ability of the service provider to meet them. As shown in Section 3 above, the customer is just one of potentially many stakeholders, and so whilst Servqual may seem to be quite comprehensive from the customers' perspective, it cannot be viewed as a comprehensive model of service quality.

3.2 Service Design

Among the earliest publications to recognise service design as a distinct activity was How to Design a Service by G. Lynn Shostack [25]. In it, the author characterises services as "processes" and distinguishes services from products as existing only in time (whereas products exist in both time and space), and as being unable to be possessed. She goes on to apply the analogy of molecular modelling to describing complex entities that may be made up of multiple services and products. The concept of a Service Blueprint is introduced, essentially a process model representing the service to be delivered. The author highlights the relationship between services and computer software systems:

"Since a service is basically a process, service blueprinting rests, as it must, on systems that have been developed to deal with processes, acts and flows. Three systems are relevant: time/motion or methods engineering; PERT project programming; and computer systems and software design." [25]

and later:

"what happens in a computer is often analogous to what must happen in order for a service to be successfully rendered." [25]

More recent development of tools and methods for service design has seen the application of use case modelling, first developed to support systems design in 1986 by Ivar Jacobson [26].

The link between software systems and services goes beyond the fact that services often depend upon systems for their successful delivery. Both services and systems are composed of components that relate to each other, and are performed in time.

They are inherently intangible. As Shostack identified, delivery of services and execution of software systems both involve performing processes.

The discipline of software engineering has also learnt from the real-world example of services. Software components are designed to reflect their architectural component counterparts, and the terminology of services is adopted to describe these components and their behaviour towards "client" components that call upon their functionality. This "service oriented" approach to software design, which is being widely adopted by systems developers, further illustrates the similarities between the design disciplines applicable to both services and software.

In the light of these similarities, it is worth re-examining the definition of software architecture to see whether it might be amended to apply equally to services:

"The software architecture of a program or computing system is the structure or structures of the system, which comprise software components, the externally visible properties of those components, and the relationship among them."

Substituting the words *service* or *process* for the words *software*, *program* and *computing system* results in a definition that is worthy of closer examination:

*"The architecture of a **service** is the structure or structures of the **service**, which comprise **process** components, the externally visible properties of those components, and the relationship among them."*

The implications highlighted by the Software Engineering Institute in the context of software architecture would appear to be equally valid in the context of Service Architecture: the architecture is an abstraction defining a set of elements; services comprise more than one element with critical relations between them. These are conclusions already reached by Shostack, Morelli and other contributors to the field of Service Design [27][28]. We may therefore reasonably reach the same conclusion for Services that Bass et al. reached for software systems: that all services have an architecture.

In the same way that well articulated systems architectures perform a valuable role in the development and maintenance life-cycles of software systems, so Service Architectures can fulfil the same role for services.

4 Service Architecture Reviews

It is beyond the scope of this paper to explore all the potential benefits of considering an architectural perspective when designing services, but one of those worthy of more detailed consideration is the possibility of applying the architecture review methods developed in the context of software systems, as outlined in Section 2 above, to Service Architectures.

4.1 Service Quality Attributes

Given the similarities between services and software systems and the methods applicable to their development, it is perhaps not surprising to see strong similarities between the quality attributes typically considered in software evaluation (described in Section 2) and the dimensions, perspectives and attributes that are typically considered in the field of public service evaluation (described in Section 3). A re-reading of the ISO standard for software quality [3], the model of which appears in Table 1 above, with the context of services instead of software systems in mind, supports this. Of the dimensions or attributes discussed by the various service evaluation authorities cited in Section 3 above, it is perhaps only equity [17] that cannot easily be classified within the ISO 9126-1 model. The authors go on to conclude that equity is itself a composite attribute, and cite the conceptual framework of Le Grand [29] as a means of breaking it down to its constituent attributes. If any of these are desired outcomes of a new service, then it is suggested that these could be classified within the Suitability sub-characteristic of the ISO 9126-1 model.

The concept of equity as a quality attribute may be a key feature that distinguishes public services from those delivered by the private sector. However, consumers have become more aware of environmental and ethical issues surrounding the products and services they purchase in recent years, and so equity may increasingly feature as a desirable Suitability sub-characteristic in both public and private sector services.

Consideration of the Servqual dimensions introduced in Section 3.1 above supports the view that the ISO 9126-1 model could be applied to services. Servqual's *Tangibles* dimension maps to the *Attractiveness* sub-characteristic in *Usability.* Servqual's *Reliability* dimension maps to the characteristic of the same name, but is also represented in the *Accuracy* sub-characteristic in *Functionality.* Servqual's *Responsiveness* dimension is represented in both the *Time Behaviour* and *Understandability* sub-characteristics. *Assurance* can be represented in the *Stability* and *Security* sub-characteristics and *Empathy* can be represented in the *Suitability* sub-characteristic. The fact that the Servqual model maps to just a small part of the ISO 9126-1 model further illustrates how Servqual only covers a portion of the overall service quality landscape.

In the same way that a system can be developed to a number of different architectural approaches, each of which will offer a different set of trade-offs among the quality attributes, so, it is suggested, can a service be delivered according to a number of different service architectures, similarly offering different trade-offs among the service quality attributes. A benefit of adopting an analysis and evaluation of architectural approaches to delivering a new service prior to its implementation is that stakeholders can assess alternative service solutions in terms of the quality attributes and outcomes they most highly value. The use of such an evaluation approach ex-ante will create a benchmark of expectations that can form the basis for any post implementation evaluation, while also improving the alignment of the service design to the intended programme outcomes (hopefully increasing the chances of a successful programme).

4.2 Service Architecture Review Method

Service Architecture Review Method (SARM) takes as its starting point the ATAM approach from the Software Engineering Institute [8] together with ISO 9126-1 as the basis for an accompanying service quality attribute model. We have already seen how the ISO 9126-1 model can be viewed as a superset of the Servqual dimensional model. The language of ISO 9126-1 may at first sight seem difficult to relate to an individual service, but it should be noted that ATAM involves mapping the generic quality attribute model to project-specific scenarios. These scenarios will be expressed in the business language with which project stakeholders should be fully conversant.

Two particular variations from ATAM are proposed for SARM:

a) It adopts the use of risk instead of utility as a means of comparing and contrasting the ability of competing architectures to deliver desired quality characteristics (following the method adopted by ONS);
b) In addition to analysing risk trade-off from a quality characteristic perspective, it adds further perspectives by analysing risk trade-off from the viewpoint of different stakeholders.

For the first of these variations, it is suggested that service designers and stakeholders, especially those engaged in the design of public services, might be more conversant with the language of risk than the language of utility, and that a solution that draws attention to the risk of failure to achieve desired outcomes may be more appropriate and is likely to produce more consistent outcomes. This is particularly likely in the case of public services, many of which involve delivery of critical, even life-saving, services.

The risk model used here is widely used in corporate risk management. Each risk consists of an agreed level of impact (out of five possible levels), and an agreed level of likelihood (also five possible levels). Overall risk exposure is expressed numerically by calculating the product of the impact and the likelihood levels. At ONS, the impact levels range in numeric value from 1 to 6, while the likelihood levels range from 1 to 5. Thus overall risk exposure can range from 1 to 30.

We have seen the importance of assessing services from the viewpoint of different stakeholders. To reflect this in SARM, a stakeholder analysis stage is introduced immediately following the identification and classification of the scenarios to be used in the trade-off analysis. This stage, which is a new extension of ATAM, requires stakeholders to be identified and associated with those scenarios in whose success they have either an "interest" or a particularly "strong interest".

This is used to generate a simple weighting model so that prospective solutions can be viewed through the "eyes" of each stakeholder, with each view focusing on the solutions considering the identified risks associated just with those scenarios in which the stakeholder has an interest.

The method involves a collaborative effort from a team of stakeholders and knowledgeable peers. These should be drawn from the stakeholder roles shown in Figure 1 above, together with those responsible for commissioning, developing, owning and running the service, plus some peer expertise if it can be identified. There are four phases to the process:

1. Identifying and classifying the scenarios,
2. Workshop Preparation,
3. The Review Workshop,
4. Completion of the Review Report.

4.3 Identifying and Classifying the Scenarios

The first phase involves the identification of scenarios that highlight or illustrate significant quality characteristics. The ISO 9126-1 model is used to select the characteristics and sub-characteristics that are of importance to the project. As the sub-characteristics are somewhat abstract, scenarios are created to illustrate the significant sub-characteristics and place them in the specific context of the project. Each scenario is thus associated with a particular sub-characteristic, which belongs to a parent characteristic in the quality model. More than one scenario may be defined for the same sub-characteristic, and not all characteristics or sub-characteristics need be represented by scenarios. Those that are considered significant will vary from project to project.

Each scenario is then considered from a risk impact perspective. The question to be addressed in the case of each scenario is:

What would be the impact if the service delivered by the project fails to satisfactorily achieve this scenario?

An agreed impact level is assigned to each scenario, following the ONS risk model described earlier. Next, the stakeholders who have an interest in the project are identified, and their particular interest in the scenarios is determined. Three levels of interest are possible: "no interest", "interest" and "strong interest". The intention is that this first phase of the SARM process can take place early in the project, once the main goals and scope of the project have been identified and articulated.

4.4 The Review Workshop

The dominant activity in SARM is the review workshop. This should have an appointed chair or leader, for whom facilitation skills are more important than domain knowledge. Since the workshop is likely to involve between twelve and eighteen stakeholders for a whole day, preparation for the workshop is an important activity to ensure that meeting logistics and relevant papers or presentation material are prepared in advance.

Part one of the workshop involves introductions, a description of the business problem or goals of the new service and a presentation of the competing solution approaches. It is assumed that a number of solution approaches, based on different service architectures, have been developed to a sufficient level to allow them to be described, and their strengths and weaknesses to be assessed.

Part two of the workshop involves the collaboration of all stakeholders in conducting a risk trade-off analysis of the competing solution approaches. This is accomplished by collective completion of a matrix, with the scenarios that were identified in Phase 1 as the rows, and the competing solution approaches as columns. The intersecting cells are used to record an agreed level of risk likelihood.

Each scenario is discussed by the stakeholders, considering the context of each solution approach in turn. The aim of the discussion is to arrive at an agreed level of risk likelihood, in accordance with the ONS risk model described earlier. For each cell, this means agreeing the likelihood that the given scenario will not be satisfactorily achieved with that particular solution approach. This measure of likelihood can then be combined with the previously agreed impact level for that scenario, the product of the two representing the overall risk exposure for that combination of scenario and solution approach.

By the end of this analysis, the review team will have completed all of the cells in the matrix. Examination of the matrix will reveal the trade-off between requirements that each solution approach represents. Colour-coding different levels of risk exposure in the matrix can help to highlight these trade-offs.

It is suggested that throughout the workshop, open lists of issues, actions and mitigations should be maintained. ONS experience of conducting software architecture reviews indicates that “it is often the insights that lead to items being placed on these lists that are of the greatest value during the review workshop” [16]. The experience of exploring all approaches from a wide variety of perspectives, among a group of stakeholders each with varying interests, tends to spawn both insight and creativity in terms of issues and solutions.

Another key benefit of the process is the generation of consensus among the team concerning where the greatest risks lie, and which requirements are the most important. It is not uncommon for the architecture review workshop to be the first time that this broad group of stakeholders has met together on the same day in the same location.

The analysis helps the stakeholders understand how the balance of risks lies across the scenario / solution landscape. The purpose of the matrix is not to inform the review team which solution approach they should adopt, but to provide them with better information upon which they can base their decision. This is a decision support, not a decision making, tool.

Since the scenarios have been classified according to the sub-characteristics and characteristics of the ISO 9126 Quality Model, further insights can be sought by aggregating risk burden by Quality Characteristic. One interesting way of examining this information is to calculate an average risk exposure for each characteristic for each solution approach, using all of the scenarios that fall within that characteristic. A total for each solution approach represents a sum total of risk with equal weight applied to each of the six Quality Characteristics.

The aggregate risk measure is not necessarily meaningful in the context of the project, since it has been calculated with equal weight placed across each of the six characteristics. Greater insight can be obtained by exploring the same overall information from the perspective of each of the stakeholders. It will be recalled that during Phase 1, the level of interest of each stakeholder in each scenario was recorded. By applying a weighting factor according to the level of interest, the information contained within the matrix can be analysed from the perspective of the risk burden carried by each stakeholder for each solution approach, based on their level of interest in each scenario.

There will inevitably be conflicts among these alternative “views” of the risk trade-off information. The review method does not resolve these conflicts, but it does help the review team to identify and understand them, and to view them from a variety of perspectives. Even where the outcome of a review is not “clear cut”, the method is able to help the review team focus its attention on the areas of risk that need to be addressed with mitigating actions, and the stakeholders whose expectations are most vulnerable.

4.5 The Architecture Review Report

Following the workshop, the chair of the workshop prepares the architecture review report documenting recommendations, issues and the outcome of the matrix analysis for each solution. This report would typically be presented to the programme board to guide the decision on which solution approach will be adopted for the new service.

5 Future Work

This paper has set out the case for applying software architecture review methods to service designs, based on an analysis of the similarities between software systems and services. The proposed Service Architecture Review Method has been described, and adoption of an accompanying service quality attribute model, which was originally developed for software quality, has been recommended. With the exception of the introduction of stakeholder perspectives, all of the elements in the method have been tried and tested in the software world, with ATAM, for example, being in widespread use for the past ten years. However, their application to the domain of service design is in its infancy. It is suggested that the introduction of this discipline to service design can bring substantial benefits; a more thorough examination of alternative designs prior to implementation, consideration of all relevant quality characteristics from multiple stakeholder perspectives and the establishment of a solid basis for post-implementation service evaluation.

The next stage of this research project is the application of the Service Architecture Review Method to a number of service design projects to be chosen from the domain of public services, and the refinement of both the method and the service quality attribute model in the light of that experience.

As indicated in Section 4 above, there is also scope to explore the impact of conducting rigorous service architecture reviews prior to the implementation of a new or changed service on the ability of a review team to evaluate the resulting service post-implementation.

Architecture reviews are just one of the tools and methods that have been evolved over the past ten years following the development of software architecture as a distinct discipline. IT architecture has already given rise to the discipline of Enterprise Architecture, whose reach includes service and business function architecture. However, there may be other "crossover" solutions that have been developed for software architecture but whose applicability to services and service architecture has yet to be fully understood. It is beyond the scope of the current project to explore these in any detail, but it is suggested that this may prove to be a fruitful avenue of exploration for future research projects.

References

[1] Bass, L., Clements, P., Kazman, R.: Software Architecture in Practice, 2nd edn. Addison-Wesley Professional, Reading (2003)

[2] Software Engineering Standards Committee of the IEEE Computer Society. IEEE Standard for a Software Quality Metrics Methodology. IEEE, Los Alamitos (1998)

[3] International Organization for Standardization, ISO/IEC 9126 - Software engineering product quality, International Organization for Standardization (1991)

[4] wikipedia.org, List of system quality attributes - Wikipedia, the free encyclopedia, Wikipedia list of system quality attributes (2009)

[5] Barbacci, M., Klein, M.H., Longstaff, T.A., Weinstock, C.B.: Quality Attributes. Software Engineering Institute, Carnegie Mellon University (1995)

[6] Clements, P., Kazman, R., Klein, M.: Evaluating Software Architectures: Methods and Case Studies. Addison-Wesley, Reading (2001)

[7] Kazman, R., Abowd, G., Bass, L., Webb, M.: SAAM: A Method for Analyzing the Properties of Software Architectures (1994)
[8] Kazman, R., Klein, M., Clements, P.: ATAM: Method for Architecture Evaluation. Software Engineering Institute, Carnegie Mellon University (2000)
[9] Bengtsson, P., Bosch, J.: Scenario-based software architecture reengineering. In: Fifth International Conference on Software Reuse, Proceedings, pp. 308–317 (1998)
[10] Bengtsson, P., Bosch, J.: Architecture level prediction of software maintenance. In: Proceedings of the Third European Conference on Software Maintenance and Reengineering, pp. 139–147 (1999)
[11] Duenas, J.C., de Oliveira, W.L., de la Puente, J.A.: A Software Architecture Evaluation Model. In: van der Linden, F.J. (ed.) ESPRIT ARES 1998. LNCS, vol. 1429, pp. 148–157. Springer, Heidelberg (1998)
[12] Dobrica, L., Niemela, E.: A survey on software architecture analysis methods. IEEE Transactions on Software Engineering 28, 638–653 (2002)
[13] Ali Babar, M., Zhu, L., Jeffrey, R.: A Framework For Classifying And Comparing Software Architecture Evaluation Methods. In: Proceedings of the Australian Software Engineering Conference, pp. 309–318. IEEE, Los Alamitos (2004)
[14] Jacobson, I., Booch, G., Rumbaugh, J.: The Unified Software Development Process. Addison-Wesley, Reading (1999)
[15] DSDM Consortium, DSDM Atern The Handbook, DSDM Consortium (2008)
[16] Field, S.: Evaluating architectural options: ONS experience of conducting architecture reviews. In: MSIS 2009. United Nations Economic Commission for Europe, Oslo (2009)
[17] Boyne, G., Farrell, C., Law, J., Powell, M., Walker, R.: Evaluating Public Management Reforms: Principles and Practice. Open University Press, Stony Stratford (2003)
[18] Connolly, T., Conlon, E.J., Deutsch, S.J.: Organizational Effectiveness: A Multiple-Constituency Approach. Academy of Management Review 5, 211–218 (1980)
[19] Cabinet Office Strategy Unit, Excellence and Fairness: Achieving world class public services (June 2008)
[20] Vedung, E.: Public Policy and Program Evaluation. Transaction Publishers, New Brunswick (1999)
[21] Welsh Assembly Government D.F.P.S.A.P., Beyond Boundaries: Citizen-Centred Local Services for Wales (July 2006)
[22] Welsh Assembly Government, Making the Connections: Delivering Better Services for Wales (2004)
[23] Rossi, D.P.H., Lipsey, M.W., Freeman, D.H.E.: Evaluation: A Systematic Approach. Sage Publications, Inc., Thousand Oaks (2003)
[24] Zeithaml, V.A., Parasuraman, A., Barry, L.L.: Delivering Quality Service: Balancing Customer Perceptions and Expectations. The Free Press, New York (1990)
[25] Shostack, G.L.: How to Design a Service. European Journal of Marketing 16, 49 (1982)
[26] Morelli, N.: Designing Product/Service Systems: A Methodological Exploration. Design Issues 18, 3–17 (Summer 2002)
[27] Tassi, R.: Service Design Tools | Communication methods supporting design processes (2009)
[28] School of Architecture and Design at Aalborg University, Designing Product Service System - home, Service Design Wiki (2009)
[29] Le Grand, J.: The Strategy of Equality: Redistribution and the Social Services. Routledge, New York (1982)

Framework for Design Research in Health and Care Services

Eva-Maria Hempe[1,3], Terry Dickerson[1], Anthony Holland[2], and P. John Clarkson[1]

[1] Engineering Design Centre, Department of Engineering, University of Cambridge, Cambridge, UK
[2] Section of Developmental Psychiatry, Department of Psychiatry, University of Cambridge, Cambridge, UK
[3] eh343@cam.ac.uk

Abstract. In England, services addressing the complex needs of people with learning disabilities by integrating health and social care are currently designed in an ad hoc fashion. A structured approach has the potential to address variable levels of service provision and quality as well as provide clarity about the purpose and boundaries of the services. A design process is a series of steps taken to develop a product or process from initial needs to final design specifications and implementation. Currently no structured design process for these complex health and care services exists. Based on a literature review and an extensive set of interviews and observations carried out in a learning disability service we suggest a research framework rooted in engineering design to develop an appropriate design process.

An existing model for design research forms the basis of an exploratory approach that allows for adaptation to different internal and external factors and constraints.

Keywords: Framework, health care, social care, integrated services, learning disability, intellectual disability, design research, design model.

1 Introduction

When designing services which aim to integrate health and social care, one has to address a set of challenges arising from e.g. a wide spectrum of complex user needs, large number of stakeholders, cultural differences between health and social care and a fast changing policy context. A structured set of design steps, a design process, can facilitate this task. However, the utility of such a process depends on its ability to address these particular challenges.

We present a research framework for developing a design process, i.e. how to design the design. Our model is based on an existing framework as a starting point, and it was modified by research carried out in a learning disability service, which served as an exemplar for health and care services.

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 125–135, 2010.

1.1 Learning Disability

According to the American Association on Intellectual and Developmental Disabilities [1], learning disability originates before the age of 18 and involves significant limitations in intellectual functioning and adaptive behaviour as expressed in conceptual, social, and practical adaptive skills. Possible causes can be physical and/or social. An intelligence quotient (IQ) score of 70 or below is generally considered as an indicator for diagnosis, but the exact criteria for a diagnosis may vary between services. While "mental handicap" or "mental retardation" are no longer used, the terms "intellectual disability" or "developmental disability" have the same meaning.

Having a learning disability means having significant cognitive impairments and limitations in adaptive behaviour. The resulting needs can be medical but often go far beyond that. This reflects the main challenge for integrated services. It is no longer sufficient for health professionals to provide treatment and social service professionals to provide care. Instead care has to be understood in a more holistic way. Good health is a prerequisite for delivering social care assistance, such as housing or day services, while on the other side a stable social environment is crucial for wellbeing and effective health care. An appropriate service design process will have to be designed to reflect this. As well as being complex, the care delivery process is also adaptive [2] and this self-modifying behaviour needs to be accounted for, too.

1.2 Services

In the England it is the responsibility of the National Health Service (NHS) to provide health care which is delivered through local primary care trusts. Social care is commissioned by the local authorities, such as county councils. Besides their function as commissioners, local authorities often also provide some services themselves. For learning disability services, health and social care partners sometimes pool resources, with one of the organizations formally leading. In Cambridgeshire, this led to the foundation of the Cambridgeshire Learning Disability Partnership (Cambs LDP) in 2003 under the lead of the Cambridgeshire County Council.

Learning disability services in England and elsewhere in the United Kingdom have seen significant changes over the past two decades. In the 1980s, health care organizations started closing down the residential hospitals where many people with learning disability had lived their whole lives with the aim of returning people to the local communities, a process known as deinstitutionalisation [3]. When dissolving the hospitals, community services started taking their place in caring for the special needs of people with a learning disability. Since around the year 2000, following the Health Act 1999, integrated teams have been formed in which health and social care professionals work together to provide a single care package. These integrated services aim to blend three components: commissioning, providing social care and providing secondary and tertiary health care. Primary care remains a responsibility of the primary care trust. Bringing together expertise from different fields of social care and health services to provide seamless care is particularly important not only because learning disability is a life-long condition but also because of the high levels of co-morbidity [4,5]. Needs range from behavioural and general mental health problems to issues caused by independent and associated physical impairments, including visual or hearing difficulties.

As part of a larger research project on health care delivery, the Cambs LDP allowed us to examine their service development processes and investigate how these could be developed into design processes. In the following, we propose a framework for carrying out this task, based on observations and literature.

2 Service Design

Service design processes bridge the gap between strategic goals and the actual delivery in a systematic way (figure 1). Designing services in an ad hoc way, as it is usually done in the health sector [6], concentrates on a solution for the particular service being designed. On the other hand, a service design process aims to give guidance on how to design a range of services. This provides a stable link between the design objectives and the designed outcomes and contributes to the goal of "getting it right first time".

Design processes impact on the delivery of care via their influence on care processes (figure 2). A care process is a coordinated set of activities within care delivery. This could be a care pathway if defining the patient journey or cross cutting functions such as appointment booking but may equally describe a whole service. Figure 2 is idealized as currently the care provided by most services is still split along the divide between medical treatment and social care. Therefore the feedback loops between delivery and processes are in reality more ambiguous. However, in a truly integrated service this divide should vanish.

Projects have been successfully carried out where a team of designers have worked together with health care experts [7,8]. However, most health care organizations lack permanent expert design capacity. Design capacity is the ability and knowledge to carry out good design and successfully put it into practice. Design processes are determined by the exisiting design capacity. However, good design processes can in return inspire an increase in abilty and knowledge (figure 2).

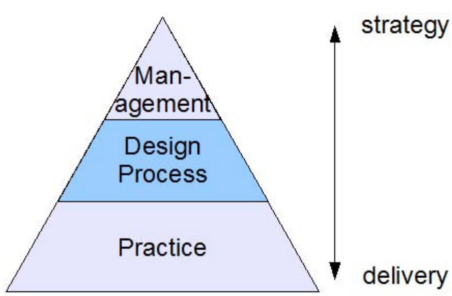

Fig. 1. Connecting delivery and strategy via the design process

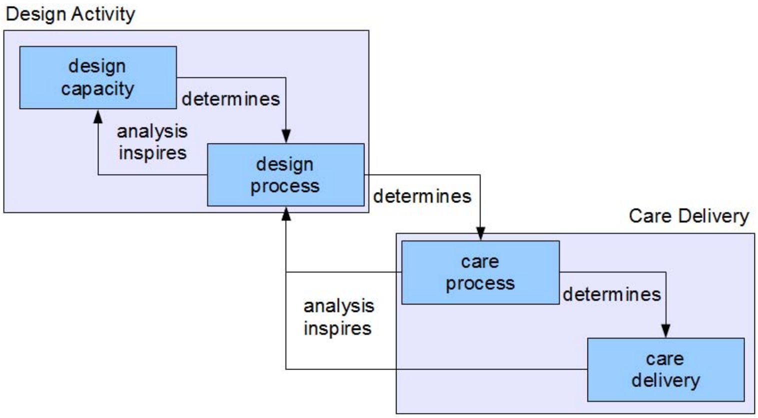

Fig. 2. Idealized relationship between care delivery, the care process and the design process

This could be achieved by hiring people with a design background or affinity for service development roles. A second option is to provide design knowledge and tools to non-specialist designers, specialists in a particular domain without explicit training in design. The options are not mutually exclusive.

Designers will bring design capacity to the organization and are familiar with design processes. This knowledge can be passed on and spread to the people involved in service design and development. If there are no permanent expert designers within an organization, co-developing a design process with experts is a first step in building capacity and can help ensuring that future projects are well designed. Further steps could include the introduction of design tools and looking into which factors are constraining creative solutions. The need for bringing design thinking into health care delivery has been recognized by the NHS which led to an adoption of the Experience Based Design approach for the NHS [9]. This approach consists of design tools and methods which have been successfully applied to service improvement projects [8].

A review of the available literature returned several examples of the application of design thinking to health care services. However there were no existing design processes specific for learning disability services. The existing general models were either too limited in scope [9,10] or too inflexible, lacking a sufficiently wide systems view and exclusively targeted at service improvement [11]. Models used by commercial design agencies also fell short in meeting the requirements we identified in a exploratory study of the issues faced in our exemplary service.

This exploratory study consisted of investigation of the current local practice by interviewing key stakeholders and analyzing documentation. We found that in particular the issues caused by combining two culturally quite different service types, health and social care, were insufficiently or not at all addressed by the existing models. We therefore decided to investigate in more depth how the service was originally developed and continues to evolve in order to draw conclusions on how to build a suitable service design process.

The foundation of the Cambs LDP was driven by national legislation and carried out by the management of the constituent partners. Examining documents from this period and interviewing senior managers, no formal or informal design process is evident. The procedure contained elements of staff and user consultations, drafting business plans and piloting. However, there is no evidence that these were embedded in an overarching process that could assure the link between objectives and outcomes. This ad hoc fashion of developing services is repeated in designing organizational structures as well as individual care arrangements. There are usually design elements, such as a need analysis or a pilot, but a more structured approach can provide more transparency and effectiveness. This could be achieved by designing in creative elements which may lead to innovative and more effective solutions. However, one of the strengths of the current system is that is allows flexibility for the range of conditions a learning disability service has to deal with. Thus a design process must not be too prescriptive.

3 Proposed Research Framework

Blessing and her co-workers proposed a general design research methodology whichw as aimed at improving the process of designing products [12]. In order to successively answer the questions of what is a successful process, how to create it and how to improve the chances of it being successful, they propose starting with problem definition-based success criteria. This is followed by a descriptive study to reveal chains of cause and effect between influencing factors and the success criteria. Based on these insights, methods are then developed in a prescriptive step and the outcomes evaluated in a final descriptive stage. Verification takes place by comparing the final description with the success criteria, as well as the situation pre-intervention.

When this methodological framework was applied to learning disability services, we encountered two main challenges. Compared to product design there is an even larger number of influences to consider. The initial problem definition is usually vague, due to the numerous stakeholders and possible ways of addressing the problem. Thus an initial phase of gaining familiarity with the field is necessary. At the same time, health care services are under public and media scrutiny. The government reacts to these pressures with frequent new guidelines and policies. Between just two strategic plans, one by the local authority and another one by the Cambs LDP, thirteen different influential national policy documents are mentioned [13,14]. This reflects a very fast changing environment to which service designs have to adapt.

The methodological framework put forward by Blessing et al needs also modification, as our aim is not the development of a particular service but rather the design of a general design process for care services. We therefore dedicated a separate stage to the actual development of the design process, which is then, according to the original model, implemented in the prescription phase.

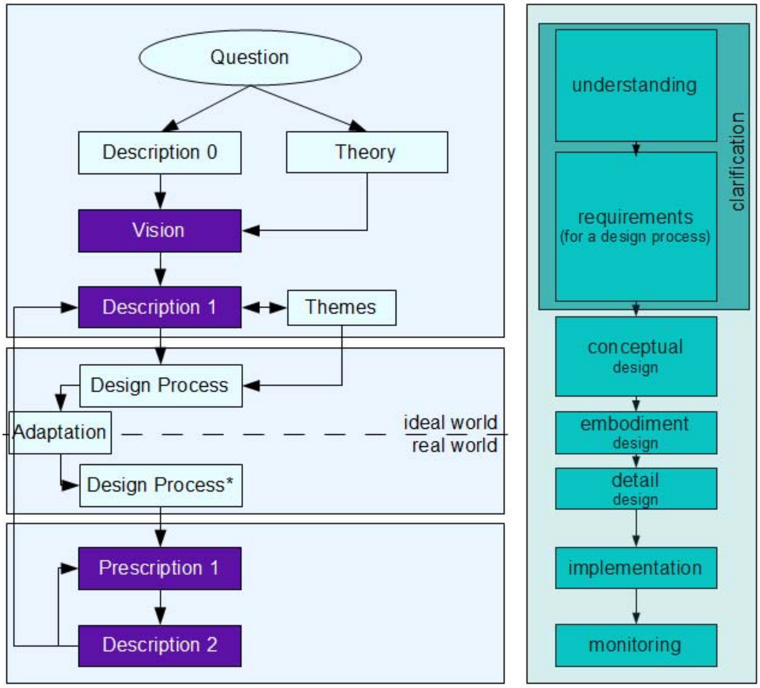

Fig. 3. Proposed research framework corresponding to classical engineering design language (right hand side), according to e.g. Pahl and Beitz [15]. The dark boxes on the left hand side are the stages in the original Blessing et al [12] design research methodology.

3.1 Initial Descriptions of the Design Task

From our experience and from comparing literature [8,16,17,18,19,20,21], we found that in designing a care service the initial problem statement is usually more diffuse than in product design. Although product design is influenced by numerous factors which have to be taken into account, it is ultimately limited by the laws of physics and mechanics. By contrast, in service design the range of options is much wider and knowledge is less centralized. When designing a new product one usually deals with clearly defined roles which are linked to certain pieces of knowledge, e.g. engineers knowing what is technically feasible. This is less so the case in health care services. It might take considerable effort to locate information and subsequently create a common base of understanding. This is in part due to frequent changes in structures and roles which have taken place in the NHS in recent years and poor knowledge systems but also due to different professional viewpoints.

For the product design process put forward by Blessing et al, the initial need has to be sufficiently well defined to derive tangible criteria for success. These criteria serve in the following as the lens for context exploration. When we tried to define criteria for a good service design process, we found that our identified need, a better design process, was too broad to enable us to develop criteria that were meaningful.

The role of a process framework is to provide guidance which steps need to be taken. However, in this case we felt that we would already need to know which steps we want to take in order to be able to use the framework. Thus an exploratory descriptive phase (description 0) was necessary to familiarize ourselves with the field of learning disability services. This included investigating the expected and actual roles of stakeholders and locating knowledge. When complemented with a review of available literature [8,17,15,20], this enables us to develop an idea of what a successful service design would look like. Instead of criteria, we prefer to name this stage *vision*. Criteria imply a fixed set of measures. However, during a project new insights might arise which can lead to a modification of these original measures while the overall goal persists. We therefore separate the general idea behind the solution, the vision, from more defined sub goals or *themes*, which are revisited and modified. These themes will be explored in detail in the more focused *description 1* phase, where the identified vision guides the information gathering. At the end of this phase we aim to obtain a comprehensive set of themes and an in depth understanding of the relevant aspects of the organization.

The requirement of initial knowledge for defining success as well as the iterative process of descriptive work and refining themes, is also observed as a general feature in specific service design projects. As part of a national initiative of the Design Council, a project asked how they could improve the lives of people with dementia and their carers. The team consisted of a design firm and staff from the Alzheimer Society, which provided the background knowledge to shape the initial question into a more general vision. Instead of focusing on measures and medical intervention, the project would look at patients' experiences. Key themes were then derived in an iterative matter and developed into concepts [7]. Applied to our framework for service design, equivalent concepts would e.g. relate to essential elements of design or how the particular environment can be taken into account within the design process.

3.2 Design Process

When designing a service, as in the example of people with dementia, the themes and insights of description 1 are the base for the development of concepts for new services. This is referred to as *prescriptive phase*. However, we aim to develop a general concept of a learning disability design process, which requires some additional modifications.

In the initial description 0 phase, we gained the impression that there are strong external drivers for both health and social care. These influence the structure, priorities and philosophies of the service. One Cambs LDP manager estimated that in the past, the structure of the organization changed about every 18 months. Contrary to the idea of a decentralized NHS, with most of the budgets held by local primary care trusts, which enables care according to the needs of the local community, the major priorities appear to be set externally. One example are the seven outcomes set by the document "Our Health Our Care Our Say" [22], which form the backbone of the Cambs LDP Commissioning Strategy [23]. Failure to comply with these external drivers will have a negative effect on performance indicators or other measures which determine funding levels and trust ratings. This is not likely to change, as health and social care can attract a high level of public interest. Particularly after tragic events this leads to pressure for action, as happened in the case of six people with learning disability whose care and treatment in hospital was well below accepted standards [24]. Thus a general design process needs to be robust and able to adapt to changing policy environment.

To achieve this robustness, we first aim for a model of how to design a service that is un-constrained, i.e. in an *ideal* world. This allows for a consensus on the features of a best-case solution. The adaptation of the process to the conditions of the particular situation will take place through an *adaptation* process; this allows flexibility to adapt to different real world scenarios - given the rapid rate of changes in policy and the frequent restructures - this was deemed an essential feature. The additional advantage of first creating an ideal world design process is that this provides guidance about the conditions to aspire to when implementing new policy or reaction to an organizational restructure. We chose the solution of an adaptation step because we deem it essential to have a clear idea of what the ideal world solution would be, even if current circumstances do not allow for it to be implemented without modifications.

3.3 Prescription and Final Description

The final two phases of the framework are in line with the original Blessing model. Depending on the results of the previous steps, changes and actions are prescribed. For a service this will include the specification of the concept which was agreed upon. For a design process the *prescription* will likely take the form of methods and tools as well as actions linked to the implementation and dissemination. The *description 2* phase is examines the situation after the changes have taken place. Verification is sought by comparing the final with the initial situation, as captured in description 1 and by comparing the final "as is" situation with the intended "to be" situation of the prescriptive phase.

4 Framework as an Engineering Design Process

The right hand column in figure 3 links the design process to the typical language of engineering design. This is to understand the proposed method as a design process in itself and to root it in a tried and tested approach for addressing complexity. The definition of *requirements* stands alone in order to stress its importance for the design process. It is preceded by a stage of gaining a general *understanding* of the problem. In the original model by Pahl and Beitz, these two stages are combined in a *clarification* stage.

The *conceptual* phase will take place towards the end of "description 1" and as the basic features of an ideal design process are determined via the vision and themes. *Embodiment design* is the phase in which the concept is turned into a practical solution. The individual parts, their functions and interrelationships are sketched out without going into detail. In figure 3 this sits between the ideal and the real design process, where a particular solution is selected. Decisions about the structure can be made without knowing the particular situation the process will operate in, but may have to be altered once this knowledge is available. This is the case in the *detail design* phase which is specific to the particular environment and thus has to be done individually for the ideal and the real process. Figure 3 depicts the design of the real world process and therefore omits the ideal world detail design stage. The "prescription 1" is the phase when the design process is actually implemented. The design of the *implementation* and the subsequent *monitoring* are essential to the design process but tend to be neglected by designers, which can lead to the unfortunate situation of a well design product or service failing because of inadequate understanding of adoption and implementation [25]. The prescriptive phase also should be used to verify the design against the requirements set out earlier by asking whether the right sort of service was designed. This is a prerequisite for the later phase of validation where "description 2" is compared with the initial problem specification to assess whether the service has been designed in the right way.

When applied to a typical engineering design problem, the different stages in the Pahl and Beitz model all involve widening the scope, generating a range of options and subsequently narrowing it back down for the beginning of the next phase. In the clarification stage, starting from the initial problem statement, the solution space is widened by analyzing the underlying true needs. Once the real problem is understood, the focus can be narrowed down again by specifying requirements for a solution. This refocusing in order to ensure a thorough exploration of all possibilities is repeated in the conceptual, embodiment and detail design phase. The output of the previous stage is expanded, multiple options are generated and the most suitable one selected to be the starting point for the next phase. The initial phase of our proposed research framework shows the same characteristics. Starting from the question how to design a design process for health and care services, the exploratory phase opened up a wide field of issues concerning to need for and use of such a process. This will be eventually narrowed down to a concise set of requirements. As a complex problem requires a sound exploration of the solution space, it seem likely that the conceptual, embodiment and detail design phase of developing the design process will also be carried out in a similar exploratory fashion.

5 Conclusion

The proposed model is a the design of a design process based on the principles of engineering design. It aims to guide the development of an adequate service design process when existing models fail to address the complexity of the task. This process guides the work of experts and also allows non-experts to incorporate good design in their services. As such it follows steps which can be traced in existing successful service design projects [8].

In this regard, our proposed framework can already serve as a rudimentary design process. However, from our initial observations we feel that a service design process needs more detail to provide meaningful guidance. There are essential features to good service design, such as an analysis of stakeholder purpose and values, which are not covered by the framework.

We identified two main characteristics for health care service design. Firstly, an initial exploratory phase is important to acquire the necessary background knowledge. Secondly, a more gradual build up of success criteria via vision and themes is a more realistic description of the research process. We identified a fast-changing policy context as another issue, which we suggest addressing through a two step process. In the first step agreement is reached on the solution in an ideal world; in the second an adaptation step takes into account the particular circumstances. Changes in context can then be absorbed by the adaptation step and do not require a complete redesign. Rapidly changing context also present a challenge in other fields attracting public interest, such as environment or education. A service design process which addresses this and allows flexibility to react to changes, is more robust and will, ultimately, be more useful.

Notes and Comments. The authors want to thank the staff of the Cambridgeshire Learning Disability Partnership for their support, in particular, Jean Clark, Tracy Gurney and George Hunt. This project is part of the Cambridgeshire and Peterborough Collaboration for Leadership (CLAHRC) in Applied Health Research and Care, funded by the National Institute for Health Research. The authors want to thank the CLAHRC team and, in particular, Dr Isabel Clare, Mark Hall, Alison Lillywhite, Liz Jones and Sallyanne Broughton. EMH also thanks the Gates Cambridge Trust and the EPSRC for their financial support.

References

1. American Association on Intellectual and Developmental Disabilities: Definition: Intellectual disability, http://www.aamr.org/content_96.cfm?navID=20 (accessed 2009)
2. Berwick, D.M.: Developing and testing changes in delivery of care. Ann. Intern. Med. 128(8), 651–656 (1998)
3. Aspray, T.J., Francis, R.M., Tyrer, S.P., Quilliam, S.J.: Patients with learning disability in the community. BMJ 318(7182), 476–477 (1999)
4. Cooper, S.A., Smiley, E., Morrison, J., Williamson, A., Allan, L.: Mental ill-health in adults with intellectual disabilities: prevalence and associated factors. The British Journal of Psychiatry 190(1), 27–35 (2007)
5. Goh, S., Holland, A.J.: A framework for commissioning services for people with learning disabilities. J. Public Health 16(3), 279–285 (1994)
6. Lovlie, L., Reason, B., Mugglestone, M., Rottingen, J.A.: A healthy relationship. Touchpoint 2, 11–19 (2009)
7. Tackara, J.: Would it be Great if.. Dott 07, Design Council, London (2007)
8. Parker, S., Heapy, J.: The Journey to the Interface - How public service design can connect users to reform. Demos (July 2006)
9. NHS Institute for Innovation and Improvement: Experience Based Design, http://www.institute.nhs.uk/ebd (accessed 2009)

10. Campbell, M., Fitzpatrick, R., Haines, A., Kinmonth, A.L., Sandercock, P., Spiegelhalter, D., Tyrer, P.: Framework for design and evaluation of complex interventions to improve health. BMJ 321(7262), 694–696 (2000)
11. NHS Integrated Service Improvement Programme: Roadmap for transformational change (2006), http://www.isip.nhs.uk/roadmap
12. Blessing, L.T., Chakrabarti, A., Wallace, K.M.: An overview of descriptive studies in relation to a general design research methodology. In: Frankerberger, E., Badke-Schaub, P., Birkhofer, H. (eds.) Designers: The Key to Successful Product Development, pp. 42–56. Springer, London (1998)
13. Cambridgeshire Learning Disability Partnership: Joint Strategic Needs Assessment for Adults with Learning Disabilities 2007/2008 (2008)
14. Cambridgeshire County Council: Strategy for the Delivery of Services to People with Disabilities (2006)
15. Pahl, G., Beitz, W.: Engineering design: A systematic approach. Springer, Heidelberg (1988)
16. Morelli, N.: Social innovation and new industrial contexts: Can designers "Industrialize" socially responsible solutions. Design Issues 23(4), 3 (2007)
17. Cottham, H., Leadbeater, C.: Health: Co-Creating Services. Design Council, London (November 2004)
18. Daniels, V., Sandler, I.: Use of quality management methods in the transition from efficacious prevention programs to effective prevention services. American Journal of Community Psychology 41(3), 250–261 (2008)
19. Coiera, E.: Designing interactions. Health Information Management: Integrating Information Technology in Health Care Work, 97 (2003)
20. Duncan, A.K., Breslin, M.A.: Innovating health care delivery: the design of health services. Journal of Business Strategy 30(2/3), 13–20 (2009)
21. Bucciarelli, L.L.: An ethnographic perspective on engineering design. Design Studies 9(3), 159–168 (1988)
22. Department of Health: Our Health Our Care Our Say: a new direction for community services (2007)
23. Hunt, G.: Commissioning Strategy for Learning Disabilities 2008-2011. Cambridgeshire County Council - Disabilities Services (2008)
24. Mencap: Death by indifference (2007), http://www.mencap.org.uk/document.asp?id=284
25. Greenhalgh, T., Robert, G., MacFarlane, F., Bate, P., Kyriakidou, O.: Diffusion of innovations in service organizations: systematic review and recommendations. The Milbank Quarterly 82(4), 581–629 (2004)

Towards an Ontology-Based Approach for Creating Sustainable Services

Anastasiya Yurchyshyna and Wanda Opprecht

University of Geneva, Department of Information Systems
Battelle, CUI, 7 Route de Drize, CH-1227 Carouge, Geneva, Switzerland
{Anastasiya.Yurchyshyna,Wanda.Opprecht}@unige.ch

Abstract. This paper introduces our ontology-based approach for developing sustainable services. After studying the current trends in technology and economy, we underline the importance of the services semantics and the role of ontological domain knowledge in creating intelligent services. We propose to put them into the core of the services information kernel, which capitalizes the knowledge indispensable for defining and creating services. To do this, we develop an approach for creating services based on their information kernel that guarantees their functionality, semantic coherence and sustainability. Finally, we discuss the conceptual methodology of its implementation as a cross-pollination space. The paper is concluded with the perspectives of the ongoing work and the priorities of our future research.

Keywords: Services, services-oriented economy, sustainable services, service support, ontologies, knowledge capitalization, knowledge actionalising, information kernel of services, semantics of services, service innovation, service value creation, creation of usage environment, cross-pollination space.

1 Introduction

The service sector is believed to become one of the major sectors in the global economy that has gained the name of services-oriented economy, where services are put in the core of all economic processes, as well as this, they are widely used in paradigms of conceptual modelling and technical implementation.

The importance of services have significantly increased in the context of the knowledge society [15] and especially, thanks to the development of the information and communication technologies (ITC), which facilitate the development and value (co)creation, as well as remove the geographical boundaries for these processes.

One of the essential characteristics of the current trends in economy and technology is the *service orientation* at multiple levels of technology and business. It states that everything (i.e. good or activity) is seen as a service, and is analysed by an interdisciplinary approach of services science that brings together study, design, and implementation of services in which specific arrangements of people and technologies take actions that provide value for others [10]. Consequently, the service-oriented architecture (SOA) turns out to declare one of the leading visions for the systems development and integration [11]: the services-based systems.

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 136–149, 2010.

It is remarkable that these current services-oriented trends also offer opportunities for information and communication technologies, which are traditionally structured around isolated or specific services, to spread over transdisciplinary branches of science and business, as well as to disseminate interoperable scientific knowledge and the practical intelligence [23] throughout these domains. As a result, services-oriented information and communication technologies contribute to the development of the knowledge society, since they are one of the main characteristics of the knowledge society, from one hand, and they offer tools for co-creation of this new type of economy.

Another difficulty our society has to consider is the problem of sustainable development. In this context, we are interested in the role of services in sustainable development and are particularly focused on the phenomenon of sustainability of services. In this context, the accent is put to sustainable services, which we envisage as services that are capable to adapt to their environment, to dynamically integrate the ever-changing conditions of the environment, and as such to be sustainably coherent with its evolving challenges.

In order to meet these objectives of sustainable development [19], we also study how to use services to identify the sources of added value, to elaborate an approach aimed at facilitating effective diffusion of scientific knowledge and technology transfer, and to develop knowledge infrastructure and networks.

Inspired by these challenges, we thus focus on the complex problem of creating sustainable services, which transversally guides the development of the current society, its economical, technological and social aspects.

This paper is structured as follows. In Section 2, we discuss the current research concerning the different aspects of this problem: service modelling, semantics aspects of knowledge representations and use of domain ontologies, as well as the problem of sustainability, in general, and sustainable services, in particular. Section 3 synthesises our ideas concerning the problem of services development. We introduce our integrated approach for the development of the information kernel, which defines the semantics of services. We also show that the proposed methodology is based on the cognitive knowledge of services, and as such contributes to the development of sustainable services and, moreover, it ensures their sustainability. In order to underline the practical interest of our hypothesis, we propose an ontology-based approach for development of the so called “cross-pollination space” (CPS) that is discussed in Section 4. To conclude, Section 5 identifies some limitations of this ongoing work and defines the scope of the perspectives of this research.

2 Related Research: Services, Ontologies, Sustainability

The central topic of our work is the research in the field of services science. Generally speaking, the notion of services science, or more precisely, Service Science, Management, and Engineering (SSME), is a term to describe an interdisciplinary approach to the study, the design, and the implementation of services systems. SSME includes three parts: Science, Management and Engineering parts [22], and is, in fact, the science resolving the complex interdependence of them.

According to this vision, services are seen as the utilizations of specific competences such as knowledge, skills and technologies of an economic entity for the benefit of another economic entity [16]. In that case, value creation occurs when a resource is turned into a specific benefit. This activity, the *resourcing*, is performed by a *service system*. Consequently, the traditional supply chain is re-conceptualized as a network of service systems, called *a service value creation network* [17].

Services are characterised by four main factors [24, 16]: (i) information is the core element of the design, production and management of services, so services are *information-driven*; (ii) customers are co-producers of services, they may require the adaptation or the customization of services, so services are *customer-centric*; (iii) *digital orientation* of services is explained by the achievements in information and communication technologies, the (semi)automation of main services-oriented activities and the creation of new domains: e.g. e-commerce, e-business, e-collaboration, e-government, e-environment; and (iv) services are driven by the performance criteria and as such are *productivity-focused*.

The second axis of our research is devoted to the problem of increasing the semantics of services and, as a result, of modelled information systems, in which they are (or might be) integrated.

Modelling of services and information systems that integrates them by increasing their semantics is not new. This problem is actively studied by multiple research schools, and various approaches [5, 21] for integrating domain and context knowledge have been developed.

There are three main ideas for the enrichment of the semantics of information systems and services.

First, the most general one is to develop more expressive knowledge bases to be used by services [12].

The second idea details the first one and focuses on the development of domain-oriented ontologies, where knowledge is fed on the usage of information systems and services [26].

The third way of enriching the semantics of information systems and services is based on the hypothesis that there are semantic correspondences between several industry-specific taxonomies. If one identifies the semantic correspondence between taxonomy with lower semantics and the one, which semantics is higher, one can apply the taxonomy from the higher semantics to the system or service, which initial taxonomy was less rich. As a result, it also contributes to the interoperability of information systems and services. This approach was applied in [9] for the interpretation and dissemination of regulations through taxonomies.

Such a general vision of ontologies as instruments for formalising the semantics was one of the keystones for our previous research [27]. In this work, we particularly focused on knowledge capitalisation: i.e. acquisition, representation and dissemination of the domain expert knowledge, which always turns out to be tacit and hardly formalisable. As one of the practical results of this research, we demonstrated the effectiveness of ontologies as knowledge capitalisation tools. Indeed, they allow: (i) formalising domain tacit knowledge; (ii) integrating the results of the usage-based validation of domain ontologies; and (iii) enriching them by the knowledge acquired from the usage of its systems or services. This work also re-questioned the problem of modelling of service-based information systems by integrating two recently most significant approaches: services-oriented and ontology-based ones. In fact, we showed that the integration of these complementary visions into an unique approach is possible thanks to the identification and capitalisation of actionable knowledge [1] resulted from the personalisation and the consumption of content [7] by services and information systems. The extracted actionable knowledge could then be added into the initial domain ontologies. This, from one hand, increases the semantic expressiveness and consistency of domain ontologies, and, from the other hand, can be used by services to dynamically enrich their services semantics.

From a different perspective, the problem of sustainable development has recently regained the interest in the scientific and industrial environments. This phenomenon can be explained by the current requirements of the modern society, the lack of different kinds of resources that are necessary for human activities, as well as the transdisciplinarity of sustainable development. Indeed, this problem is very complex, as it comprises environmental, economical, social, and technological aspects; and needs to be integrated into the process of economic growth and social coherence of our society. This explains a large number of various researches devoted to sustainable development.

In the context of our research, we discuss several research viewpoints that synthesise main characteristics of sustainable development from the side of the knowledge- and services-oriented economy. The identification of the main characteristics of this process helps us to identify the further research challenges related to sustainable development, in general, as well as to clarify the role of services in this process and to guarantee the sustainability of the services, in particular.

The concept of sustainable service has been defined in [8], where the authors identify three factors for sustainable service excellence (or "health factors") which are to be examined in the three phases of the service system lifecycle: infancy phase, maturity phase and reincarnation phase. The first factor is value co-creation: the collective value creation for all parties inside and outside the service system. It represents the mindset of the service system as it guides its activities. The second factor is balancing of innovation and commoditization activity dynamics, which realises the value co-creation goals. The third factor is the configuration of service systems resources, i.e., people, organization, technology and information. These three factors play an important role in service innovation. For example, in [2], the authors present their Sustainable Service Innovation Process (S2IP), which is based on a participatory and collaborative approach to support the development of innovation services. S2IP is made of several iterative processes, such as: Service Value, Service Design, Service Promotion, Service Management and Service Capitalization, which may be executed in parallel. The innovation sustainability of services is then supported through a strong tie with its users.

Generally speaking, the research of the sustainable development reflects the interdependence of cognitive aspects of the exchanged information and the fundamental role of knowledge in sustainable development. In the reflexions on reconstructing the cognitive world [25], the author focuses on recent work in artificial intelligence-oriented robotics, by discussing the nature and status of representational explanation, and whether cognition is computation. This leads to a conclusion of the necessity of the cognitively rich fundamental concepts that, from one side, describe the context of the knowledge society and, from another one, define principles serving as deep assumptions of the sustainability.

The analysis of these various researches leads to the intuitional hypothesis of interdependence between the sustainability of services and the knowledge- and services-based economy. This preliminary analysis helps us to consider that services become the factors and engines for sustainable development. In other words, we aim to show that the development of the society relies on and leads to creating and using sustainable services. These ideas are discussed in more detail in Sections 3 and 4.

3 Towards Sustainable Services

In this section, we introduce our vision on a sustainable service by building its information kernel, as well as by arguing the impact of its kernel on its sustainability.
First of all, let us clarify our understanding of sustainable services. We envisage a sustainable service as a service that is capable to adapt to its environment, to dynamically integrate the ever-changing conditions of this environment, and as such to be sustainably coherent with its evolving challenges.

It is important to underline that the development of our vision on services takes into account three main keystones in the current transdisciplinary trends (i.e. economics, IT, social sciences, etc.). First, we focus on the importance of the semantic consistency of services-related knowledge and the leading role of knowledge in services engineering and implementation. Second, we propose a schematic description of a formal definition of the information kernel that identifies the content of services and the feedback of their usage. Third, we establish a parallel between two essential phenomena that characterize services: the semantic coherence to domain ontologies and the services sustainability. Thus, we argue that the information kernel is in fact the tool and the environment for developing sustainable services that not only takes into account their domain semantics, but also allows enriching it dynamically, according to the results of services functioning and usage.

3.1 Identification and Usage-Based Validation of the Information Kernel of Services

Among main starting points motivating our research on creating sustainable services, we particularly focus on the following ones:

- enriching the semantics of services;
- underlining the importance of the semantic consistency of the corresponding knowledge bases and ontologies;
- identifying the content of services by formalising it as an information kernel; and;
- mutualising the roles of service providers and service consumers ("Service providers are becoming service consumers" [22]) that is typical for services development.

Before presenting our ontology-based approach for developing the information kernel of services and due to the variety of multiple definitions of ontologies in scientific literature and business practices, we find it important to precise the semantics of this term.

In the context of our research, the ontologies for the development of services are viewed as knowledge bases that can be characterised by the following characteristics: (i) ontologies allow the formal representation of the knowledge, which is mandatory for the development of services; (ii) the knowledge defined by ontologies is *non* contradictory *and shared* by domain experts, as well as by users of these services; (iii) this knowledge is *sustainable*: it can not be doubted during the development and usage of services. In other words, this knowledge is valid during the whole services lifecycle.

Another important remark that drives out research on creating sustainable services is the comprehension that a particular attention should be given to the dualistic nature of the design, production and management of services. On one hand, these services-related activities are based on knowledge bases (or ontologies, in a broader meaning). On the other hand, the results of these activities can be capitalised and integrated into services themselves, in order to increase the consistency of initial knowledge bases. This is the main principle that we take into account in the development of the information kernel of services.

To develop the information kernel of services, we propose a three-level ontological model[1]. The first (upper) level is ontological, it comprises all ontologies needed for services functioning: e.g. meta-service ontology, domain ontologies, law ontology containing rules and regulations concerning the modelled domain, organisation and/business process ontologies, etc. The second (lower) level corresponds to the implementation of services: (i) it allows acquiring the usage-based knowledge from the results of the implementation of services; and (ii) the technological implementation: models, technologies and tools used for services design and functioning. The third (intermediate) level is the information kernel itself. It is developed as a conceptual model of the exchanged knowledge, concretises the semantics of services and is based on shared concepts, roles, business rules and integrity constraints of the service (seamlessly connecting the level of ontologies and the implementation level and ensuring the coherence of all service activities).

The development of the information kernel is based on the process of actionalising the knowledge [1] related to services.

First, we define the causality of the actionable knowledge of the practical domain (cf. Figure 1, stage A), i.e. the knowledge from the ontological level that might be useful for services. Second, we detail the scope of the domain knowledge to be actionalised in form of key concepts and relationships between them and the ontological rules for actionalising this knowledge (cf. Figure 1, stage B). Third, we study if they are shareable by all elements at the ontological level, and define those which are (or may be decided) shared (cf. Figure 1, stage C). Fourth, we analyze the results of the implementation (cf. Figure 1, stage D) of services and the semantics of the usage of concepts and relationships of the information kernel (cf. Figure 1, stage E). Fifth, we check if the knowledge acquired from the usage is shareable by all elements of the initial ontologies, transform it in shared concepts and integrate it into the information kernel (cf. Figure 1, stage F). Finally, we modify the initial ontologies (cf. Figure 1, stage G) and the services related to actionalising the knowledge (cf. Figure 1, stage H), in order to dynamically update the information kernel, according to the actionalised knowledge.

Therefore, actionalising of knowledge is the core process of our approach for developing the information kernel of services. It is transdisciplinary, since it relies on services and ontologies, and “cognitive”, since it integrates not only the knowledge of

[1] The first results of this approach were discussed in out previous work [27]. In the context of this research, we present an enriched approach that particularly emphasises the interdependence of services and information systems, which (may) implement them.

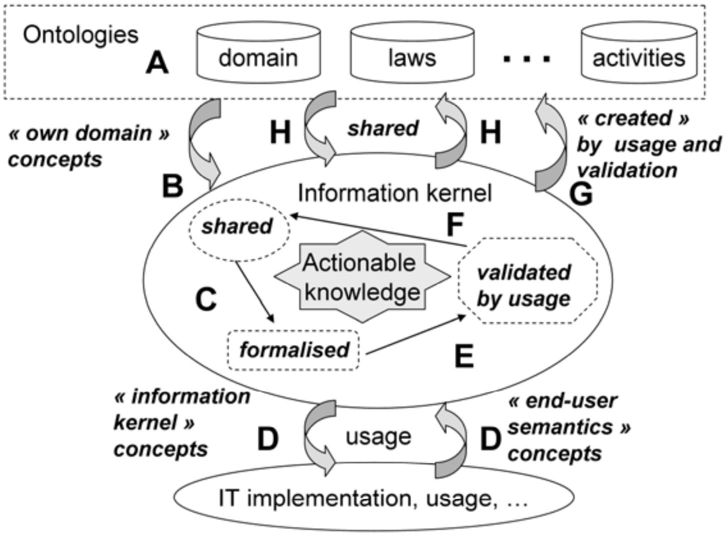

Fig. 1. Information kernel

initial ontologies (e.g. domain ontologies, laws and regulations, etc.), but also the knowledge acquired from the usage of services. The development of the information kernel contains thus the usage-based validation of its semantics *during* the process of usage.

3.2 Co-creation of the Information Kernel of Services and Sustainability

In the previous section, we showed how the development of the information kernel of services is dynamically validated by the usage of these services. This leads us to an idea that the presented methodology preserves and enriches the semantics of services and as such it contributes to the development of sustainable services.

Indeed, the development of the information kernel of services by actionalising the knowledge shows, in fact, that services have a double role in this process: they serve as a tool for such actionalising, and, at the same time, contribute to the creation of the environment, where such actionalising is elaborated. In other words, services are both the tools and the environment of co-creation and usage, in other words, the sustainable development of services.

We particularly underline the practical importance of services for sustainable development that contribute both to the development and implementation of information systems, but also guarantee the coherent co-creation of its fundamental concepts, and as the result, (in its complexity) the sustainable development of the design principles of the knowledge society. We argue that services become the key element for knowledge value creation that is achieved by actionalising the knowledge related to corresponding domain ontologies. We claim that it is the actionable knowledge [1] that forms the basis for the cognitive information.

In the scope of this paper, we do not particularly focus on the interdependence of the phenomenon of sustainability of services and the sustainability of services-based economy: this represents another axis of our future work. However, we find it important to capitalise the conclusion that actionalising of knowledge, as a key component of the information kernel, is the main means to ensure the sustainability of services, since it contributes to the development, implementation and usage validation of the knowledge from services-related ontologies.

3.3 Towards Defining Sustainable Services

While developing our ontology-based approach for building the information kernel of services and demonstrating the impact of the information kernel to sustainability of services (cf. Section 3.1, Section 3.2), we have identified some important aspects that can be envisaged as classifying characteristics for defining a sustainable service.

Let us summarise them in a definition of a sustainable service as follows.

First, according to our initial vision, a sustainable service is a service that is capable to adapt to its environment, to *dynamically* integrate the *ever-changing* conditions of this *environment*, and as such to be sustainably coherent with its evolving challenges.

Second, a sustainable service is dynamically built thanks to its *information kernel* that relies on domain, legal and knowledge ontologies and *defines the semantics* of services.

Third, according to our approach for building the information kernel, we propose a methodology for *capitalising tacit knowledge* related to the usage of services. In other words, we discuss how tacit domain knowledge can be acquired, formalised and enriched in the process of using a service.

Fourth, the dynamic process of building the information kernel also implies the *usage-based validation*. Indeed, some of the knowledge from the information kernel will be dynamically detailed and updated *by practices of usage*, and as such a new semantics will be identified and integrated into the information kernel.

Fifth, sustainable services are largely based on ontologies – formalised as knowledge bases and non-formalised expert knowledge, as well as transdisciplinary common practices. It is thus very important to *ensure this transdisciplinarity* – of ontologies, practices, actors and types of knowledge. One of the possible ways to do this is, to our viewpoint, the introduction of the *cross-pollination space (CPS)* that represents a platform supporting the creation of new domain services. A more detailed description of the CPS is provided in Section 4.

We find it important to underline that the definition of a sustainable service that we schematise in this section is build dynamically, according to its main characteristics, and is only one of the possible definitions. We do not claim its completeness and/or uniqueness, but point to the necessity of the further research on its enrichment. However, we envisage these identified characteristics to be essential for the definition of a sustainable service.

The reflexions on the nature of sustainability presented in this section, as well as the conceptual approach for the development of the information kernel of services, are the milestones of our conclusion that services become the factors and engines for sustainable development. We demonstrated their leading role in value co-creation and showed how this process guarantees the sustainability of services. As a result, the development of the knowledge society might be considered as the one that relies on and leads to creating and using sustainable services.

4 Services-Based Approach for Development of the Cross-Pollination Space

In order to concretize the findings on the development of sustainable services, presented in Section 3, we introduce here the concept and the general framework of a cross-pollination space (CPS), which development is based on the information kernel.

CPS is a platform for enabling the creation of new domain services (domain services examples are: "electronic voting" in the domain of e-Government or "mobile health" in the domain of electronic medicine). This platform aims to support collective, transdisciplinary and co-creative activities for the generation of ideas. It mostly intends to act as support in the innovation phases of a service lifecycle[2] for a sustainable development of this latter. In order to fulfill these criteria of sustainability for the service it aims to support, the platform is built (i) on an information kernel, (ii) around ontological bases, and (iii) to integrate actionable knowledge (via usage-validation).

Briefly, the cross-pollination space originates from the concept of think tank for its transdisciplinary and ideation activities, but also from the Swiss concept of initiative[3], which empowers the Swiss citizens with the right to make a request to amend a constitutional article, or even to introduce a new article into the constitution.

The general frame of the cross-pollination space partly lies on the coordination theory [18] linking the following components (and their respective processes): goals, activities, actors and interdependencies. In order to enrich these components, we add the component `Ontologies` and link it with other ones. Thus, the cross-pollination space bloc components are as follows: `Ontologies`, `Actors`, `Activities` and `Missions` (cf. Figure 2).

One may consider the CPS as a service upon domain services. Indeed, as well as domain services, the CPS is built on top of an information kernel as it has been described above (cf. 3.1). A CPS instance is made of an information kernel which comprehends four aspects : static (classes and relationships), dynamic (transactions), reglementary (integrity rules) and responsibility (actors, roles). The static aspect of the information kernel is derived from a first ontology on the basis of a set of derivation rules. A simple example of derivation rule (DR) from the ontology to the information kernel may be the following:

DR: $\forall c \in$ OntoConcepts, $\forall r \in$ OntoRelations $\forall cl \in$ InfoKernelClasses, $\forall rl \in$ InfoKernelRelations $\rightarrow c=cl \wedge r=rl$

Once this first derivation rule is applied to the initial ontology, three more rules need to be applied in order to build the CPS information kernel from a first ontology:

NR: The necessity rule which requires that each concept/relation be indeed related to the team's mission.

---

[2] A service lifecyle is composed by: Service innovation, Service exploration, Service engineering and Service sustainment.

[3] Rights to a popular initiative `http://www.ch.ch/abstimmungen_und_wahlen/01277/01283/index.html?lang=en]`

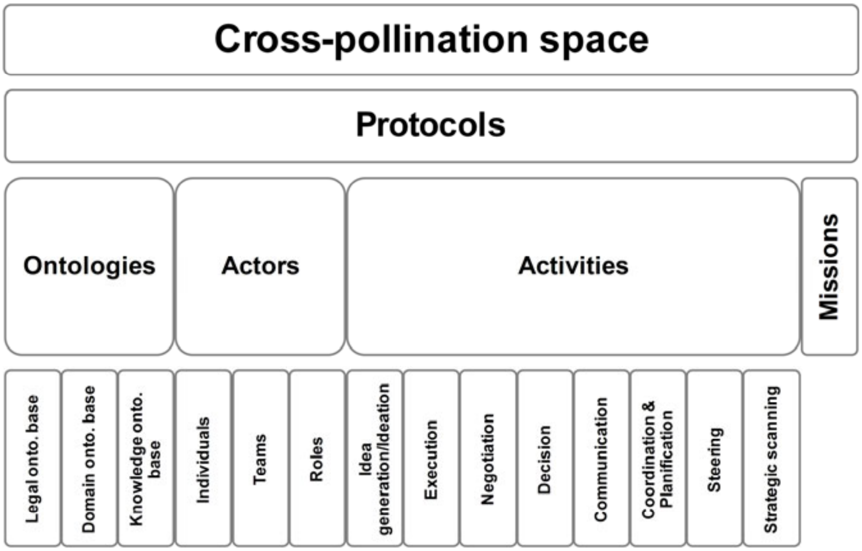

Fig. 2. Conceptual frame of the cross-pollination space

SR: The shared rule which requires that each concept/relation be accepted by the team members as initial shared knowledge base.

IR: The irredundance rule which requires that each concept/relation in the team's members set be irredundant.

Thus, a contextual information kernel is architectured for the CPS instance of one team to support its innovative work towards service innovation.

For the CPS, we define three main types of ontologies: (i) legal ontological base; (ii) domain ontological base; and (iii) knowledge ontological base. The Legal ontological base is the repository where statutory, regulatory and case laws are stored. Fragments of laws are indeed of great importance for the creation of electronic services in several contexts, such as e-government or electronic architecture. E-government services must not only comply with governmental laws from their inception, but should also ensure their compliance to governmental laws when these latter evolve (e.g. the amendment of a law, the abrogation of a law and the introduction of a new law) [13].

The Domain ontological base is fed with expert knowledge on common practices. The knowledge captured in this base is formalised (and as such is explicit). However, its objects of conceptualisation could be of different types: i.e. generic or applicative; and its detail level and its completeness level could be heterogeneous. It provides the cross-pollination space transdisciplinary teams with (i) the knowledge on the different team member's domain (such as for example: industry standards, official statistics, etc.), (ii) the shared and transdisciplinary knowledge produced by them.

The Knowledge ontological base is fed with scientific knowledge. The knowledge captured in this base is formalised (and as such is explicit). However, its objects of conceptualisation could be of different types: i.e. generic or theoretical; and its detail level and its completeness level could be heterogeneous. It provides the cross-pollination space transdisciplinary teams with the knowledge extracted from scientific sources (conference papers, peer reviewed journal articles, etc.).

From these three ontological bases may originate information fragments representing potential source of strategic intelligence, i.e. weak signals. Weak signals are of anticipatory, qualitative, ambiguous, fragmentary nature and of various presentations [3]. Their overlaps may produce significant information carrying a strategic value.

As stated before (cf. 3.1), only the Domain ontological knowledge is validated against the usage, but not the Legal or Knowledge ontological one.

The actors of the cross-pollination space are as follows: (i) Individuals; (ii) Teams (of individuals); and (iii) Roles (of individuals in a team). Within a team, individuals share common missions, but originate from different disciplines. A team may be composed of architects, economists, university professors, artists, psychologists, for example. This transdisciplinarity of domains is seen as a place of fertilization for the co-creation of disruptive innovation in the services. The role of an individual in a team can be: domain expert [4], modelling mediator [4], facilitator [20], model builder [4], collaboration engineer [6], etc.

In order to form a team, individuals gather around one or more missions. A mission is a statement of qualitative and strategic nature which defines a direction and an activity perimeter. It defines the team's ethical and behavioural obligations. Briefly, it is composed by two conceptual attributes: unity (internal coherence) and identity (external coherence). Contrary to goals, a mission cannot be validated against any criteria.

We identify, then, the following main collective activities: (i) Idea generation; (ii) Execution; (iii) Negotiation; (iv) Decision; (v) Communication; (vi) Coordination/Planification; (vii) Steering; and (viii) Strategic scanning.

In this paper, we summarize the activity of idea generation, which grounds on the general patterns of collaboration [14]. The first pattern "Generate" intent is to end with a pool of shared concepts: either by gathering individual concepts, or by creating new concepts or by elaborating existing shared concepts. Here, each of the cross-pollination space's ontologies (legal, domain, knowledge ones) can be a source of a concept, as well as each team's member. It leads then to the second pattern "Reduce" whose intent is to focus the team attention to a set of fewer concepts. The third pattern "Clarify" intent is to add more shared understanding to the latter set of concepts by adding descriptions. The fourth pattern "Organize" intent is to add more shared understanding to the relationship among the latter described concepts. Then, the fifth pattern "Evaluate" intent is to add more understanding of the relative value of the concepts. Finally, the sixth and last pattern "Build consensus" intend is to gather the group members around the commitment of a proposal for an innovative service (cf. Figure 3).

The activity following this ideation process is an activity of execution. It could be a collaborative edition of an article, of a white paper or of a mission statement by example.

A set of protocols (as sets of rules generally governing the communication) are defined at several levels in our cross-pollination space platform: between ontologies and actors, between groups of actors, between activities and missions, to cite a few. We will not go further in details with those protocols here, but we can add that with our

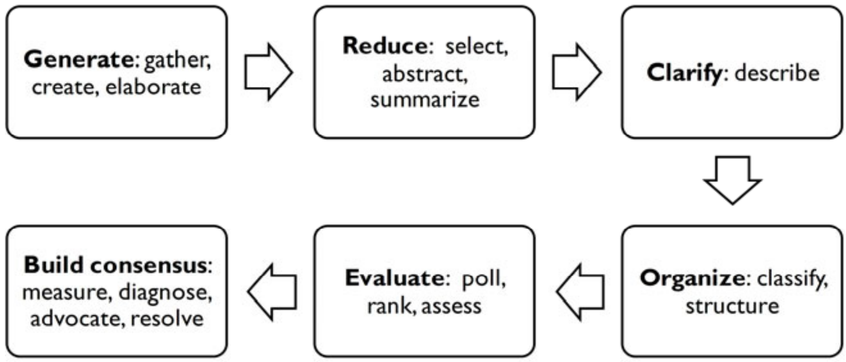

Fig. 3. Idea generation activities

exploratory approach, the usage of the cross-pollination space platform will enable the discovery of new protocols which will be re-injected into the platform.

The creation of the cross-pollination space is our ongoing work and we are currently studying the development of its other activities, as well as evaluating the role of ontologies in this process.

It is important to consider that in the context of this research we do not demonstrate the results of its validation. This task represents another research axis of our ongoing and future work. We envisage doing so by developing a case study that implements the described methodology for the CPS oriented scientific e-conference.

Whilst it is most encouraging to find such a positive response to these methodological explorations, it is also clear that this fundamental area of investigation will likely continue to need more case implementations, to allow grounded conclusions on its validation.

5 Perspectives and Conclusions

In this paper, we introduced our ontology-based approach for developing sustainable services. We first provided a foundation for a thorough understanding of services based on the related ontologies: domain, legal and knowledge ontologies. We described our vision on the development of the information kernel, which synthesises and conceptualised the semantics of services, their main activities and the related exchange of knowledge involved in services usage. Practically, we introduced the conceptual methodology of the implementation of our approach in the form of a cross-pollination space, a platform for enabling the creation of new domain services. Another important contribution of this research is the identification of five essential characteristics of a sustainable service and the proposition of its definition.

Despite the early stages of our transdisciplinary research, its initial investigations are promisingly encouraging. However, it has a number of limitations that we envisage as important perspectives of this research. First, a more detailed formalization of the information kernel is required that will imply the necessary modifications in the methodology for its dynamic development. Second, we are currently working on the formalization of the term of a sustainable service and its theoretical homogenization in the context of SSME. The third axe is devoted to the practical implementation for several use cases of the cross-pollination space and the analysis of its usage. The results of the usage-based validation are to be next integrated into our approach and the theoretical validation of these modifications is to be proven. In general, we envisage a potential in carrying out this work for application in a broader scale from the theoretical point of view, as well as from the point of view of the implementing it as a tool facilitating the idea creation process for transdisciplinary research teams, organizational structures, cultures and inter-organizational relationships.

References

1. Argyris, C.: Actionable knowledge: Design causality in the service of consequential theory. Journal of applied behavioral science (JABHAP) 32(4), 390–406 (1996)
2. Barafort, B., Rousseau, A.: Sustainable Service Innovation Model: A Standardized IT Service Management Process Assessment Framework. In: Software Process Improvement, Communications in Computer and Information Science. Springer, Madrid (2009)
3. Blanco, S., Caron-Fasan, M.L., Lesca, H.: Developing Capabilities to Create Collective Intelligence within Organizations. Journal of Competitive Intelligence and Management 1(1), 80–92 (2003)
4. van Bommel, P., Hoppenbrouwers, S.J.B.A., Proper, H.A., van der Weide, T.P.: Exploring Modelling Strategies in a Meta-modelling Context. In: Meersman, R., Tari, Z., Herrero, P. (eds.) OTM 2006 Workshops. LNCS, vol. 4278, pp. 1128–1137. Springer, Heidelberg (2006)
5. Brézillon, P.: Context modeling: Task model and practice model. In: Kokinov, B., Richardson, D.C., Roth-Berghofer, T.R., Vieu, L. (eds.) CONTEXT 2007. LNCS (LNAI), vol. 4635, pp. 122–135. Springer, Heidelberg (2007)
6. Briggs, R.O., Kolfschoten, G.L., de Vreede, G.J., Dean, D.L.: Defining key concepts for collaboration engineering. In: Proc. of the 12th Americas Conference on Information Systems, Acapulco, Mexico (2006)
7. Cencioni, R., Bertolo, S.: From Intelligent Content to Actionable Knowledge: Research Directions and Opportunities under Framework Programme 7, 2007-2013. In: Meersman, R., Tari, Z. (eds.) OTM 2006. LNCS, vol. 4276, pp. 1125–1131. Springer, Heidelberg (2006)
8. Chen, Y., Spohrer, J., Lelescu, A.: Three Factors to Sustainable Service System Excellence: A Case Study of Service Systems. IEEE SCC (2), 119–126 (2008)
9. Cheng, C., Lau, G., Law, K., Pan, J., Jones, A.: Improving Access to and Understanding of Regulations through Taxonomies. Government Information Quarterly 26(2), 238–245 (2009)
10. Demirkan, H., Kauffman, R., Vayghan, J., Fill, H., Karagiannis, D., Maglio, P.: Service-oriented technology and management: Perspectives on research and practice for the coming decade. Electronic Commerce Research and Applications 7(4), 356–376 (2008)
11. Erl, T.: SOA: Principles of Service Design. Prentice Hall/PearsonPTR (2008) ISBN: 0132344823
12. Gruber, T.: Toward principles for the design of ontologies used for knowledge sharing. In: International Workshop on Formal Ontology, Stanford Knowledge Systems Laboratory Report KSL-93-04 (1993)

13. Khadraoui, A., Opprecht, W., Aïdonidis, C., Léonard, M.: Laws-Based Ontology for e-Government Services Construction Case Study: The Specification of Services in Relationship with the Venture Creation in Switzerland. In: PoEM 2008, pp. 197–209 (2008)
14. Kolfschoten, G.L., de Vreede, G.-J., Briggs, R.O.: Computer Aided Pattern-Based Collaboration Process Design: A Computer Aided Collaboration Engineering Tool. In: Haake, J.M., Ochoa, S.F., Cechich, A. (eds.) CRIWG 2007. LNCS, vol. 4715, pp. 165–172. Springer, Heidelberg (2007)
15. Lavergne, R., Earl, R.: Knowledge management: a value creation perspective. Journal of Organizational Culture, Communications and Conflict (July 2006)
16. Le-Dinh, T., Léonard, M.: A Conceptual Framework for Modelling Service Value Creation Networks. In: 1st International Workshop on Information Technology for Innovative Services (ITIS 2009), IEEE 12th International Conference on Network-Based Information Systems (NBiS 2009), Indianapolis, Indiana, USA (August 2009)
17. Lusch, R.F., Vargo, S.L., Wessels, G.: Towards a conceptual foundation for service science: Contributions from service-dominant logic. IBM Systems Journal 47(1) (2008)
18. Malone, T.W., Crowston, K.: What is coordination theory and how can it help design cooperative work systems? In: CSCW '90: Proceedings of the 1990 ACM conference on Computer-supported cooperative work, pp. 357–370. ACM, New York (1990)
19. Riddleberger, E., Hittner, J.: Leading a sustainable enterprise. Leveraging insight and information to act. IBM Report (2009), `ftp://ftp.software.ibm.com/common/ssi/pm/xb/n/gbe03226usen/GBE03226USEN.PDF` (last accessed on the 08/10/2009)
20. Rittgen, P.: Collaborative Modelling – A Design Science Approach. In: HICSS, pp. 1–10 (2009)
21. Sheth, A., Ramakrishnan, C., Thomas, C.: Semantics for the Semantic Web: The Implicit, the Formal and the Powerful. Intl. Journal on Semantic Web & Information Systems 1(1), 1–18 (2005)
22. Spohrer, J., Maglio, P.P., Bailey, J., Gruhl, D.: Steps Towards a Science of Service Systems. IEEE Computer (1), 71–77 (2007)
23. Sternberg, R.J., Forsythe, G.B., Hedlund, J., Horvath, J.A., Wagner, R.K., Williams, W.M., Snook, S.A., Grigorenko, E.L.: Practical Intelligence in Everyday Life. Cambridge University Press, New York (2000)
24. Tien, J.M., Berg, D.: A case for service systems engineering. Journal of Systems Science and Systems Engineering 12(1) (2003)
25. Wheeler, M.: Reconstructing the Cognitive World: The Next Step. MIT Press, Cambridge (2005)
26. Yurchyshyna, A., Faron-Zucker, C., Le Thanh, N., Zarli, A.: Towards the Knowledge Capitalisation and Organisation in the Model of Conformity-Checking Process in Construction. In: Lovrek, I., Howlett, R.J., Jain, L.C. (eds.) KES 2008, Part I. LNCS (LNAI), vol. 5177, pp. 341–348. Springer, Heidelberg (2008)
27. Yurchyshyna, A., Leonard, M.: Bridging Ontological Vision and Service-oriented Approach for Development of Cognitive Information Systems. In: Accepted and to be published in Proc. COGNITIVE 2009, Athens, Greece, November 15-20 (2009)

Systemic Service Design: Aligning Value and Implementation

Arash Golnam, Gil Regev, Julien Ramboz, Philippe Laprade, and Alain Wegmann

Ecole Polytechnique Fédérale de Lausanne (EPFL)
School of Computer and Communication Sciences
CH-1015 Lausanne, Switzerland
{arash.golnam,gil.regev,julien.ramboz,philippe.laprade, alain.wegmann}@epfl.ch

Abstract. The promise of service orientation is that it enables an organization to prosper by delivering continuous value to customers. This prosperity is of strategic value to the organization. There is value in service orientation for both the organization and its customers. We call these two values, customer value and strategic value. When designing a service it is necessary to align both value propositions with the service building blocks. We propose to use a systemic method where whole and composite reasoning are interleaved on both the organizational and functional dimensions. We begin by producing an as-is model that describes how customer value is delivered by a set of actors and the responsibility of each actor. Improvement opportunities are identified in terms of customer value and strategic value to the organization. A to-be model is built that specifies the new interaction between actors and their new responsibilities. The method is illustrated with an example.

1 Introduction

The IT Infrastructure Library (ITIL) defines the concept of service as, "a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks" [1]. This definition can be split in two parts: 1) a service delivers value to customers by providing them with the outcomes that they desire. 2) The service relieves the customers from dealing with the cost and risks associated with the outcomes they desire. We call the first part the "service offering" and the second part the "service implementation". The ITIL definition reminds us that customers often care more about the value they derive from a service than the way the service is implemented. In most cases a service is offered as a black box, without customers knowing how it is implemented. The service provider, however, must make sure that the implementation is capable of delivering the value expected by customers. Service design is the act of aligning the value (the black box view as seen by customers) with the implementation (the white box view as seen by the service provider). The service provider provides the service to customers for a reason. It benefits directly and indirectly from the relationship with customers. Direct

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 150–164, 2010.

benefits include service payments made by customers. Indirect benefits can be the growth of the customer base leading to more customer payments. Hence, the service provider also finds value in the service. We therefore distinguish between customer value (the value delivered to the customer) and strategic value (the value to the service provider). The service offering includes both these value propositions.

In this paper, we show how to the Systemic Enterprise Architecture Modeling (SEAM) can be used to design the service offering and the service implementation while capturing the customer and strategic value. SEAM designates a family of Enterprise Architecture methods. In this paper, we describe a version of SEAM for service design. For sake of simplicity we call it SEAM rather than SEAM for Service Design. Each SEAM method includes a design process and an enterprise model. The foundations of SEAM are in General Systems Thinking (GST) [2] and in RM-ODP [3]. GST is the study of principles that are applicable to any kind of system (e.g. business system or IT system). RM-ODP is a software engineering ISO standard that provides solid definitions for the SEAM concepts. SEAM is rigorously defined based on these systemic and software engineering concepts (e.g. object, state, behavior). SEAM federates multiple modeling techniques (such as discrete behavior, goals or quantitative models). SEAM has been applied for teaching [4] and consulting [5] since 2001. Prior applications of SEAM to service design have been published in [6] and [7].

The SEAM design process has three phases as illustrated in Fig. 1. First, we analyze the service offering and implementation as-is to identify how well the service offering is aligned with the service provider's strategic value. We then identify the service improvement opportunities. This leads to the redesign of the service offering and implementation. The dashed arrow in Fig. 1 suggests that the method can be applied more than once for continuous improvement.

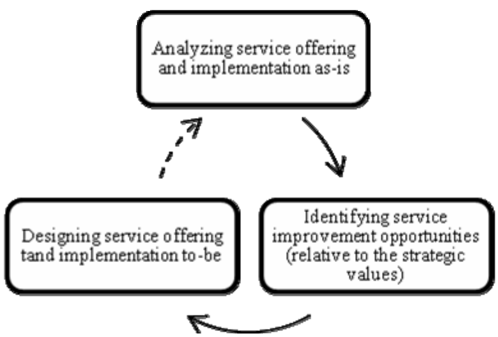

Fig. 1. Phases in design process

The SEAM enterprise model for designing services conceptualizes the service provider and its environment as a hierarchy of systems that includes value segments, value networks, companies, IT systems and employees. Fig. 2 illustrates this hierarchy of systems.

We define a system as a group of entities that interact and that we can consider as a whole (not showing the system's components, also known as black box) as well as a composite (showing the system's components, also known as white box). The concept of system is generic and is independent of the nature of what is modeled. To help the designer, we give different names to the different kinds of systems: the value segment, value network and the company. A value segment is a system made of value networks; a value network is a system made of companies; a company is a system made of employees and IT systems.

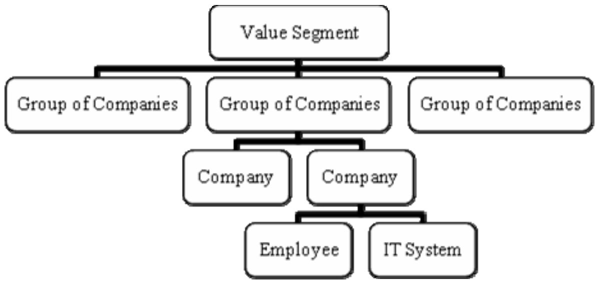

Fig. 2. Hierarchy of systems in enterprise model

A system is either represented as a whole or as a composite along two axes: the organizational axis and functional axis, see Fig. 3. When moving down on the organizational axis, we refine a system into its components. Systems and component systems are represented as block arrows. When moving from left to right on the functional axis, we refine a system's behavior into its component behavior. A behavior is represented as a rounded rectangle. A behavior represents a service offering when it is within a system as a whole. It represents a process when it is within a system as a composite. When moving from the top left corner to the bottom right corner we move from the service offering to the service implementation. This hierarchical representation is only a tool to simplify the conceptualization of a complex reality. We do not imply that the world is hierarchical. However, we can represent reality as a hierarchy in order to simplify the design process, see [8].

In our description of SEAM we make the distinction between us as designers of SEAM and the service provider's project team that uses SEAM for the design of a service. The project team is trans-disciplinary because people of different disciplines design different parts of the service. For example, the service provider's top management and marketing design the strategic value; Experts in finance design the charging system; Marketing experts design the customer value; Experts in logistics design the order fulfillment system.

In all phases of a service design project (Fig. 1), the project team elaborates a single enterprise model for the whole project. The model represents the enterprise and its environment. All changes to the enterprise model are made through the use of diagrams that show different views of the same enterprise model. The two main diagrams are: the system diagram and the supplier/adopter relationship (SAR) diagram. The system diagram represents the hierarchy of systems and the hierarchy of behavior, as shown in

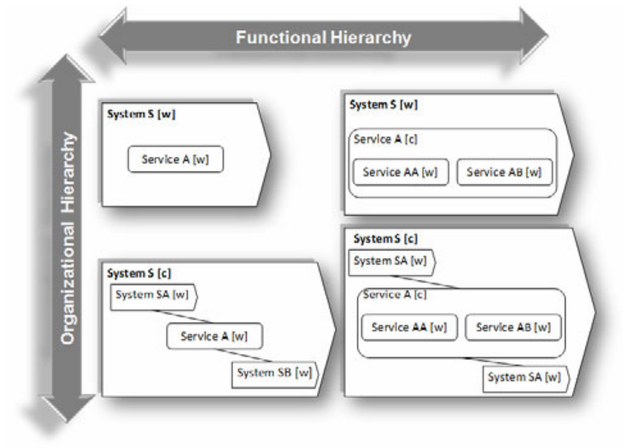

Fig. 3. Double hierarchy in SEAM

Fig. 3. It also includes the building blocks, features and value properties of a service. The SAR diagram represents the relations between these concepts. This paper illustrates the use of these two diagrams use. It does not describe their formal semantics, which is still part of the future work.

We illustrate our method by applying it to the example of service design and implementation at Amazon.com. This example is based on publicly available information about Amazon.com and its market. We describe a hypothetical project, code named A, run by a hypothetical project team, called the A team. Amazon.com was founded as an online bookseller in July 1995. In 1998 Amazon diversified its offering to include new product categories. In November 2000 Amazon introduced the Amazon Marketplace, thereby allowing other companies to place their products alongside Amazon.com's products in the Amazon.com website. Amazon.com is currently offering e-business and IT services to companies of different sizes [9], [10]. In our example, we focus on the transition between selling new books and establishing a partnership with other booksellers to sell used books. We make an as-is model that represents Amazon.com selling new books. We show the misalignment with Amazon.com's future strategy and how the to-be service that enables booksellers to sell used books through Amazon Marketplace might be implemented.

The paper is structured as follows. In section 2, we apply SEAM to the case of service design at Amazon.com. In parallel, we elaborate on the underlying concepts and rationale of our systemic approach. Section 3 includes the related work and in section 4, we present our future work and the conclusion.

2 Designing Service Offering and Service Implementation

In this Section, we detail each phase of the design process defined in Fig. 1. In each phase, we first present the concepts necessary to make the model, and then we discuss the rationale behind these concepts and illustrate them with the example.

2.1 Analyzing Service Offering and Implementation As-Is

In this phase, the A team conceptualizes the service offering and the service implementation as-is. As a result, the team members develop a common understanding of the systems that need to be considered in the service description. This information is captured in two system diagrams and in one SAR diagram.

We represent only the Amazon.com Supplier Value Network as a whole and as a composite (Amazon.com Supplier Value Network [w] and [c] in Fig. 4) because we are only interested in the service provided by this value network. When viewing a value network as a whole, we model the service offering. When viewing it as a composite, we model the interactions between the companies that belong to the value network and that participate in the service implementation; in the Amazon.com case, the Publisher Company, the Distributor Company, ISO (ISBIN), the Credit Card Processing Company, Amazon.com Company, Amazon.com's Bank and the Adopter's Bank. In a real project, the A team would also have to analyze the service offered and the service implemented by Amazon.com itself. In that case, the team would have to analyze Amazon.com as a composite as well as a whole. As the design of the service provided by Amazon.com would be done in the same way as the design of the service done by Amazon.com Value Network. We do not present this here.

Amazon.com Supplier Value Network and the SciFi Book Reader Adopter Value Network are components of a value segment (Fig. 4). The supplier value network provides a service to the adopter value network. We usually model the adopter value network as a composite to show all the entities who benefit from the services. In our example, we represent the reader of SciFi books as well as his/her partners. This is useful to analyze the value that the service brings to the SciFi reader (main adopter) as well as to his or her partners, for example the SciFi Community.

In SEAM, we consider the service as an n-to-n relationship: multiple companies participate in the service and multiple entities benefit from the service (directly or indirectly). In SEAM, we also use very concrete examples to make the model more expressive. In consulting, we even write the name of real people and companies. The originality of SEAM is to combine structured diagrams – that capture part of the theory – together with concrete representations of the reality (e.g. real names, photos). This combination brings rigor and relevance to our workshops.

Systems are characterized by their behavior. Understanding system behavior is essential. Systems as wholes and systems as composites have behavior. In service design, we call the behavior of a system as a whole a "service". The behavior of the system as a composite is called a "process". In the system diagram, we identify three processes: the supplier / adopter process (within the value segment as a composite), the process within the adopter value network as a composite and the service implementation process within the supplier value network as a composite. Processes are necessary to analyze the interaction between sub-systems. Each sub-system provides services to processes. In the system diagram, we identify two services: the one provided by the supplier value network as a whole and the ones provided by the companies within the supplier value network as composite.

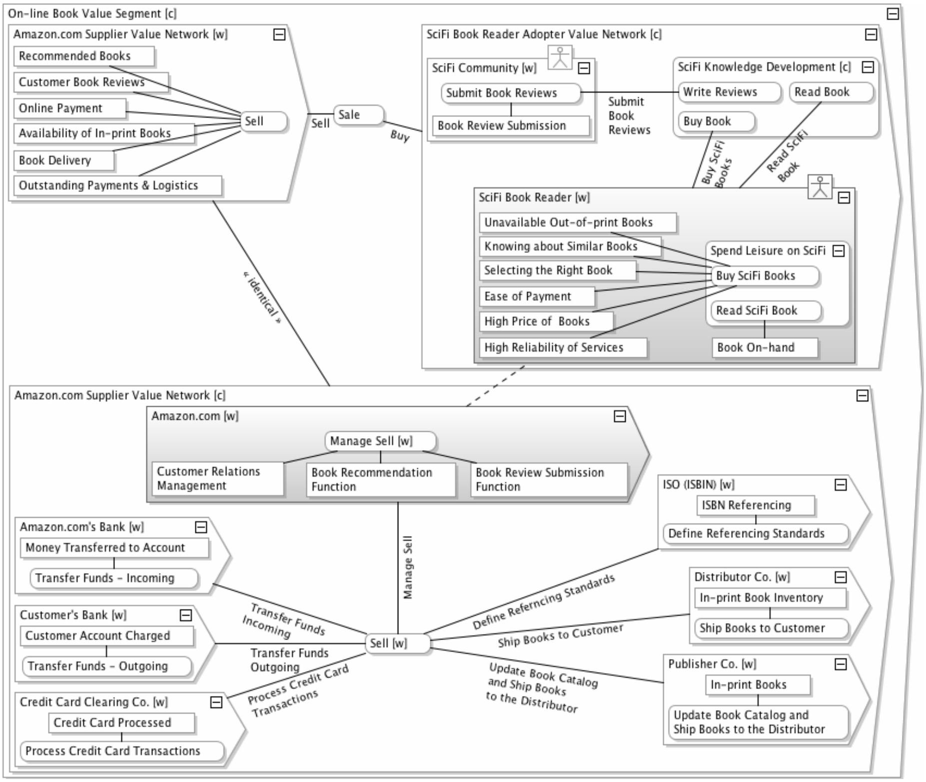

Fig. 4. System diagram, value segment defining the service offering and its implementation as-is, process Sell as a whole

Concretely, in Fig. 4, "Sale" is the process between the Amazon.com Supplier Value Network and the SciFi Book Adopter Value Network. "Sell" within Amazon Supplier Value Network [c] is the implementation process of the service. "Sell" within Amazon Supplier Value Network [w] is the service provided. The "Sell" on the association between the supplier value network and the "Sale" process makes explicit that the "Sell" service is actually related to the process "Sale". The difference between the "Sale" process, the "Sell" service and the "Sell" process is one of the main challenges in designing services. Using a graphical representation greatly facilitates this understanding because it shows the relation between these concepts.

Each system as a whole has properties. Properties are dual to behavior. Properties capture the state of the system. The state is modified by the behavior. When modeling services, these properties have different names depending on how they relate to the service offering/implementation. We define three of them:

- **building block (property)** is a property of a company that implements the service within the supplier value network (as a composite);
- **feature (property)** is a property of the service provided; it is represented in the supplier value network as a whole (independently of who provide the feature);

- **value (property)** is a property of the adopter (or of one of its partners); it represents the value the adopter sees in the service. We define the value as an interpretation by a stakeholder of the worth (positive or negative) of a characteristic of a system; the value is expressed in the vocabulary of the stakeholder. In the system diagram, the properties are represented by rectangles. To be able to reason independently on building blocks, features and value properties are useful to understand the viewpoint of the different stakeholders of the services. Value properties are useful to understand customer value. Building blocks are useful to understand the service implementation. Service features are useful to link building blocks and value properties. Finding convincing value properties is a challenge. We have noticed that modeling real customers (such as someone known and who loves SciFi reading) greatly helps identifying customer value.

In Fig. 4, “Book Recommendation Function” and “Book Review Submission Function” are service building blocks provided by Amazon.com within its VN, “Recommended Books” and “Customer Book Reviews” are the service features and, “Selecting the Right Book” and “Knowing about other Similar Books” are property values on the adopter side. These properties are related. For example, the “Selecting the Right Book” value is related to the “Customer Book Reviews” feature, which is supported by the “Book Review Submission Function” building block. The SAR diagram (Fig. 5) makes these relations explicit and specifies the context in which the property exists. So, using a SAR diagram, the A team represents the mapping between the features and the value (service offering design), and between the building blocks and the features (service implementation design). The SAR diagram is an extension of the house of quality [16] in which the relations between “engineering characteristics” and “customer attributes” is established. We added to the house of the quality who provides the characteristics (the “feature” in SEAM and who benefits from the attributes (the “value” in SEAM).

The SAR is also useful to make explicit who provides which building blocks and who benefits from which feature. It is an essential complement to the system diagram as it illustrates who is involved. Sometimes, on the supplier side, we use the RACI technique to capture the involvement of each supplier. RACI stands for Responsible, Accountable, Collaborate, Informed [11]. On the adopter side, we represent with “++”, “+”, “-“ and “- -“ how the value influence the adopters.

The SAR can represent strategies and – more importantly – how features influence strategic value properties. This is done in a similar way as the modeling of the values for the adopters; it is actually a representation of the values for the suppliers. For example, in Fig. 4, the features of the service affect negatively or positively the values of the provider.

The SAR is useful to verify the alignment between all these properties and to identify service improvement opportunities on the basis of the underlying strategic values of the service. Fig. 5 is a SAR diagram of as-is service building blocks, features and values of Amazon.com.

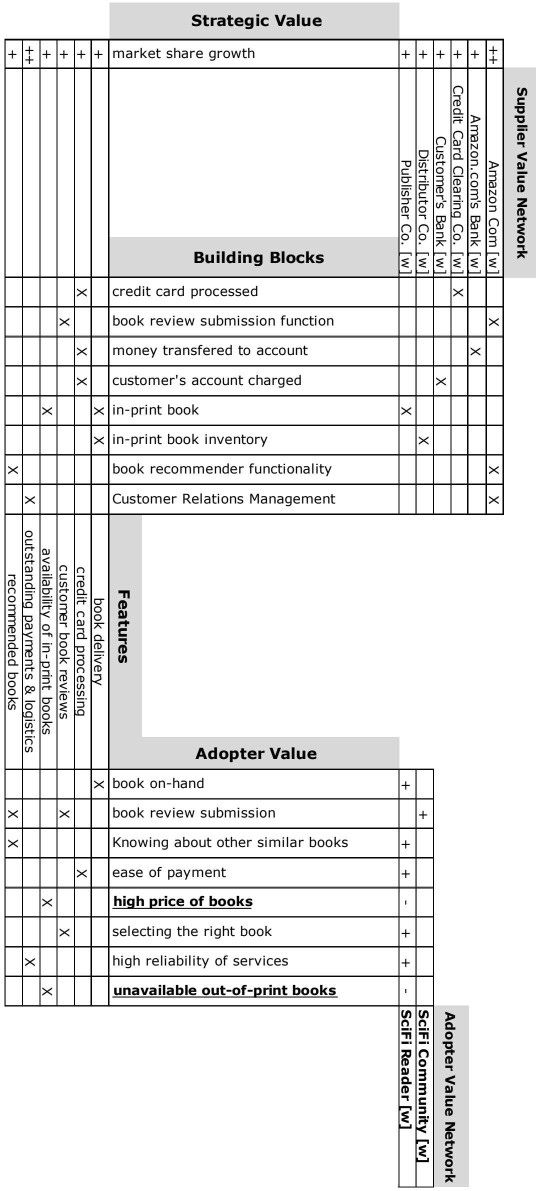

Fig. 5. SAR diagram, service building blocks, features and values as-is. The issues to address are in underline bold

The system diagram can represent behavior at different levels of detail. This is very useful to separate issues related to the outcome of a behavior as opposed to the detailed execution of the same behavior. For example, in Fig. 4, the "Sell" process is represented as a whole. This means that we only care about what is needed for the

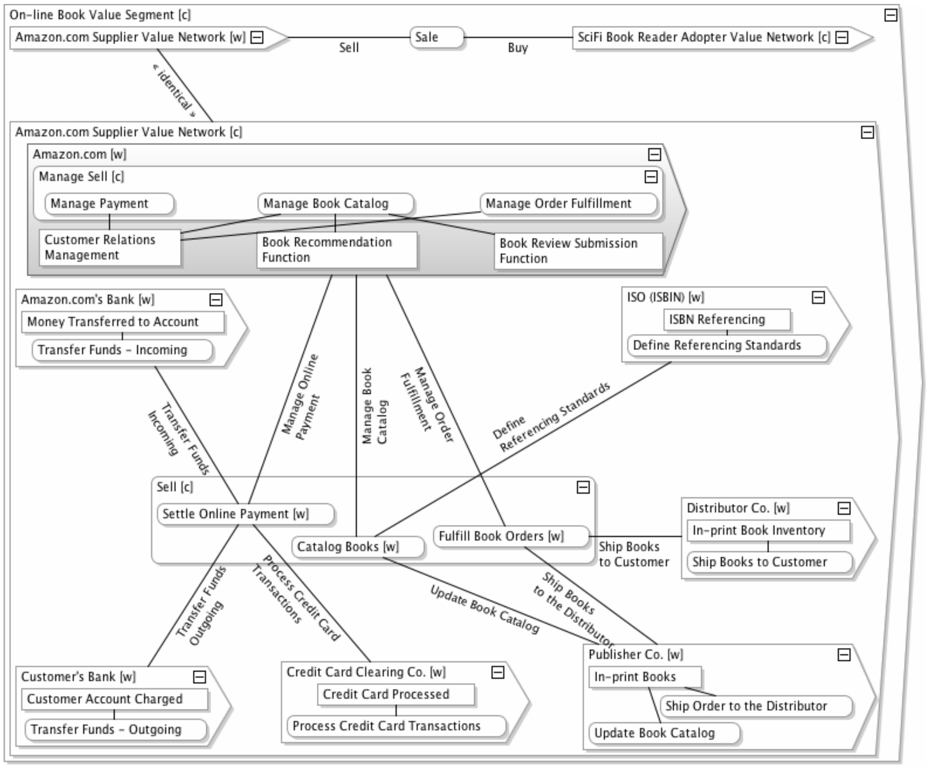

Fig. 6. System diagram, value segment defining the service offering and its implementation as-is, process "Sell" as a composite. This details the responsibilities of each stakeholder.

process to execute and the outcome of the process. In Fig. 6, we represent the "Sell" process as a composite and the details of the process are then visible. In SEAM, we found it very valuable to work on both representations. In most workshops, the representation of the process as a whole is the adequate one. This representation avoids distracting the workshop participants with implementation details.

2.2 Identifying Improvement Opportunities

In this phase of the service design process we seek improvement opportunities in service offering and service implementation. The goal is to achieve a better alignment between the service and the value properties of the adopters and the strategic value of the suppliers. This is done in three steps: (1) Identification of the issues, (2) listing of the alternatives, and (3) selection of the most appropriate solution. The SAR diagram is used in each step.

The issues are identified by analyzing the SAR. In the case of Amazon.com, "high price of books" and the "unavailability of books" are the major factors that negatively impact the customer (Fig. 5). Hence, Amazon.com may fail in achieving its strategic objectives and value (i.e. market share growth) unless the current situation is improved.

Strategic Value: market share growth	Strategic Value: **reduced competition**	Features	**Available out of print books**	**low price of used books**	**large variety of books available**	book on-hand	book review submission	Knowing about other similar books	ease of payment	high price of books	selecting the right book	highly reliability of services	unavailable out-of-print books	Adopter Value Network
							+							SciFi Community [w]
			+	+	+	+		+	+	-	+	+	-	SciFi Reader [w]
+	+	book delivery				X								
+	+	credit card processing							X					
+	+	customer book reviews					X				X			
+	+	availability of in-print books								X			X	
++	+	outstanding payments & logistics										X		
+	+	recommended books						X						
+	++	**multiple booksellers**	X		X									
++	+	**used book available**	X	X	X									

Fig. 7. Proposing service offering to-be. The new value propositions are in underline bold.

Based on these issues, different alternatives can be identified. For example, the high price of the book can be addressed by providing used books, or by providing electronic copies of the book. This last solution might require specific hardware and software solution. The A team needs to evaluate each alternative and to decide which one to develop. This selection process is not detailed in this paper. We make the assumption that providing used book is the selected solution (Fig. 8). Amazon.com offered two new service features to the customer: availability of books from other online booksellers on Amazon.com and selling used books on Amazon.com.

These changes in the service feature, result in creating value on the adopter side such as, providing the customers with “large variety of books”, “lower cost of books” and “available out print books” due to the changes in the service offering.

This is also the right time for the A team to think of the strategic value properties of the supplier. For offering these new features, Amazon.com has to cooperate and compete with the booksellers who sell their books alongside Amazon.com books simultaneously. This coopetitive strategy [12] creates the strategic value of “reduced competition” for Amazon.com while leading Amazon.com delivering value to the customers.

2.3 Designing the Service Offering and Implementation To-Be

In this phase, the A team designs the service to-be. In the previous section, the team identified that a new feature is needed: providing used books. It also recognized the need to have multiple book sellers.

The design is done in three steps. First the model is modified to capture the new value properties and features. To add the service building blocks, it is necessary to add the new actors. In our example, Powell Books and the Powell Books’s Bank needed to be added. These novelties are represented in the system diagram in Fig. 8. The Sell process is not detailed. Thanks to this, it is not needed to design the detail of

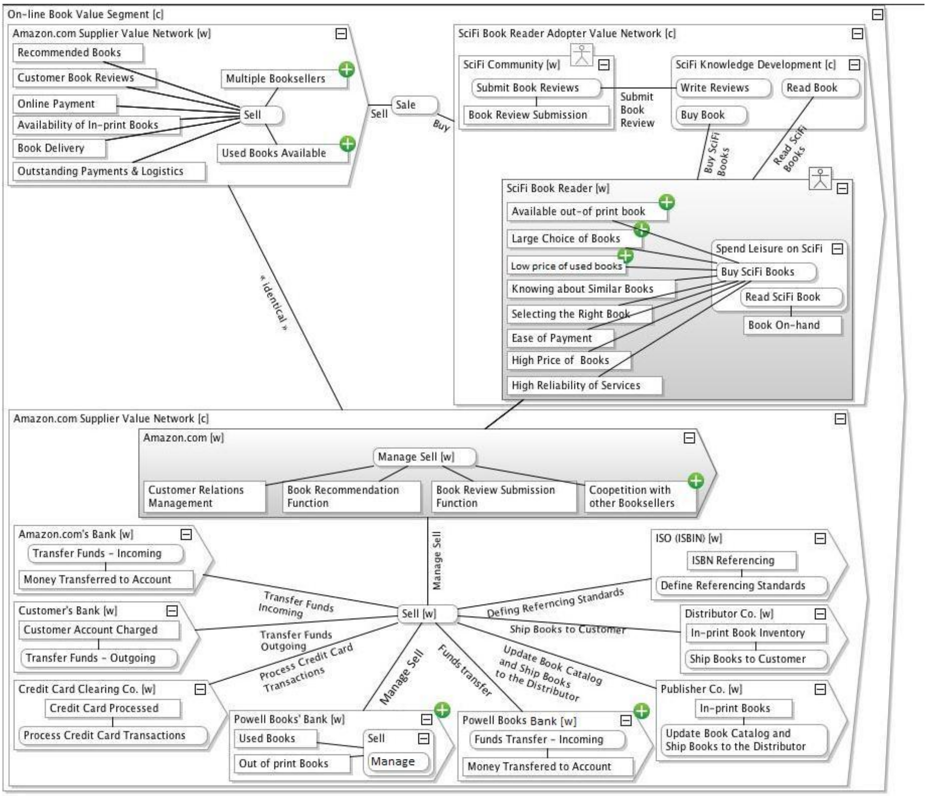

Fig. 8. System diagram, service offering and implementation to-be, process "Sell" as a whole. The additional stakeholders to be considered in the selected solution are marked with a +.

the interaction. The model only expresses that two new actors are needed and they will provide the building blocks necessary to provide the features that will lead to the value properties for the customer. At this point the SAR can be regenerated to represent the relations between all the concepts (Fig. 9).

To implement the service, the "Sell" process needs to be specified in more detail. In Fig. 8, Sell is defined as a whole and the process outcome is described. The details of the interaction is not described. To refine the process, the A team needs to think in terms of instances of behavior. For example, when the catalog of books is created, both Amazon and Powell Books need to participate. The "Catalog Book" action is quite close to the one defined in Fig. 6 with one additional participant. However, the "Fulfill Book Orders" action cannot be modified in the same way. Both Amazon and Powell Books collaborate. In the Fulfill process, Amazon.com and Powell Books compete. There are two processes: one in which Amazon.com provides the books and one in which Powell Books provides the books. The role of the Distributor and the Publisher is especially interesting as they participates in both fulfillment processes. When designing the process, it will be important to analyze how potential conflicts of interests will be solved. Fig. 10 represents the Sell process as a composite.

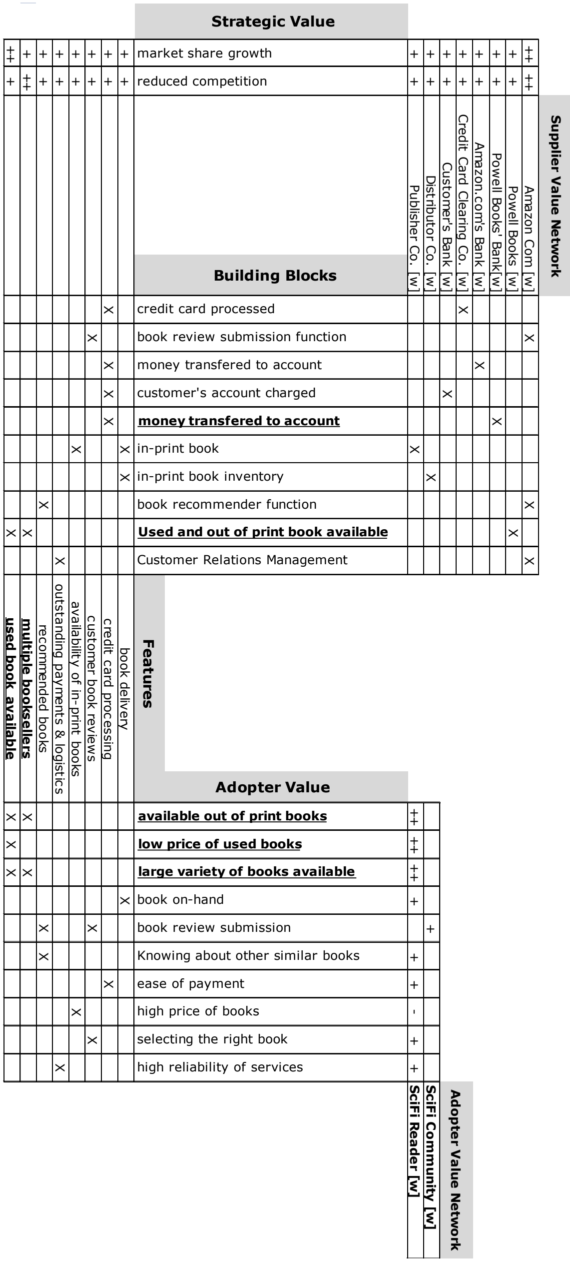

Fig. 9. SAR diagram - Service building blocks, features and values to-be

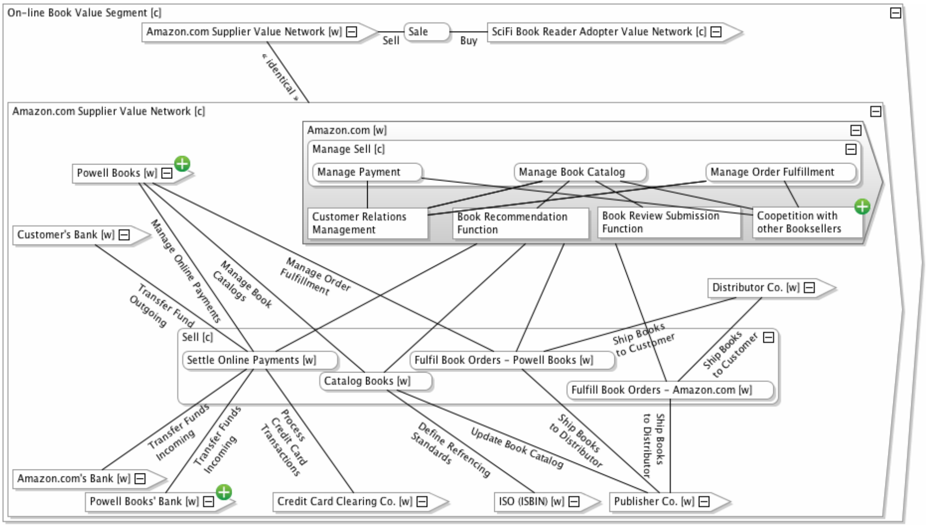

Fig. 10. System diagram, service offering and implementation to-be, process "Sell" as a composite. Definition of the actions in which the new stakeholders participate.

In summary, designing the to-be requires developing a system diagram that represents the project goals (new actors, building blocks, features and value properties). The SAR is then developed to validate the alignment and understand the strategic value properties for the companies in the supplier value network. The system diagram is refined to describe the detail of the business process and to take into considerations issues such as collaborations, conflicts of interest, etc…

3 Related Work

ITIL [1] is a set of best practices in IT service management which is used by organizations to develop and enhance service management capabilities. The latest version of ITIL, V3, was released in 2007. ITIL V3 focuses on services. It describes service strategy, design, transition, operation and continual service improvement. SEAM a more concrete systemic approach than the ones described in ITIL.

e3Service [13] is a method for semi-automatically reasoning about matching service offerings with customer needs. In order to make this semi automatic reasoning possible, e3Service assumes that the customer and supplier share the same ontology, that the customer specifies her needs in the same vocabulary as the supplier specifies its offering. In SEAM, we precisely avoid to make this simplifying assumption. This comes at the cost of enormously complicating automatic or event semi-automatic reasoning with the benefit of models that more accurately reflect reality. Also, e3Service defines the value of a service only from the point of view of the customer. In SEAM, this value goes both ways, a service also provides value to its supplier.

i* [14] is one of the leading modeling method used in the requirements engineering research community for reasoning about FR and NFR. i* provides modeling artifacts for reasoning about alternative satisfactions of NFR. i* models describe relationships as actors dependencies. i* doesn't have an explicit hierarchy or an explicit value constructs. Hence, i* offers better support for reasoning about alternatives . i* has been extended with value reasoning in [15].

House of Quality [16] is an improvement method, which main modeling artifact is very similar to the SEAM SAR model. The House of Quality was derived from Quality Function Deployment, a method that was developed by Japanese companies to improve manufacturing processes for greater customer satisfaction. House of Quality is, therefore, more geared toward manufacturing processes. In addition, the House of Quality does not represent who the providers and the adopters are.

4 Conclusion and Future Work

Designing services where the implementation is aligned with the value they provide is a challenging task. It involves people with very different backgrounds (business people to define service offering, financial people for financial model, technical people for implementation). Developing a common enterprise model can help the members of this trans-disciplinary team to agree on what needs to be developed and how to develop it.

In this paper we have shown how to use the SEAM design process and enterprise model for designing services so that their implementation is aligned with the value they provide to both their customers and service providers. The design process has three phases with in which as as-is and a to-be models are built and improvement opportunities are sought. The enterprise model has a double refinement hierarchy that enables us to model a service offering and its implementation simultaneously. We illustrated how to design the service provided by the value network. In a real project, the project team must also design the service provided by the service provider and the service provided by the IT system. This is done using the same diagrams.

The models were developed in a tool, called SeamCAD [17]. In SeamCAD models are built by specifying the changes from one model to the next. It thus maintains the synchronization – as much as possible – between the different models and thus their alignment. Our future work includes validating the approach in commercial workshops, the formalization of the diagrams – and especially of the SAR - and improving SeamCAD. The validation will be done on coopetitive markets and will be based either on a case study or an action research.

References

1. ITIL, Version 3. OGC, Office of Government Commerce. London TSO, The Stationery Office (2007)
2. Weinberg, G.M.: An introduction to general systems thinking (silver anniversary ed.). Dorset House Publishing Co., New York (2001)
3. ISO, I.T.U.: ISO/IEC 10746-1, 2, 3, 4| ITU-T Recommendation X. 901, X. 902, X. 903, X. 904. Open Distributed Processing-Reference Model 98 (1995)

4. Wegmann, A., Regev, G., De la Cruz, J.D., Lê, L.S., Rychkova, I.: Teaching Enterprise and Service-Oriented Architecture in Practice. In: Second Workshop on Trends in Enterprise Architecture Research (TEAR 2007), St. Gallen (2007)
5. Wegmann, A., Regev, G., Loison, B.: Business and IT Alignment with SEAM. In: Requirements Engineering for Business Need and IT Alignment Workshop (REBNITA05), Paris (2005)
6. Wegmann, A., Regev, G., Garret, G.-A., Marechal, F.: Specifying Services for ITIL Service Management. In: The International Workshop on Service-Oriented Computing Consequences for Engineering Requirements (SOCCER'08), Barcleona (2008)
7. Rychkova, I., Regev, G., Wegmann, A.: Declarative Specification and Alignment Verification of Services in ITIL. In: 1st International Workshop on Dynamic and Declarative Business Processes (DDBP 2008), Munich (2008)
8. Checkland, P., Scholes, J.: Soft Systems Methodology in Action. Wiley, Chichester (1999)
9. Afuah, A., Tucci, C.L.: Internet business models and strategies: Text and cases. McGraw-Hill Higher Education, New York (2000)
10. Spector, R.: Amazon.com: Get Big Fast. Collins Business (2002)
11. A Guide to the Project Management Body of Knowledge. Project Management Institute (2008)
12. Brandenburger, A., Nalebuff, B.: Co-Opetition: the Game Theory That's Changing the Game of Business. Currency (1996)
13. de Kinderen, S., Gordijn, J.: e3 service: A model-based approach for generating needs-driven e-service bundles in a networked enterprise. In: 16th European Conference on Information Systems, Galway (2008)
14. Yu, E.: Towards modelling and reasoning support for early-phase requirements engineering. In: The 3rd IEEE International Symposium on Requirements Engineering (RE'97), Citeseer (1997)
15. Gordijn, J., Yu, E., Van Der Raadt, B.: E-service design using i* and e 3 value modeling. IEEE software 23, 26–33 (2006)
16. Zachman, J.A.: A framework for information systems architecture. IBM systems journal 38, 454–470 (1999)
17. Le, L., Wegmann, A.: SeamCAD: Object-Oriented Modeling Tool for Hierarchical Systems in Enterprise Architecture. In: Hawaii International Conference on System Sciences, vol. 39, p. 179 (2006)

A Framework for Developing a Co-design Environment for e-Business Applications

Yazrina Yahya, Muriati Mukhtar, Norleyza Jailani, Salha Abdullah, Zuraidah Abdullah, and Abdul Razak Hamdan

Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor Malaysia
{yaz,mm,norly,sa,za,arh}@ftsm.ukm.my

Abstract. The Internet has presented the business world with an unprecedented opportunity in terms of reaching their customers. It has also given rise to new business models and allows firms to engage in e-business. Customers now can browse from one e-store to another and purchase the products that they need right from the comfort of their homes. However, current e-business systems are often criticized based on the fact that it is impersonal and does not satisfy the social needs of its customers such as interactions, collaborations, socialization and networking. As such efforts must be made to give these particular experiences to the customers. Based on the examination of the literature, it is realized that this can be achieved by using two emerging concepts. The first is the concept of value co-creation and the other is via the use of virtual worlds. Using the context of the local wood based products industry, the objective of this paper is to present a conceptual framework for designing a virtual world that will serve as an experience environment that incorporates value co-creation opportunities.

Keywords: Experience environment, co-creation value, e-Market place, wood based industry.

1 Introduction

Due to the advent of the Internet, businesses are currently transforming the way they are doing their business. More e-business applications and services using the Internet technology are designed and developed. However current e-business services are designed according to the traditional way of design using a system development, software engineering or a web based design methodology. This leads to typical ways of presenting the services offered which utilizes the web and the use of portals. As such values in terms of personalized experience are not captured accordingly. This can be seen in most e-business system offered on the Internet in which these systems are accessible through a single access windows (using the portal concept), thus forcing the users to choose the application/system they want to access. Typically the values embedded in these systems are actually on accessibility, meaning it allows users to access the digital version of the system easily through the Internet. However other values such as personalized experience, price-experience [1] and effort-experience [2] relationships are yet to be uncovered. As such the success of these developed systems

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 165–178, 2010.

is yet to be determined. This is contrary to new breed of systems such as Facebook, Amazon.com, Google Mail and Twitter that promotes the personalized experience values to the users.

A phenomenon shaped by the home computer known as the virtual world or augmented virtual reality is proposed as the environment to provide the personalized experience for the e-business application system. This is due to the fact that e-business system that supports business activities needs to include the social issues such as interactions, collaborations, socialization and networking. Current e-business system is often designed as contemporary interactive system that lacks the satisfaction of social needs.

This paper presents the design of an experience environment using the virtual world technology to conduct e-business services specifically for a wood based product industry and to provide the lively and sustainable online community that are able to interact, collaborate, socialize and incorporate value co-creation opportunities for the user.

2 The Research Framework

This research draws inspirations from three main streams of literature. The first concerned the literature and research conducted on the local wood-based products industry. Our own research on the wood based products industry revealed current business practices and led to the development of an e-marketplace portal to facilitate business transactions between the wood based products community. The second set of literature concerns the changing role of customers. Customers are now more connected allowing them to be more informed, making them smarter and more aware of their choices. The impact of the connected, informed and active customers or users results in the changes in how they would want to be served either in terms of product design or services offered. This has in part led to an outgrowth of literature concerning customer value and value co-creation as characterized by Vargo and Lusch [3] and Prahalad and Ramaswamy [4]. The third area of literature concerns the technological advancement that has given rise to the use of virtual reality applications. From

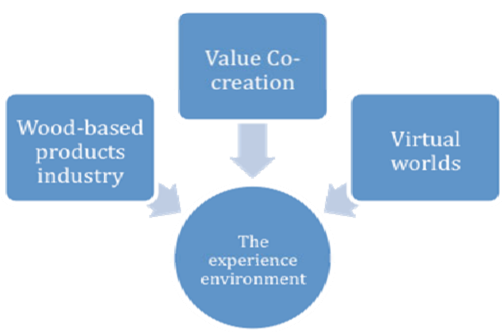

Fig. 1. The research framework

immersive virtual reality experiences to augmented reality applications, the use of virtual reality applications has flourished. It is now seen almost everywhere from online games to virtual showrooms and it has provided users with an almost real environmental settings and enabled them to explore new worlds thus giving them new experiences. The research framework is depicted in Fig. 1.

It is envisaged, via the framework, the wood based products e-marketplace portal will be given a facelift, from the traditional web portals, to a 3D virtual augmented reality system that provides an experience environment to the users.

3 The Traditional e-Business Environment – A Malaysian Scenario

The wood-based products industry in Malaysia has experienced tremendous development over the past decade. The industry has been identified as one of the resource-based industries and most rapidly growing economic sectors to be further developed as an important export-oriented key industry in Malaysia [5]. The wood-based industry is conspicuously different from other industry in Malaysia. It is largely domestic owned and it shares the centre stage within the SMEs category, which the government has identified as the cornerstone of the Malaysian manufacturing sector, poised to play a critical role under the Third Industrial Master Plan (2006-2020) [5].

Malaysia has seen rapid growth and expansion of ICT in the country in the last decade or so. This has led to a growing ICT usage by the SMEs in recent years. In the wood-based industry, SMEs has the potential to be transformed into an intensively digital industry by harnessing the advances in ICT and virtual environment. E-business represents one of the most innovative opportunities currently available to SMEs. Current initiatives for e-business deployment in the wood industry are related to the establishment of business-to-consumer (B2C) e-marketplaces, which have opened a gateway for buyers, suppliers and the communities to meet and trade with each other.

As one of the Malaysian key export sector, wood-based SMEs needs to take advantage of the potentials of applying e-marketplace technologies within its trading processes. It would enhance communications between buyers and sellers, improve marketing channel and may eventually lead to online transactions. The benefits expected from participating in e-marketplaces are wide and exciting [6], [7]. For buyers they can have more negotiating power when they can choose to buy from more suppliers via virtual marketplace. This will benefit both parties in terms of efficiencies in product availability, delivery and inventory management. Suppliers would find marketplaces attractive because they could easily and cost effectively reach new customers. They provide greater exposure to larger buying communities, with improved reach, range and efficiency, increased in volume of transactions, and healthy competition.

An analysis of the overall industry [8] also revealed that there is a need for a common web platform where the buyers and sellers in the wood based products industry can meet and engage in business transactions. This provides the motivation for the establishment of a third party e-marketplace portal for the wood based products industry [9]. This portal will lead to more efficient trading and will provide the web presence for local wood based companies [10].

Although the study also revealed several other business processes which can be incorporated in an e-marketplace framework, only e-catalogue, e-negotiation and e-auction is included in the proposed integrated framework. This approach is in line with the findings from [11] and [12] which emphasize an iterative approach for e-marketplace implementation for SMEs. Further studies [8] on the business processes of the wood based companies also revealed that there are several processes which can be performed electronically to increase efficiency and productivity. These are the advertising of products, searching for business partners and products, negotiation of prices and auction of products. These and some other findings, which formed the requirements for the e-marketplace, are given in Table 1.

Table 1. Requirements of the e-Market place

Requirements
It is quite common for wood buyers to get information on for sale stands placed by from local forestry associations and sometimes directly from the sellers. If the same information were provided via e-marketplace, the buyers would not have to physically go to supplier office to check the lists of price. When a sales offer is entered to the database by the seller, it will be seen by all the prospective buyers. It is also easier to keep such information up-to-date in an electronic system.
It is the usual practice for prospective buyers to come on location to check the product description, quality and conditions. In the e-marketplace, the product quality should be described accurately enough to avoid any complaint from buyer.
The establishment of electronic marketplace needs to be as simple as it can. The easier the trading mechanism is, the more appealing it should become for wood trading participants to use the electronic marketplace. A web-based system with a convenient interface and search function is required.
The e-marketplace should be able to facilitate the process of matching buyers to the appropriate sellers and vice-versa. In this e-marketplace two matching mechanisms are deemed suitable. The first one is the automated mobile agent based multi attributes e-auction and the second is the semi automated SMS incorporated e-negotiation module.

Examples of interfaces for the web portal developed for the wood-based products industry are shown in Fig. 2. The web portal has so many features such as search function, e-marketplace products, online bidding, local news and events, users' registration and others. However only three features are used in the design of the 3D virtual experience environment namely the searching, the bidding process and the lists of events and advertisement. These features are selected as it is felt that they are the main process involved that makes the e-marketplace a marketplace.

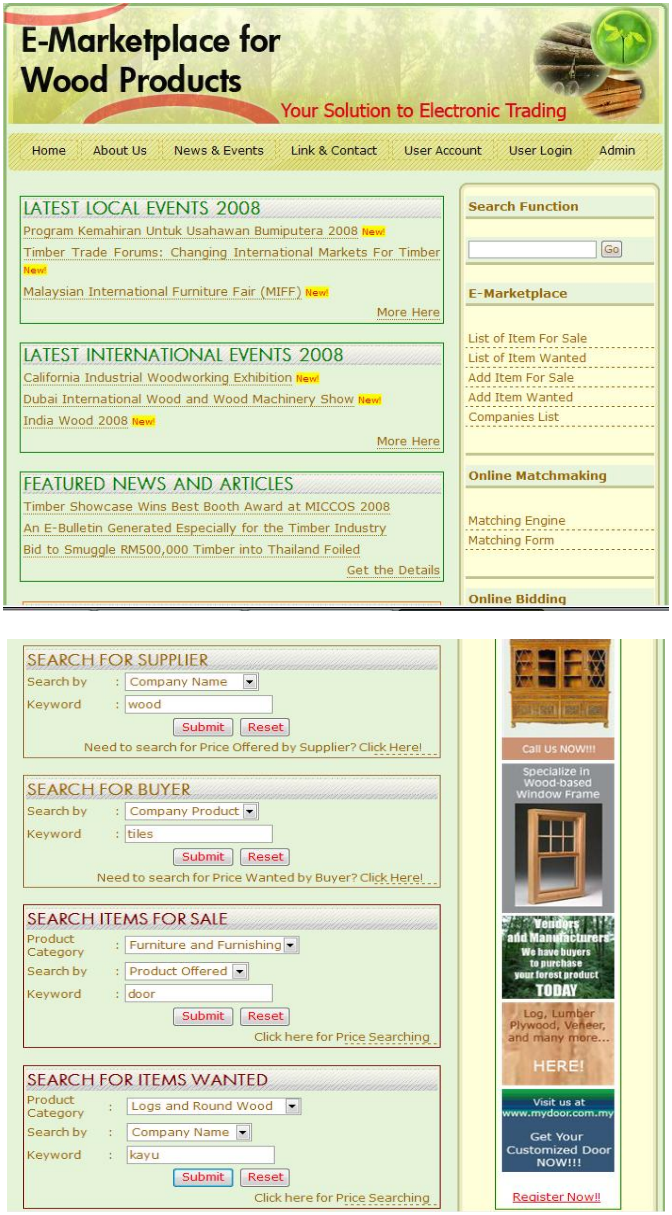

Fig. 2. Web portal for the wood products based industry e-marketplace

4 New e-Business Environment

Due to technology convergence, globalization, ubiquitous connectivity and industry deregulation, there is a change in products or services development. Products and services are now viewed differently by the consumers or users in which there is a portending shift in the balance of the consumers and the product. Consumers are now more connected allowing them to be more informed, making them a smarter consumer and more aware of their choices and they are now more active compared to previously. The impact of the connected, informed and active consumers or users results in the changes in how a product is designed, in which consumers are now seeking ways of exercising their influence in the product design to create values specific to their needs.

As the world is rapidly changing towards a boundaryless world, a more emergent world geared towards an e-Economy milieu, the fundamental assumptions about the product development system in terms of values, value creation process and the nature of the relationship between the producer and consumer are challenged. The challenges result in opportunities in value creation and innovation of product design, in which producers and consumers are working together in co-creating values at points of interactions resulting in personalized co-creation experiences.

Co-creation is not unique to Information Technology (IT) or electronic innovators such as Amazon.com, IBM, Cisco system, Dell, Microsoft, Yahoo and others. These companies are currently partnering with their customer to co-create values and capturing greater values than either party could have created independently [13]. This leads to the development of new types of information or software systems in the current e-Economy setting, where an information system is viewed as services that are mutable, reflective and loosely coupled. The current concept of the information system is based around the notion that users provided with smaller function components are capable of assembling unique systems that suit their own contexts, tasks, use patterns and metaphors [14]. Users are able to create unique, personal service configurations, blogging, tagging ideas, discovering, enriching and mashing up information and integrating knowledge [15].

Virtual worlds or virtual augmented reality system is used as it addresses the satisfaction of users' social needs and are complemented with a realistic experience. It supports the way a person acts and communicates in real life to a certain extent and offers an environment to meet people. As such it provides the satisfaction of social needs that is often neglected in contemporary interactive system like the web portals. In addition it is also designed to provide the co-creation avenues where users experience the virtual world that provides an experience environment for customer who wants to buy the product.

5 The 3D Virtual e-Business Experience Environment: Design Considerations

Experience environment are characterized by robustness, the capacity to accommodate a wide range of context-specific experiences of heterogeneous individuals. An experience environment facilitates a total experience for the customers. It includes products and services as well as the various interfaces for individual interactions with the company, employees and the communities [16]. At a minimum, the experience environment must offer opportunities to customers to co-construct their own experience on demand in specific context and time. It must also accommodate a heterogeneous group of customers, from the very sophisticated and active to the very unsophisticated and passive. The environment must also facilitate new opportunities afforded by the evolution of new emerging technologies. In addition it must also accommodate the involvement of the customer who formed the communities. The interactions occurred in the environment must be able to engage the customer emotionally and intellectually as such it must recognize both the social and technical aspects of co-creation experiences. Creating an experience environment will be difficult; however new emerging technologies that provide capabilities to design a robust experience environment are now available in the market, allowing such experience environment to be built easily [16].

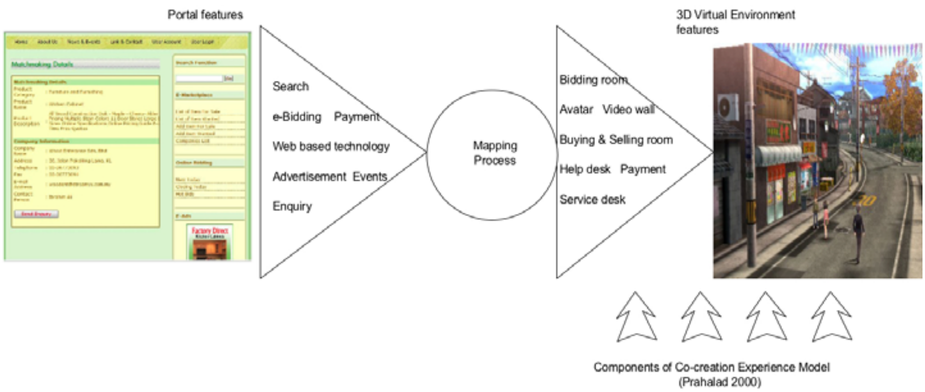

Fig. 3. Portal features versus the 3D environment

The 3D virtual e-business experience environment on the other hand is designed to emulate the way humans operate and interact in the real world. However as the 3D virtual experience environment is designed based on the web portal mentioned above, therefore the humans involved are actually organisations. This is due to the fact that the portal is a B2B web portal for wood based market place. As such the environment will enable organizations, presented as an avatar to participate in a heterogeneous society of business organizations visualized in a 3D virtual world. As such the avatar will represent an organisation in particular. In addition the environment will also capture the real life environment of a market place for a wood based product shop where a buyer may purchase their required wood products. Therefore to create the real life environment that provides real life experience environment and incorporate users value co-creation opportunities, the design needs to analyzed the web portal and also the real life experience of conducting the business of wood based products, and captured the important elements. Based on the conceptual understanding of co-creation environment experience by Prahalad [17], the mapping between the traditional ways of conducting the wood based business and the 3D virtual environment application is as shown in Fig. 3.

As stated earlier in the previous section, the wood based web portal consists of several features however only three features were mapped into the 3D virtual experience environment. The search component in the web portal allows the customer (buyer or seller) to search for products offered on the market place. The e-bidding on the other hand allows customer to bid for products using the reverse auction mechanism. The marketing element comprises of the list of events and news; and details regarding the sellers. The web portal provides a service that allows customer to find the required products based on their specific needs through their matchmaking facility. The matchmaking facility, allows matching of specific requirements by users to the ones offered by the sellers in the market place. In addition another type of service offered is the enquiry service in which users are allowed to post questions on matters arise regarding transactions or other related process.

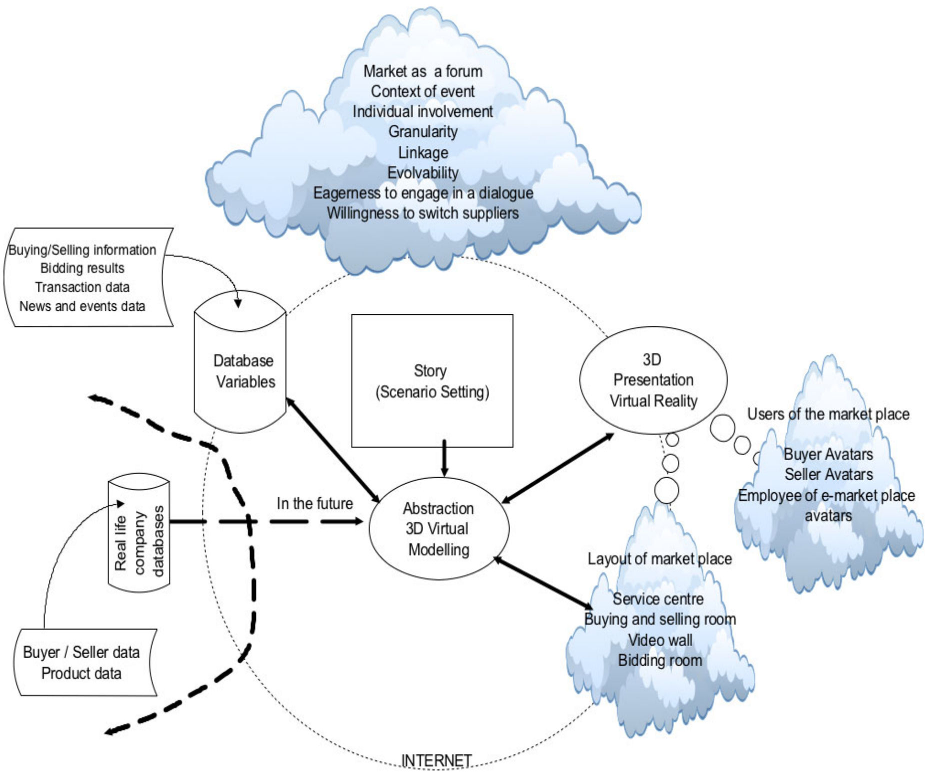

Fig. 4. Conceptual Framework

The 3D virtual environment on the other hand will look at the customers' dimensions especially in terms of their needs, goals and organizational styles. In addition, the interaction with other organizations, their socialization aspects, and how the word of mouth influences the customers is also important to be looked into. Additionally, the freedom of choice to interact with the market place owner or employees through a range of experiences across multiple channels such as through chatting, email or others are also looked at. The environment must also provide experience-centric options that reflect the organizational desires. In addition due to the advent of technology, business organizations usually want an easy, convenient, safe access and reliable services offered when conducting business transactions, this must be materialized in the 3D environment through transactions available.

Therefore to design of the experience environment, a conceptual framework that encompasses the co-creation model as proposed by Prahalad and Ramaswamy[16] is used. The framework was based on Bryceson [18] and shown in Fig. 4.

Based on the above conceptual framework, to design the 3D virtual experience environment there is a need to look at the 3D presentation aspects, for instance how the rooms are to look like, the types of avatars namely the customer avatars, employee avatars, the marketplace setting where the design should incorporate the viewing room, the buying process, the product displays and others. All these need to be designed accordingly tailored to real life setting so that the users will be at ease and felt as if they operate and interact in the real world.

The story scenario setting element incorporates most of the Prahalad and Ramaswamy [16] component of co-creation experience model. Each component is then explained in detail in the next section.

6 Components of Co-creation Experience Model

The components of co-creation experience model by Prahalad and Ramaswamy [16] are described as follows and mapped against the story scenario setting relevant to the wood based products industry market place.

***Individual Involvement*:** Individual involvement is one of the benchmark used to show that the market place is fully utilized to the maximum by the users. The involvement may come in many forms such as through transactions among users' and various products, interaction using different types of channels, usage of services offered, and inquiring for customer support service Prahalad and Ramaswamy [19]. Capturing the values appreciated by users during their involvement in participating in the activities offered are essential to make sure that the market place is being used at the maximum. Therefore in designing the 3D virtual environment for the wood based market place, users (namely the business organizations – presented using avatars) interests, knowledge, needs and desires are identified and recognized.

***Granularity*:** This particular component gives the customer the ability to interact with the experience environment at any desired level of specificity, immersing the customer in the experiences over time in whatever way the customer chooses. This is translated through the ability to design the experience environment based on events in which the customer interactions can occur at different levels of aggregation and richness [16]. Therefore in designing the 3D virtual experience environment, customers are able to walkthrough the market place through various rooms in which there are various entry points such as the main hall where customers may want to get started when they get into the market place, or they may go straight to the viewing room where products are displayed and they are able to select the products wanted or to the bidding room to bid for a specific product. Aside from the viewing room, customers are also able to initiate dialogue with the customer support avatars to get assistance about products or other related matters.

***Linkage*:** Linkage is the recognition that events connect in multiple ways from a consumer point of view. Therefore a collection of related events and not just a single event, affects the quality of the co-creation experience [16]. In the 3D virtual experience environment customers are allowed to experience meeting other business organizations through their avatars. Conversation or interaction initiated by an avatar may lead to product negotiation, development of new product or establishing new partnership. Following the product negotiation process or the bidding process, a customer may choose to use the delivery service that will send the product to their home.

***Evolvability*:** Evolvability involves capturing the learning from co-creation experience and using it to develop experience environments that shape themselves to customers' needs and preferences [16]. As a customer, the 3D experience environment will allow the organization to get the recommendations for products related to the item bought, in addition the recommendations will be based on the organization preferences as the history of item bought and it's specific features are captured. In addition the experience environment will also provide a selection of customers who have purchased the same products, reviews by professional critics on the product sold, fellow of the system users and other criteria. If the customer discovers that the product does not fit to the customer needs than there is no obligation to buy the product. The customers may also buy or sell used products at the marketplace. These features will capture all relevant information that may be used for future marketability purposes.

***Market as a forum*:** The co-creation concept converts the traditional market into a forum where dialogue between customers, the organisation, customer communities and networks of others can take place. In the market-as-a-forum paradigm, networked customer communities are the driving force. This is due to the fact that human beings natural instinct is to connect with each other and belong to a social network. In addition, it is also important to take note that customers influence one another's experience. This is based on real life experience where the word of mouth of others do influence the experience or choices made by an organization and the heterogeneity of interactions among organizations is important in order to co-create experience for the customers. As such details of interactions such as eagerness to engage in dialogue, tolerance for irritants and willingness to switch suppliers and products need to be looked into detail [16]. Therefore in designing the 3D experience environment customers are allowed to engage in the dialogue with other customers, specific communities who have the same interest or bought the same product, engage in a dialogue wit ha customer support service, a supplier or the other people such as the delivery person just like in an actual environment.

***Knowledge environment*:** To co-create value, it is necessary to continually co-create new knowledge in which this is obtained through solving a particular problem, or identifying major emerging opportunities. As such a knowledge-sharing environment needs to be created. The knowledge sharing environment should be designed in which it is easy to use, be available twenty four hours a day, seven days a week, permit people to talk to one another directly, with minimal distortion, provide everyone access to the company's knowledge base, allow everyone to contribute knowledge to the system, allow communication in any language preferred by the user and continuously capture new knowledge from questions and answers in the system [16]. The 3D experience environment can combine bulletin boards, chatting, libraries, electronic forums and specialist forum is put into place and the information obtained is transferred into the knowledge base supplemented with external information sources. In addition the information provided to the customers must be transparent and readily accessible in order to provide the venue for knowledge environment.

Based on the above components the 3D virtual experience environment is designed. Details of the scenario are described in the next section.

7 3D Experience Environment: Design Scenario

Based on the conceptual framework the design scenario of the web portal consists of B2B e-marketplace. As such the 3D virtual experience environment will also fully utilise the same B2B concept. In order to materialize the idea, three features are selected as mentioned earlier, namely the buying and selling room – which is presented as search mechanism and transaction process in the web portal, bidding room – which is described as the e-bidding function in the web portal, video wall – which is presented as the news, events and bulletin board in the web portal. Additionally to make certain that the 3D virtual experience environment resembles the actual or real market place, help desk and service desk features are also provided in the environment.

In the 3D virtual environment market place, the avatars represent several types of users namely buyer avatar represents an organization that bought the products offered; seller avatar represents the organization that sells the product; employee avatar represent the market place people that consist of e-market place operator, customer support, cashier, sales/promoter and others. As the environment is designed to emulate the ways human operate when entering the market place and interact in the real world, the 3D virtual experience environment will use the space with an immersive experience in order to construct a usable virtual representation of a particular domain. As such a particular role of a participant/end-user in the virtual world is represented by means of a specific outfit. Therefore an avatar dress code allows the perception of visual cues associated to the roles of participants introduced. For instance the employee avatar will be dressed in a specific work wear.

Virtual worlds visualized in 3D are environments where people meet. As such consistent interface metaphor that facilitates awareness of other participants are central in these environments. Users will be aware of other users in the experience environment, as such communication possibilities must be made possible, therefore text-based communication is realized by means of a chat facility offering a synchronous mode of interaction. However asynchronous communication is also provided in terms of e-mail, bulleting boards and information digesting services. In the 3D virtual experience environment, active participation is required, however for lurkers that exist in this type of virtual environment [20], services such as tutorial area for newcomers, special help animators who identifies the user inactivity and attachment of visual cue that describes the quest in the market place is provided [21].

Apart from the avatar, types of communication and others described above, the setting of the environment also includes specific settings namely the entrance hall, points of entry, points of exit, rooms such as buying room, selling room or sections, socializing room, help desk and payment counter. Additionally the video wall incorporates videos or live bulleting boards that provide and display information of news, event, promotions and other information about product, details of seller and other information that are relevant to the customer. Each of these settings will use the 3D virtual objects that resemble the actual objects in the real world.

The information stored and provided to the users to promote the co-creation learning process entails the information about the product such as the name, type, purpose, dimensions of the product, description, colour, product availability, performance, efficiency, price and other relevant features. The services offered to the customer is obtainable through the customer support avatar and designated rooms, in which explanation of services offered are given such as credit payment services, special orders, product protection plan, warranty periods, returns and refund.

The design of the 3D virtual experience environment for wood based market place is conceptualized in Fig. 5.

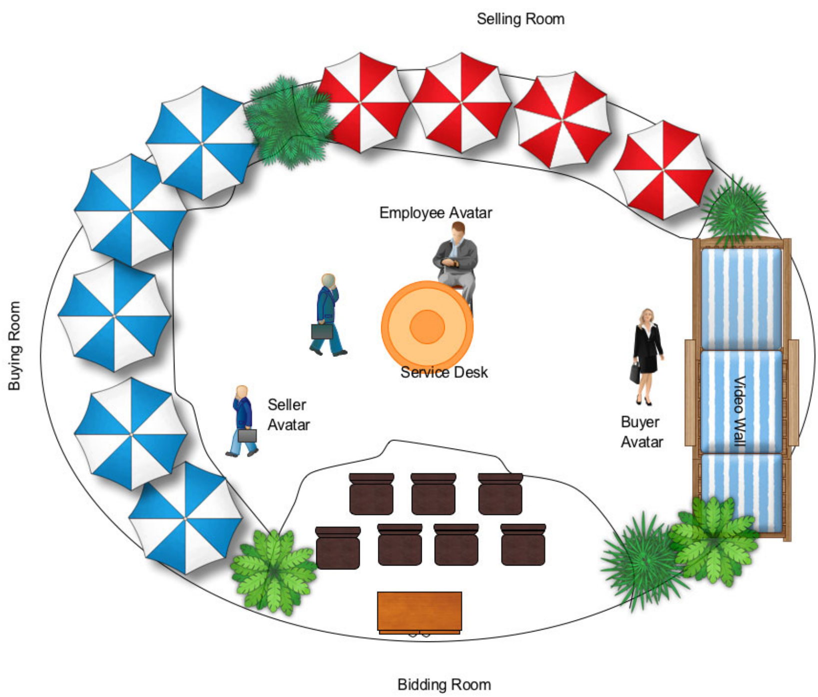

Fig. 5. A design scenario for a 3D Virtual Experience Room for the Wood Based Products Industry Marketplace

8 Conclusion

Considering the popularity of 3D virtual environment especially among the younger generation and the growing market share of products being bought online by them, the combination of 3D virtual environment and business has the potential of creating enormous synergy. With inclusion of value co-creation in the design phase has given the system an added value, as customers will be able to appreciate the system more than ever. To this end, we have presented a conceptual framework and design scenario for the 3D virtual experience environment to support the complex interaction patterns between the members of this heterogeneous society in an e-marketplace setting. The planned 3D virtual experience environment provides a visualization of the interactions supports business activities and provides the basis for a lively online interaction and other values that is important to the business organizations. The innovative approach of marrying the 3D virtual with electronic business elevates interaction with e-Business applications to a more social, joyful and more meaningful experience for the customer thus enhancing the marketplace functions and applications. The contribution of the work also aids the process of integrating IT and co-creation value with current business applications that enriches the development of e-marketplace for the betterment of business community.

References

1. Prahalad, C.K., Ramaswamy, V.: Experience co-creation (2006), `http://www.macpartnership.com/practiceareas/co-creation.htm`
2. Hwang, Y.-C., Su, C.-H.: Experience Co-Creation on Ubiquitous Cultural e-Service Provision: A Case of Taiwans Hakka Culture. In: Proceedings of Fourth International Conference on Networked Computing and Advanced Information Management, NCM, vol. 2, pp. 438–443 (2008)
3. Vargo, S.L., Maglio, P., Akaka, M.A.: On value and value co-creation: A service systems and service logic perspective. European Management Journal 26(3), 145–152 (2008)
4. Prahalad, C.K., Ramaswamy, V.: Co-creation experiences: The next practice in value creation. Journal of Interactive Marketing 18(3), 5 (2004)
5. Kareem, M.A.A.: Wood-based industry deserves more Attention. Malaysian Institute of Economic Research (MIER) Report, `http://www.mier.org.my/mierscan/archives/pdf/drariff28_11_2005`
6. Phan, D.D.: E-business development for competitive advantages: a case study. Information and Management 20(17), 1–10 (2002)
7. Feldman, S.: Electronic Marketplaces. IEEE Computer Society Publisher, New York (2000)
8. Kurniasary, E.: Kerangka Kerja Pasaran Elektronik. Published Masters Thesis, Fakulti Teknologi dan Sains Maklumat, UKM (2009)
9. Mukhtar, M., Yahya, Y., Jailani, N., Abdullah, S., Abdullah, Z.: An Integrated e-Marketplace framework: A Case Study Wood-Based Products Industry Malaysia. In: Proceedings of ICEEI 2009 (2009)

10. Kurniasary, E., Mukhtar, M., Jailani, N., Abdullah, S., Yahya, Y., Abdullah, Z.: Designing e-Marketplace Prototype for Wood Based Product Industry in Malaysia: A Concept that Fits Reality. In: Proceedings International Symposium on Information Technology 2008. Kuala Lumpur Convention Centre Malaysia, pp. 586–592. Press (2008)
11. Zahir, S.: Designing a Prototype E-Marketplace for Horticultural Products of Bangladesh: Forget the Hype and Embrace the Reality. In: Proceedings of ICCIT (2004), http://dlib.secs.iub.edu.bd/Conferrence/ICCIT2004/Papers/paper-076.pdf
12. Yu, H.-C., Hsu, C.-S., Hsi, K.-H.: Setting up an e-marketplace: A three Stage Approach. Technology in Society 24, 473–482 (2002)
13. Kambil, A., Friesen, G.B., Sundaram, A.: Co-creation: A New Source of Value. Outlook Journal (1999), http://www.accenture.com/NR/rdonlyres/63EBA8BD-5931-49D5-9752-8A0C65FF8049/0/cocreation2.pdf
14. Germonprez, M., Hovorka, D., Collopy, F.: A Theory of Tailorable Technology Design. Journal of the Association for Information Systems (JAIS) 8(6), 315–367 (2007)
15. Hovorka, D.S., Germonprez, M.: From Practice to Design and Back: Emergence of an Information Service Vew. In: Proceedings of 19th Australasian Conference on Information Systems, ACIS, pp. 433–441 (2008)
16. Prahalad, C.K., Ramaswamy, V.: The Future of Competition: Co- Creating Value with Customers. Harvard Business School Press, Boston (2004)
17. Prahalad, C.K., Ramaswamy, V.: Co-opting Customer Competence. Harvard Business Review 78(1), 79–87 (2000)
18. Bryceson, K.P.: The development of VAG-a 3D virtual agribusiness environment and strategy game. Electron. Commer. Res. 9, 27–47 (2009)
19. Prahalad, C.K., Ramaswamy, V.: Co-creating unique value with customers. Strategy & Leadership 32(3), 4–9 (2004)
20. Berger, H., Dittenbach, M., Merki, D., Bogdanovych, A., Simoff, S., Sierra, C.: Playing the e-Business Game in 3D Virtual Worlds. In: OzCHI'06, CHISIG, pp. 1–3 (2006)
21. Livingstone, D., Kemp, J., Edgar, E.: From Multi-User Virtual Environment to 3D Virtual Learning Environment. ALT-J: Research in Learning Technology 16(3), 139–150 (2008)

On Service Systems – By Definition of Elementary Concepts towards the Sound Theory of Service Science

Petra Hocová and Zdenko Staníček

Masaryk University, Faculty of Informatics
Botanická 68a
602 00 Brno, Czech Republic
qhocova@fi.muni.cz, stanicek@fi.muni.cz
http://kirlab.fi.muni.cz/

Abstract. Recently, there has been recognized a significant movement towards services, which is reflected in GDP of countries as well as it is mirrored by customers needs and expectations. Therefore, since the services are provided by means of service systems, the attention has to be paid to the service systems and their description. The Service Science theory is being developed and improved every day, hence it will take some time to build it stabile and sound. Basic and commonly shared knowledge is still missing.

This paper contributes to the service science foundation. Based on extended definition of service systems, it proposes the concept of a prime service system as a service system in a context of clients benefits. A definition of the cooperation of service systems is given and the paper concludes with a definition of a dual service system, which is a service system based on collaboration of two prime service systems. The paper discusses the introduced concepts on examples of business enterprises and academic institutions.

Keywords: Service science, service system definition, service system triangle, prime service system, dual service system, service systems cooperation.

1 Introduction

According to various sources, "[T]he services sector is undeniably a key engine of growth in today's leading global economies" [1]. Services currently account for 80 per cent of the GDP of the USA and the ratio is increasing in other economies as well. For example China is strongly supporting the development in the service sector in its 11th Five-Year Plan (2006-2010) [5], [8]. Mindsets of the people and more importantly rules applicable within the more and more perceived service orientation of the economy are often referred as the Service–Dominant Logic (e.g., [15], [16]). Such movement caused a significant contribution to formation of so called Service Science.

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 179–191, 2010.

In the Europe and the US, Service Science, Management, and Engineering has been proposed as a new field of study to face the challenges of the increased predominance of services. According to [7] "there is a need for a new science of service systems, which aims to increase service innovation by applying scientific understanding, engineering discipline, and management practices to designing, improving, and scaling service systems." Many universities all over the world respond to this expressed need and open the new courses, or even the whole programs, with focus on services. Not only the universities who are used to provide scientific basis are working on the sound theory of the services and service systems, but business organizations are also involved.

1.1 Service Mindset and Service Systems Definitions

The separation of the producer from the customer no longer holds in many domains. The production control and the product standardization are no longer required within the service focus. "In contrast, the emerging service–dominant logic is focused on the interaction of the producer and the consumer and other supply and value network partners as they co-create value through collaborative processes" [6]. Although the term Service–Dominant Logic is already quite known and it is being used, we argue that term "Service logic" express the same meaning in a better way.

As [6] presents, the settings of the mindset of service oriented agents is different compared to the one which was dominating in the past. In [6], authors elaborate eight areas wherein the shift is visible: (1) a shift to the process of serving rather than the creation of goods, (2) a shift to the primacy of intangibles rather than tangibles, (3) a shift to the creation and use of dynamic operant resources as opposed to the consumption and depletion of static operand resources, (4) a recognition of the strategic advantage of symmetric rather than asymmetric information, (5) a shift to conversation and dialog as opposed to propaganda, (6) an understanding that the firm can only make and follow through on value propositions rather than create or add value, (7) a shift in focus to relational rather than transactional exchange, and (8) a shift to an emphasis on financial performance for information feedback rather than a goal of profit maximization.

Services are provided in an environment of the service systems. According to [11] "[s]ervice systems are dynamic value co-creation configurations of resources [...], where at least one resource is an operant resource, specifically a person with rights, and capable of interaction and judging outcomes. Service systems are connected to other service systems via value propositions." The configuration is set up from people, technology, other internal and external service system, and shared information (such as language, processes, metrics, prices, policies, and laws) [10].

Basically, there are three core elements in any service system - a service provider, a service consumer (service client)[1], and a target. And also, there

[1] In later text, we use terms "service consumer" and "service client" in the same meaning.

are connections/relationships between every couple of elements from this triple - a) the relationship between the service provider and the service consumer, b) the connection between the service provider and the target, c) the connection between the service consumer and the target. The service provider continuously maintains the relationship with consumer/client and the consumer/client shares and discusses his notion of the target with the provider [3]. Time is an important issue here and time has to be captured when we model any service system [4].

Based on previous definitions and extending them, we mention here definition according to [14] which is rather exhaustive. A developed version can be find in [13].

Definition 1 (Service System). Service system *is a time limited composite of agents, technology, environment, and/or organization units of agents and/or technology, functioning in a space and time.*

There exists at least one context in which the roles of a client, a provider and a target of agents and/or environment can be recognized.

For an entity to be considered as a *service system,* the following statements must hold:

1. The relationship *Provider-Consumer* is about consulting, negotiation, planning, development of ideas and plans. It is build upon:
   – the information sharing,
   – the knowledge sharing,
   – negotiations,
   – balancing and establishing value propositions of each side and their mutual match,
   – continuous revision of previous items;
2. The relationship *Consumer-Target* expresses that the consumer uses the target in a certain way. It is about an active approach and about putting things into a practice. The relationship *Consumer-Target* expresses a kind of ownership where:
   – the consumer owns the target,
   – the consumer owns rights to use and/or manipulate the target,
   – the consumer has ("owns") a problem. The solution involves an operation and/or a transformation of the target;
3. The relationship *Provider-Target* is about improvements on the target performed by the provider. The improvements represent benefits for the client. The utilizations are proceeded most likely due projects and/or programs of projects. The goals of such projects/programs (or even portfolios of projects and programs) aim to enhance the consumers' satisfaction and positive experience of the overall service. The relationship *Provider-Target* expresses a competence where:
   – the provider knows the target and is able to operate upon it,
   – the provider knows the target and is able to execute the transformation of the target,

– the provider understands the target and is able to plan operations and/or transformations of the target.

4. For elements of the *Service System Triangle (consumer–provider–target)* holds:
   a) Any involved *agent* (i.e. an agent who plays one of the roles) may be a service system too.
      The agent is one of the following:
      - a human being,
      - in some way organized group of human beings,
      - any of the two previous items coupled with technology and possibly with a piece of environment,
      - some kind of organization,
      - virtual, i.e. artificial, agent built from software and/or hardware components,
      - combination of any previous items;
   b) The target is either an agent or a "piece" of environment (environmental element) (including technology),
   c) The time period of existence of a service system is not a trivial one compared to actions performed within a service provision process. □

This definition helps us to distinguish between entities which we consider as service systems and the other entities (not service systems). To make this definition clearer we would like to add few comments to summarize our view on service systems.

Service systems are composed from agents and very often from environmental elements. An agent can play any role from the Service System Triangle; it either can represent the consumer, the provider or the target. In contrast, environmental entities ("pieces of environment") act only in the target role.

During its whole life cycle the service system can be viewed from many perspectives. These perspectives (based on observer's history and experiences) together with structure of the situation (i.e. other arbitrary entities in the time and space and their relationships) create a context. We are interested in such contexts where we can recognize the particular agents (and environmental entities) and as well where we can recognize the individual roles played by those agents.

To study service systems, we have to study contexts together with various distributions of the roles. Useful categorization of typical situational settings of elements is given in [2], where the author introduce seven contexts for service design as follows: person-to-person, technology-enhanced person-to-person, self-services, multi-channel, services on multiple devices or platforms, back-stage intensive, and location-based and context-aware.

1.2 Main Considerations and Organization of the Paper

As [9] mentions, there are many reasons which contribute to the not very fast progress of the service research. To name one, it is its interdisciplinary nature.

Although we believe that by conceptual modeling and abstractions above various kinds of service systems (such are organizations, academic institutions, communities), important characteristics of the service systems can be discovered and later on validated.

Therefore, in this paper we focus on the definitions of basics concepts, as we believe it is necessary to define them. Common understanding can improve the level of shared knowledge and it may fasten the research progress.

In the following section 2 we present definitions of elementary concepts which were discovered during the service systems research. The section 2 is organized into three subsections. In section 2.1 we introduce a concept of a prime service system and present its main characteristics on example of two enterprises. In section 2.2 we define a service systems collaboration. The example from previous section is elaborated and an example of business and academic collaboration is added. In section 2.3 we define a dual service system as a collaboration of two prime service systems. Section 3 highlights some relevant conclusions.

2 Boundaries, Contexts and Cooperation

Our understanding of service systems comes from our research and practical experiences within the domain of information technologies and the project management, in particular the portfolio–program–project management.

While it seems these two domains quite differ, from a sight of the service science, they are alike and both encourage us to ask (and more importantly to answer) serious questions. Which, reciprocally, make us to better understand their functioning and inexplicit rules.

Recall the Definition 1 from the previous section. According to it, it is possible (and very likely) that one particular service system can be represented as a hierarchical structure with other service systems embedded in it, or it can be itself part of another service system. Therefore we ask ourself following questions:

When/in which situations it is more appropriate to see certain service system as one entity and in which situations we would rather speak about more than one service system which are somehow connected/cooperating in some way?

Are there any general criteria to distinguish such situations? Or is it a pragmatical choice only?

As in any collaboration, the rule which pays off is to unify stakeholders' vocabularies at the very beginning. Doing so, we decrease the number of situations where misunderstanding takes a major place. Such situations are either a) one collaborator uses certain term in a certain meaning and the same term has for another collaborator (slightly or completely) different meaning, or b) some particular concept is expressed by two different terms while that is not necessary and sometimes it is not even recognized, that the agents are dealing with the same object or meaning the same concept.

The answers to those questions above are crucial for common understanding in the field of service systems. There are many confusing situations which can arise when for example one stakeholder focusses on different level of the hierarchical system than the other stakeholder.

In this paper we introduce new concepts which, as we already personally witnessed while working in our *Service System, Modeling and Execution research group* ([12]), can decrease a ratio of puzzlement while discussing the service system matter. In the following subsections, new concepts *Prime service system, Service system cooperation,* and *Dual service system* are introduced and properly defined.

2.1 Prime Service System

Let us start with an example of a service system, which follows the Definition 1 and leads us to the next definition, which is a definition of a prime service system.

Let us say, there are two enterprises, a software house called Heavysoft and a telecommunication company Telecoco. After internal analysis of its resources and in line with its business strategy, Telecoco decided to outsource its information system. After the necessary negotiations were made, relevant information was shared as well as knowledge, the service system was established based on formulated and agreed value proposition.

The roles are as follows: Telecoco enterprise is the client, Heavysoft plays the role of provider. Agreed target is an information system which will reflect directives and regulations of Telecoco enterprise which supports all Telecoco operations. Heavysoft uses its competences to act for the sake of Telecoco on this target. Telecoco will regularly pay a service fee.

Such example is a general representant of many situations nowadays and it seems natural to describe the situation this way. Therefore now, we would like to draw your attention to the way we have just used to explain the example. What we did, is that we have described the outsourcing system from the client's point of view. Through the *client's benefits* (Telecoco benefits here) one is more used to hear about the situation within service system when services like outsourcing are described.

Less common is to view the example through the benefits of the provider, i. e. within the *context of Heavysoft benefits.* With this change of perspective, we see the Heavysoft in the role of the client. The provider is in this case the Telecoco enterprise. The target is a bank account of the Heavysoft company, to which Telecoco sends its regular service payments. To setup such service system, all the initiation steps had to be done as well (as they were done in the first case, in the case of the context of Telecoco benefits). This service went through negotiation, sharing relevant information and knowledge between the stakeholders. The results were part of the initial value proposition.

These two contexts are only examples of many possible contexts in which this service system could be seen.

In both contexts, in the *context of Telecoco benefits* and the *context of Heavysoft benefits*, same distribution of roles holds during the whole life cycle of our service system. The assignment of roles in Service System Triangle (provider–consumer/ client–target) does not change in any of those contexts through the time.

Hence, we can talk about two service systems which are originated in our example. These two service systems were established by decomposition of the service system described as the example above. The first one belongs to the *context of the Telecoco benefits,* the second one belongs to *the context of the Heavysoft benefits.*

The strict separation of the service system according to benefits for particular agents make easier to understand the evolution of the systems (in the time and space) and brings better understanding of posteriority of events.

Based on previous discussion, we define the prime service system.

Definition 2. *(Prime Service System) A service system is called* prime service system *if following conditions hold:*

1. *the roles provider–client–target are distributed between agents (and environmental elements) within one context,*
2. *assignments of roles do not change during the life of the service system.*

In most cases, when talking about some service system, the prime service system is meant. However, the Definition 1 covers the marginal cases as well.

2.2 Service Systems Cooperation

The two discussed service systems, one based on the context of Telecoco benefits and the second one based on Heavysoft benefits, are tightly connected. To be able to do a decomposition of the service system to its prime service systems, first we have to describe them together and also we have to pay attention to their mutual cooperation. The service systems cooperation is defined as follows:

Definition 3. *(Service Systems Cooperation) We will say that a prime service system* $P1$ cooperates *with another prime service system* $P2$ *if the following conditions hold:*

1. *the agent who plays the role of the client in the service system* $P1$ *plays the role of the provider in the service system* $P2$*,*
2. *the agent who plays the role of the provider in the service system* $P1$ *plays the role of the client in the service system* $P2$*,*
3. *benefits of the client of the service system* $P1$ *(*$P2$*) depends on benefits of the clients of the service system* $P2$ *(*$P1$*) respectively.* □

Note that no constraints are done on either the target of the service system $P1$ or the target of the service system $P2$. In terms of two prime service systems, when we describe the outsourcing of Telecoco information system and the Heavysoft regulations for operating such information system, we are speaking about *cooperation* of two service systems.

The target of the service system $P1$ (let us assume that it is the service system described by the context of Telecoco benefits) is Telecoco information system reflecting directives and regulations of the Telecoco enterprise. The target of the service system $P2$ (it means the service system described by the context of Heavysoft benefits) is Heavysoft's bank account. The service provided by Heavysoft to the service system $P1$ is the outsourcing of information system's operations. The service provided by Telecoco to the service system $P2$ is payment. A success of one of those processes cannot be reached without success of the other one.

Another typical example of cooperating service systems is a cooperation between an academic institution and a business entity. To make this example more specific, let us talk about Faculty of Informatics, Masaryk University in Brno, Czech Republic as the academic partner, and about IBM Integrated Delivery Center in Brno, Czech Republic (IBM IDC) as the business entity[2].

The faculty educates its students towards their future employments and as well it does a research in new technology principles. One of the things, the business partner does, is that it develops new services while it uses new technologies and as well it puts into use competences of faculty graduates.

The benefits for the business partner from possible cooperation with the academic partner could be listed as follows:

– faculty graduates are fitted for business processes of the partner,
– there is a possibility to influence an educational process of the faculty according the business partner's needs,
– there is a possibility to select the most suitable graduates with desirable skills and capabilities,
– there is a possibility to expand research capacity of the business partner by collaboration with faculty research laboratories,
– there is a possibility to be closer to the faculty research results which are believed to be valuable for the business and therefore there is a possibility of easier access to such results
– there is a possibility to use research results.

On the other hand, benefits for the faculty could be listed as follows:

– students are involved in practical projects in a real business environment during their studies,
– faculty graduates have good starting positions on the labor market since they are well prepared for the practice. There is a possibility that many of them will be hired by the business partner straight away after finishing their studies,
– there is a possibility to ease the process of transferring the faculty research results into the practice,

[2] Although Masaryk University collaborates with IDC, please note that examples used here are illustrative.

- the market position of the faculty in the competition for new students can be increased by a good reputation and a high ratio of employed faculty graduates,
- there is a possibility of money transfers from the business partner to the faculty (e.g., grants, scholarships, donations, etc.).

Let us describe the situation in terms of service systems and denote the service system according to the IBM benefits as $R1$ and the second service system as $R2$ (i. e. the service system according to the benefits of Faculty of Informatics, Masaryk University.

Within $R1$ the roles of the Service System Triangle are distributed as: the role of the client plays the business partner (IBM IDC), the role of provider plays the Faculty of Informatics, Masaryk University, and the target is a business field of strategic outsourcing. Based on the assignments into the roles and based on benefits stated in the previous text, we elaborate some examples of statements that can be included in a value proposition for the business partner:

- a pipeline for talented students and graduates who are fitted to enter straight to business processes is established;
- experts from the management and strategic research and development teams are associated members of such scientific boards which can influence the educational processes and the curricula contents;
- research topics arisen from business practices are investigated and studied at research faculty laboratories;
- an up-to-date list of annotated research projects which are being solved by the faculty as well as short situational reports about these projects is available.

Within $R2$ (the service system described by the benefits of the Faculty of Informatics, Masaryk University) the roles are distributed: the role of the client is played by the Faculty of Informatics, the role of provider plays IBM IDC. The target of such service system is the field of the study processes and the research processes at Faculty of Informatics. Some examples of sentences that can be included in a value proposition within the $R2$ follows:

- there is a contract between us and business partner, which establishes a number of students participating in full time projects (5 months long) every semester in a business partner's department. The focus of the projects is put to the service systems' domain (their creation and operation);
- a list of topics for diploma thesis originated in business practice is established. This list is continually updated based on the collaboration with appointed guarantors form IBM IDC;
- a financial support of faculty research is regularly obtained from IMB IDC;
- our faculty stands on the list of institutions which offer an education in the service science field published on the official web pages of the IBM corporation.

The question here is: *Is it possible for the service system $R2$ work without the service system $R1$?* Well, the answer is *Yes.* On the other hand, the value brought by Faculty of Informatics compared to the effort which would be consumed by IBM IDC while working on establishing such system, is attractive. Therefore entities such Faculty of Informatics do exist and also service systems where the Faculty of Informatics, Masaryk University, plays the role of the provider do exist. Same reasoning can be used for the existence of service systems where the IBM IDC plays the role of the provider. And also, we can apply this logic to our first example about Telecoco and Heavysoft enterprises.

The important issue when speaking about cooperating service systems is a *mutual usability* (as shown for both examples). The usability for the client is expressed in the value proposition. To suggest/evaluate whether the cooperation of the service systems will be successful (i.e. that both parties will be satisfied while playing the client's roles) the focus have to be put on analysis and evaluation of the respective value propositions. In fact, this means to understand what particular knowledge have to be expressed and shared, what information have to be collected and shared, in which ways in the world understood by each of the partners, how is the value created.

Another important comment on the interaction between the service systems is about the particular agents acting on behalf of the partners. There is never an interaction between service systems as business entities. The interaction is done between agents who are involved in the service systems.

Service system can be seen as an "relationship envelope" wrapping existing entities. The main characteristics lays in the relationships. Recall the Definition 3 on the cooperation of service systems. There, we do not speak about interacting entities, but we describe the way agents interacts with each other while playing roles of the client, the provider, or the target. These relationships let emerge the characteristics of the cooperating service systems.

Value propositions can be defined only after the targets of both prime service systems are set. The statements of value propositions are related to targets, therefore we can say that a formulation of value proposition is based on chosen target of the service. We presented it for both examples earlier in this paper.

When we deal with different value propositions we would like to be able to find out whether both value propositions are in balance. To compare them, it is useful if they have similar structure. Details required to compare the structure of the value propositions go beyond the scope of this paper, more details will be given in [13].

The simplest situation which we want to discuss here is when both targets are the same. It supports better understanding. In such situation the agent participating in the service system is familiar with the matter from both perspectives: from the provider's point of view, and also from the client's point of view. The two individual value propositions per agent can be substituted by one bidirectional value proposition.

To explain this on examples, following statements can be formulated:

- a pipeline for talented students and graduates of Faculty of Informatics, Masaryk University, who are fitted to enter straight to business processes of IBM IDC is established;

– there is a contract between Faculty of Informatics, Masaryk University, and IBM IDC, which establishes a number of students participating in full time projects (5 months long) every semester in a department of IBM IDC. The focus of the projects is put to the service systems' domain (their creation and operation);
– Experts from the management and strategic research and development teams of IBM IDC are associated members of such scientific boards at Faculty of Informatics, Masaryk University, which can influence the educational processes and the curricula contents;
– a list of topics for diploma thesis for students of Faculty of Informatics, Masaryk University, originated in business practice is established. This list is continually updated based on the collaboration with appointed guarantors form IBM IDC and Faculty of Informatics, Masaryk University;
– research topics arisen from business practices of IBM IDC are investigated and studied at research laboratories of Faculty of Informatics, Masaryk University;
– a financial support of research at Faculty of Informatics, Masaryk University, is regularly obtained from IMB IDC (e.g., grants, scholarships);
– Faculty of Informatics is listed between institutions which offer an education in the service science field and it is published on the official web pages of the IBM corporation

A definition in the next section will help us to talk about two cooperating prime service systems as about dual service system.

2.3 Dual Service System

Notation remark: Within the service system I*, let* C_i, P_i, T_i *stand for the client, the provider, and the target, respectively. It means we are talking about agents with assigned roles.*

Definition 4. *(Dual Service System) Let us have a service system in which two prime service systems (*$P1$ *and* $P2$*) can be identified (by using two main benefit contexts). Let the service system* $P1$ *be denoted by triplet* (C_{P1}, P_{P1}, T_{P1}) *and the service system* $P2$ *be denoted by triplet* (C_{P2}, P_{P2}, T_{P2})*.*

If it holds that

1. $C_{P1} = P_{P2}$ *and* $P_{P1} = C_{P2}$*;*
2. $T_{P1} = T_{P2}$*;*
3. *a union of value proposition of* (C_{P1}, P_{P1}, T_{P1}) *and value proposition of* (C_{P2}, P_{P2}, T_{P2}) *creates a bidirectional value proposition, which covers benefits for* C_{P1} *as well as for* C_{P2}

than we call the service system (C_{P1}, P_{P1}, T_{P1}) *or the service system* (C_{P2}, P_{P2}, T_{P2}) dual service system. □

The Definition 4 about dual service systems talks about such service system which contains two basic context. These contexts are based on the benefits of involved agents. The target remains the same for both cases.

The Definition 4 is helpful when we need to formulate a value proposition which balances benefits of involved agents (who plays the roles of client/provider and provider/client).

3 Conclusions

The proposed concepts of the prime service system, the service system cooperation, and the dual service system presented in this paper resulted from our work on real projects from the software development field and also from the project management domain.

We build up on the extended definition of the service system, according to which the agents involved in the service system can play any role from the service system triangle depending on a context. These roles are the client, the provider, and the target.

The concept of the prime service system is discovered by separation of clients' and providers' benefits. In other words, by changing the perspective of the viewer, the assignment into roles can change. The agent, who played originally the client, is by the switch of the perspective seen as the provider. Therefore it seems reasonable to view the situation through the agent's benefits.

Next concept of the service systems cooperation, defined later on in the paper, gains from the prime service system's definition and is followed by the definition of the dual service system. Dual service system is introduced as two cooperating prime service systems. All definitions are accompanied by detailed illustrative examples from the field of business enterprises and academic institutions.

We are aware that later research on this topic has to be done since some concepts used in this paper were used quite vaguely, with no proper explanations.

The proposed concepts were already proven to be useful in disputations in our research group [12], where the precise meaning is necessary to discover desired solutions. To verify the usefulness of the presented concepts in the academic field, other researches have to find them useful for their own research. Therefore the feedback is appreciated.

References

1. Basole, R.C., Rouse, W.B.: Complexity of Service Value Network: Conceptualization and Empirical Investiagation. IBM Systems Journal, SSME - Service Science, Management, and Engineering 47(1), 53–70 (2008)
2. Glushko, R.J.: Seven Contexts for Service System Design. In: Mglio, P.P., Kieliszewksi, C., Spohrer, J. (eds.) Handbook of Service Science. Springer, New York (2010) (to be published)
3. Hocová, P., Falcão e Cunha, J., Staníček, Z.: Assessment of Individuals Cooperating Towards Value Co-Creation in a Dynamic Service System Environment. In: Proceeding of the QUIS 11 - The Service Conference, Wolfsburg, Germany (June 2009)

4. Hocová, P.: INnovation&COoperation: the Reference Model of Service System for Supporting Cooperation. Faculty of Informatics, Masaryk University, Internal Report, FIMU Botanicka 68a, Brno, Czech Republic, 2009-10-01 (provisional title; to be submitted as PhD thesis) (2009)
5. Facts and figures: China's main targets for 2006-2010 (2009), http://english.gov.cn2006-0306content219504.htm (retrieved October 1, 2009)
6. Lusch, R.F., Vargo, S.L.: The Service-Dominant Mindset. Service Science, Management, and Engineering, 89–96 (2008)
7. Maglio, P.P., Spohrer, J., Seidman, D.I., Ritsko, J.J.: Preface. IBM Systems Journal, SSME - Service Science, Management, and Engineering 47(1), 3–4 (2008)
8. Qui, R.: Service Science: Scientific Study of Service Systems. Service Science (2009)
9. Spohrer, J.: Services Sciences, Management, end Engineering (SSME) and its relation to academic disciplines. In: Proceedings of First German Service Science Conference (2006)
10. Spohrer, J., Maglio, P.P., Bailey, J., Gruhl, D.: Steps toward a Science of Service Systems. IEEE Computer 40(1), 71–77 (2007)
11. Spohrer, J., Andersson, L., Pass, N., Ager, T., Gruhl, D.: Service Science. IBM Research. Journal of Grid Computing, Special Issue on Grid Economics and Business Models (August 2007)
12. Service System, Modeling and Execution Research Group at Faculty of Informatics, Masaryk University, Czech Republic, http://www.fi.muni.cz/research/enterprise/services.xhtml.en
13. Staníček, Z.: SSME* - Service Systems, Modeling, Execution, Education, Evaluation. Faculty of Informatics, Masaryk University, Internal Report, FIMU Botanicka 68a, Brno, Czech Republic, 2009-10-01 (provisional title; to be submitted as habilitation thesis) (2010)
14. Staníček, Z., Winkler, M.: Service Systems through the Prism of Conceptual Modeling. In: Proceedings of the 2009 Naples Forum on Service: Service-Dominant Logic, Service Science and Network Theory. Giannini Editore, Napoli (2009)
15. Vargo, S.L., Lusch, R.F.: Evolving to a New Dominant Logic for Marketing. Journal of Marketing 68, 1–17 (2004)
16. Vargo, S.L., Lush, R.F.: The Four Services Marketing Myths: Remnants from a Manufacturing Model. Journal of Service Research, 324–335 (May 2004)

A Conceptual Framework for Service Modelling in a Network of Service Systems

Thang Le Dinh[1] and Thanh Thoa Pham Thi[2]

[1] Université du Québec à Trois-Rivières, Québec, Canada
Thang.Ledinh@uqtr.ca
[2] Dublin City University, Dublin, Ireland
Thoa.Pham@computing.dcu.ie

Abstract. Although the service sector has dominated the modern economies, there is still a little research on service modelling, especially on new models, methods and frameworks. In this paper, we present a conceptual framework for service modelling in a network of service systems based on network configuration and shared information. We study firstly the needs for the conceptual framework and present the related works in literature. Then we propose and analyse the architecture of our framework that consists of three different levels: the Service level concerned with service operation, the Service system level concerned with service creation, and the Network of service systems level concerned with service specification. A case study of this framework shows that our approach is pertinent and efficient. This paper also opens new directions for future research in service design and innovation.

Keywords: Service science, service system, conceptual framework, service modelling, network of service systems.

1 Introduction

In these times, the service sector consists of 75 percent of the gross domestic product (GDP) of developed countries and has dominated the modern economies [1]. Despite the dominance of the service sector and its rapid growth worldwide, there is still a little research that addresses the challenges of service design and innovation [2]. Therefore, it is important to have a thorough understanding as well as innovative approaches, such as new methods, models and frameworks for designing and managing services in order to succeed in the global competition [3].

On the other hand, the obligation to become more competitive and more effective to provide better products and services requires enterprises to transform from traditional business into networked business. The availability of Internet and information technologies has promoted new business strategies that take the advantages of enterprises' abilities to create networks or to network with other enterprises.

For this reason, our research interest focuses primarily on the challenges of service designing in a network of services systems. In the context of a network, several economy entities work together to co-produce different categories of services. As a matter

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 192–206, 2010.

of fact, the traditional methods for service design often focused on designing services inside an economic entity, not in a network of several economic entities.

This paper addresses the challenge of service modelling, which is a crucial component of service design. It presents a conceptual framework for service modelling in a network of service systems based on network configuration and shared information. The remainder of the paper is structured as follows. It continues with the literature review of service systems, networks of service systems, services and service modelling. Thus, it presents the conceptual framework for service modelling in a network of service systems at three levels: the Service level concerned with *service operation*, the Service system level concerned with *service creation*, and the Network of service systems level concerned with *service specification*. Furthermore, an example about modelling services in a travel and tourism network is illustrated. Finally, the paper ends with a conclusion and future directions.

2 Background

This section begins with the definition and the characteristics of services, service systems, and networks of service systems. Thus it continues with literature review of service modelling and points out the difference between our approach and other approaches.

2.1 Services and Service Systems

A **service** is defined as "*a change in the condition of a person or a good belonging to some economic entity brought about as the result of the activity of some other economic entity, with the approval of the first person or economic entity*" [3][5].

According to [6], there are four main characteristics of services:

- *Information-driven*: the creation, management and sharing of information are essential to the design and the production of services;
- *Customer-centric*: customers are co-producers of services that can require the adaptation or the customization of services;
- *Electronic-oriented*: the achievements of information and communication technologies improve the automation and the connection between economic entities and enable e-commerce, e-business, e-collaboration, e-government and then e-services; and
- *Productivity-focused*: in order to obtain the competitive advantage in the global economy, services are measured based on dimensions of performance measurement such as efficiency and effectiveness.

A **service system** is defined as a "value-coproduction configuration of people, technology, other internal and external service systems, and shared information" [1].

An interesting question is that what are the differences and similarities between service systems and information systems. The main difference here is *people* whose *behaviour* cannot be easily modelled or simulated. Consequently, service systems, which are complex adaptive systems and made up of people, must be also dynamic and open in order to adapt to the behaviour of their stakeholders [1].

Service science is a new science of services systems, which aims at increasing service innovation by applying scientific understanding, engineering discipline, and management practices to understanding and working with services systems [7].

2.2 Networks of Service Systems

The **service economy** refers to the service sector that has become the most important sector of economies. Service economy is based on the new logic: *service-dominant logic* that is contrasted with the traditional *goods-dominant logic* [8]. In service-dominant logic, services are defined as utilizations of specific competences such as knowledge, skills and technologies of an economic entity for the benefit of another economic entity [4]. In that case, value creation occurs when a resource is turned into a specific benefit. This activity is called *resourcing,* which is performed by a service system. Consequently, the traditional supply chain is re-conceptualized as a *network of service systems* or a *service value creation network* [8].

A **network of service systems** is an organizational network that is defined as a group of several autonomous organizations that work together to achieve not only their own goals but also a collective goal [9]. In fact, a network is viewed as a mechanism of coordination, or is referred to as *network governance*. The first two forms of network governance are *Market* and *Hierarchy* [10]. *A* hierarchy is a system, in which each part is exactly defined in order to perform a specific function. *A* market is a system of agents, in which an agent can provide products and services to other agents. Recently, the third form of governance had been proposed: *Network* [11]. *A* network is system that helps its members work together by communication, based on trust.

According to [9], there are three typologies of networks: *Participant-governed networks*, *Lead organization-governed networks* and *Network administrative organization-governed networks*. A participant-governed network is governed by the network members themselves with no separate governance entity. On the contrary, in a lead organization-governed network, network governance can occur through a lead organization. Finally, the basic idea of a network administrative organization-governed network is that a separate administrative entity is set up specifically to govern the network.

2.3 Service Modelling, the Proposed Approach and Related Work

Service modelling amounts to the representation of relations between what is provided to customers, how it is provided, the technical definition of the service, and resources needed for operating the service [12]. In other words, service modelling aims at clarifying the role of people, technology, and shared information in the service system. It also aims at pointing out what are service systems and networks of service systems, how those systems and networks arise and evolve, and how to coordinate between internal and external service systems.

Current approaches for service modelling can be classified into two categories: Process-oriented approaches and System-oriented approaches.

Process-oriented approaches have come from different areas such as operational research and industrial engineering that often focus on modelling traditional services such as person-to-person and single channel. Firstly, *service blueprint* is a method proposed by Shostack [13][14] and evolved by several authors [15][16][17][18]. A blueprint is a two-dimensional picture of a process: the horizontal axis represents the chronology of actions and the vertical axis represents different areas of actions. Another process-oriented approach is the *Lean Consumption* approach developed by James P. Womack and Daniel T. Jones as a service counterpart to the manufacturing concept of "lean production" [19].

System-oriented approaches have mostly come from software engineering that focus strongly on the system being developed and functional requirements. Some of those approaches based on the *business process perspective* for designing service-bases systems [20][21]. Others tried to capture *business goals and requirements* and translate them into system design [22]. Recently, the *Value and goal driven* approach utilizes both value and goal models as the foundation for designing e-services [23].

Recent researches emphasize that IT solutions need to be derived from business perspectives [22][23]. We utilize this direction in our work; however, the approach that we propose will focus on the *network configuration* instead of business models, goals or value such as in [22][23]. We consider that a value creation network reflects obviously and completely the value proposition and exchanges, which are accepted by all the stakeholders. Therefore, network design and configuration are more general than business and goal models and can be used as the foundation for service modelling in a network of enterprises. In our approach, we view a value creation network as a variable network of service systems with different network governance configurations and could have different network levels. Thereby we are able to specify complex and modern types of services in a value creation network such as multi-channel services or network-based services.

In the following sections, we present our approach at different levels. The *Network of service system level,* concerned with service specification, aims at modelling services as a chain of value creation and exchanges in which involved service systems co-produce some common results. The *Service system level*, concerned with service creation, includes the implementation and configuration of service specifications. Finally, the *Service level*, concerned with service operation, ensures that the service is linked to adequate resources and supported correctly by IT solutions.

3 Conceptual Framework for Service Modelling

The evolution of inter-organizational field requires that an organization becomes "*a system which is enabled by information technology and is characterized by information sharing*" [3]. Thus, the integration of technology, business processes and people needs to be developed to create higher value from value creation networks. In our point of view, the most important characteristic of service systems is that services are information-driven. Therefore, the foundation for service systems should take into account the creation, management and sharing of information that are essential to the design and the production of services. For this reason, our approach is defined as *an information-driven approach* that focuses on the creation, management and sharing of information in the processes of service specification, service creation and service operation.

In the following, the conceptual framework is presented at three levels: the *Service level,* concerned with service operation, presents what are provided to customers and how they are provided; the *Service system level,* concerned with service creation, describes what are service systems and the roles of people, technology, and shared information; the *Network of service systems level,* concerned with service specification, depicts what are networks of service systems and the value co- producing between internal and external service systems.

The conceptual framework includes a set of key concepts that can be used to present a thorough understanding of services, service systems and networks of service systems. Enterprises can evolve and adapt those key concepts for modelling their own services. In this section, we will use simplified UML (Unified Modelling Language) notation for the meta-model [27] of our framework.

3.1 Service Level

At the Service level, service modelling focuses on the unit of shared information that represents the operation of the service at high level of abstraction. Therefore, the conceptual framework at the Service level includes the three key aspects of information systems: *Static*, *Dynamic* and *Rule aspects* [24].

The **Static aspect** deals with the informational dimension of services, describing what types of shared information exist, their structures, as well as their interrelations. This aspect includes the key concepts such as Classes and Attributes. An object type and a set of objects of this type define a *class*. An *attribute* of a class is a function corresponding to every object of this class and to a set of objects of other classes.

The **Dynamic aspect** deals with the operational dimension of services, representing the behaviour, performance, and quality of services. This aspect answers the questions of how to capture and measure the result of an activity or a process. There are two levels of behaviour:

- *Local behaviour*, defined as the behaviour of objects of a class, includes Dynamic states and Methods. *Dynamic states* of an object are conditions, modes or situations during which certain methods are “enabled” and other methods are “disabled”. Besides, a dynamic state represents a subset of objects of a class; therefore, it is a subclass of this class. A *method* of a class is used to transit between a set of dynamic states of the objects to another set of dynamic states of objects of the class.
- *System behaviour*, defined as the behaviour of the service system, is represented by Processes. A *Process* uses a set of methods and performs a transformation of a set of dynamic states of the service system. A *pre-condition* states the constraint that must be true before performing a process. On the contrary, a *post-condition* states the constraint that must be true after performing a process.

The **Rule aspect** deals with the legal dimension of services, concerning different factors in the environment in which enterprises operate such as goals, regulations, policies, and contracts. Those factors could be translated into business rules in service systems. The key concepts of the Rule aspect include Integrity rules, Scopes, and Risks. *Integrity rules (IR)* represent the implementation of business rules in a service system. *Scopes* of an IR represent the context of an IR, which is defined as a subset of classes. *Risks* are the possibilities of suffering the incoherence of information that may lead to fail points. Each method may involve a set of attributes and may concern with a set of risks.

Fig. 1 summarizes the key concepts of the framework at the Service level.

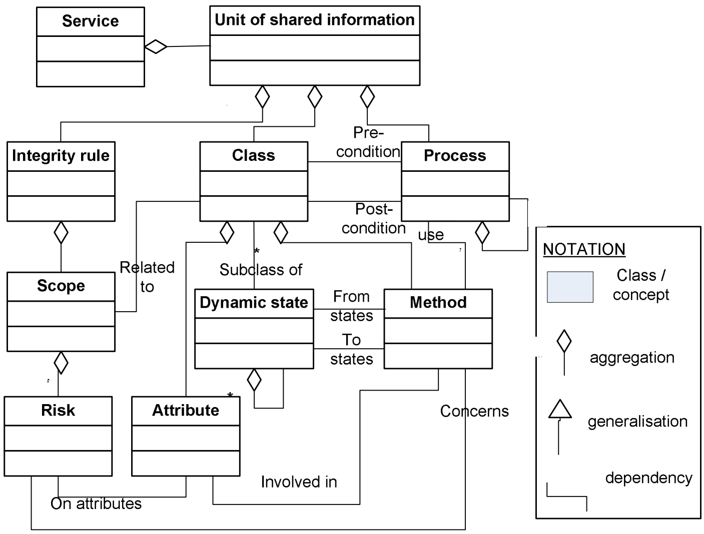

Fig. 1. Meta-model of a unit of shared information of a service

3.2 Service System Level

At the Service system level, service modelling focuses on the implementation of services that consists of the relations between the shared information, the technical definition, and resources needed. In general, a service is represented by a unit of

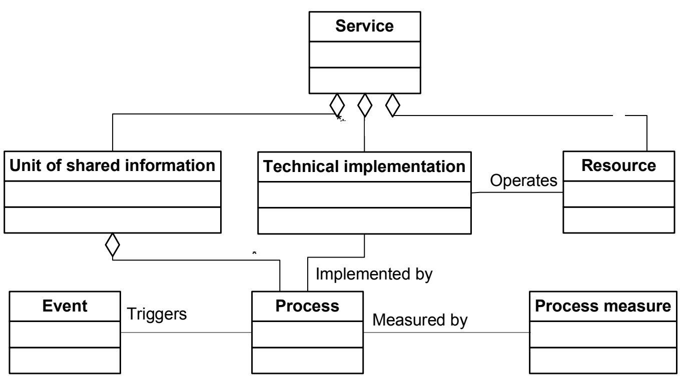

Fig. 2. Meta-model of a service

shared information. Each process of the unit of shared information could be implemented by one or several technical implementations, and it needs resources to operate those technical implementations.

An *event* is the request from external economic entity. A *process* is a feedback of the service system to the occurrence of an event that changes dynamic states of the service system. *Process measure* is a subset of indicators used to measure the result of a process or a subset of processes based on the dimensions of performance measurement (efficiency, effectiveness and sustainability) and quality aspect. Fig. 2 summarizes the key concepts of the framework at the Service system level.

3.3 Network of Service Systems Level

The framework at the Network of service systems level presents the organizational aspect of a network of service systems that reflects the value creation and exchanges in the network. The framework at this level includes key concepts such as Economic entities, Networks, Roles, Overlap situations, and Overlap protocols.

Each *economic entity* is a stakeholder of the network and has distinct goals. For example, the *Service client* seeks reducing cost and improving services. The *Service provider* seeks increasing revenue and customer satisfaction. An economic entity could be an individual, an enterprise, a government, or an economy.

A *network of service systems* is composed of variety of economic entities. Each economic entity assures a subset of responsibilities and roles in the network. Each network is governed by *one form of network governance* (Hierarchy, Market or Network) and is organized based on a typology of networks. Depending on the form of network governance, members of a network may play different *roles* and provide different services that are available in the network.

Furthermore, there are two categories of services in a network: Independent services and Dependent services. *Independent services* or autonomy services whose realization is independent with services provided by other economic entities. On the contrary, *dependent services* need the cooperation with other economic entities for their realization.

Fig. 3 summarizes the key concepts of the framework related to the organization of a network of service systems.

Let's continue to discuss about the interdependencies between economic entities in a network of service systems. At first, each service is represented by a unit of shared information. Information overlap among units of shared information is indispensable when several economic entities co-produce value and share a common subset of shared information. In fact, information overlap reflects the interdependencies between economic entities in a network that is represented by two key concepts of the framework: Overlap situation and Overlap protocol.

An **overlap situation** occurs when there is at least one class or one process is common to several units of shared information [25]. There are possibly three types of overlap situations between a subset of units of shared information: i) *Distinct*: there is no common class and no common process between units of shared information; ii) *With-border*: there are common classes, but no common process; and iii) *With-overlap*: there are common classes, and common processes performing operations on those common classes, and probably common integrity rules whose scopes are those common classes.

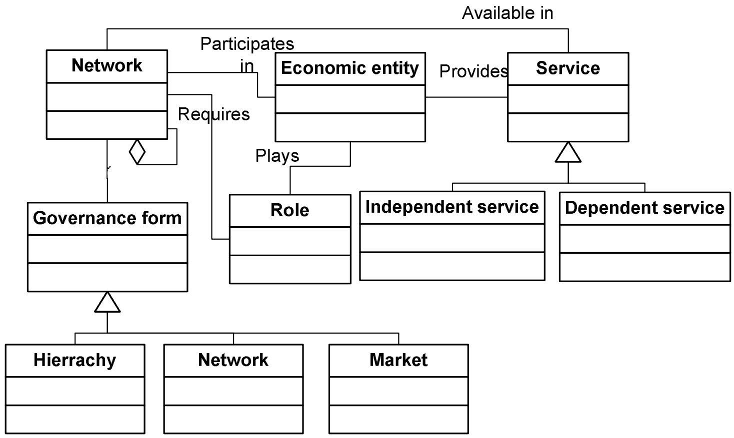

Fig. 3. Meta-model of a network of service systems

An **overlap protocol** is a protocol that allows each economic entity to perform its own processes locally. Meanwhile, this protocol also helps the economic entity to take into account the processes in other economic entities that can influence its own processes based on the form of its network governance [26]. Consequently, there are three theories of coordination: Hierarchical, Market, and Network theories. Our framework provides the facilities to support the all three theories of coordination to adapt to different styles of networks of service systems.

Fig. 4 summarizes the key concepts of the framework related to the information overlap in a network of service systems.

Corresponding to the theories of coordination, we propose the following categories of overlap protocols:

- *Ownership-based overlap protocol*, corresponding to Hierarchy form of network governance, appoints which economic entity would play the role of the *owner* for each common object. The owner of an object takes the responsibility for defining, developing and maintaining it. The other economic entities (as *referrers*) may communicate to the owner to obtain information about this object.
- *Market-based overlap protocol*, corresponding to Market form of network governance, appoints which economic entity would play the role of the *custodian* for each common object. The custodian of an object takes the responsibility for providing services related to this object. This protocol allows other economic entities (as the *requesters*) to send a request to perform a process to the provider. Normally, the custodian performs the requested process and returns the result to the requested economic entity.
- *Network-based overlap protocol*, corresponding to Network form of network governance, allows each economic entity (as the *co-owner*) to monitor the consequences that causes by the other *co-owners*, which have performed a process overlapped between them.

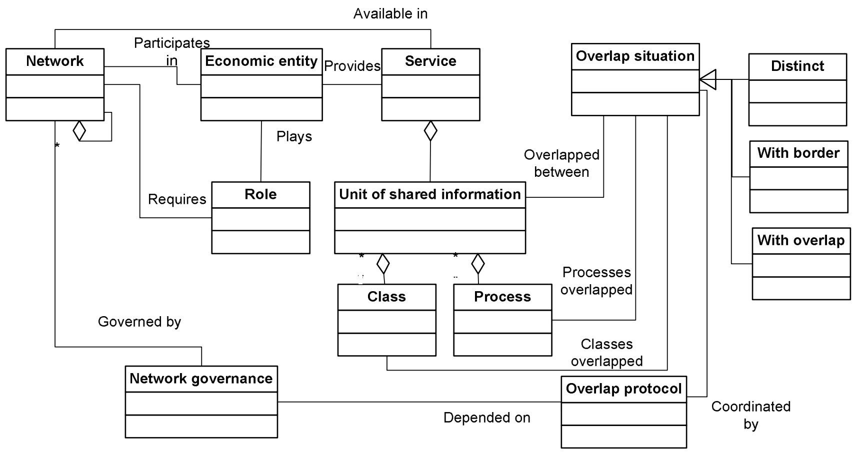

Fig. 4. Meta-model of information overlap in a network of service systems

Indeed, the first overlap protocol conforms to With-borders overlap situations; meanwhile, the second and the third overlap protocols conform to With-overlaps overlap situations.

4 Example of a Network of Service Systems

Let's continue with an example about modelling services in a travel and tourism network. A travel agency in the Netherlands aims at offering long-distance travel packages such as travelling to Egypt or to South Africa to its clients. A travel package includes flight, accommodation and sightseeing services.

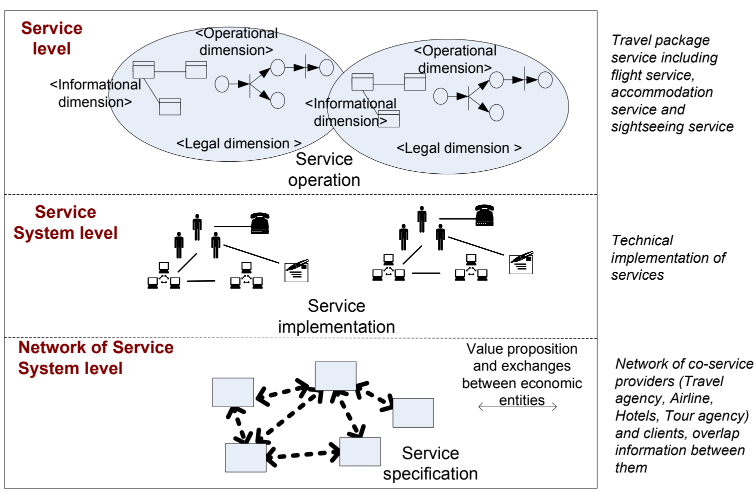

Fig. 5. A model for services in a network of tourism and travel agencies

The travel agency has some business partners who provide flights, accommodation and sightseeing activities with reasonable price. Each travel package is organized and planned in details such as during, start date, flight schedule, accommodation information and activities of each day. Because of the business competition, the agency often chooses the best airline and hotels in terms of the service quality and the good price. They could change their service providers when it is necessary.

Clients who want to travel with this agency will receive a list of travel packages and their prices. Clients can book online by Internet, by phone call, or in person at the agency office and they must pay all fees before taking their trip.

Based on the proposed framework, the model for services in our example can be represented at the three levels as in Fig. 5.

The modelling details of each level are presented in the following. We will use simplified UML notation [27] for the informational dimension (Static aspect) and Petri-net diagram [28] for the operational dimension (Dynamic aspect).

4.1 Service Level

The main service of this example is the *Travel package* service. Let's discuss about the three key aspects of the unit of shared information representing the *Travel package* service.

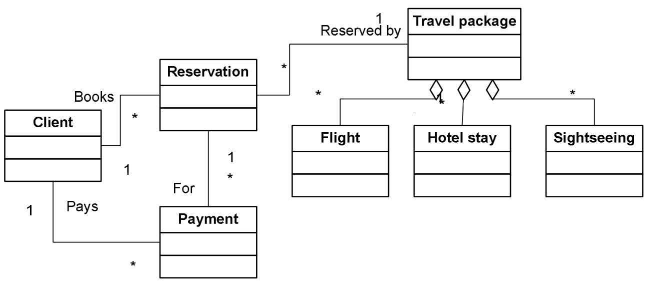

Fig. 6. Static aspect of the *Travel package* service

The **Static aspect** includes the following classes: *Client, Reservation, Travel package, Flight, Hotel stay, and Sightseeing* (see Fig. 6). A client makes a reservation for a travel package. A travel package includes flight, hotel stay and sightseeing activities. Clients may pay one or several payments for his reservation.

The **Dynamic aspect**, including a set of dynamic states and processes, is represented by a Petri-Net diagram as in Fig. 7, in which a state represents a dynamic state and a transition represents a process.

A client may choose and book a travel package. Then he can pay the package to complete booking and to receive a receipt. However, if the client changes his idea, he could cancel the reservation. Otherwise once the booking is completed, he may start

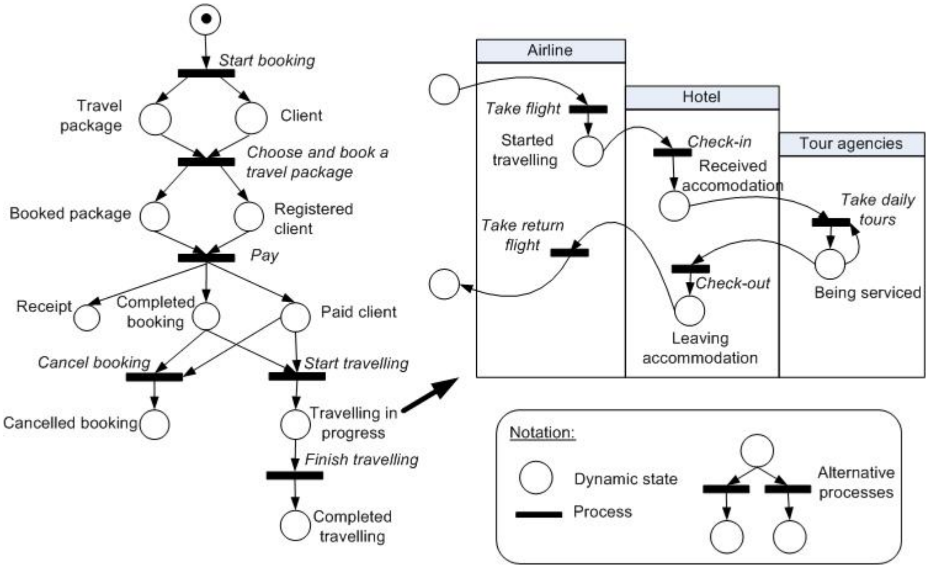

Fig. 7. Dynamic aspect of the Travel package service

his trip, take his flight, stays at booked hotels, and attends booked sightseeing tours. The right side of Fig. 7 depicts a refinement of the *Travelling in progress* state which describes processes performed by co-providers during the trip such as *Take flight, Take return flight, Check-in*, *Check-out*, and *Take daily tours*.

The **Rule aspect** concerns the regulations and contracts between the *Client* and the *Travel agency*. In the case of travel and tourism networks, a service contract used to be a *service level agreement (SLA)* where the level of service is formally defined. A SLA used to refer to the delivery time of services, quality of services or performance. In our example, there are integrity rules that verify regulations such as how to calculate sale tax or how to calculate penalties for customers who cancel their booking late. Besides, delivery times of services are captured as *process measures* and there are integrity rules to verify whether the value of delivery times of services (time frame related to flight, hotel stay and sightseeing activities) is in the acceptable range of the SLA or not.

4.2 Service System Level

At the Service system level, the technical implementation of processes which are defined at the Service level is described. We propose the list of processes which are performed by the Travel agency as well as their technical implementations and the resources needed as in Table 1.

Table 1. Processes performed by the Travel agency

Process	Technical implementation	Resources
Choose and book a travel package	By Internet	Web site
"	By phone call	Travel agent, phone, computer
"	In person	Travel agent, computer
Pay	By Internet	Web site
"	In person	Travel agent
Issue receipt	By Internet	Web site
"	In person	Travel agent, computer, printer
Cancel booking	By Internet	Web site
"	In person	Travel agent, computer
"	By phone call	Travel agent, phone, computer

4.3 Network of Service Systems Level

Travel and tourism networks are a typical example of a network of service systems. The economic entities in the travel and tourism network are: the *Tourist* is service client who bought a travel package; the *Travel agency* is service provider for the *Travel package* dependent service. Furthermore, the *Airline, Hotel* and *Tour agency* are also service providers that provide the *Flight, Hotel stay* and *Sightseeing* independent services (see Fig. 8).

Consequently, this travel and tourism network is governed by the Market form of network governance and organized by the *Travel agency* as the Network administrative organization. Each economic entity who participates in the network may provide different services. The *Travel agency* service provider provides *Travel package* service to *Tourist* service client that is composed several services from its partners such as *Airline*, *Hotel* and *Tour agency* service providers.

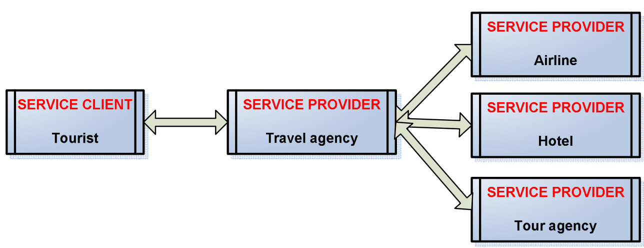

Fig. 8. Economic entities in a travel and tourism network

The Table 2 represents the overlap situations between the economic entities in the Travel and tourism network and the overlap protocols to operate those overlap situations. *Booked travel packages* class is a sub-class of *Travel packages*. *Offered hotels* and *Offered sightseeing activities* classes are also subclasses of *Hotel* and *Sightseeing activities* classes.

Table 2. Overlap situations in the Travel and tourism network

Overlap situation	Travel agency	Client	Airline	Hotel	Tour agency	Overlap protocol
- Classes: *Travel packages*	O	RR	RR	RR	RR	*Hierarchy*
- Classes: *Booked travel packages* - Processes: *Choose and book; Cancel booking*	C	R	R	R	R	*Market*
- Classes: *Client information* - Processes: *Choose and book*	C	R	R	R	R	*Market*
- Classes: *Payment information* - Processes: *Pay*	C	R				*Market*
- Classes: *Flights* - Processes: *Choose and book, Take flight*	R	R	C			*Market*
- Classes: *Offered flights* - Processes: *Choose and book, Take flight*	C	R	R			*Market*
- Classes: *Hotels* - Processes: *Choose and book*	C	R		R		*Market*
- Classes: *Offered hotels* - Processes: *Choose and book, Check-in, Check-out, Receive other services*	R	R		C		*Market*
- Classes: *Sightseeing activities* - Processes: *Choose and book*	C	R			R	*Market*
- Classes: *Offered sightseeing activities* - Processes: *Choose and book*	R	R			C	*Market*

Note: R: requester, C: custodian, O: owner, RR: referrer.

Let's discuss thoroughly about the first and second overlap situations. The first overlap situation related to the *Travel packages* class is a *with-border* overlap situation, which is operated by Ownership-based overlap protocol. The *Travel agency* economic entity is the owner of the *Travel packages* class. The second overlap situation related to the *Booked travel packages* class (representing information about client bookings) and corresponding processes is a *with-border* overlap situation which is operated by Market-based overlap protocol. The *Travel agency* economic entity is the custodian of the *Booked travel packages* class. The other economic entities may request to perform a process on that class.

5 Conclusion

Nowadays, the service sector has dominated the global economy. Consequently, there is still a need for a strong foundation for service design and innovation [2]. For this reason, our work focuses on proposing a conceptual framework for service modelling in a network of service systems based on network configuration and shared information. The key concepts of the conceptual framework clarify the role of people, shared information and technology in a network of service systems. The perspective of this work is to provide an effective framework that would be best suited for modelling complex and networked services at a high level of abstraction and in a coherent manner.

The conceptual framework includes three levels: *Service, Service system*, and *Network of service systems levels*. The Service level, concerned with service operation, represents the IT solutions for service systems (including three aspects of shared information: *Static, Dynamic,* and *Rule aspects*). The Service system level, concerned with service creation, represents the organizational aspect of service systems (including *Units of shared information, Technical implementations, and Resources*). The Network of service systems level, concerned with service specification, represents the design and configuration of networks of service systems (including *Economic entities, Networks, Roles, Overlap situations*, and *Overlap protocols*).

Concerning our future directions, much work remains to be carried out to apply the conceptual framework to a broader scale. A systematic guideline will be developed for using the framework effectively. We are actually working on a formal model to represent different aspects of services in a coherent manner in order to simulate effectively the behaviour of stakeholders. Besides, we are also building a software tool to generate the architecture supporting service specification, service implementation and service operation in a network of service systems based on the specific characteristics of its members such as network governance, overlap protocols, inter-organizational relationships, management styles, and technologies used.

References

1. Spohrer, J., Maglio Paul, P., Bailey, J., Gruhl, D.: Steps Towards a Science of Service Systems. IEEE Computer (1), 71–77 (2007)
2. Bitner, M.J., Ostrom, A.L., Morgan, F.N.: Service Blueprinting: A Practical Technique for Service Innovation. California Management Review 53(3), 66–94 (2008)
3. Chesbrough, H., Spohrer, J.: A Research Manifesto for Services Science. Communication of the ACM 49(7) (2006)
4. Vargo, S.L., Lusch, R.F.: Evolving to a New Dominant Logic for Marketing. Journal of Marketing (1), 1–17 (2004)
5. Mohr, M., Russel, S.A.: North American product classification system: Concepts and process of identifying service products. In: Proceedings of the 17th Annual Meeting of the Voorburg Group on Service Statistics, Nantes, France (2002)
6. Tien, J.M., Berg, D.: A case for service systems engineering. Journal of Systems Science and Systems Engineering 12(1) (2003)
7. Maglio, P.P., Spohrer, J.: Preface. IBM Systems Journal 47(1) (2008)
8. Lusch, R.F., Vargo, S.L., Wessels, G.: Towards a conceptual foundation for service science: Contributions from service-dominant logic. IBM Systems Journal 47(1) (2008)
9. Provan, K.G., Kenis, P.N.: Modes of network governance: Structure, management, and effectiveness. Journal of Public Administration Research and Theory 18 (2008)
10. Williamson, O.E.: Markets and Hierarchies: Analysis and Antitrust Implications. Free Press, New York (1975)

11. Powell, W.W.: Neither market nor hierarchy: network forms of organization. Research in Organizational Behavior 12, 295–336 (1990)
12. Räisänen, V.: Service Modelling: Principles and Applications. Wiley, Chichester (2006)
13. Shostack, L.G.: How to Design a Service. European Journal of Marketing 16(1) (1982)
14. Shostack, L.G.: Design Services that Deliver. Harvard Business Review, 133–139 (1984)
15. Bitner, M.J., Ostrom, A.L., Morgan, F.N.: Service Blueprinting: A Practical Technique for Service Innovation. California Management Review 50(3), 66–94 (2008)
16. Kingman-Brundage, J.: George, and W.R.: Service logic: achieving service system integration. International Journal of Service Industry Management 6(4) (1995)
17. Patricio, L., et al.: Designing Multi-Interface Service Experiences. Journal of Service Research 10(4), 318–334 (2008)
18. Bitner, M., Ostrom, A., Morgan, F.: Service blueprinting: A practical technique for service innovation. California Management Review (2008)
19. Womack, J.P., Jones, D.J.: Lean Consumption. Harvard Business Review, 93–103 (March-April 2005)
20. Terai, K., Izumi, N., Yamaguchi, T.: Coordinating Web Services based on business models. In: Proceedings of the 5th international conference on Electronic commerce (2003)
21. Piccinelli, G., Emmerich, W., Zirpins, C., Schutt, K.: Web service interfaces for inter-organisational business processes an infrastructure for automated reconciliation. In: Enterprise Distributed Object Computing Conference (2002)
22. Mylopoulos, J., Chung, L., Yu, E.: From object-oriented to goal-oriented requirements analysis. Communications of the ACM 42(1), 31–37 (1999)
23. Henkel, M., Johannesson, P., Perjons, E., Zdravkovic, J.: Value and Goal Driven Design of E-Services. In: Proceeding of IEEE Conference on e-Business Engineering (2007)
24. Le Dinh, T.: Information Upon Information Systems: A conceptual framework. PhD thesis, University of Geneva, No. 577, Geneva (2004)
25. Le Dinh, T., Le Tang, H.: Towards an approach for modelling interoperability of information systems. In: Proceeding of the RIVF'07, Ha-Noi, VietNam (2007)
26. Le Dinh, T., Léonard, M.: Towards coordination-ready information systems: the Information System Component approach. In: Proceeding of AISTA, Luxembourg (2004)
27. Rumbaugh, J., Jacobson, I., Booch, G.: The Unified Modeling Language Reference Manual. Addison Wesley Longman, Amsterdam (1999)
28. Peterson, J.L.: Petri Nets. ACM Computing Surveys 9(3) (1977)

Services Design for People

Rafael Zaballa

La Salle Innovation Park of Services for People
(La Salle Campus Madrid)
rzaballa@lasallecampus.es

Abstract. Service Science, Management & Engineering i.e. SSME, is a framework where new approaches and interdisciplinary connections can be made to produce relevant and useful knowledge to create services that solve people's needs for a better quality of life. New solutions to old problems, new applications for existing technologies and innovative entrepreneurial initiatives are hopefully expected to appear from this new field. Services consequently must be planned and run, procuring customers' confidence for a sustained business success. Design, as an activity focused on service utility and meaning has a key role in customer's perception. Designing services for the future requires a mindset introducing new concepts and disciplines which must be managed precise and correctly. With this mindset, we introduce the concept of Strategic Design as a framework for services innovation and management through creativity considering value creation for all the stakeholders. This paper is aimed to give a guideline to this approach and its new elements with the related knowledge fields involved.

Keywords: Services Design, Strategic Design, Service Utility, Customer Experience.

1 What Is Services Design?

"Designing is a structured working process to create objects, images, spaces, services and innovative entrepreneurial strategies. Designing is defining the structural, functional characteristics and appearance (physical, use, and symbolic functions as well as psychological aspects) of a product to suit its mission at maximum effectiveness and efficiency" [3].

This definition, like many others, is an interpretation derived from the field of Industrial Design which has gone a long way ever since the XIX century industrialization and it was born in the need to produce large series of products adequate for people's use at minimum cost and market failure risk. It is also accurate for Services, adapting words such as appearance, and structural and functional characteristics to their precise meaning for this activity. It's clear that product appearance is what it looks like, functional characteristics refer to how it works, but the concept of **structural characteristics** for a product is not as intuitive and clear as the others. It is more comprehensible when we consider the product as a **whole**. What we usually understand as **the product** only refers to one of the critical elements that mean value for a

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 207–214, 2010.

customer, that is, the basic product. The “holistic concept of product”, is formed in the following way:

a. Basic Product: The idea or basic need it satisfies.
b. Actual Product: The basic product plus the brand, the packing, labeling, added information and other tangibles.
c. Augmented Product: The actual product plus the warranty, after-sales service, guarantee…
d. Perceived Product: The augmented product plus the subjective intangibles considered by the customer.

The Product seen in this way is closer to a **service concept**, as customer’s choice relies not only on product functionality and usability but on the after sales service, the guarantees, brand, product information, etc.

Professor John Heskett, from the Institute of Design of the Illinois Institute of Technology, states that “design combines the form utility and meaning of practical objects that reflect the identity and aspirations of their users through form and **decoration”** [4]**.**

Form utility is only one of the five (5) types of common marketing known utilities. Utility is a subjective product quality that refers to its capability to solve customers’ needs. See the following definitions:

Form utility: The capability of a product to solve customers’ needs in terms of its form. It refers to its usability (ease at use). Design is a main issue for this type of utility but the way the product is delivered, rather fully built and ready to use, or build it yourself, also has to do with form utility. It is the case of IKEA products, where customer accepts building the product in compensation for a good price and a thoughtful design.

Place utility: The capability of a product to solve customers’ needs in terms of where it is placed. Logistics and product placement play an important role on this utility. If it’s too far away or not accessible it has no value for the customer.

Time utility: The capability of a product to solve customers’ needs in terms of the time to receive it or use it. Again, if I’m not going to have it when I need it, it has no value. But if I’m urged I’ll get it from whoever delivers first.

Information utility: The capability of a product to solve customers’ needs in terms of having the information to use it correctly and with all its affordances. This is especially important in the use of sophisticated products like technological ones.

Possession utility: The capability of a product to solve customers’ needs in terms of the satisfaction it provides for owning it. This utility does not only stand for the control of use of the product which may be enhanced by time and place utility, but also to customer’s subjective feeling of ownership. This is where intangibles appear.

It is especially interesting to notice some facts about services regarding utilities. First of all, services are not possessed. Secondly, services are unstable systems, meaning that you cannot expect the exact same performance on each interaction (human factor reasons among others). Finally, time and place full availability cannot be guaranteed. Notice that time and place utilities can be considered indeed crucial features for many services. They are as important for services design as formal utility is for product design. Process definition and planning must be included in service design as it has a main influence in its **usability**. Service availability, time consumption or mobility costs are key factors for customer's satisfaction in services versus fatigue and frustration.

Correct and useful information are of extreme importance in services. Graphical design plays a very important role in many of them. Understanding a service as a **System** and graphical design as a tool that creates coherence in it as a whole is a key issue. This will enable to create a useful homogeneous and predictable language for customer interactions, gaining liability. On the other, hand graphical design is the natural support for brand communication and therefore a strategic tool if it is correctly managed.

The fast advance of internet services opens an enormous field for design. Aesthetics and functionality must be wisely balanced. Website success is very much determined by its accessibility to the broadest range of population possible for which inclusive design (user's participation) can play an important role especially for disabled minorities and elderly.

Product meaning in people's life was fully and deeply explained in an investigation project made by Mihaly Csikszentmihalyi and Eugen Rochberg-Halton in 1981 [2] that finally lead to a book called *"The Meaning of Things: Domestic Symbols and the Self"*. It describes the enormous flexibility with which people give objects a sense extracting meanings from them. An object's physical characteristics do not dictate the meanings they can evoke but those characteristics often confer certain meanings against others. It is clear that we can like or even, for some people, **love** objects but the fact that we give them meanings, and moreover personal ones, delivers some keys to why possession utility plays such an important role in sales and marketing. Possession utility is a consequence of objects reflecting the identity and aspirations of its users. It is here where needs turn into desires, and utility connects to implications of psychological order in the domain of the perceived product.

In the case of services, possession utility does not have sense, but somehow human psychology works in a similar way as in products. No doubt that the use of a specific service is connected to personal identity we can agree with or not, i.e. like or dislike. Groucho Marx referred to this in his famous sentence: "I would never join a club that would accept me as a member". But except for exclusive services that are clearly designed to distinguish the identity of its members, emotional connections on services are implied by the **marketing strategy and use experience.**

A correct operational advertising and communication infers a service the meaning it cannot carry by its own as it happens with objects. Therefore, marketing issues must be considered in a very early stage of service conception and are an intrinsic part of service design. Brand colors, decoration, spaces and graphical design are all part of the service design deeply interconnected with marketing. Corporate identity delivers instant awareness and liability to users but, especially in services, they only sustain if they are underpinned by good operating performance and commitment to quality.

Donald Norman, in his book *"Emotional Design: Why We Love and Hate Everyday Things"*, reveals how form creates emotions [7]. But the ones raised by use are a key factor of long term success. Most of the product icons known today have arrived to this position thanks to the word spread by their owners regarding the satisfaction and pride they feel with their use. Harley Davidson and its puffing sound, Volkswagen's Beatle, Fender`s Telecaster, Faber-Castel pencils, Rolex's Sea-master, and many other for long known products underpin their success on customers' emotions.

Other manufacturers even invite their customers to get in action and feel emotions. See Nike with their "Just do it" or Ovation electro-acoustic guitars with their famous "Plug it in", that just means: Try it and you'll see.

So, creating customer emotions in the use of a service, wherever it is possible and it makes sense of course, can be a challenging and interesting way to create value through service design. Entertainment is an ideal field for this. Designing touristic resorts, cruise experiences or sports areas with a service design discourse can add uniqueness and improved quality. The paradigm of creating emotions in services through design is, with no doubt, Disney Productions with their films and amusement parks. Thematic restaurants pretend offering their customers a different service experience through decoration, cuisine and creating a special environment [8].

2 Designing Services for Customer Satisfaction

Hospitals, banks, schools, insurance companies, telecommunications, dealers, retailers, amusement parks, etc., like any other business, need to create customer satisfaction for a long term business success. The traditional approach to service business models relies on effective and efficient processes. The gradual introduction of more resources and infrastructures to improve them is a key element. This was the Scientific Management approach following Frederick W. Taylor's ideas introduced at the beginning of the XX century where the close control over the processes was the main strategy. Taylorism has gone a long way since then thanks to, among others, the introduction of information systems and quality management. Although it is still valid today, competition and the increasing demand of better products and services for citizenship brings more and more the need and interest of designing with the participation of the users and delivering a human-centered design. Human centered design also works as a pull force for the introduction of innovative products and services according to market needs. The interaction with the users improves the communication lines between designers and users that stimulate initiatives for new products and services in an endless circle.

As it happens with products, customer satisfaction from a service can only be determined in a certain period of time where a significant number of interactions between customer and business provider have taken place. Each interaction is the consequence of many actions and elements that form the service which must be defined and planned accurately to match customer's needs and create a good customer experience. We will proceed to explain how this works from back-office to front-office:

Companies have **Infrastructures** that give support to their actions and decisions such as Information Systems (ERPs, CRMs), Facilities and Service Infrastructures. These infrastructures work under specific **Procedures** such as company policies, defined processes, business rules or agreed tactics and strategies. Procedures convey the logic that runs the operations. Some of the procedures are in the systems and others are taught to the employees. The **places, spaces or channels** where the connections with customers are made are the **Contact Points** such as the shops, call centers, mail or internet. Customers connect through the contact points for different activities that we may call **Interactions.** Each business can originate hundreds of interactions. In a bank, for example: making deposits, withdrawing money, making checks, paying bills, opening and closing accounts, delivering account information to users, etc.. Interactions are at the front office and the sum of what customer perceives through them is his **Experience.** What does customer perceive? That is the mission of Service Design.

Hence, the domain of activities covered by Services Design is extremely ample. In general design performs on four (4) axes: **objects, environments, communication and identities.** But as you may notice, the above mentioned are **static aspects** of design that naturally derive from product design. A service is dynamic and dynamism is introduced by **people and processes** that we can consider an intrinsic part of the design too. The goal is no more to define how things will be as it is for products, but how things will happen. Therefore, the scope of activities of services design plays in the following axes: **Objects, Environments, Communication, Identities, People and Processes**. Customer satisfaction will clearly depend on the fact that he gets what he expected in the way he expected it. If we manage to surpass customer's expectations, then we will have a happy customer who will most probably repeat the experience.

Objects in services can be of many kinds such as interfaces, vehicles, carriers, tools, etc.. Designing concepts for these elements does not differ from industrial design. Ergonomics, accessibility, usability can be some of the features together with meaning and identity adding factors.

In the same manner, the **Environment** where the service takes place can play an important role in the process, identity, communication and user's emotions. Environmental psychology, cognitive ergonomics and architectural psychology are only some of the fields that study the influence of environments on human beings' perception, emotions and behavior. Architecture, built environments and learning environments are some of the fields that study the creation of spaces for human activities.

A correct **Communication** is essential in Services design. Graphics design can play an important role for information communication. But, although it can confer communication together with other marketing tools and the other axes, the fact of sending a comprehensible message to the user, in the proper media, according to the context where he is, where he can add a meaning to, and take a decision, is not always an obvious or simple thing. Communication guidance defines how and which information is transmitted in the service and it must assure that other media, together with graphics design, perform in the same direction. The alignment of the marketing strategy with the operational communication is frequently a source of earnings and a guarantee of effectiveness.

Services are systems and systems need some type of control. On the other hand **Identity** is a key strategic factor for service differentiation and customer identification. Identity can be conveyed in many ways such as the graphics design, objects design, architecture, but also by people's performance and the uniqueness of the business model.

Training **People** is an essential part of many services. Their performance in terms of skills, style, creativity, human touch and professionalism are essential for the experience. Interactions involve many **moments of truth**, where a word, a gesture or a decision can be of vital importance. Alignment of people's training with the values, identity and strategy of the service can become an important competitive advantage.

Finally, **Processes** determine each customer interaction. Customer's trust, time, patience, capabilities and energies are put into play on each interaction. The business model chosen, determines the processes and these reflect the style of the company. Service efficiency depends on the processes' design and early modeling with customer participation can be of effective use.

3 Services Design for a Complex World

At the beginning of car industry, manufacturers designed automobiles according to what they thought would be a good product for the market. Today, a car is just one element of a road mobility system. Consequently, cars must be designed attending the requirements the system they work in. Turn signals, flash lights, painting, tires, dimensions, all must be conceived according to the rules and conventions that apply in the system. Designers cannot remain focused on product features without considering their interdependencies with external elements and criteria. Moreover, if they pretend to be innovative they must be able to detect the needs and opportunities that appertaining to a system can bring up. Consequently, designer's observation, knowledge and skills scope must be broaden to the extent of the system.

On the other hand, we have internet, which was actually born with established codes, protocols and rules, and has become the biggest and freest playground for business interaction and communication humankind has ever developed. With no doubt, those rules were the basis for such a creative self-development. Anybody would agree today that for service today, an analysis of internet business models, opportunities or just its use as a marketing tool should be considered.

Internet is one of globalizations main contributors. Its use is a main reason why Japanese kids wear the same clothes and adapt the same styles and behaviors as kids from the New York Bronx, and why planet warming consciousness is today one of humanities main concerns. Internet has raised the planet's diversity awareness and has been a facilitator for the appearance of subcultures inside countries themselves. This multicultural new market that goes far beyond internet itself generates also a new mindset for services design where the respect for everybody's beliefs and values is a new space for reflection.

At the same time, there is a reinforcement of local, regional and national identities as a consequence of the risk of losing them to globalization, the appearance of emerging countries in the global arena and the surge of new countries after the fall of the former Soviet Union. But local identity is also a strategic asset. Its elements and values are worth preserving because they confer differentiation and uniqueness of great value for competitive reasons. Governments all over the world are aware of the importance of national branding for their income and the competitiveness of their products in both local and foreign markets.

This complex world leads to more complex business activities and especially in the need of attending to a diversity of stakeholders: shareholders, partners, alliances, society, clients, prosumers, aftermarkets, suppliers, personnel, distributors, franchisees, local governments, research institutions. They are not the customers, but they are extremely important. Creating sustained value for them will for sure contribute to our long and fructuous business success. Designing, after all, is creating value but especially perceived value. We all agree by now that perception is design's playground.

The alignment of marketing, human resources, product design, operations and corporate social responsibility are of vital importance for value creation. This requires a top-down approach including all the main actors of the company and the general management to establish a strategic design of the service that will assure a common and unique value proposal for the stakeholders. This so called **Strategic Design** has its underpinnings in creativity and design methodologies and principles to assure results beyond traditional management disciplines. It will be a consequence of teamwork and the best teams will get the best scores.

4 Services Design for People

Unfortunately, for many reasons design has become a banal and superfluous concept in the modern world. It is most frequently identified with luxurious and unaffordable goods for most of the population or supposedly beautiful products without utility. But design lets us build our world according to our own wills and needs. No other species has this capability. Design, together with language is a defining characteristic of humankind and this places it far beyond triviality[2]. Design is the priceless capability of transforming an idea into something of value for people and consequently it is the seed for exchange.

We understand services design for people as contributing to the creation of adequate, affordable, available and accessible services that improve people's quality of life. It is therefore a key activity for progress that covers all the areas of human beings' activities, even the most basic ones, along their complete lifecycle.

Identifying the needs is the first step. Without it, the designer can do little. In this sense, design is just one part of the innovation cycle. Once identified the need, the designer must create his so called observatory with all the main elements and actors involved in the field. End users are main players to consider for the best design results. A marketing activity that discovers customer behaviors, styles, subcultures and tendencies is in use at some fields of consumer products and clearly identified in Web 2.0, but it is not relevant for many services yet. For sure, market surveys will not fulfill this task but an "innovation approach", developing an observatory to identify new tendencies and customer needs will surely be of great help. Customers' opinions and advice can be of priceless value and living labs can corroborate many of their inputs. This sets the basis to consider customer participation as a good practice not only at the test bed but from the conceptual phase leading us to an effective experimentation with the inclusive services design concept. This user creative thinking must be used as the foundation for how ideas, knowledge and products are developed and arranged in the local and global spheres for the common well-being of society [5].

Designing for a better world is intrinsic to designing for people. Both environmental and social sustainability play an important role as determining factors of the design.

Governments are aware of the importance of design as a development enhancer and a strategic competitive activity. Studies show that it is more and more clear that effective design and economic competitiveness are related [6]. Governments can make a strong contribution by assisting the creation of a Design Milieu, referring to Manuel Castells` Milieu of Innovation, as the space where the necessary synergy to develop new knowledge, processes, products and services are created by establishing the right set of relationships of design stakeholders within a spatial proximity in a metropolitan setting [1].

Improved design education will certainly stimulate the growth of design sector activity and the consciousness for a design discourse. University level is very important but scholar level can bring design into a wider scope of population that will certainly have an effect on people's creativity in their future lives and societies. On the industry level, design education will have an important impact in craftsmanship as a capacity builder and Social design is an important enabler[5].

5 Conclusions

Design is the step of the innovation cycle that turns the idea into a value proposal. We have made the leap from utility to customer experience as the final step of design in services. We have analyzed the chain of critical elements involved from back to front stage in the experience. Nevertheless, nowadays it is not enough with creating value for customers. Services and products are parts of more complex systems and this belonging implies interdependencies with other stakeholders for who we must also create value. A strategic design approach aligning marketing, product design, people, processes and corporate social responsibility is the key for such a holistic value proposal.

Finally, people are the end goal, and design wins when we listen to their needs, we have them to participate in the validation of design proposals and considering that design is meant to make affordable, adequate, accessible and available services.

Governments all over the world are more and more aware of the importance of design as a competitive asset and their implication in promoting design milieus and education will result in higher progress rates.

References

1. Castells, M.: The Information Age: Economy, Society and Culture. The Rise of the Network Society, vol. 1. Blackwell Publishing, Oxford (2005)
2. Csikszentmihalyi, M., Rochberg-Halton, E.: The Meaning of Things: Domestic Symbols and the Self. Cambridge University Press, Cambridge (1981)
3. Fundación Cotec. Diseño e Innovación. La Gestión del Diseño en la Empresa. Fundación Cotec, Madrid (2008)
4. Heskett, J.: El Diseño en la Vida Cotidiana. Gustavo Gili, Barcelona (2008)
5. Miettinen, S. (ed.): Design Your Action. Social Design in Practice. University of Art and Design Helsinki, Helsinki (2007)
6. New Zealand Design Taskforce. Success by Design, New Zealand (2003)
7. Norman, D.: Emotional Design: Why We Love and Hate Everyday Things. Basic Books, New York (2004)
8. Pine, J., Gilmore, J.H.: The Experience Economy: Work Is Theater & Every Business a Stage. Harvard Business School Press, Harvard (1999)

Life Cycle of Virtualized Service Resource in BIRIS Environment

Xiaofei Xu, Xianzhi Wang, and Zhongjie Wang

School of Computer Science and Technology, Harbin Institute of Technology,
150001 Harbin, China
{xiaofei,wangxianzhi,rainy}@hit.edu.cn

Abstract. Novel service mode namely bilateral resource integration is proposed for rapid establishment of connections between customer and appropriate service provider. Both sides of service participants are deemed as valuable resources and virtualization mechanism concerning customer requirements and service resources is put forward. Concept of virtualized service resource (VSR) is emphasized for facilitating rapid integration and scaled personalization, and a life cycle view towards VSR is given, including establishment, selection, usage, discard and management as key stages. The advantage of this solution is that service integration is done in an abstract level and in a more flexible way, with accumulative recommendation, require-resource mapping and dynamic service composition combined reasonably together, and personalized characteristics extracted from VSR based structural knowledge easily.

Keywords: Life cycle, virtualized service resource, service bundle, bilateral resource integration.

1 Introduction

In modern services, insufficiency and abundance of service resources are both barriers for improving customer satisfaction. With limited resources, service providers could hardly afford services of high quality due to resource shortage; while facing too many choices, it's also difficult for customers to find appropriate resources rapidly. Those are just from service provision view, i.e., we consider more about how service capability matters the satisfaction of customers' requirements. Actually, both service capability and customer are crucial factors for sustainable business success. As for customer, they enjoy feeling free to select from a large range of products/services, and being convenient to acquire what may best fit; when it comes to service provider's viewpoint, customers and their requirements are regarded as valuable resources because they imply new service trends or more business opportunities.

In the light of this notion, bilateral resource integration service mode (BIRIS) is proposed. Instead of taking a separate view at the value of customer and service capability like what we traditionally do, it takes both sides of service participants as customers. BIRIS employs a third-party platform as service center, thus attracting customers all the way to service providers with gathering/integrated power, and vice versa. Connections between customers and providers are established rapidly, and

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 215–223, 2010.

collaboration among providers, competition among providers, as well as optimized service provision/distribution is facilitated, too. Improved interaction between customer and provider is achieved by setting up credit/reputation archives to regulate their behaviors in business activities.

BIRIS is supposed to have following characteristics: personalized new service content or service delivery method; added value for both sides of service participants; establishment of service center or delivery center; integration of distributed service resources into virtual service resources; adaptive solution or service evolution approach; life cycle oriented service quality assessment, and service recommendation and optimization based on it; accumulation and utilization of historical credit/reputation records of service participants; IT enabled especially Internet based service supporting platform.

BIRIS comprises three parts: customer, service center and service provider. As an open platform□service center lies between customers and service providers, organizes customer requirements and resources, and makes mutual recommendation for both sides through configuration and algorithmic approaches, performing monitoring and administrative functions. As two main types of participants, customer and provider, both register to the platform to enjoy membership. Customers can either take what the platform recommends or issue personalized requirements to get desirable services; while service providers need to register their services to the platform by unit of what is often recognized as service component to make their service capability available for direct usage or as building blocks for constructing new services.

Resource integration is a key concern in BIRIS. Besides feature of integrating multi-source service resources, BIRIS views resources from both customer and provider sides, regarding both customer and provider as valuable resources. In BIRIS, customers and their current/potential requirements, service capabilities and service entities that enabling them as well as service products are considered as service resources, while records of resource utilization fall into category of service assets.

Both sides of resources are important. Plenty of service providers are important because more service resources from different sources mean greater service capability, which provide more opportunities and higher possibility for customers to found satisfactory services, thus attracting more and more customers to john this platform; Conversely, plenty of customers are of equivalent importance because they are the main (perhaps potential) sale points for platform to attract providers to participate in. The sharing of customers among providers multiplies the size of potential customers of each provider and enables service providers to bear greater missions through collaboration with other.

As said at the beginning, the flourish of resources from both sides can easily results in greater difficulty in finding appropriate candidates dynamically for one specific task, within limited computational complexity. The solution proposed here is the concept and utilization of virtualized service resource (VSR). VSR simplifies service integration in both static and dynamic phases by setting one upper layer beyond resources, which means the recommendation of resources based on insight upon the group feature of customer preferences and the recommendation based mainly upon the personalized requirements of one specific customer are both done at a higher level of abstraction.

2 Related Work

Currently, several approaches have been done to establish rapid connections between customers and suitable service resources. Non-automatic service composition is a classical approach where service processes are predefined in BPEL [1] and individual services are composed manually in a static manner. This approach is effective under circumstances when the number of available services is small. To pursue high efficiency and improved quality, automatic service composition [2] is proposed and it soon becomes a hot spot in research aiming at automating the discovery and process planning of services. Though integration can be achieved dynamically, the computational cost for such planning is severe and further studies are still needed to make it more practical. Furthermore, personalization might be considered incomplete in those approaches due to inadequate exploitation to historical service records. Actually, personalized aggregation of information resources has already been done commonly in information retrieval [3], where each individual is presented with multiple resources supposed fit to him/her, and both current and potential trends are acquired or predicted in [4] by data mining methods to delivery service content responding quickly to market trends. Though personalization is done in a large scale, the deliverables are still limited to single resources, instead of resource bundles.

Customer community [5] and service community [6] are two approaches proposed to partially tackle these problems. In a customer community, relationships among customers are emphasized and customers are grouped by cluster analysis. Social network [7] and small world theory [8] are commonly adopted to discover routines in reputation propagation for community-guided resource integration. Service community is supposed to accelerate service composition by organizing service resources in fine structure and persisting historical composition cases. It makes it possible that a request is responded with well-defined compositing results rather than always consider single services as first choice.

In above approaches, either the management of customer requirements or that of historical compositing results is omitted or incomplete. Our solution is to take a comprehensive view towards service participants and to utilize concept of virtualization to combine accumulative/gradual way and real-time way together for rapid resource integration and scaled personalization. Instead of doing real-time composition each time a request arrives, dozens of requirements and resources are both abstracted into virtual images which are to match with each other. Virtualized service resources are extremely suitable for exploiting patterns by data mining, and through the organizational description of VSR from both requirement and capability specific levels, scaled personalization is greatly eased as well.

3 Service Resource Virtualization

Virtualization is a process that abstracting real resources into images to accelerate and simplify affairs irrelevant to practical execution. In section 3.1, a global framework of virtualization is to be introduced, and virtualized service resource is to be specially discussed in section 3.2.

3.1 Bilateral Resource Virtualization Mechanism

Service resource is emphasized in this paper, but in BIRIS, virtualization is a two-side process done to both requirement and resource. To distinguish different processes of virtualization in BIRIS, we call the virtualization result of individual requirement virtualized requirement or task, and that of individual resource virtualized service resource. The operation mechanism of virtualization is shown in Fig.1.

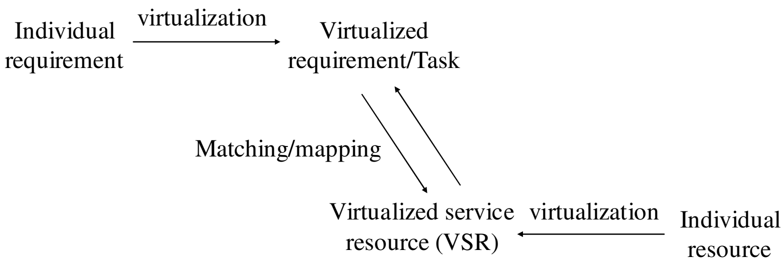

Fig. 1. Operation mechanism of Virtualization in BIRIS

Firstly, individual requirements are clustered into tasks based on similarity analysis, so that each task may comprise a group of similar requirements. To split large tasks into associated smaller ones and to merge mutually independent small tasks into larger ones are all possible strategies to make them more suitable for matching with VSRs, which are virtual images of real service resources and are gradually accumulated and dynamically adjusted.

Secondly, tasks are filtered to reject ones that are undesired or impossible to be accomplished; tasks are ordered according to predefined or calculated priorities to obtain optimal processing sequence complying with platform's strategy; possible new tasks are predicted based on statistical analysis on historical tasks to make appropriate adjustments on VSRs in advance for better future performance.

Thirdly, tasks are mapped to existing VSRs to obtain optimal requirement-resource pair; modifications to VSR might be necessary to get a perfect match. In case of failure, new virtual resources needs to be generated based on existing available service resources.

Finally, real service resources corresponding to each specified VSR are designated for some functions following certain rules. With assistance of possible human activities or other external actors in the service eco-system, IT platform is able to run smoothly fulfilling tasks which will directly or indirectly fulfill the original requirements from customers.

3.2 Virtualized Service Resource

Virtualized service resource is paid special attention to in this paper and viewed from life cycle's perspective. Virtualized service resource (VSR) is a virtual image of service capability (including service products, as long as they can serve customers) in real service systems. Several resources can be virtualized into one VSR, which can be recognized as a solidified storage of service composition; while one resource can have multiple images on the platform for different purposes. To state in a formal way, *VSR*= (*vName*, *vFunction*, *vElement*, *vStructure*, *vTrait*, *vUtilization*), where *vName* is the name of *VSR*, *vFunction* is the function/purpose of *VSR*, *vElement* is the real resources corresponding to *VSR*, *vTrait* is quantified parameters in different aspects of *VSR* exhibiting its unique feature, *vStructure* depicts the organizational/logical structure of real resources, and *vUtilization* represents its utilizing information, e.g., method of usage, using frequency and so on.

Virtualized service resource reflects the conviction of rapid service resources integration by combining the static and dynamic integration approaches together. Instead of compositing resources dynamically according to real-time requirements, VSR seeks to exploit promising solutions from previous endeavors. The cost of doing modification or partial replacement to an existing solution is far lower than constructing a brand new one.

VSR supports scaled personalization during resource integration. Personalized requirements of individuals are delivered in differentiated multiple facets representing customized characteristics. After a suitable VSR are designated for one piece of requirement, facets of the requirement are associated with it, too. So when requirements are issued again by this customer, VSRs that fit her/his own style will be approved as initial candidates. Also, as we mentioned above, based on statistical computation on massive cases, useful behavioral or content related routines about customers are promising to come out, making it possible to offer reliable and feasible recommendation to single customer.

4 Life Cycle of Virtualized Service Resource in BIRIS Scenario

The basic process of resource integration utilizing concept of virtualization has been described roughly in section 3.1. As a key product of virtualization, VSR reflects the mass integration nature of BIRIS distinctly. Similar to web service composition [9], VSR has a life cycle of four stages: establishment, selection/modification, runtime usage and discard, as shown in Fig.2.

In this section, a life cycle view towards VSR is presented specially to obtain a detailed insight into it.

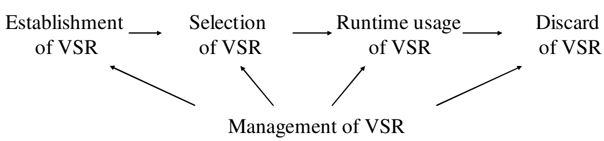

Fig. 2. Stages of life cycle of VSR

4.1 Establishment of Virtualized Service Resource

All services emerge for requirements. As illustrated in Fig.1, individual requirements from customers are virtualized into tasks as a start. Generally, tasks are compared with VSR from different aspects (② in Fig.3). If the similarity between a task and a

VSR surpasses certain threshold, small modifications might be needed to adjust existing VSR/task to make a perfect match. Particularly, if it's already a satisfactory task-VSR pair, mapping is directly done between them; in case of failure, a dynamic service composition (①in Fig.3) algorithm is employed to integrate resources directly from individual ones in real-time.

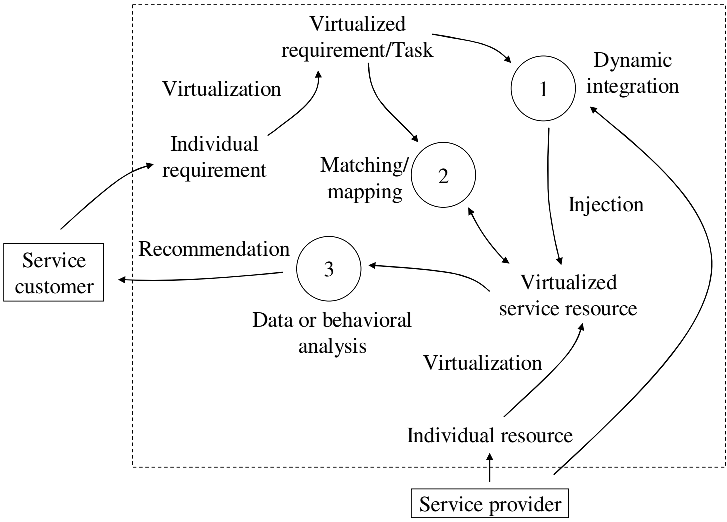

Fig. 3. Generation of virtualized service resource

After formation, the newly generated VSR is injected into VSR-repository and tasks are stored as well; with accumulated VSRs, community oriented analysis can be done to disclose prevailing trends or predict new trends of customer requirements. Individual oriented analysis is also possible to advance personalized recommendation to each specific customer (③in Fig.3).

4.2 Selection of Virtualized Service Resource

The process of resource integration is the process of service selection and matchmaking. Multiple resources are selected to perform necessary functionalities and to exert desired outputs. Global performance is assessed to determine how these resources match with each other, thus attaining resource selection with global optimization.

As defined in section 3.2, VSR is a sextuple. The attributes or aspects that need comparing with requirements are represented by *vTrait* as a set. Formally speaking, *vTrait*= (*Input*/*Output*, *Quality*, *Credit*/*Risk*), where *Input*/*Output* is sets of input and output of *VSR*, *Quality* is a set of service quality metrics indicating performances of *VSR*, and *Credit*/*Risk* is the overall reputation or risk of *VSR*. Differing from quality which is independent, reputation follows certain propagation rule among resources according to underlying social/business relations among service providers. Similar to VSR, task is a virtualized image of individual requirement and its a triple, *Task*= (*tTraits*, *tConstraints*, *tObjectives*), where *tTraits* is a set of the aspects which requirements are describing in, and is a subset/counterpart of *vTrait* in *VSR* definition, *tConstraints* is a set of restrictions on these aspects, and *tObjectives* is a set of prioritized targets to be pursued and optimized globally.

Sequenced tasks are picked out one by one for VSR retrieval. Besides functionality, quality and credit/risk relevant metrics are also taken into account for multi-dimension similarity assessment. Each dimension is weighted to represent priority and domain ontology [10] might be adopted to clarify the concepts in services and to represent the semantics of input/output.

In VSR facilitated resource integration, each service bundle represented by VSR is shown to the outside as a whole, so internal trivial will not be paid attention to, which is supposed to ease the integrating process dramatically. Even on occasions that VSR needs modifications or partial replacements, workload is believed to be relieved, too. Moreover, further exploitation can easily be done based on VSR opposed to analysis by combining specially purposed using records and individual resources dynamically together.

4.3 Runtime Usage of Virtualized Service Resource

Virtualization of resources guarantees the transparent classification, linkage, and integration of heterogeneous service capabilities, as well as global optimized deployment in both build-time and run-time phases. Once a VSR is designated for a task, there should be some means enabling corresponding resources to really work. Several techniques might be adopted to achieve this goal:

1) Virtualization of human activities. Most business processes cannot run automatically, thus needing participation/assistance of human to perform a complete and smooth run. BPEL4People [11] and WS-HumanTask [12] are proposed standards or specifications to virtualize human interference into software interfaces. Two types of interfaces are provided via virtualization, machine-machine interface and human-machine interface. The first one is for programs to invoke and the other is for human-machine interactions, including notifying people of manual operations and notifying program of human activity ending.

2) Web service [13], semantic web service [14] and web service composition technologies. Languages like OWL-S [15] and BPEL are two dominating specifications for describing and executing services. Access to VSR with OWL-S or BPEL description can be achieved through Internet for direct invocation.

4.4 Management of Virtualized Service Resource

VSRs are organized in a two-tier structure in repository, i.e., capability specific layer and requirement specific layer from bottom to up. In capability specific layer, VSRs are ordered by values in each aspect from favorable to unfavorable, forming multiple sequences/queues which can be seen as recommended service solutions determined by VSR itself. Based on these sequences, personalized feature-domains can be discriminated by their differentiated emphasis on these aspects. These domains are highly requirement specific thus forming requirement specific layer. Each customer may have a corresponding domain as far as he ever participated in the service. VSRs inside each domain are ordered by using frequency, which is adjusted after usage and in case of expansion, new VSR should be neatly inserted into these two levels of sequences.

So VSRs are scattered in a multi-dimension conceptual space, with each dimension corresponding with an independent aspect. Then new comprehensive features are setup as new dimensions roughly representing individual characteristics of each or several personalized requirements. Adjustment to the orientation of VSRs is also necessary when VSRs are modified based on quality monitoring results, reputation records of resources, or even feedbacks from customers after practical operation.

4.5 Discard of Virtualized Service Resource

Customer requirements in services are continuous changing and new trends never stop to emerge. To keep virtualization mechanism work efficiently, VSRs with little possibility of usage should be removed from repository. Many classical strategies such as LRU (Least Recently Used), LFU (Least Frequently Used) are all applicable for VSR removal.

5 Conclusion and Future Work

A virtualization based new service mode called BIRIS is proposed. In BIRIS, Service providers are participants of virtualization featured service ecosystems where chances of cooperation and competition become inevitable and are both increased dramatically, which makes them more dedicated to enhancing their advantages as well as improving their weak points for sustained profits. As one of the most crucial feature of requirement-resource mapping/matching mechanism, this paper holds a life cycle view towards VSR, and focuses on its merits in facilitating large scaled personalization and accumulating service bundles by which in case of usage, cooperation agreements are gained quickly.

This paper introduces virtualization featured BIRIS inside which the organizational structure and operational mechanism and VSR are specially emphasized. It's just a framework and more detailed research is to be done. Though lots of efforts have been paid on forecasting the mainstream trends of customer requirements in dominant service systems, but in BIRIS environment, individual's enjoyable experience are emphasized where virtual personal service are flourishing. Personalization brings about various individual requirements styles that we can never expect in prediction, so methods ensuring successful matches with smallest cost of modification to existing instructions might be the next research point.

Acknowledgments. Research works in this paper are supported by the National Natural Science Foundation (NSF) of China (60803091, 70971029).

References

1. Weerawarana, S., Curbera, F.: Business Process with BPEL4WS: Understanding BPEL4WS (2002), `http://www-128.ibm.com/developerworks/library/ws-bpelcol1/`
2. Kuster Rao, J., Su, X.: A survey of automated web service composition methods. In: Cardoso, J., Sheth, A.P. (eds.) SWSWPC 2004. LNCS, vol. 3387, pp. 43–54. Springer, Heidelberg (2005)

3. Liu, F., Yu, C.: Personalized web search for improving retrieval effectiveness. IEEE Transactions on knowledge and data engineering 16(1), 28–40 (2004)
4. Hong, S.J., Weiss, S.M.: Advances in predictive models for data mining. Pattern Recognition Letters 22, 55–61 (2001)
5. Kodama, M.: Customer Value Creation through Community-Based Information Networks. International Journal of Information Management 19, 495–508 (1999)
6. Perryea, C.A., Chung, S.: Community-based Service Discovery. In: IEEE International Conference on Web Services (ICWS'06), Salt Lake City, Utah, USA (2006)
7. Mankoff, J., Matthews, D., Fussell, S.R., Johnson, M.: Leveraging Social Networks to Motivate Individuals to Reduce their Ecological Footprints. In: Proc. of 40th International Conference on Systems Science (HICSS 2007), Waikoloa, Big Island, Hawaii, USA (2007)
8. Kleinberg, J.: The small-worlds phenomenon: an algorithmic perspective. Technical report, Cornell University (1999)
9. Yang, J., Papazoglou, M.P.: Service Components for Managing the Life-Cycle of Service Compositions. Information Systems 28(1) (2004)
10. Zhang, R., Arpinar, I.B., Aleman-Meza, B.: Automatic composition of semantic web services. In: Proc. of the 2003 Int. Conf. on Web Services (ICWS'03), Las Vegas, NV, USA (2003)
11. Agrawal, A., Amend, M., Das, M., et al.: WS-BPEL Extension for People (BPEL4People), version 1.0, http://download.boulder.ibm.com/ibmdl/pub/software/dw/specs/ws-bpel4people/BPEL4People_v1.pdf
12. Agrawal, A., Amend, M., Das, M., et al.: Web Services Human Task (WSHumanTask), version 1.0, http://download.boulder.ibm.com/ibmdl/pub/software/dw/specs/ws-bpel4people/WS-HumanTask_v1.pdf
13. Alonso, G., Casati, F., Kuno, H., Machiraju, V.: Web services: Concepts, architectures and applications. Springer, Heidelberg (2003)
14. McIlraith, S.A., Son, T.C., Zeng, H.: Semantic Web Services. IEEE Intelligent Systems 16(2), 46–53 (2001)
15. Martin, D., Burstein, M., Hobbs, J., Lassila, O., et al.: OWL-S: Semantic Markup for Web Services, http://www.daml.org/services/owl-s/1.1/overview/

A Conceptual Model of Service Exchange in Service-Dominant Logic

Geert Poels

Faculty of Economics and Business Administration, Ghent University,
Tweekerkenstraat 2, 9000 Gent, Belgium
Geert.Poels@UGent.be

Abstract. The service system is the basic abstraction of Service Science. This paper proposes the Resource-Service-System model as a conceptual model of service systems interacting in service exchanges, assuming a service-dominant logic economic worldview. The paper explains how the model was developed starting from the Resource-Event-Agent business model ontology, taking into account insights gained from studying Service Science literature and existing service ontologies. The paper also explains how different model views can contribute to study various aspects of service systems and exchanges.

1 Introduction

Service Science is the study of the application of the resources of one system for the benefit of another system in the context of an economic exchange [1]. The systems referred to in this definition are *service systems* [2]. In [1] the service system concept has been formally defined in terms of general systems theory, assuming a view on economic activities that can be described as Service-Dominant Logic (SDL) [3]. In SDL each economic exchange between natural or legal persons is viewed as an exchange of service for service, where service is considered as the process of doing something for another party. This stands in contrast with the dominant economic worldview, Goods-Dominant Logic (GDL) [3], in which goods (tangible production outputs embedded with value) are the focus of economic exchanges and services are merely seen as an intangible type of output or an add-on that enhances the value of goods [4].

A recent symposium on Service Science emphasized the need for modelling and simulation tools to help studying service systems [5]. Current challenges for Service Science include the formal representation and measurement of work in service systems [2] and the development of a shared vocabulary (i.e. an ontology) to describe service systems [1]. This paper aims to contribute to Service Science by proposing a *conceptual model of service exchange in SDL*. The model is intended as an instrument to be used in the study of service systems and their interaction in the context of service exchanges. The model is not portrayed as an ontology for service or service systems as in its present form it does not satisfy criteria like being completely and explicitly specified and being formally represented. As it stands, the model is a conceptualization that might provide a basis for further ontology development.

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 224–238, 2010.

Business modelling plays an important role in Service Science [6]. Although many sorts of things can be viewed as service systems, including persons, families, cities and government agencies [1], enterprises constitute a major category of service systems when service exchanges are considered in an economic context (as is done in SDL). A business model expresses the business logic of an enterprise in terms of objects and relationships that allow “a simplified description and representation of what value is provided to customers, how this is done and with which financial consequences” [7]. Modelling enterprises as service systems, emphasizing the application of their resources for the benefit of other systems in the context of economic exchange, is therefore a business modelling effort.

Business modelling knowledge has been specified and formalized in business model ontologies, which offer concepts in terms of which business models can be articulated. According to [8], the most comprehensive and well defined ontologies for business models are the Resource-Event-Agent (REA) ontology [9], the e^3-value ontology [10], and the Business Model Ontology (BMO) [11]. BMO takes the perspective of a single enterprise facing its environment without focusing on the actual economic exchanges between the enterprise and actors in its environment. REA and e^3-value are different as they emphasize the creation of value through economic exchanges. E^3-value contains concepts to describe networks of actors exchanging value objects (i.e. things of value) as well as value activities, meaning activities performed by these actors to create the value objects. REA is centred on constellations of resources, events, and agents that are mirrored through the principle of economic reciprocity. It contains concepts to describe what things of value (e.g. goods) an enterprise gives up in exchange for other things of value (e.g. money) it takes in, clearly identifying which parties are involved in these exchanges.

Service systems are configurations of resources [1] and being able to represent the resource composition of service systems and the resources applied in services is an important requirement for the conceptual model of service exchange. Whereas mirrored Resource/Event/Agent constellations can also account for internal conversion processes (i.e. converting raw materials into finished goods) [12], the production of value objects cannot be described in detail using e^3-value as value activity is a ‘black box’ concept. E^3-value puts resources in the picture only if they flow between value activities or actors. REA is able to identify all resources needed to produce value. Therefore, REA was chosen for providing a foundation for the conceptual model of service exchange.

The rest of this paper is structured as follows: section 2 contains background material and discusses related work. Section 3 presents in an incremental manner the proposed conceptual model of service exchange in SDL. Section 4 concludes the paper.

2 Background and Related Work

2.1 Service-Dominant Logic and Service Systems

Service in SDL is defined as the application of specialized competences (knowledge and skills) for the benefit of another entity [13]. SDL replaces the traditional classification of products as either goods or services[1] by the distinction between operand and operant resources. Operand resources are passive resources that require action to make them valuable, whereas operant resources are active resources that are capable of creating value. Competences are embodied in operant resources and the acting of operant resources upon other resources is what constitutes service. For instance, a car mechanic is an operant resource that embodies car repair/servicing knowledge and skills and that uses operand resources like garage tools, facilities (e.g. a garage pit) and consumables (e.g. motor oil) to repair or service a car, which is another operand resource.

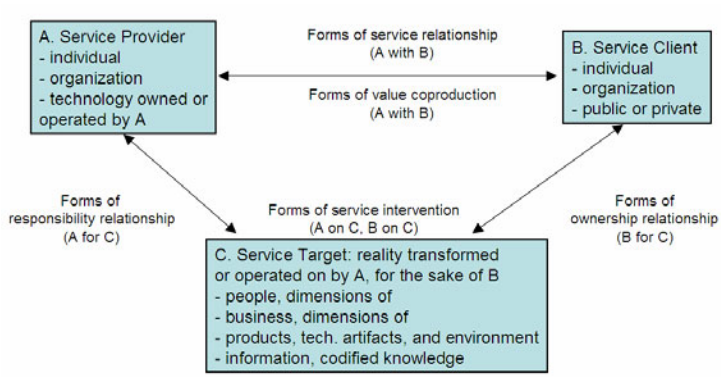

Fig. 1. Definition of service in terms of relationships and actions among service provider, service client, and service target [2]

It is important to notice that goods do not disappear in SDL as they are conveyors of competences [4], e.g. it is via the garage tools, facilities, etc., that the car repair/servicing competence is applied to the car. Further, it is clear that service is a collaborative value creation process in which there is neither value producer nor value consumer, but each party co-creates value by bringing in or making accessible its unique resources [4]. In the example, the car owner needs to make his car accessible for repair or servicing, otherwise no service is possible and no value is created. SDL stresses this resource integrator role of the service beneficiary [15]. An entity benefits from a service by integrating the competences applied by another entity into its own resources.

The entities involved in a service are service systems, meaning “value-coproduction configurations of people, technology, other internal and external service systems, and shared information (such as language, processes, metrics, prices, policies, and laws)” [16]. Service systems interact in the role of service provider or service client. Fig. 1 shows a service system A (the service provider) taking responsibility for transforming or operating on a service target C that is owned by service system B (the service client). The model shows that the intervention of both service systems A and B is required to create value for the service beneficiary (i.e. the service client).

[1] Traditionally, services are viewed as second-class products that suffer from ‘shortcomings’ like intangibility (inability to perceive by the senses), heterogeneity (inability to standardize), inseparability (of production and consumption) and perishability (inability to store) [13], [14].

Recently, Maglio et al. [1] defined the service system concept in terms of SDL. In this view, service systems are configurations of resources[2], of which at least one operant resource, that interact to co-create value. In our example, both the garage and the car owner are service systems. The garage applies operant and operand resources (e.g. the competence embodied in the car mechanic, a garage pit, tools, etc.) and the car owner integrates these applied resources with the car (i.e. an operand resource controlled by the car owner) by making the car accessible for servicing.

The shift from GDL to SDL represents a shift in the logic of economic exchange rather than a shift in the type of product under investigation [4]. In SDL, service is exchanged for service on the basis of voluntary, economic reciprocity. Accordingly, Maglio et al. formally define a service system as "an open system (1) capable of improving the state of another system through sharing or applying its resources (i.e., the other system determines and agrees that the interaction has value), and (2) capable of improving its own state by acquiring external resources (i.e., the system itself sees value in its interaction with other systems)" [1]. Hence, service systems do not interact to create value for just one of them. They interact in mutually reciprocal services such that value is created for both of them. The garage applies resources to improve the state of the car owner (i.e. the car owner perceives benefits in having his car repaired or serviced) and the car owner applies resources to improve the state of the garage (i.e. he transfers money from his account to the garage's account). Paying the garage is the reciprocal service for repairing or servicing the car.

Service exchange is the economic motive for service systems to engage in interactions with other service systems. This reality is not represented in Fig. 1. This paper proposes a conceptual model of service systems interacting in services with an explicit representation of service exchange. To explain the basis for this conceptual model, the next sub-section reviews REA. Next, three ontologies are reviewed that describe the nature of service and related concepts.

2.2 The Resource-Event-Agent Ontology

REA originates in an accounting data model proposed by William E. McCarthy in 1982 [17]. Fig. 2 shows the core concepts and relations of REA; further ontological extensions and refinements have been proposed [9], [12], [18], [19]. An *economic resource* is a valuable good, right, or service that is presently under the identifiable control of a particular person. Person, in this context, must be read as a natural or legal person, recognized by law as having legal rights and duties, able to make commitment(s), assume and fulfil resulting obligation(s), and able to be held accountable for its action(s) [20]. An economic resource is under the control of a person if that person owns the resource or is able to derive economic benefit from it [20]. An *economic event* is an occurrence in time that results in an *inflow* or *outflow* of economic resources in the context of an economic exchange of economic resources between persons. An *economic agent* is a person that is responsible for an economic event that occurs in the context of an economic exchange. Two economic agents participate in

[2] Including physical resources with legal rights (people), conceptual resources with legal rights (organizations), conceptual resources treated as property (shared information) and physical resources treated as property (technology) [1].

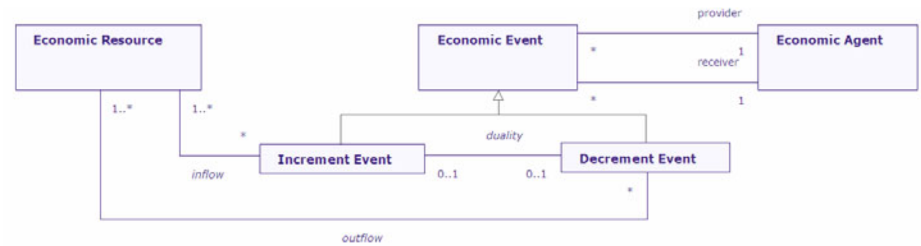

Fig. 2. Basic Resource-Event-Agent Model (based on [19])

each economic event: one agent in the role of *provider* of economic resources and another agent in the role of *receiver* of economic resources.

REA emphasizes that enterprises create value through economic exchange. Fig. 2 can therefore serve as a conceptual model of economic exchanges of resources between agents. Resources are exchanged through dual economic events, in which each event has two roles: *increment event* for the receiving agent and *decrement event* for the providing agent. The *duality* relation between increment and decrement events has the status of an 'axiom' in REA, signifying that agents will only participate in economic exchanges on the basis of economic reciprocity (i.e. *quid pro quo*). The loss in value that is caused by giving up resources must be balanced by a gain in value that is caused by getting other resources.

Being rooted in the accounting discipline, REA assumes the traditional GDL worldview and considers services as a type of economic resources.[3] This means that services can be exchanged for other economic resources. For instance, the garage and the car owner can exchange a car repair service for money. The flow of resources is caused by economic events. So apart from identifying car repair service as an economic resource, it is necessary to identify an economic event that causes the car repair service to flow from the garage to the car owner. This event, e.g. service delivery, is a decrement event for the garage and an increment event for the car owner. In return the car owner pays the garage, causing a flow of money from car owner to garage. Payment is the dual economic event of service delivery.

The view of service as a resource stands in sharp conflict with SDL which considers service as a process. The REA distinction between services (as economic resources) and services delivery (as economic events) is therefore not supported by SDL. According to SDL, resources have no intrinsic value but are valued through their application (in a service) and integration with other resources [13]. This contradicts the REA view of services delivery as a decrement event for the provider (i.e. the provider loses value) and an increment event for the receiver (i.e. the receiver gains value). So, although REA offers a conceptual model of economic exchange, in its current form it is invalid as a conceptual model of service exchange in SDL.

[3] The view of 'service as a resource' implies that at any moment services can be materialized, which is required for valuation of enterprises.

2.3 Service Ontologies

Weigand et al. [21] propose the Basic Service Ontology, which is based on REA concepts (Fig. 3). A distinction is made between two types of resources: external resources are those that can be exchanged between agents whereas internal resources cannot be exchanged. Consistent with the GDL/REA view, a service is an external resource "as it is viewed as valuable by some agent and can be exchanged between agents" [21]. Unlike REA, the special nature of services is recognized as they are external resources that have as goal to modify and add value to other resources. This is modelled by the *hasGoal* relation between service and economic event. The economic resources that are modified are identified via the *concerns* relation.

The realization of a service is distinguished from the service itself. A service can be realized in different ways (modelled as the *realizes* relation with *process*) and service realization processes are *governed* by *policies*, which are internal resources. To address workflow and service composition aspects in realizing services, the *work process* concept is introduced.

Although not shown in Fig. 3, the Basic Service Ontology also recognizes that service exchanges meet the REA duality axiom. The view that services are resources that can be exchanged is however not in line with SDL. Further, the value co-creation that is so essential for the SDL view on service is not addressed very well, as agents *control* resources and *execute* work processes but it is nowhere implied that agents should collaborate, each bringing in their own resources [4], to create value. In SDL, service is a collaborative process and not something that is produced by one party (i.e. service realization) and then consumed by another party (i.e. achieving the service's goal). The decoupling of production and consumption is typical GDL thinking where it is promoted for efficiency reasons [4].

Other ontologies of service or service system have been proposed or are being developed. In [22], Alter gives a theoretical foundation for the concept of service system using Work System Theory, which is recognized as another normative view on describing service systems and explaining their behaviour [5]. A *work system* "is a system in which human participants or machines perform work using information, technology, and other resources to produce products and services for internal or external customers" [22]. According to [22] there is no significant difference between the concepts of service system and work system. Hence, the ontology that is being developed for work systems (called Sysperanto [23]) could serve as an ontology of service systems. However, as evidenced in the work system definition, the production of services corresponds to GDL rather than SDL as it implies a 'service as a resource' view.

An interesting development is Ferrario's and Guarino's ontological foundation of Service Science grounded in the DOLCE upper-level ontology [24]. According to [24] "a service is present at a time t and location l iff, at time t, an agent is explicitly committed to guarantee the execution of some type of action at location l, on the occurrence of a certain triggering event, in the interest of another agent and upon prior agreement, in a certain way". The basic idea is that there is a commitment state in which one agent guarantees the execution of some type of action in the interest of another agent. This commitment state is the service [25]. In terms of the DOLCE

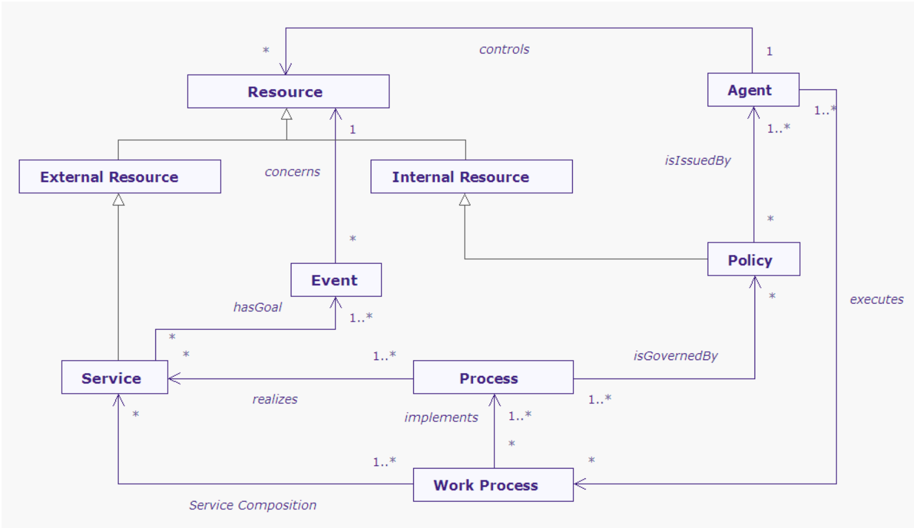

Fig. 3. Basic Service Ontology [21]

ontology, it is a static event, i.e. an entity which occurs in time. Ferrario and Guarino argue that, because a service is an event and events cannot be owned, a service cannot be transferred [24]. Ferrario and Guarino conclude that "it seems legitimate to assume that goods are *objects* (endurants, in DOLCE's terms), while services are *events* (perdurants)" [24]. This conclusion is in line with SDL ('service as a process') and contrasts with the previously discussed works that consider service as a resource.

The proposal by Ferrario and Guarino also extends to service outside the business realm. In [25] they provide examples of public and social services like fire and rescue, snow removal, and child care. They argue, for instance, that here and now there is a commitment state called fire-and-rescue service even if at this very moment there is no fire here and no rescue actions are being performed. In [24] the example of a car repair service is given. The commitment state starts when a mechanic commits with a Public Administration (like a Chamber of Commerce) with a subscription act. Starting from that moment, the mechanic guarantees that he will execute a certain type of job according to the local rules. Although following the line of reasoning of Ferrario and Guarino, the car repair service now exists, there have been no interactions yet with the beneficiaries of the car repair service (i.e. car owners of broken cars). It seems that the understanding of service that is articulated by Ferrario and Guarino is different (broader?) than the understanding posited in this paper. Also because the concept of service system as a configuration of resources [1] is not prominently present in the ontological structure of service proposed by Ferrario and Guarino, the conceptual model of service exchange proposed in this paper was developed starting from REA and Weigand et al.'s proposal, leaving the alignment with the proposed DOLCE foundation for Service Science as a topic for future research.

3 The Resource-Service-System Model

In a first sub-section, the basic conceptual model of service exchange in SDL is presented. A second sub-section extends this basic model with additional model views, capturing different aspects of service systems and their interaction in services.

3.1 Basic Service Exchange Model

SDL positions service as a process and not as a type of product as in GDL. The ontological analysis by Ferrario and Guarino [24], [25] supports the SDL view by classifying service as event. Therefore, in an SDL interpretation of REA, service maps closer with economic event than with economic resource. Economic events cause flows of resources. A service is the acting of one or more operant resources on one or more other resources (operand, but possibly also operant [1]). From an economic perspective, the acting of operant resources that embody competences (e.g. the car mechanic) presents a cost (e.g. labour cost). Operand resources that are acted upon may be conveyors of competences and their use (e.g. garage tools and facilities) or consumption (e.g. motor oil, tires) is another cost. The resources that the operant resources are applied to (possibly via conveyor operand resources) are also acted upon and may also present a cost (e.g. a car that is being repaired cannot be used by its owner, the car owner spends time and effort bringing the car to the garage, etc.), but more important is that the integration creates value. A repaired car has more value than a broken car, which is true for both *value in use* (the SDL perspective) as *value in exchange* (the GDL perspective) [13].

Based on the similarities between the REA concept of economic event and the meaning of service in SDL, including their respective relations with resources, the conceptual model of service exchange in SDL is constructed starting from the REA conceptual model of economic exchange (Fig. 2) by replacing economic event with *service* (Fig. 4). Like REA economic resources, resources in SDL are under the control of a particular person. If economic exchanges are service exchanges then the persons controlling resources are service systems (meaning configurations of resources [1]). Therefore, the *service system* concept is introduced in the model. As shown in Fig. 4, a service system is an aggregate of resources that are controlled by the system. The *resource* concept is specialized into *operant resources* and *operand resources* instead of goods, services and rights. According to [13] the distinction between operant and operand resources can enrich the conceptual foundation of Service Science as service systems are driven by operant resources rather than operand resources. The model shows that at least one operant resource must act in a service and at least one resource must be acted upon, meaning that service implies the application of competences which must be integrated with other resources to create value. These *acts_in* and *be_acted_upon_in* relations replace the inflow and outflow relations of REA.

The emphasis that REA puts on identifying the persons that are responsible for economic events can be explained by the importance of concepts like governance and control in management (accounting) literature. Enterprises can delegate the responsibility for an economic event to an employee or a subcontractor and this agent can subsequently be held accountable for the event. This emphasis is not found in the

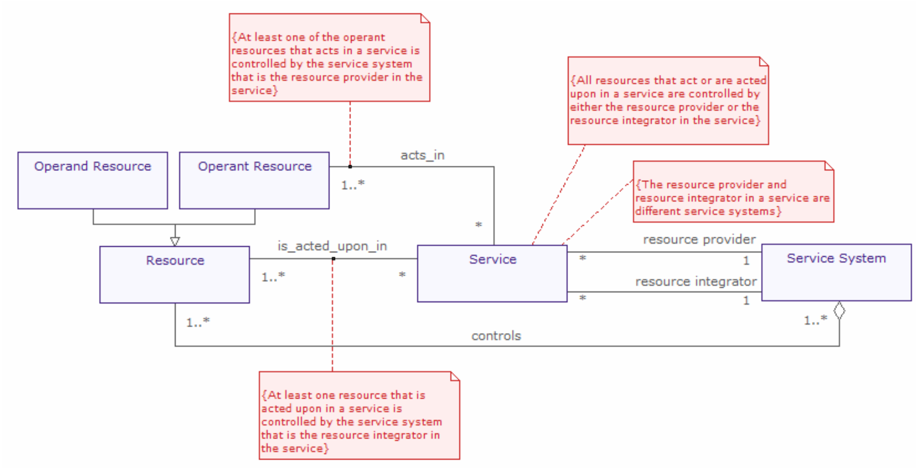

Fig. 4. Basic Resource/Service/System Constellation

SDL literature, so the basic model in Fig. 4 does not include an SDL interpretation of economic agent. Instead, the service systems involved in a service are explicitly identified via *value co-creation roles*. A *resource provider* co-creates value with another service system (i.e. a resource integrator) for the benefit of that other system by providing/applying resources. A *resource integrator* co-creates value with another service system (i.e. a resource provider) for its own benefit by integrating the resources provided/applied by the other system. The term *resource* provider/integrator is deliberately chosen as in all reviewed service (system) ontologies (see sub-section 2.3), references are made to *service* provider/client/producer/consumer, which do not make sense as in SDL a service cannot be transferred between parties, be produced by one party, or be consumed by one party.

Finally, the model shown in Fig. 4 also includes a number of constraints, modelled using multiplicity constraints or described textually[4], which are derived from the SDL definitions of service, service system and service exchange provided in [1].

The car repair or servicing example can be used to illustrate the model shown in Fig. 4, which can be referred to as the *Basic Resource/Service/System Constellation*. If, for instance, an oil change is the service, then a garage and a car owner participate in the service in the respective roles of resource provider and resource integrator. The car mechanic is an operant resource controlled by the garage that acts upon the car which is an operand resource controlled by the car owner. In the service, other operand resources controlled by the garage (e.g. motor oil, a garage pit, etc.) are acted upon as they convey the oil change competences embodied in the car mechanic that are applied to the car.

The Basic Resource/Service/System Constellation is not a complete conceptual model of service exchange as the reciprocal exchange of services between the service

[4] As the model is articulated using UML, these constraints can also be specified using OCL. For this paper, readability and clarity is more important than precision and formality; therefore a textual description was chosen.

systems is not represented. In other words, the REA duality relation is not represented. Fig. 5 offers a model view that can be integrated with the Basic Resource/Service/System Constellation and that includes a bidirectional *is_reciprocal_of* relation between services. This *Service Exchange View* shows via mandatory participation constraints that each service needs a reciprocal service. This means that when a service system provides resources for a service that benefits another service system, then this other service system must provide resources for a requiting service that benefits the first service system. So, in the requiting service the resource provider and resource integrator roles of the service systems that co-create value are switched.

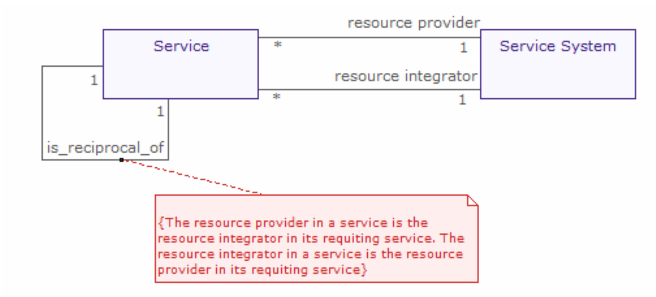

Fig. 5. Service Exchange View

In the car repair example, the garage is a resource provider in the car repair service and a resource integrator in the requiting payment service, whereas the car owner is the resource integrator in the car repair service and the resource provider in the requiting payment service. The car repair service and the payment service are reciprocal, or in REA terms, dual services.

The integration of the Basic Resource/Service/System Constellation (Fig. 4) and the Service Exchange View (Fig. 5) is a conceptual model of service exchange in SDL. This model will be referred to as the *Basic Service Exchange Model*.

3.2 Additional Model Views

The Basic Service Exchange Model does not show that service systems are themselves resources, more particularly operant resources [1]. As service systems are resources, service systems can be composed of other service systems as shown in the *Service System Composition View* (Fig. 6). As mentioned before (sub-section 2.1), a composition of resources needs to include an operant resource, otherwise it cannot be considered a service system.

Maglio et al. [1] stress that service systems are highly dynamic, meaning that they frequently compose, recompose and decompose over time. The Service System Composition View can be used to keep track of the resources that at any given moment are comprised by a service system. It can for instance be used to identify all the resources (or only those considered relevant for a particular application) that together make up a garage service system. The Basic Service Exchange Model also relates resources to the service systems that control them, but here the idea is more to identify the resources that service systems employ in mutually reciprocal services, for instance to identify the operant and operand resources that a garage provides in an oil change service.

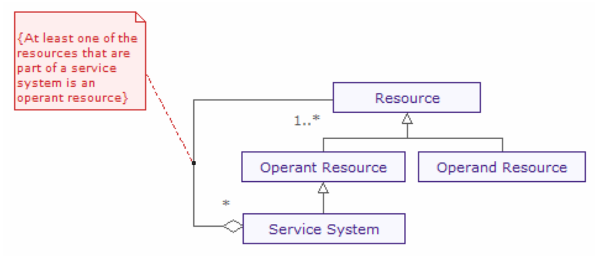

Fig. 6. Service System Composition View

The grounding of the conceptual model of service exchange in REA provides an interesting 'accountability' perspective on service exchanges. The *Accountability View* in Fig. 7 shows that service systems can delegate their resource providing and integrating responsibilities to *agents* that can subsequently be held accountable for the service. There is no agent concept in the SDL-based service system definition provided in [1], so the model view that is described here extends the original service system definition.

Regarding the participation of agents in services, two accountability roles can be distinguished. A *resource providing agent* acts on behalf of the service system that is the resource provider in the service. A *resource integrating agent* acts on behalf of the service system that is the resource integrator in the service. An agent that acts on behalf of a service system is an operant resource controlled by the system. Furthermore, it is an operant resource that acts upon other resources in the service, meaning that specific agent competences are employed in the service. The model view in Fig. 7 further assumes that a service system that is a resource provider or integrator in a service can have at most one agent that is accountable for that service. If accountability is shared amongst a group of persons, then the group is the agent.

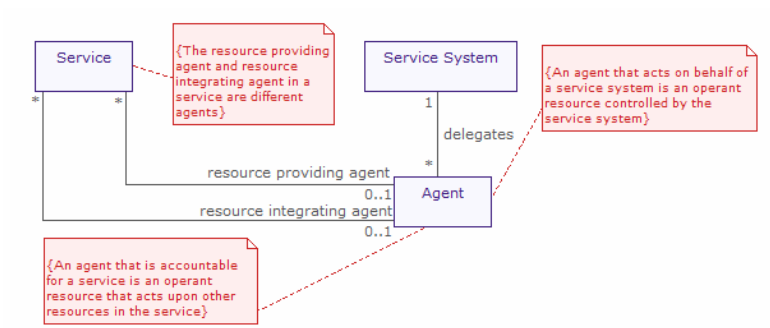

Fig. 7. Accountability View

By integrating this model view with the Basic Service Exchange Model, the agents acting on behalf of interacting service systems can be explicitly identified. As the model in Fig. 7 shows, this identification of agents is optional. If no agents are identified, then the service system as a whole is held accountable for the service.

In the example of a simple oil change service, the garage will probably delegate the oil change to a car mechanic who has the authority to provide whatever garage's resources necessary for the oil change. If there is no interest in identifying accountability relations, then the Basic Service Exchange Model can be used to represent the car mechanic as an operant resource controlled by the garage and acting upon other resources (including the car controlled by the car owner) in the oil change service. If there is interest in accountability structures, then the Accountability View can be used to indicate that the car mechanic is not just an operant resource controlled by the garage, but that it is acting on behalf of the garage as a resource providing agent. Important to note is that in that case the car mechanic can only be held accountable for the provision of resources and not for their integration which is the responsibility of the resource integrating service system or an agent that acts on behalf of it (e.g. the car owner may fail to bring in his car for servicing).

The last model view that is proposed here is the *Service Process View* (Fig. 8). The service ontologies reviewed in sub-section 2.3 include notions of service process. In Ferrario's and Guarino's service ontology [24], a service process implements a service. It is stated that the various actions that lead to service production constitute this service process. Also the Basic Service Ontology of Weigand et al. [21] distinguishes services and processes that realize services. Alter provides a model, the Service Value Chain Framework, which details the sequence of service encounters that may occur "before, while, and after a specific service is delivered to a specific customer" [22].

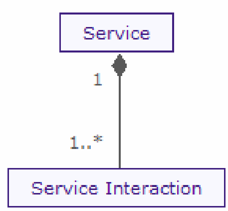

Fig. 8. Service Process View

Service processes that refer to production and delivery of services are hard to reconcile with SDL. An alternative view on the 'dynamics' of a service, which *is* a process according to SDL, is the ISPAR (Interact – Serve – Propose – Agree – Realize) model proposed by Maglio et al. [1]. This model poses that value co-creation interactions between service systems are service interactions. So a service can be seen as being composed of *service interactions* between the resource providing and integrating service systems (Fig. 8). In each of these service interactions, both service systems are involved. At least one service interaction is required, before we can say that there is a service in which both parties participate.

ISPAR is meant as a normative model that covers all possible interactions between service systems in terms of ten different outcomes, including both 'happy' and 'unhappy' paths. In the 'happy' path, a first service interaction takes place when a service proposal (i.e. a 'value proposition') is communicated. Communication requires a sender and a receiver, so both service systems are involved in the interaction. In the car servicing example, an effective communication of a service proposal has taken place when, for instance, the car owner acknowledges the garage's proposition of conditions and prices for a particular type of car servicing. A second service interaction concerns the reaching of an agreement between both parties on the value proposition. In the context of a service exchange, agreement is reached on the reciprocal services. For instance, the garage agrees to perform a particular type of car servicing on a particular date and time and the car owner agrees to bring in his car on the scheduled date and time, and pay the garage for the car servicing within one month's time. A third interaction is the realization of value by both parties. For the car owner this means that the state of his car is improved and for the garage this means that payment is received. The 'unhappy' path describes negative outcomes or interactions between service systems that do not qualify as service interactions. An example of a negative outcome is when the garage is not paid within the agreed period of time. An example of a non-service interaction is the car mechanic and car owner discussing the current quality and price of motor oil available on the market.

The Service Process view can be integrated with the Basic Service Exchange Model if there is interest in identifying the state in which a certain service is. This state can be expressed in terms of the service interactions that have taken place or that are currently going on.

4 Discussion and Conclusion

The Resource-Service-System model proposed in this paper presents a novel perspective on modelling service systems as it differs from its REA conceptual foundation and the REA-based Basic Service Ontology proposed in [21]. Unlike REA and the Basic Service Ontology, the Resource-Service-System model considers service as a process (as in SDL) and not as a resource having intrinsic value (as in GDL). Service exchanges do not transfer services but are constituted of economically reciprocal services, which the model represents as events. Further, service systems are not viewed as value producers or consumers but as value co-creators playing roles of *resource* provider and integrator.

The model may contribute to Service Science in that it can be used to study various aspects of service systems. The core of the model, i.e. the Basic Resource/Service/System Constellation, can be used to identify all operant and operand resources that the resource providing and integrating service systems contribute in a service, which is interesting from a service management perspective (e.g. for cost accounting and pricing purposes). Extended with the Service Exchange View, the model explicates the economic motive for service systems to engage in service exchanges, which is useful for service innovation (e.g. designing new value propositions), marketing (e.g. identifying target service beneficiaries), and strategy (e.g. profitability analyses). The Service System Composition View offers additional insight into the resource composition and capabilities of service systems, which is valuable for service operations (e.g. resource acquisition, subcontracting and outsourcing decisions). The Basic Service Exchange Model extended with the Service Process View may provide a detailed account of service interactions between resource provider and integrator, which is interesting from a service engineering perspective (e.g. for measuring and improving service performance as indicated in [1]). Finally, the Accountability View can be used to identify the agents to which service systems delegate resource providing and integrating responsibilities, and which can be held accountable for the realization of the service benefits (i.e. service governance and control).

The Resource-Service-System model is a conceptual model but not an ontology. Further development is needed to make its specification more complete and formal. Also, as ontologies specify shared conceptualizations, the model needs to be evaluated, refined and further elaborated by testing it on actual service exchanges involving a wide variety of service systems. Future research also includes its alignment with ontologies that consider services not only in economic contexts (e.g. the service ontology proposed in [24]). We finally wish to point out that the implicit working hypothesis underlying the development of the model also needs testing, as the usability of the model depends on the usability of SDL as a conceptual foundation of Service Science.

References

1. Maglio, P.P., Vargo, S.L., Caswell, N., Spohrer, J.: The service system is the basic abstraction of service science. Inf. Syst. E-Bus Manage. 7, 395–406 (2009)
2. Maglio, P.P., Srinivasan, S., Kreulen, J.T., Spohrer, J.: Service Systems, Service Scientists, SSME, and Innovation. Communication of the ACM 49, 81–85 (2006)
3. Vargo, S.L., Lusch, R.F.: Evolving to a New Dominant Logic for Marketing. Journal of Marketing 68, 1–17 (2004)
4. Vargo, S.L., Lusch, R.F.: From goods to service(s): Divergences and convergences of logics. Industrial Marketing Management 37, 254–259 (2008)
5. Succeeding through service innovation: A service perspective for education, research, business and government. University of Cambridge Institute for Manufacturing, Cambridge (2008)
6. Chesbrough, H., Spohrer, J.: A Research Manifesto for Services Science. Communications of the ACM 49, 35–40 (2006)
7. Osterwalder, A., Pigneur, Y., Tucci, C.L.: Clarifying Business Models: Origin, Present and Future of the Concept. Communications of the AIS 15, 1–40 (2005)
8. Andersson, B., Bergholtz, M., Edirisuriya, A., Ilayperuma, T., Johannesson, P., Grégoire, B., Schmitt, M., Dubois, E., Abels, S., Hahn, A., Gordijn, J., Weigand, H., Wangler, B.: Towards a Reference Ontology for Business Models. In: Embley, D.W., Olivé, A., Ram, S. (eds.) ER 2006. LNCS, vol. 4215, pp. 482–496. Springer, Heidelberg (2006)
9. Geerts, G.L., McCarthy, W.E.: An Ontological Analysis of the Economic Primitives of the Extended REA Enterprise Information Architecture. International Journal of Accounting Information Systems 3, 1–16 (2002)
10. Gordijn, J.: Value based requirements engineering: Exploring innovative e-commerce ideas. VU University, Amsterdam (2002)
11. Osterwalder, A.: The Business Model Ontology - a proposition in a design science approach. University of Lausanne, Lausanne (2004)

12. Hruby, P.: Model-Driven Design Using Business Patterns. Springer, New York (2006)
13. Lusch, R.F., Vargo, S.L., Wessels, G.: Toward a conceptual foundation for service science: Contributions from service-dominant logic. IBM Systems Journal 47, 5–14 (2008)
14. Vargo, S.L., Lusch, R.F.: The Four Services Marketing Myths: Remnants from a Manufacturing Model. Journal of Service Research 6, 324–335 (2004)
15. Lusch, R.F., Vargo, S.L.: Service-Dominant Logic: Reactions, Reflections and Refinements. Marketing Theory 6, 281–288 (2006)
16. Spohrer, J., Maglio, P.P., Bailey, J., Gruhl, D.: Steps Toward a Science of Service Systems. IEEE Computer 40, 71–77 (2007)
17. McCarthy, W.E.: The REA Accounting Model: A Generalized Framework for Accounting Systems in a Shared Data Environment. The Accounting Review 57, 554–578 (1982)
18. Geerts, G.L., McCarthy, W.E.: Policy-Level Specifications in REA Enterprise Information Systems. Journal of Information Systems 20, 37–63 (2006)
19. Gailly, F., Laurier, W., Poels, G.: Positioning and Formalizing the REA Enterprise Ontology. Journal of Information Systems 22, 219–248 (2008)
20. Information technology – Business Operational View – Part 4: Business transaction scenarios – Accounting and economic ontology (ISO/IEC 15944-4). ISO (2006)
21. Weigand, H., Johannesson, P., Andersson, B., Bergholtz, M.: Value-Based Service Modeling and Design: Toward a Unified View of Services. In: van Eck, P., Gordijn, J., Wieringa, R. (eds.) CAiSE 2009. LNCS, vol. 5565, pp. 410–424. Springer, Heidelberg (2009)
22. Alter, S.: Service system fundamentals: Work system, value chain, and life cycle. IBM Systems Journal 47, 71–85 (2008)
23. Alter, S.: Architecture of Sysperanto: A Model-Based Ontology of the IS Field. Communications of the AIS 15, 1–40 (2005)
24. Ferrario, R., Guarino, N.: Towards an Ontological Foundation for Services Science. In: Domingue, J., Fensel, D., Traverso, P. (eds.) FIS 2008. LNCS, vol. 5468, pp. 152–169. Springer, Heidelberg (2008)
25. Ferrario, R., Guarino, N.: A New Ontological Perspective for Social Service. In: Corradini, F., Polzonetti, A. (eds.) Proceedings of the 2nd International Conference on Methodologies, Technologies and Tools Enabling e-Government, pp. 41–51. Halley, Beijing (2008)

Think Large, Act Small: An Approach to Web Services for Embedded Systems Based on the OSGi Framework

Roman Roelofsen[1], David Bosschaert[2],
Volker Ahlers[1], Arne Koschel[1], and Irina Astrova[3]

[1] University of Applied Sciences and Arts Hannover, Faculty IV, Department of Computer Science, Ricklinger Stadtweg 120, 30459 Hannover, Germany
{volker.ahlers,arne.koschel}@fh-hannover.de,
roman.roelofsen@googlemail.com
[2] Progress Software, Shelbourne Road 158, Ballsbridge, 4 Dublin, Ireland
david.bosschaert@progress.com
[3] Institute of Cybernetics, Tallinn University of Technology,
Akadeemia tee 21,12618 Tallinn, Estonia
irina@cs.ioc.ee

Abstract. Traditionally, web services were used in large distributed systems. In this paper, we propose an approach to using web services in embedded systems, which have small memory footprints. At the heart of our approach lay: (1) the use of Apache CXF to extend the OSGi framework with distribution; and (2) the adaption of Apache CXF to embedded system platforms such as Java Standard Edition Embedded, JamVM and Java Micro Edition. We give examples of possible application of our approach in a car tracking system and an advertising system for car drivers.

Keywords: Web services, embedded systems, OSGi, Apache CXF.

1 Introduction

In recent years, web services and service-oriented architectures (SOAs) have become standard technologies for integration of large distributed systems [6, 9]. Web services are, however, attractive for embedded systems too. Processors such as ARM/XScale, PowerPC and Intel x86 are usually found in embedded systems that are used in varying environments. Web services offer a way to provide embedded systems with applications that are needed in specific situations. This is a challenging task in face of memory restrictions of embedded systems.

2 Web Services

A web service is defined as a software system designed to support interoperable machine-to-machine interaction over a network [18]. Web services are currently one of the prominent standards of implementing SOAs [6, 9, 10]. Within SOAs, loosely coupled applications with well-defined service interfaces can communicate with each

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 239–253, 2010.

other in a highly heterogeneous distributed environment. Web services seek to provide means of integrating applications using open standards, protocols and languages widely adopted on the Web, regardless of the intrinsic heterogeneity of the distributed environment.

In addition, web services employ the same communication protocols adopted by the Web, allowing data exchange through corporate firewalls. Web services are also capable of providing application interaction without human intermediation. Web services can communicate with other web services and then can supply new applications merging all their services. Other advantages of web services include that they are build upon the principles of distribution and interoperability.

3 Embedded Systems

Embedded systems are losing their original meaning, which referred to small computational isolated (stand-alone) systems that give functional support for devices that do not fit to the definition of a computer [21]. Today we can define an embedded system as a micro-processed device, thus programmable, which uses its computing power for a specific purpose [22].

Embedded systems comprise the biggest niche in the market. “Of the 9 billion processors manufactured in 2005, less than 2% became the brains off new PCs, Macs, and Unix workstations. The other 8.8 billion went into embedded systems.” [24].

4 Example Scenarios

The advantages of Web services, on the one hand, and the market trends towards embedded systems, on the other hand, give rise to the idea of using web services in embedded systems. Traditionally, web services were used in large distributed systems. However, scenarios using these technologies also exist in the world of embedded systems such as in-car embedded devices. To illustrate this, we focus on two example scenarios:

- A car tracking service (see Fig. 1a).
- An advertising service for car drivers (see Fig. 1b).

Both example scenarios deal with embedded devices that are installed inside of a car and able to communicate with the outside world via the UMTS network. Since web services are being used, the spectrum of possible services offered to or by the devices cannot be known in advance.

4.1 Car Tracking Service

A car tracking service allows car rental companies to follow the positions of their cars. The in-car embedded device provides a web service that exposes the current GPS data of the car to the car rental company. A web application at the car rental company can consume the web service and show the position of the car on a map via a web frontend.

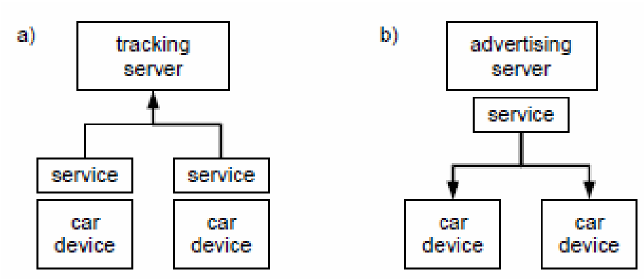

Fig. 1. Example scenarios: (a) car tracking service and (b) advertising service for car drivers

Since the car provides the necessary data itself by means of web services in a standardized format, no central server that knows about all possible cars is required. Instead, the car tracking service can be used in a local distributed configuration. Furthermore, the web services can easily be extended to provide additional information relevant to individual customers.

4.2 Advertising Service for Car Drivers

An advertising service gives advertisement information to drivers waiting at traffic lights, shops, restaurants, etc. Using the in-car embedded device, the car driver can control which type of advertisement (if any) to be shown.

By using web services, the providers do not need to agree on a common standard format. Instead, different clients of consumer are installed on the in-car embedded device just in time as the car enters a local hot-spot network. The clients can be saved for later reuse or they can be deleted when the car leaves the network. Thus, the clients can live in isolation and be controlled in a fine-grained way.

5 Requirements of Example Scenarios

In each of the example scenarios, a car has to communicate with an external system. This communication is initiated either by the car itself or by the external system. The communication takes place in a highly heterogeneous distributed environment where different networks or services may need different technologies. Technologies such as SOAP and XML are best suited to enable the communication.

The distributed aspects of the example scenarios introduce a number of requirements, which include:

- Exposing information for external consumers.
- Accessing external information.
- Enabling simultaneous use of technologies.
- Facilitating loose coupling between services and technologies.

5.1 Exposing Information for External Consumers

The car tracking service makes demand on exposing information to external consumers. This service should be independent of a specific car manufacturer and should respect existing standards like SOAP to enable third-party integration. In addition, to broaden the number of perspective users, the service should expose the information using different technologies at the same time. However, to ease the consumption of the information, new proprietary protocols and semantics should not be introduced.

5.2 Accessing External Information

While the car tracking service needs to expose information for external consumers, the advertising service needs to access external information using existing standards like SOAP. The most promising solution would be to abstract from the underlying technologies to ease the consumption of external information.

5.3 Enabling Simultaneous Use of Technologies

Depending on the services offered to or by the in-car embedded device, different technologies will be used. However, the use of one technology should not prevent the in-car embedded device from using another technology. Since the technologies may evolve independently from each other, the in-car embedded device should be able to replace the technologies. On the other hand, different technologies may be used at the same time. However, a simultaneous use of technologies should not lead to an inconsistent environment.

5.4 Facilitating Loose Coupling between Services and Technologies

The term loose coupling usually refers to the coupling between services and consumers, especially over a network. Here, the coupling between services and technologies is getting observed.

As said above, services may use different technologies at the same time. However, they may not know in advance, which of the technologies will be used. Therefore, a loose coupling between services and technologies should be enforced.

6 Problems with Using Web Services in Embedded Systems

The example scenarios bring up a number of design trade-offs and problems for using web services in embedded systems. In particular, they require independent transport technologies to enable unobstructed communication between highly independent parties.

Local area networks (LANs) may offer services that neither the driver nor the car can know in advance. Even when they know the services, they cannot assume that these services will be available in the future. Thus, the services offered by the LANs are unpredictable. Once the car has exposed a service to the outside, the consumer needs to discover the car and the service in the LAN. Furthermore, both parties need to agree at least on the underlying transportation protocol and mechanism. Similarly, the consumer does not know which car can expose the necessary information. Or there can be several cars that provide the services for one request.

In the traditional enterprise and personal home computer environments, these problems are addressed by using highly standardized technologies like web services. However, embedded systems rarely have enough memory (and processing power) to run web services [3].

7 OSGi

OSGi [16] is an emerging successful standard for developing component-based software. At its core, OSGi is about bundles and services. Bundles provide modularization and encapsulation for components. A bundle is also a deployable unit, which can be directly installed at runtime. Bundles can register services, which can be looked up and used by other bundles.

We selected OSGi for its ability to deal with a dynamic availability of services. In particular, bundles and services can come and go at runtime without the need for a restart of the OSGi framework. Therefore, we can defer the loading of bundles until their functionality is really needed and remove afterwards. This way we can ensure to keep the memory footprint at runtime as low as possible, which is very important for embedded systems. Multiple versions of the same bundle and multiple implementations of the same service can exist at the same time, without interfering each other. Furthermore, OSGi can be deployed on a wide range of devices from sensor nodes, home appliances, vehicles to high-end servers, and allows many small components called bundles to collaborate on both local and remote machines.

8 Apache CXF

Apache CXF [2] is an enterprise service bus that helps to develop services using different frontend programming APIs on different protocols, which use web services defined by WSDL contract with SOAP binding over HTTP.

We selected CXF for providing OSGi with distribution capability because being an open source, CXF has no license fee and allows us to modify and extend the code to adapt CXF to embedded system platforms. Yet CXF offers certain functionality that is needed to meet the requirements of the example scenarios. In particular:

- *Exposing information for external consumers.* Bundles can register their service in the OSGi Service Registry when they want external consumers to access the service. CXF can read the specified properties and create the endpoint.
- *Accessing external information.* CXF can create a dynamic proxy at runtime to forward all requests to the endpoint. The service interface and the URL have to be known. However, users of the service do not have to know if the service is local or remote.
- *Enabling simultaneous use of technologies.* CXF supports a whole set of different technologies including JAX-WS and SOAP. Furthermore, new technologies can be added to CXF as plug-ins. CXF can use the service interface and the specified

properties to export the service using different technologies at the same time. However, bundles do not have to know about all these technologies.

- *Facilitating loose coupling between services and technologies.* Bundles can use different configurations and do not have to know about the technologies that are needed to process the specified properties in order to create the endpoint. CXF can be connected to the service that has to be exported using the OSGi Service Layer. The example scenarios take place in a highly heterogeneous distributed environment where different networks or services may need different technologies. CXF allows these independent parties to use the needed technologies while participating in other networks or with other services provided that a common set of technologies exists.

9 Providing OSGi with Distribution Capability

To meet the requirements of the example scenarios, we need to supply bundles with a powerful distributed framework. As said above, we selected CXF for this. There are two main approaches to using CXF's functionality by the bundles:

- Embedding distribution capability inside the bundles.
- Providing CXF as a set of OSGi bundles (which we follow).

9.1 Embedding Distribution Capability Inside the Bundles

We can embed all the necessary files of CXF (jar and configuration files) inside the bundles and use them just as we would do in a standalone application. This approach works fine as long as there is only one bundle that uses CXF. As soon as a second bundle wants to use CXF, we are faced with the following three problems:

- *Memory waste*. Since OSGi allows each bundle to have its own class path, each bundle can contain the CXF libraries and list them in its bundle class path, thus duplicating jar files. This is not acceptable for embedded systems with small memory footprint.
- *Resource completion.* The central part of CXF is CXFBus. This bus is aware of all extensions like transport mechanisms and responsible for connecting them. While exposing a web service, the CXFBus will create a Jetty instance to listen at a certain port. If each bundle has its own CXFBus, Jetty instances will have to listen at different ports. Therefore, it will not be possible to distinguish web services by URI only.
- *Class incompatibility.* Since each bundle will have its own class loader, classes loaded by different class loaders will be incompatible with each other. Without configuration information, it will not possible to assign the CXFBus of one bundle as a reference to another bundle. The result would be a class loader exception.

9.2 Providing CXF as a Set of OSGi Bundles

OSGi makes it natural to provide CXF itself as a set of bundles. The problems above with memory waste, resource competition and class incompatibility will not occur because there will be only one CXFBus and because only one class loader will be responsible for loading the necessary classes.

The web service bundle has no dependencies on the CXF bundle, thus allowing us to replace the CXF bundle with a different implementation. This way the CXF bundle and web service bundle are completely decoupled. We do not even need to rely on an activation order of the bundles. Not only can CXF listen for new services, but it can also query existing ones. In particular, CXF bundle can be installed after the web service bundle or removed after a certain time.

However, we need a way to connect the bundle exporting a web service to the CXF bundle at runtime. Since the CXF bundle can be installed after the web service bundle and removed after a certain time, we have to enforce a loose coupling between the two but still enable the use of each other. We decided to use a Whiteboard pattern.

The Whiteboard pattern [7] has been originally developed as an alternative to the listener model, where listeners can register themselves e. g. at a button instance to get informed on the appearance of certain events. Every button is then responsible for managing the registered listeners. CXF can register a service in the OSGi Service Registry that provides the necessary functionality for exporting services. E.g. a service could have a method `exportService`, which contains parameters for the service information like the interface, port number and context URI. Bundles, which want to export this service, would fetch the CXF service from the service registry and call the method with the corresponding parameters. Due to the dynamic nature of the OSGi framework (i.e. due to that bundles can be removed and installed at runtime), bundles cannot assume the continuous existence of this CXF service. Hence, bundles need to monitor the service registry to check for the CXF service. Since each bundle needs to implement this logic, the listener model is error-prone.

Instead of letting CXF register the service that should be used by bundles, the Whiteboard pattern lets each of the bundles register the services that should be exported. In addition to the registration of the services, bundles can provide additional properties (e.g. `expose.service`, `expose.interface` and `expose.url`). These properties can then contain the necessary configuration information. CXF can use the service registry and the service listener to identify services that have defined these properties. Bundles do not have to track the state of CXF and no action is required by the bundles if CXF is updated at runtime.

When using the Whiteboard pattern, CXF uses the OSGi Service Layer to communicate with bundles and vice versa. The configuration information is embedded in service properties and bundles can change these properties at runtime. Hence, a bundle is able to change the configuration at the time of deployment and afterwards when needed. If a bundle wants to stop a service from being exported, it can remove the service from the service registry to inform CXF. A bundle is therefore able to control an exported service at runtime. Furthermore, service properties can be used as filters when the service registry gets browsed for specific services. E.g. CXF could query all services that need to be exported with SOAP or at a specific port. This querying is, however, not possible when this information is embedded in a proprietary file format.

To distinguish between users of different services, a service of the registered user could implement a certain Java interface. Since we did not want to change the code, we decided to provide the configuration information during registration. There are three approaches to this:

- Java properties.
- Declarative Services Specification.
- Spring-OSGi.

Java Properties. This is the simplest approach; it embeds the configuration information directly into Java classes. Another advantage of this approach is that it allows full control over the properties and thus, it can be used if e. g. some values need to be calculated at runtime. Fig. 2 shows a code example of how to register a service using Java properties. Here `context` is an instance of `org.osgi.framework.BundleContext`; it is provided during the CXF bundle activation. The CXF bundle would now listen e.g. for services that have a property `expose.service=true`. This property is stored in `java.util.Dictionary`, which is then passed as a parameter during registration. Since the interface of the service uses JAX-WS [5], we can use the new features of Java 5 such as annotations, without having to fork CXF.

```
ExampleService service = new ExampleServiceImpl();
Dictionary dict = new Hashtable();
dict.put ("expose.service", true) ;
dict.put ("expose.interface", ExampleService.class);
dict.put ("expose.url",
"http://localhost:8080/exampleService");
context.registerService (  ExampleSer-
vice.class.getName(), service, dict);
```

Fig. 2. Registering a service using Java properties

Declarative Services Specification. The intention of Declarative Services Specification (DSS) [26] is to ease the use of the OSGi Service Layer. Services can get registered and unregistered. Because of the dynamic nature of the OSGi framework, users of the services have to track their state all the time. Instead of "hard-coding" the necessary logic for the registration and the tracking of services, DSS allows to define this declaratively. Bundles that want to publish or use services define their service intention in a configuration file that is then processed by DSS. DSS also provides sophisticated features like dependency injection [27]. Fig. 3 shows a code example of how to register a service using DSS.

Spring-OSGi. This approach is similar to DSS. The key difference is that Spring-OSGi [4] itself defines a service registry like the OSGi framework does. This registry is managed by `BeanFactory`. In particular, OSGi services can be searched and registered by `BeanFactory`; `BeanFactory` also makes services applicable to dependency injection. Fig. 4 shows a code example of how to register a service using Spring-OSGi. Here `exampleService` is a normal Spring bean that will act as the instance of the service. `<osgi:service>` publishes `exampleService` in the service registry by referencing it and embeds additional information like the OSGi service interface and the necessary properties for CXF.

```
<?xml version="1.0" encoding="UTF-8"?>
<component name="ExampleService">
<implementation
class="com.example.ExampleServiceImpl"/>
<property name="expose.service">true</property>
<property name="expose.interface">
com.example.ExampleService
</property>
<property name="expose.url">
http://localhost:8080/exampleService
</property>
<service>
<provide interface="com.example.ExampleService"/>
</service>
<component>
```

Fig. 3. Registering a service using Declarative Services Specification

```
<?xml version="1.0" encoding="UTF-8"?>
<bean id="exampleService"
class="com.example.ExampleServiceImpl"/>
<osgi:service ref="exampleService">
<osgi:interfaces>
<value>com.example.ExampleService</value>
</osgi:interfaces>
<osgi:service-properties>
<prop key="expose.service">true</prop>
<prop key="expose.interface">
com.example.ExampleService
</prop>
<prop key="expose.url">
http://localhost:8080/exampleService
</prop>
</osgi:service-properties>
</osgi:service>
```

Fig. 4. Registering a service using Spring-OSGi

10 Accessing Services Remotely

In addition to exposing a local OSGi service to remote parties (see Fig. 5), the example scenarios also require to access remote endpoints. E.g. the advertising service requires that a client application installed in the car fetches advertisement information from a remote server found in the LAN. Provided that service discovery has already taken place, there are two approaches to accessing services remotely:

- Creating a remote API.
- Creating a proxy (which we follow).

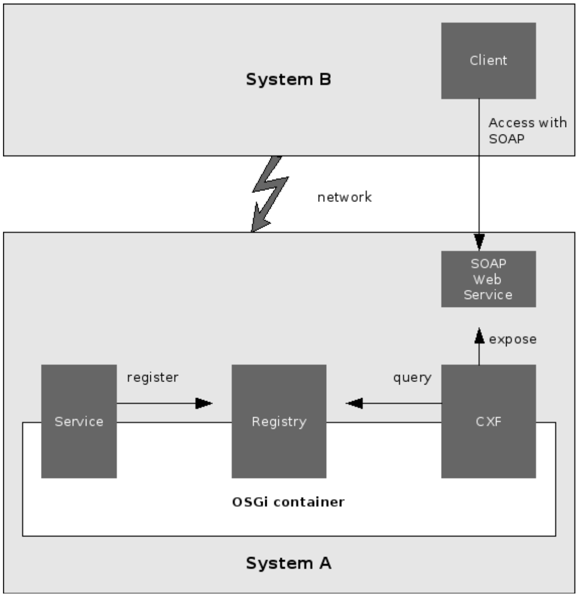

Fig. 5. Exposing a local OSGi service to remote parties

10.1 Creating a Remote API

To let bundles access remote endpoints, CXF could offer a special API that encapsulates the necessary logic. A service that is to be used by the bundles could then be registered in the OSGi Service Registry. Fig. 6 shows a code example of how to create a remote API.

```
RemoteEndpoint re=new RemoteEndpoint();
re.setAddress(url);
re.setDataBinding(getDataBinding(databinding));
Object result=re.callMethod("methodname", "parameter");
```

Fig. 6. Creating a remote API

This approach, however, introduces several drawbacks. All the information specified in the service interface is lost. This interface defines which methods are available and which parameters the methods require. Hence, it represents the contract between a server and a client. By embedding the method name and parameters in a method call, we have to ensure that the specified values conform to the service interface. Moreover, depending on the used frontend, the service interface may specify additional semantics. E.g. some methods may use asynchronous call semantics and require the registration of a callback method. When using a "remote endpoint API", a suitable API would have to be aware of all these possibilities.

10.2 Creating a Proxy

Byte code abstracts from the underlying hardware platform; thus it helps to create new classes or methods dynamically (i.e. at run time). Without byte code, the application would need to generate machine code instructions, which require detailed knowledge of the platform.

```
ClientProxyFactoryBean factory=new
ClientProxyFactoryBean();
factory.setServiceClass(iface);
factory.setAddress(url);
factory.getServiceFactory().setDataBinding(
getDataBinding(databinding));
Object proxy = factory.create();
Dictionary props = . . .;
context.registerService(serviceClass.getName(), proxy,
props);
```

Fig. 7. Creating a proxy

We can take advantage of byte code and create a Proxy object [25]. This proxy will implement the service interface. Thus, it can be casted to a variable declared as an instance of the service interface. The proxy forwards method calls to the remote endpoint, waits for the result, and passes the result to the caller. This way we have both an elegant and a flexible way to access services remotely.

Fig. 7 shows a code example of how to create a proxy. The information about the service interface, the URL and the data binding are passed to the proxy. After the proxy has been created, it gets registered in the OSGi Service Registry. (CXF provides a class `ClientProxyFactoryBean` to create a proxy.)

11 Embedded System Platforms

For deployment of web services on embedded systems, we selected Java platforms because of their popularity. Java Standard Edition (SE) and Java Enterprise Edition (EE) are widely being used in the IT world. However, these platforms typically have memory footprints well beyond the capabilities of embedded systems. Nevertheless, there are several adaptations of Java platforms to embedded systems. These are:

- *Java Standard Edition Embedded* (Java SEE) [15]. This platform is based on Java 1.4 for ARM processors and on Java 5 for PowerPC and Intel x86 processors. Although Java SEE aims at providing a full implementation of Java SE, it requires only 30 MB memory for Java 5 which is less than half the size of Java SE.
- *JamVM* [8]. This platform is based on Java 5 too. But by contrast to Java SEE, it has a very small footprint and runs on ARM processors.
- *Java Micro Edition* (Java ME) [14]. This platform is based on Java 1.4 for ARM processors, PowerPC and Intel x86 processors. Java ME Connected Device Configuration (CDC) is viable for low end devices with memory footprint starting from 2 MB.

12 Adapting Apache CXF to Embedded System Platforms

To meet the memory restrictions of embedded systems, we had to adapt CXF to Java SEE, JamVM and Java ME CDC. This adaptation was straightforward to Java SEE and JamVM because both platforms are able to execute Java 5 byte code. (Java 5 is required to run web service applications on CXF.) The main difference is that JamVM has a more restricted class library. In particular, it uses GNU Classpath as the class library. Since this library lacks several classes, we had to make several changes to it. These changes mostly affected the `java.io` and `javax.xml` packages.

Since Java ME CDC is based on Java 1.4, the adaptation was challenging to this platform. We had to use byte code weaving and a class library Apache Harmony [1].

The byte code specification of JVM has not been changed in Java 5; it is one and the same as in Java 1.4. Therefore, Java 5 byte code can be executed on Java ME CDC. On the other hand, the class library has been changed in Java 5. And new language constructs such as annotations have been added. Since Java ME CDC is based on Java 1.4, annotations cannot be used on this platform. However, we simulated annotations using reflection. This is called byte code weaving. There are several tools capable of doing this (e.g. [11]).

Byte code weaving solved only the problem with new language constructs. In addition to new language constructs, Java 5 has introduced new classes and changed existing ones. We had to use Harmony to solve this problem.

13 Related Work

The related work is found in two areas:

- Extending OSGi with distribution capability.
- Deploying web services on embedded system platforms.

13.1 Extending OSGi with Distribution Capability

One of the weaknesses of the OSGi framework is that the current OSGi standard defines how services talk with each other within a single JVM only. In today’s IT world, distributed systems have been used rapidly in business applications. Thus, a lack of support of distribution is a severe hindrance for the use of OSGi in distributed systems. Therefore, several extensions – e.g. OpenSOA [13], Redistributable OSGi (R-OSGi) [12, 17], Distributed OSGi (D-OSGi), IBM Lotus Expeditor, Eclipse Communication Framework [23], Newton Framework and Apache CXF [2] – were done to allow services to talk with each other across multiple JVMs. The goal of all these extensions is to add distribution capability to the OSGi framework, thus enabling a service running in one OSGi framework to invoke a service running on another, potentially remote, OSGi framework. While meanwhile distribution has become part of D-OSGi, it lacks features like asynchronous messaging. This is, however, possible with our approach by utilizing both the relevant CXF features and the extensions that we are currently implementing.

13.2 Deploying Web Services on Embedded System Platforms

There are several tools capable of deploying web services on embedded system platforms. Examples include Microsoft Web Services on Devices [19] and Fast Infoset [20]. Fast Infoset is not a web service technology per se, but it provides a binary encoding of XML that makes web services to consume less bandwidth during communication. Both Web Services on Devices and Fast Infoset fall short in their flexibility of generating different code artifacts for the large variant of embedded systems based on different protocols.

14 Conclusion

We have proposed an approach to web services for embedded systems based on the OSGi framework. Our approach does not require making changes in the existing programming model. Rather, it encourages using the concept of bundles. Our approach allows cars to participate in a SOA that spans machine boundaries using network infrastructures.

We have added distribution capability to the OSGi framework using CXF. CXF enables remote parties to call internal OSGi services. Bundles can define which of the registered services should be accessible. CXF is used to create the accessible endpoints and helps to utilize different technologies when needed. Our approach ensures a loose coupling between CXF and the registered services. Services do not need to be aware of the distribution framework or how they are exposed to external parties. The only needed interface is the OSGi Service Layer. Furthermore, local bundles can access remote endpoints. A proxy delegates to the endpoint and gets registered in the OSGi Service Registry in order to be used by the bundles. The access to external systems is fully transparent.

In addition, we have adapted CXF to Java platforms for embedded systems. To this end, we have decided to provide CXF as a set of OSGi bundles in order to meet the memory restrictions of embedded systems. We have deployed our approach on three Java platforms: Java SEE, JamVM, and Java ME CDC. Since both Java SEE and JamVM are based on Java 5, the deployment has been relatively straightforward. In the case of JamVM, however, we have been forced to make several changes to CXF because of the limitation of the available Java API. The deployment has been far more challenging on Java ME CDC, which is based on Java 1.4. Since CXF makes wide use of Java 5 features such as annotations, we have been forced to use byte code weaving and a class library Harmony.

Acknowledgments. Irina Astrova's work was supported by the Estonian Centre of Excellence in Computer Science (EXCS) funded mainly by the European Regional Development Fund (ERDF).

References

1. Apache Software Foundation: Apache Harmony pages, `http://harmony.apache.org` (last access: December 10, 2009)
2. Apache Software Foundation: CXF pages, `http://cxf.apache.org` (last access: December 10, 2009)

3. Barr, M., Massa, A.: Programming Embedded Systems, 2nd edn. O'Reilly, CA (2007)
4. Interface21 Inc.: Spring-OSGi, http://www.springframework.org/osgi (last access: December 10, 2009)
5. Java Community Process: JSR 181: Web services metadata for the Java TM platform, http://jcp.org/en/jsr/detail?id=181 (last access: December 10, 2009)
6. Krafzig, D., Banke, K., Slama, D.: Enterprise SOA. Prentice Hall, NJ (2005)
7. Kriens, P., Hargrave, B.J.: Whiteboard pattern (2004), http://www.osgi.org/documents/osgi_technology/whiteboard.pdf (last access: December 10, 2009)
8. Lougher, R.: JamVM pages, http://jamvm.sourceforge.net (last access: December 10, 2009)
9. Newcomer, E., Lomow, G.: Understanding SOA with Web Services. Addison-Wesley, Upper Saddle River (2005)
10. OASIS: SOA pages, http://www.oasis-open.org/committees/tc_cat.php?cat=soa (last access: December 10, 2009)
11. Puchko, T.: Retrotranslator, http://retrotranslator.sourceforge.net (last access: December 10, 2009)
12. Rellermeyer, J.S., Alonso, G.: Services everywhere: OSGi in distributed environments. In: EclipseCon 2007, Santa Clara, CA (2007)
13. Siemens, A.G.: OpenSOA press release (2007)
14. Sun Microsystems Inc.: Java ME pages, http://java.sun.com/javame/overview/techpapers (last access: December 10, 2009)
15. Sun Microsystems Inc.: Java SE Embedded pages, http://java.sun.com/javase/embedded (last access: December 10, 2009)
16. OSGi – The Dynamic Module System for Java, http://www.osgi.org (last access: December 10, 2009)
17. Swiss Federal Institute of Technology (ETH) Zurich: R-OSGi pages, http://r-osgi.sourceforge.net (last access: December 10, 2009)
18. World Wide Web Consortium: Web services pages, http://www.w3.org/2002/ws (last access: December 10, 2009)
19. Microsoft Web Services on Devices, http://download.microsoft.com/download/a/f/d/afdfd50d-6eb9-425e-84e1-b4085a80e34e/CON-T475_WH07.pptx, http://www.microsoft.com/whdc/rally/Rallywsd.mspx (last access: December 10, 2009)
20. Fast Infoset Project, https://fi.dev.java.net (last access: December 10, 2009)
21. Janecek, J.: Efficient soap processing in embedded systems. In: 11th IEEE International Conference on the Engineering of Computer-Based Systems (ECBS), pp. 128–135 (2004)
22. Wolf, W.: Computer as Components: principles of embedded computing system design. Morgan Kaufmann, San Francisco (2001)
23. Eclipse Foundation. Eclipse Communication Framework, http://www.eclipse.org/ecf (last access: December 10, 2009)
24. Barr, M.: Embedded Systems Glossary, http://www.netrino.com/Publications/Glossary (last access: December 10, 2009)
25. Gamma, et al.: Design Patterns. Addison-Wesley, Reading (1995)

26. Cervantes, H., Hall, R.S.: Automating Service Dependency Management in a Service-Oriented Component Model (2003), http://www.osgi.org/wiki/uploads/Links/AutoServDependencyMgmt_byHall_Cervantes.pdf (last access: December 10, 2009)
27. Fowler, M.: Dependency Injection, http://martinfowler.com/articles/injection.html (last access: December 10, 2009)

Value Co-creation and Customer-Driven Innovation in Social Networking Systems

Garyfallos Fragidis[1], Ioannis Ignatiadis[2], and Chris Wills[2]

[1] Technological Education Institute of Serres, Faculty of Business Administration, Terma Magnesias, 62124 Serres, Greece
garyf@teiser.gr
[2] Kingston University, Faculty of Computing, Information Systems and Mathematics, Penrhyn Road, Kingston-upon-Thames, Surrey KT1 2EE, UK
{I.Ignatiadis,c.c.wills}@kingston.ac.uk

Abstract. Value co-creation is a core concept in service science. In this paper we investigate value co-creation to provide some answer on what is it and how can it be achieved. We take a customer-oriented perspective by focusing on the end-customer, the people that utilize services in their everyday lives to meet their personal needs. We consider that value creation is a social activity and we propose social networks as the basic infrastructure for the co-creation of value with business and other organizations, peers, relatives and friends.

Keywords: Service value, value co-creation, service system, open innovation, social network.

1 Introduction

Service science emerged as a new scientific field for the acceleration of innovation and value creation in the new service-based economy [1]. More recently, the adoption of Service Dominant logic as the philosophical underlay of service science [2, 3] has rendered the co-creation of value as a key concept in service science. According to Service Dominant logic [3, 4], the customer is always a co-creator of value, which means that value creation is interactional; the provider can only make value propositions to the customer, rather than produce the value with his own procedures. In this context, value can only be idiosyncratically determined by the consumer of services, who perceives or experiences it according to his situational context and his personal needs and preferences.

Even though the co-creation of value is an attractive concept that offers huge potential for innovations both in business operations and in interactions with the customer, there is still limited research output on value co-creating service systems, which cannot clearly explain what does value co-creation in service interactions exactly mean and how can it be achieved. We distinguish as key reasons for this the lack of a truly interdisciplinary perspective on service systems and the lack of customer orientation that goes beyond B2B relationships and focuses on the individual.

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 254–258, 2010.

The recent success of the so-called Web 2.0 applications shows that the Web can provide the technological foundations for the development of novel, customer-oriented models that focus on the needs of the users and support people in their everyday lives. However, the development of major innovations requires we looked beyond technologies and artifacts and emphasized on innovative uses. In other words, we should see the Web not as a set of protocols and standards, but as a creative environment for businesses and users to develop together innovative solutions that meet better their needs and satisfy their goals. For the development of innovations in a service-based world information services (or software services) should be regarded as artifacts that provide electronic access to (real world) services. It is clear that the importance is not in the artifact, but in the services. However, in practice, information services are not related to services explicitly and research focuses currently on working with information services (e.g. compositions, technical aspects etc.). We consider that there is significant room for making analogous progress with services in their composition, execution and coordination, because value in the real world comes from the integration of services from different providers.

In this paper we attempt to make a step forward in this direction to provide a framework for the co-creation of value and reflection on the development of service systems that enable customers/ users in creating, receiving, modifying and integrating services to develop individualized solutions that meet their unique needs. The rest of the paper is organized as follows: in section 2 we describe briefly the key characteristics of a framework for value co-creation that focuses on the needs and requirements of the customer. In section 3 we describe a service model and provide an exemplary use of a social networking platform for the co-creation of value. We conclude with some remarks and guidelines for future research.

2 A Conceptual Framework for Value Co-creation

In this section we describe briefly a framework for the co-creation of value by explaining the concept of service, the meaning and the types of value co-creation and the structure of value co-creation environments. The framework is based on the assumption that the needs of the customer are unique, contextual and rather complex, which means that predefined solutions from the providers cannot usually meet them, unless they are adjusted, enhanced and integrated. The framework is customer-oriented because we make the assumption that the value creation process is governed by the needs of the customer and should be driven by the customer himself.

A fundamental question in this research is whether value co-creation is possible. The ‘service economy’ was developed because people decided more and more to buy some activities from the market to meet their needs and wants, instead of doing them by themselves. In an imaginary continuum of services offered exclusively by providers and actions performed exclusively by individuals, there is in between a huge area of co-created services (e.g. pre-cooked food, self-service operations, etc.) that require contribution from both the provider and the customer. It means that co-creation is not only possible, but – when viewed from the customer point of view – it is the primary pattern in services.

However, according to statistical and economic practices, only marketable activities are considered services. Services are traditionally defined as "an act or performance offered by one party to another … an economic activity that creates value and provides benefits for customers" [5]. Such a definition emphasizes the operations of the provider and leaves aside the customer, his needs and activities. But if we talk about the value for the customer and the co-creation of value, then we should incorporate the activities of the customers as well. Accordingly, *in our framework, we take an expanded approach and define service as any item or action someone can offer which could meet the needs of himself or somebody else*. This definition is compatible with Service Dominant logic [4], which regards services as activities, rather than as tangible or intangible outputs.

We distinguish three basic types of value co-creation: co-production, customization and integration. *Co-production* refers to the participation of the customer in the production process, when the customer performs some activities that normally are performed by the provider (e.g. self service, etc.). *Customization* refers to changing some characteristics of the service, so that make it fit or bring it closer to the preferences of the customer (e.g. vegetarian meals or business class services in flights); customization activities can be performed by the provider or the customer (or a third entity on his behalf), before, during or after the service provision. *Integration* refers to synthesizing service elements from a network of organizations and peers and adding proprietary activities -if necessary- to create individualized solutions; integration is required because of the complexity of people's needs, which cannot be met by 'simple services'. The three basic types of value co-creation can co-exist in the value co-creation process. For example, in a flight the passenger makes self check-in, customizes in-flight services and integrates the flight with ground transportation (e.g. taxi, metro, car rental) and accommodation. We distinguish integration as the primary mode of value co-creation (however, the least studied, at least from the customer point of view), which provides also the general context for the co-creation of value.

Value is co-created in networks of businesses, other organizations and other people (peers, relatives or friends). The operation and evolution of such networks depends on the aptitude of individuals to take advantage of the services and value co-creation opportunities offered there, as well as the aptitude of the network members to add their services, handle them effectively and offer opportunities for adding value (e.g. co-production, customisation, integration with other services, etc.). The function of such a value co-creation network of services should be improved not only by user feedback on utilized services, which is the main focus of current approaches, but by user-generated activities as well, which may propose new uses, introduce new services or improve the existing ones. Such a network of services, therefore, provides a space for open innovation that is driven by people's needs and actions.

3 A Social Networking Platform for Value Co-creation

We consider that value co-creation for the customer is a social process because it aims to resolve real life problems, it refers to human practices and it takes place in networks of experts, peers and friends. Everybody accepts the great success of social networking services (e.g. Facebook, YouTube, etc.), which rests on the ability of the user to participate actively in the formulation of the service by co-producing, customizing or integrating resources, thereby creating value for himself, his peers and the community. We believe that such environments for social networking (i.e. social networking platforms) can become the key technological infrastructure for the co-creation of value with the customer. Next we describe briefly a basic service model and a use case of a social networking platform for the co-creation of service value.

The objective of such a platform is to provide front-end and back-end services for enabling value co-creation with the users in the search, creation, customization and integration of services that are provided by organisations or peers. The platform can have two primary types of users: a) individual users who want to use existing services or create new ones to meet their needs or provide service to their peers or the community, and b) business users who make their services available in the platform for selling, marketing or collaboration with others.

The platform can be based on SOA standards and Web Service (WS) technologies; it must be open, scalable and interoperable. In the back end, the WS infrastructure can support the operations; in the front end, a simple and easy to use Web 2.0 interface can allow users to fully exploit the benefits offered. Although simple and efficient WS creation tools already exist, such a platform should pay attention to allowing users to socially interact with each other.

An exemplary use case may refer to a citizen who is seeking employment or career advancement opportunities. She has some evidence, credentials and data relating to her personal, educational and professional achievements so far, including academic degrees, other certified or uncertified qualifications (such as languages or e-skills), business experience (documented either in paper or in digital format), digital artefacts like videos and photographs evidencing her achievements or her personality (e.g. on Flickr or YouTube), a blog where she posts ideas and views that could interest prospective employers, etc. However, all these evidences and data are sitting in a number of different places. The platform should enable her provide an integrated view of her academic, professional and personal profile to prospective employers.

This use case is customer-oriented, because it satisfies user's complex and real life needs, and enables the co-creation of value, because the user receives services from external providers, creates and adds her services and integrates all of them together in a personal way to develop a unique solution that meets the needs and preferences of this user. The platform is an enabler of the value co-creation process between various service providers, peers and the user herself, by facilitating the search and integration of service elements.

The platform can provide the following types of services:

Registration services. They refer to registration, profile creation and maintenance.

E-portfolio services. They refer to editing an e-portfolio of qualifications and educational and professional achievements.

Profile aggregation services. They refer to aggregating in the e-portfolio credentials and data from different places (e.g. LinkedIn, Facebook, etc.).

Job preference services. They refer to setting job preferences in terms of type of work, location, conditions, etc. (e.g. she might prefer tele-working, which would allow her to combine childcare with professional career).

Job search services. They refer to searching for hiring ads and collecting information, either from external places (e.g. private employment agencies and public services on job vacancies), or within the platform, through the similar services created by other users.

Consultation services. They refer to identifying job offers to other users with similar profiles and/or preferences.

Affinity search services. They refer to searching for affinities with persons that are working or used to work in prospective employers in other social networking platforms.

Job reviewing services. They refer to providing comments and reviews on jobs she was hired or interviewed in the past. Other people can consult these reviews or provide their comments.

Peer communication services. They refer to finding other users that have working or interview experience with a prospective company and engaging in communication with them (e.g. before being invited to an interview).

Communication services with employers. They refer to getting in contact with prospective employers, allowing them have access to her e-portfolio of qualifications or some aspects of it, and managing communication with them.

4 Conclusions

This paper confronts the issue of innovation and value co-creation in the new 'service economy'. We recognize the primary role of the end-customer and suggest that the focus should be posed on real world services, rather than the engineering of software services in terms of design, development and deployment. We ascertain the need to provide more user-friendly approaches and emphasize real-world aspects of services (e.g. time conflicts of different services, cost, social relations, location, etc.), instead of pure technical considerations. There are great business and technological challenges in this effort, because research currently still focuses on the engineering of software services. However, it is necessary to focus on users and uses, if we wish to accelerate the development of innovations in the future.

References

1. Chesbrough, H., Spohrer, J.: A research manifesto for services sciences. Communications of the ACM 49(7), 35–40 (2006)
2. Maglio, P., Spohrer, J.: Fundamentals of service science. J. of the Academy of Marketing Science 36(1), 18–20 (2008)
3. Vargo, S.L., Lusch, R.F.: Service-dominant logic: continuing the evolution. J. of the Academy of Marketing Science 36(1), 1–10 (2008)
4. Vargo, S.L., Lusch, R.F.: Evolving to a new dominant logic for marketing. J. of Marketing 68(1), 1–17 (2004)
5. Lovelock, C.H., Wirtz, J.: Services Marketing: People, Technology, Strategy, 6th edn. Pearson Education, London (2007)

e-Profile Management as a Basic Horizontal Service for the Creation of Specialized e-Services

Maria Chiara Pettenati, Franco Pirri, and Dino Giuli

Electronics and Telecommunications Department, University of Florence
{mariachiara.pettenati,franco.pirri,dino.giuli}@unifi.it

Abstract. Integrating raw data with the Web, i.e. making a Web of Data, has the intrinsic power to create maximum utility for the Netizens. However current technical approaches in this direction fail in handling properties such as data provenance and licensing, thus increasing the chasm between the trend to "open data for maximum reuse" and the security and privacy needs related to users' personal data (e-Profile) treatment. In such a context a specific challenge is the development of innovative and alternative approaches for e-Profiles creation and management. The InterDataNet architecture is herewith considered as infrastructural solution aiming at providing a Web-based trust-enabling management of e-Profiles to third party generic e-Service Providers to support access and delivery of trusted and personalized e-Services. This paper presents some flashes of a more detailed analysis in progress on this problem, made according to the multiplicity of the Service Science, Management and Engineering perspectives, to highlight the prospected advantages and the viability involved by the proposed approach.

1 Introduction

Information guides our behavior and decisions. We live in an age in which the essential raw material is information; i.e. data with a context. Handling distributed granular information and its context via the Web, in such a way that it can ground the development of e-Services is a cornerstone in the development of science fields related to the Web Science (webscience.org/home.html). The pervasive fruition of e-Services in several domains of human's life, ranging from information communication and culture, citizenship, social relations, finance, commerce, mobility, education, working, entertainment, assistance, emergency, etc. inevitably involves a significant management of *personal digital information,* also referred to as *user profiles* or *e-Profiles*. In this paper we address the creation and management of e-Profiles as basic global – i.e. Web-wide - e-Service. The e-Profile basic service is conceived as a horizontal service handled by a network of e-Profile Service Providers (e-PSP), which can be made commonly shareable and accessible by heterogeneous e-Services delivered by third party Service Providers supporting the effective and trust-enabling management of users-digital identities, while guaranteeing consistence and availability of user personal information across several application domains. Generic Service Providers could thus focus on the delivery of specialized, trusted and added value services, relying on an e-profile basic Service provided by a third, trusted party.

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 259–263, 2010.

We advocate the feasibility of such an e-Service System thanks to the use of InterDataNet infrastructure as a trust-enabling middleware framework for managing e-profiles data in a distributed Web-based way. The Web-based management of users' profiles involves nowadays subtle and complex processes of creation, collection, management and exploitation of users' data which are at the centre of many controversies and studies.

Specific, yet often domain-dependent analysis, of e-profile management comes from domains such as:

- E-commerce, customer relationship management, service personalization, etc.
- Management of public sector information.
- e-government back-office and front-office service provision, etc.
- Human-computer interaction, usability, accessibility, etc.
- Law, regulation, policies.
- Security and privacy.
- Identity management, federated identities, personal data portability.
- Network protocols.

In order to approach the "Web of Trust" functions [1] the development of evolutionary e-Service architectures is needed. Such architecture should deal, among others – with the following user-related requirements: privacy, security, usability and accessibility, self-management, role-based access/functions, transparency, IPR, reliability, availability, personalization, service level agreement etc. [2, 3].

At present, proposed solutions to meet these requirements, often aim to address a limited set of users' needs and/or they represent vertical, domain-dependent and, largely, proprietary solutions. Moreover, current approaches to e-profiles creation and management are not suitable for being extended as Service Systems for providing the basic services needed for the proper development of further specialized e-Services (such as e-government, e-business, etc.) because they do not provide the required scalability and flexibility to allow a profile based on many different and changing parameters to be exploited in different contexts, because they are either based on applications-specific, centralized architecture or require adoption of common (technological and organizational) standards.

2 e-Profile Service System

At a general level, the e-Profile Service System (e-PSS) mediates the relationship between a Client (the user) and the Server (the generic Service Provider) – see Fig. 1 - in order to allow access and delivery of trusted and personalized Services. To this end, the Service System is required to provide to the user the needed authentication and access capabilities to the System. The e-PSS manages the e-Profiles Production, i.e. the aggregation of (open and private) data from different users' data sources. The e-PSS provides the user's e-Profile views to third party Service Providers (S in Fig. 1) for the creation of personalized services.

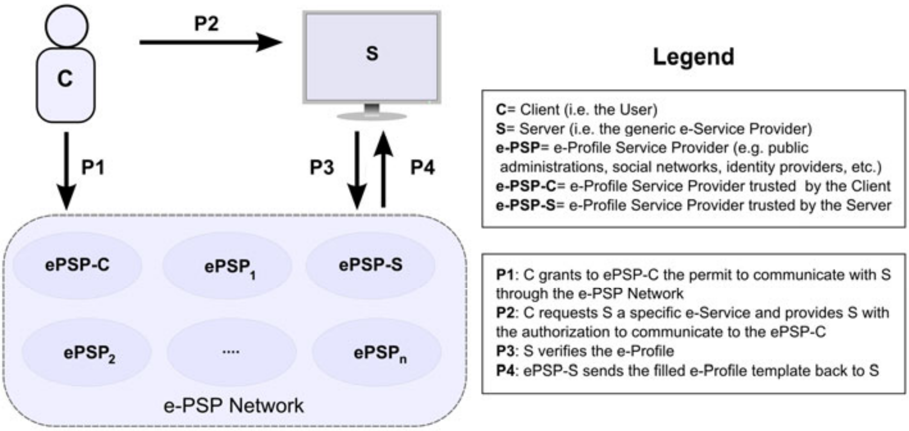

Fig. 1. Main functions of the e-Profile Service System (e-PSS)

As it is illustrated in Fig. 1, the Client (i.e. the User) defines and manages its own e-Profile together with one or more "trusted eProfile Service Providers" (e-PSP-C in Fig. 1). The generic e-Service Provider (S in Fig. 1) defines and manages the e-Profile templates it needs to build specialized e-Services together with one or more "trusted eProfile Service Providers" (ePSP-S in Fig. 1). The "e-Profile Service Provider Network" (e-PSP Network in Fig. 1) puts together the Client's e-Profile according to the specified Service Provider's template and can anonymize sensible data if needed. The communication paradigm of the e-PSP Network is not specified at this stage, but the simplest case is when ePSP-C and ePSP-S directly communicate through a secure private channel.

3 A Middleware Infrastructure Managing the e-Profile as a Web-Based Basic e-Service

The approach proposed in this paper introduces a significant innovation along one of the Service Science areas [4, Table 11-4], the Information and Communication Engineering area, since it leverages on a transitional development of the Web infrastructure in which personal digital information is managed. This view builds on the idea that the current Web of document is unsuitable for providing the required System properties of a global basic e-Profile management services because of three main issues: 1) the lack of granularity in the access and management of the single data element composing the e-Profile 2) the lack of control on attributes such as provenance and authorship of the granular data, 3) the lack of infrastructural support to 1) and 2). Indeed, granular data management is addressed by the current Web of Data approach [5] aimed at providing machine-readable data given explicit semantics and published online, coupled with the ability to link data in distributed data sets.

If this approach could seem to satisfy the property 1) above, improvements are sought in order to satisfy also property 2). However, the heart of the matter is that

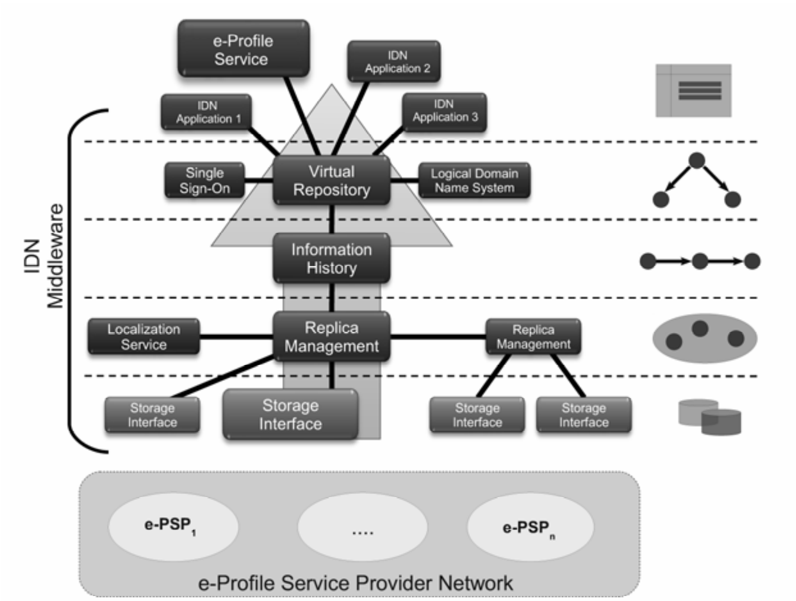

Fig. 2. InterDataNet Middleware [6, 7] grounding the e-Profiles Basic Service

current state of the art Web of Data approaches lead us back to a complex system solution in which property 3) in not at all addressed let alone satisfied. This introduces a higher level of complexity of the system on managing e-Profiles at a global level than the one verified in the Web of Documents. In order to decrease system complexity and increase the manageability of the problem, we propose the introduction of a common infrastructure which can provide e-Services Providers with transparent access to e-Profiles management services at a Web-wide scale (see Fig. 2). Our approach innovates on the Web of Documents because it introduces granular addressability of data and offers a uniform Web-based read-write interface to distributed heterogeneous profile data management in a cooperation-enabling environment. This approach is sustained by the InterDataNet (IDN) [6, 7] middleware conceptual infrastructural solution (see Fig. 2). IDN architecture sustains global addressability of resources and is designed to infrastructurally handle basic cooperation-oriented capabilities (licensing, provenance, consistency, security, privacy, availability and history). IDN framework is described through the ensemble of concepts, models and technologies pertaining to the following two views:

1. **IDN-IM (InterDataNet Information Model).** It is the shared information model representing a generic document model which is independent from specific contexts and technologies. It defines the requirements, desirable properties, principles and structure of the document to be managed by IDN.
2. **IDN-SA (InterDataNet Service Architecture).** It is the architectural layered model (see Fig. 2) handling IDN-IM documents (it manages the IDN-IM concrete instances allowing the users to "act" on pieces of information and documents). The IDN-SA exposes an IDN-API (Application Programming Interface) on top of

which IDN-compliant Applications can be developed. The e-Profile is an IDN standard document modelled according to the IDN Information Model. Each node of the e-Profile document is a complex assertion implicitly declared true by the User. It can thus be formalized as an aggregation of data units handled by the different e-PSP (see Fig. 1). The e-Profile is a graph and each data of the graph can be handled using its global identifier and according to its specific properties – i.e. metadata. The IDN-SA handles such data structure through its layers (see Fig. 2) to guarantee their properties and provide – at an Application Level – the e-Profile template document filled with users' data aggregated from trusted sources.

We have introduced an overview of the ongoing work related to the concept of e-Profile basic service aimed at supporting access and personalization of e-Services. Specific highlight is provided on the InterDataNet solution for its capabilities in enabling the development of such a e-Profile Service System (Fig. 1).

References

1. Artz, D., Gil, Y.: A survey of trust in computer science and the Semantic Web. Web Semant. 5(2), 58–71 (2007)
2. Giuli, D., Pettenati, M.C., Parlanti, D.: Individual and social needs motivating trust-enabling intermediation services. In: Proceedings of the 13th European conference on Cognitive ergonomics: trust and control in complex socio-technical systems, pp. 111–112. ACM, Zurich (2006)
3. Hoffman, L.J., Lawson-Jenkins, K., Blum, J.: Trust beyond security: an expanded trust model. Commun. ACM 49(7), 94–101 (2006)
4. Targowski, A.: Information Society and Societal Development, pp. 254–276. Information Science Reference, Hershey (2009)
5. Bizer, C., Heath, T., Berners Lee, S.T.: Linked Data - The Story So Far. International Journal on Semantic Web and Information Systems, Special Issue on Linked Data 5(3) (2009)
6. Pirri, F., Pettenati, M.C., Innocenti, S., Chini, D., Parlanti, D., Ciofi, L.: Proceedings of WebSci'09: Society On-Line, InterDataNet: an Infrastructural Approach for the Web of Data Athens, Greece, March 18–20 (2009)
7. Pettenati, M.C., Innocenti, S., Chini, D., Parlanti, D., Pirri, F.: Interdatanet: A Data Web Foundation For The Semantic Web Vision. Iadis International Journal On Www/Internet 6(2) (2008)

Febos: A Service-Oriented System for Collaborative Music Creation

Ignacio López, Antonio Cañabate, and Ruth Raventós

Universitat Politècnica de Catalunya (UPC),
Campus Nord, Jordi Girona 1-3, 08034 Barcelona, Spain
ignaciolopez000@gmail.com,
{antonio.canabate,ruth.raventos}@upc.edu

Abstract. This paper describes the building of Febos[1], a set of web services to be used in the development of aggregate services applications that allow the collaborative creation music over the Internet. The paper describes the context in which musical creation takes place and how digital technologies have changed the relationships among the actors involved within such context. Febos has been built as a service-oriented system, which means that it has been built by using *services* as first-class objects for the whole development process.

Keywords: Collaborative music creation, service-oriented paradigm.

1 The Digital Music Revolution: Services for Collaborative Creation

Over the past two decades, digital technologies have been transforming the music industry. One of the most remarkable changes has been the possibility of distributing songs in different digital formats through the Internet. This new technological enhanced distribution channel has brought more power to music consumers: a wider offer of music, richer forms for searching and discovering artists and songs, new ways to enjoy music and new models of consumer acquisition rights. Apart from the piracy phenomena and the copyright controversy, nowadays, users may lawfully download music at a very cheap price or even for free. They may listen to music through streaming services like Last FM or Spofy or through specialized online radio stations. They even may benefit from richer experiences in sites like myspace.com or official fan websites where they may access to biographies, concerts schedules, videos and other multimedia, merchandising, etc. of their preferred artists or bands.

This situation has threatened the established structure of the industry, traditionally driven by record companies that manage the music production process by marrying artists with the right mix of coworkers (producers, songwriters, and musicians), handling legal aspects of music creation, packaging artists for marketing purposes, and distributing their works (songs on CD or other media) through brick-and-mortar

[1] Roman name used, in Greek and Roman mythology, for the God of music, poetry and oracles (in Greek is also named, Apollo).

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 264–269, 2010.

retailers. The increased visibility of the Internet in the music industry may rattle the pole position of record labels [1].

This new emerging distribution paradigm is affecting the role and relationships between all players in the value chain: record companies, retailers, broadcasters, costumers, artists and other professionals; and it is also bringing new key players and business models into the music industry [1]. Music artists have today more freedom, more choices at every stage in the music creation process: composition, recording, producing and marketing. They do not longer need to be backed by a record company (at least, not to such degree as before) that would handle (costly) advertising [2].

Moreover, new technologies have dramatically downloaded the cost of the equipments needed in the production process. There is no longer the need of buying very expensive equipment for recording, editing, mixing and mastering, as two decades ago. Today, affordable and even free software exists that coupled with specialized hardware may convert a personal computer into a recording studio. Furthermore, at the marketing stage, all interested parties within the industry acknowledge that the Internet has been helpful in promoting the artists' works [2].

As music professionals have become less dependent from record companies, new forms of collaboration between composers, performers, and sound engineers in the music production process have aroused, which means that new challenges in innovative services, under the paradigm of "peer production" (production systems that depends on self-selected and decentralized individual actions) must be faced [3].

2 Febos: Exploring New Services for Collaborative Music Creation

As described in the previous section, artists and music professionals, by acknowledging the power the Internet gave them, have been forced to acquire new skills to be part of the new setting [2]. Some of them have early tried to collaborate with peers using standard internet services not specifically intended for the purpose of music creation [4]. Some experimental projects have been developed, like FMOL [5], focused on the collaborative composition stage. Barbosa, in [6], surveyed different projects existing at the time (2003) and proposed a classification for those systems. He placed them across two dimensions: interaction (synchronous / asynchronous) and location (co-located /remote). There have been also some know initiatives: the Youtube project [7] and several online "proprietary" services, free or paid, to provide support for collaborative music creation and diffusion.

Febos is a project developed at the UPC which, according to Barbosa may be classified as a *Music Composition Support System*. It is project oriented and enhances the traditional collaboration paradigms by allowing geographical displacement and asynchronous collaboration.

Febos, from the *strategic perspective*, does not provide an aggregate service to final users, as many similar services over the Internet. It provides a set of atomic services that can be used by service aggregators [8], such as social network services, and bundled together with services from other sources. Moreover, Febos is intended to be released under GNU- LGPL [9], which allows aggregators to develop non LGPL software linking to it and to market their services solutions by capturing value in different ways.

Febos was conceived to be used for discovering and exploring the possibilities of collaborative music creation through service-oriented systems. Therefore, its lifecycle does not cover the phases of *service management and marketing*. For the requirements specification phase, three proprietary online services[2] were analyzed to identify the different functionalities they supplied to end users. Febos supplies the set of services that covers the three stages in music creation (see Table 1).

Table 1. Stages of the music creation process, roles and outputs

Stage	Role	Outputs
Composition	Artist-composers	Scores
Performances recording	Artist-performers	Tracks (instruments,)
Edition, mixing, mastering	Music engineers	Works (songs)

The requirements were validated by testing them with performers and music engineers. Moreover, the possibilities of using Febos by services aggregators were also explored by creating a desktop pilot that aggregated Febos services, and also by bundling file hosting services from other sources.

3 The Service-Oriented Development of Febos

Due to the particular characteristics of this type of systems, the application of conventional software engineering methods, which suppose a sound and accurate understanding of a company's way of doing business, are not the most appropriate ones to apply [10].

After considering different service-oriented development proposals [10-15], we partially adopted, for the building of Febos, the Service-oriented MDA-Based approach (SOD-M) [11]. SOD-M method starts by identifying the services required by business customers, to make it possible to create a web service composition model. Its main features are: (i) services are the first-class objects for the whole process of the IS development; (ii) it is an MDA-based [16] approach by extending the computer-independent models (CIM), platform-independent models PIM and platform-specific model PSM levels and; (iii) it uses UML with a service-oriented profile as modeling language. Moreover, the modeling process of SOD-M begins by building the models from the business perspective, at CIM level, and go forward by building the models at PIM and PSM levels, the models from the system perspective.

Business Modeling: (CIM level) includes three different models: the value model, the business process model and the business service list. The value model is obtained by applying the *e³value* business modeling method [10]. It allows us to identify the *end-users* of the business, the *business services* that will be offered by the systems to satisfy the needs of the consumers and the *business collaborators*, those entities that collaborate in providing the business services. The business process model is used to describe the set of tasks that need to be performed to achieve a given business result. SOD-M represents this model through UML activity diagrams where each activity or

[2] www.ejamming.com, www.digitalmusician.net and www.esession.com

set of activities can give rise to the identification of one or more *business services*. Finally, the business service list is a textual description of all of the services forming part of a business and offered to satisfy the needs of its end-consumers.

As a result, of the business modeling, we have identified three types of end-users who want to share information in order to create music: compositors, musicians and sound technicians. Additionally, *Febos collaborator*, is the actor that offers the services (storage, management and publication of users and projects), which are the value activities expected to be profitable and shareable among users. The services provided by Febos collaborator have been grouped in two groups: user management services and project management services. User management services include those for the management of information and features of the different users that interact to the system. Project management services include those needed for the users to collaborate in the creation of music. Table 2 shows the business service list included in project management.

Table 2. List of business services for the Project Management of Febos

End Consumer	Business service
Compositor, musician and sound engineer	Service for creating and managing information of projects Service for searching for and inviting people to collaborate with Service for creating and managing musical works Service for creating and managing scores Service for creating and managing tracks Service for controlling changes on projects Service for publication and searching of works, tracks and scores Service for FTP hosting of musical files

System Modeling. SOD-M proposes different models for the behaviour modelling of the system at the PIM level: *use case model*, *extended use case model*, *service process model* and *service composition model*. Such models focus on the identification of the *business services* to be offered by the system, and on the identification of the functionalities and processes needed to carry them out.

The UML use case model, in SOD-M, is straightforward obtained from the list of services where end-consumers are identified as actors and business services are represented as use cases. The extended use case model is used when use cases are composite.

The service process model is used to represent the logically related activities that need to be performed in the system to carry out a business service. So, the activities of this model represent a behaviour that is part of the workflow needed for the performance of a business service. In SOD-M, such a model is represented by using the UML activity diagram [17]. Fig. 1 shows the service process model, used to represent the workflow needed to perform the business service "to manage scores".

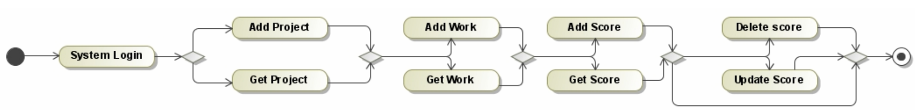

Fig. 1. Service process model for the business service "to manage scores"

Moreover, the service composition model extends the service process model by identifying those entities that collaborate in the business processes, performing some of the actions that are necessary to carry out the business services and the actions that each of them performs.

SOD-M proposes, at the PSM level, the following models to combine the specifications contained in the PIM models with the details of the platform chosen for implementing the system: the *extended service composition* model and the *web service interface* model.

The extended service composition model is represented by means of an activity diagram. The diagram specifies which actions of the service composition process will be implemented by web services. In Febos, we decided to implement all the actions as web services to facilitate the reusing of them, it allows the communication with external collaborators and also allows the possibility of performing calls to Web Services already implemented.

Finally, the web service interface model is used to describe the interface of the Web services that will be used in the delivery of each of the services offered by the system. In SOD-M, this model is represented by means of UML class diagrams where the modelling elements correspond to the components defined by the WSDL (Web Service Description Language) [18].

Implementation. One of the main requirements in the implementation of Fobes was that all the tools, languages and technologies used on the development were open-source.

Febos was implemented in JAX-WS [19], a JAVA API that simplifies fundamental aspects on designing web services, such as safety and efficiency. Febos uses the SOAP (simple Object Acces Protocol) [20] protocol, which is based on the exchange of data in XML using the HTML protocol messages. This means that any client application may use the web service, regardless of the platform and programming langue, whenever follows SOAP.

The application was implemented on the Apache Tomcat server [21], whose latest version work fine in high level traffic conditions. For the data persistence, we chose MySQL [22] database server which is threaded, multiuser and efficiently manages large amount of data.

Acknowledgements

This work was partly supported by the Ministerio de Ciencia e Innovación under TIN2008-00444 project.

References

1. Lam, C., Tan, B.: The Internet Is Changing The Music Industry. Communications of the ACM 44, 62–68 (2001)
2. Patokos, T.: A New Era for the Music Industry: How New Technologies and the Internet Affect the Way Music Is Valued and Have an Impact on Output Quality. PanoEconomicus 55, 233–248 (2008)

3. Benkler, Y.: The Wealth of Networks: How Social Production Transforms Markets and Freedom. Yale University Press, New Haven (2006)
4. Cutler, M.: The World Is Your Workstation, http://emusician.com/tutorials/musicians_online_collaboration
5. Jorda, S., Wust, O.: A System for Collaborative Music Composition over the Web. In: 12th International Workshop On Database And Expert Systems, pp. 537–542 (2001)
6. Barbosa, A.: Displaced Soundscapes: A Survey of Network Systems for Music and Sonic Art Creation. Leonardo Music Journal 13, 53–59 (2003)
7. YouTube Internet Symphony Orchestra, http://www.youtube.com/user/symphony
8. Papazoglou, M., Traverso, P., Dustdar, S., Leymann, F.: Service-Oriented Computing: A Research Roadmap. International Journal of Cooperative Information Systems 17, 223–255 (2008)
9. GNU Lesser General Public License, http://www.fsf.org/licensing/licenses/lgpl.html
10. Gordijn, J., Akkermans, J.: Value-Based Requirements Engineering: Exploring Innovative E-commerce Ideas. Requirements Engineering 8, 114–134 (2003)
11. De Castro, V., Marcos, E., Wieringa, R.: Towards a Service-Oriented MDA-Based Approach to the Alignment of Business Processes with IT Systems: from the Business Model to a Web Service Composition Model. International Journal of Cooperative Information Systems 18, 225–260 (2009)
12. Mantell, K.: From UML to BPEL. IBM DeveloperWorks (2005)
13. Baïna, K., Benatallah, F., Casati, F., Toumani, F.: Model-Driven Web Service Development. Advanced Information Systems Engineering, 527–543 (2004)
14. Parih, A., Pradhan, R.: Modeling Augmented Web Services. Java Skyline (2003)
15. Tongrungrojana, R., Lowe, D.: WIED: A Web Modelling Language for Modelling Architectural-Level Information Flows. Journal of Digital Information 5(2) (2004)
16. MDA Guide version 1.0.1. Object Management Group (2003)
17. Unified Modeling Language Superstructure, v2.2 - Formal/09-02-02. Object Management Group (2009)
18. Web Services Description Language (WSDL). W3C, http://www.w3.org/TR/wsdl
19. JAX-WS Reference Implementation. GlassFish Community, https://jax-ws.dev.java.net/
20. SOAP Specifications. W3C, http://www.w3.org/TR/soap/
21. Apache Tomcat. The Apache Software Foundation, http://tomcat.apache.org/
22. MySQL: The world's most popular open source database. MySQL Enterprise, http://www.mysql.com/

Compliance in e-Government Service Engineering: State-of-the-Art

Slim Turki and Marija Bjekovic-Obradovic

CRP Henri Tudor, 29 Av. John F. Kennedy
L-1855 Luxembourg-Kirchberg, Luxembourg
{Slim.Turki,Marija.Bjekovic}@tudor.lu

Abstract. Today's organizations are faced with the need to conform to various laws and regulations governing their domain of activity. The information systems (IS) supporting organizational activities have to align to these enforcements as well. The obligation of compliance is particularly stressed in domains in which legal framework determines the entire functioning of an organization. E-government is such a domain. This state-of-the-art study aims to investigate the practices of regulation analysis for extracting key information for IS engineering. The study addresses the practices in any regulation domain, not only the one of e-Government, and will focus on approaches aiming to achieve and maintain regulatory compliance of IS and services with given regulations.

Keywords: Regulation compliance, traceability, model, information systems engineering, service design.

1 Introduction

The increasing body of regulations coupled with the general trend of requiring from organizations more transparency in their governance, has lead regulatory compliance to become recently an important research topic. The obligation of compliance is particularly stressed in domains in which legal framework determines the entire functioning of an organization. E-government is such a domain. European Commission refers to e-government as to the use of ICT systems and tools to provide better public services to citizens and other businesses [6]. In this context, administrative laws regulate the activities and decision-making of governmental institutions. These laws constitute an extensive source of requirements that have to be respected when designing information systems (IS) that support institutional activities and (e-)services to public. When respecting given regulatory enforcements, IS and services are said to be compliant with regulation.

From the perspective of engineering compliant IS and services, an important challenge consists in deriving requirements from legal documents. A number of difficulties when dealing with laws is faced: 1) choosing laws applicable for the given context, 2) finding relevant information and understanding relations between information fragments in the text, 3) determining true meaning of legal statements, and 4) coping with continuous evolution of laws that is, of requirements imposed on organizations [14].

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 270–275, 2010.

Furthermore, law analysis may be prone to interpretations and misunderstandings, which in turn may lead to designing non-compliant IS [16]. Such a situation has lead to traceability gaining on significance in this research area: the ability to maintain the links between originating laws and derived artifacts (requirements, IS specifications etc.) is seen as the measure to enable better understanding of legal documents and to prevent non-compliance of produced specifications.

This state-of-the-art study aims to investigate the practices of regulation analysis for extracting key information for IS engineering. The study addresses the practices in any regulation domain, not only the one of e-Government, and will focus on approaches aiming to achieve and maintain regulatory compliance of IS and services with given regulations. Furthermore, in the context of compliance, it is essential to demonstrate how IS and service specifications relate to the fragments of legal text they are derived from. Law analysis for IS and service analysis and design, since still mostly done by humans, are susceptible to subjectivity and interpretations. Thus, it is important to keep trace of the evolution of artifacts being produced, and also of the underlying rationale for these evolutions. This is why the state-of-the-art study will also investigate the traceability support different approaches provide.

This paper is organized as follows: Section 2 addresses requirements extraction from law; Section 3 focuses on business process compliance, and Section 4 is dedicated to traceability support for compliance.

2 Extracting Compliance Requirements from Legal Texts

Regulatory compliance is an area where much of the research has been done by requirements engineering community. Most of the existing approaches have been applied in domains of privacy and security regulations, addressing topics such as: modeling legal text, deriving compliance requirements from legal documents, verifying compliance of existing software systems, aligning software requirements with those derived from laws, etc. Modeling regulations and extracting key concepts from legal documents are recognized as particularly challenging tasks for requirements engineers, system developers and compliance auditors [16]. Several reasons for it are underlined: 1) the very nature of language in which laws are written, containing many ambiguities, cross-references, domain-specific definitions, acronyms etc., 2) overlapping or complementing regulations at different level of authority, 3) frequent changes or amendment of regulations over time, etc [14, 16].

2.1 Extracting Rights and Obligations from Regulations

[16] examines various approaches for modeling regulations, extracting key concepts from legal texts, and creating compliance checking systems in last half-decade. Amongst different historical approaches discussed, the deontic logic approach is acknowledged as worthwhile approach to extract key information from regulations. By extracting the rights and obligations, it enabled disambiguating regulations and making extracted concepts more exploitable by information system designers.

Several researches work to illustrate this approach can be mentioned:

- [15, 20] support the extraction of "objects of concern" (right, anti-right, obligation, anti-obligation, and exception) from legal texts, with the adapted semantic annotation tool Cerno. Obligations, constraints and condition keywords are highlighted in a regulation and a list of constraints and obligations are obtained (including traceability markers).
- [2, 17] address automated extraction of normative references, such as specific rights and obligations, detailed in legal texts, and address the problem of the law's evolution by tracking changes over time.
- Antón et al. [3, 4] developed the methodology to extract and balance formal descriptions of rules (rights and obligations) that govern actors' (or stakeholder's) actions from regulatory texts. The approach combines goal-oriented analysis of legal documents and techniques for extracting rights, obligations, constraints, rules from natural language statements in legal text. Semantic parameterization entails identifying the ambiguities within a legal text and balancing the extracted rights and obligations. Such a decomposition of regulations enabled to identify both explicit and implied rights and obligations, and their capturing is not addressed by the other deontic logic approaches. However, the extraction of these elements from regulations still has to be done manually. The important strength of the approach consists in resolving the problems of ambiguity, polysemy, cross-references when analyzing legal text, and maintaining traceability across all the artifacts in the process. The proposed methodology has been applied in US regulation governing information privacy in health care domain.

2.2 Modeling Regulations with Goal-Oriented Models

The approach of SecureTropos ([9, 10]) uses goal-oriented techniques to model security requirements, for the purpose of assessing the organization's compliance with Italian Data Protection Act. SecureTropos is based on i* framework, and involves extracting and representing goals, soft goals, tasks, resources, and social relationships for defining obligations. The focus of this research is on applying requirements engineering principles and techniques for modeling security requirements, and furthermore, it investigates how an organization can assess the compliance with security standards from a particular regulation. However, the extraction of concepts from law has to be done manually, and the coverage of legal documents is limited only to security aspect.

Similarly, in their framework for tracking compliance of business processes to legislation, Ghanavati et al. [7, 8] aim to establish different types of links between models of legislation, on one side, and organizational policy and processes, on the other side. These links would enable examining the influence of evolving legislations on organizational policies and business processes, and would help to guarantee their compliance. The approach combines goal-oriented requirement language (GRL), user requirements notation (URN), and use case maps (UCM). The requirements from legal documents are modeled in terms of actors, goals and tasks with GRL and the extraction of these concepts from law is performed manually. The framework has been applied in the domain of information privacy in healthcare in Canada.

3 Regulation Modeling and Business Process Compliance

Regulatory compliance and its management has also been a topic in the business process research area. The work [13] proposes to rely on ontologies for formal modeling of regulations. Ontologies are seen to help resolving inconsistency of legal definitions and regulatory information fragments. These models would be coupled with semantic business processes, thus constituting the basis for compliance management framework flexible to evolution in both business process and legislation.

Karagiannis et al. [11, 12] developed a business process-based solution for making a company compliant with particular governance regulation of Sarbanes-Oxley (SOX) act. The solution is based on meta-modeling approach. The regulatory aspects are expressed in models, and included into business processes (models), to improve or redesign them for compliance with corresponding regulations.

Compliance of business processes against non-prescriptive regulations (like SOX and Basel II), is also addressed in the CRP Henri Tudor [27, 19]. This research is in particular focused on providing effective support for financial business process design (compliant to Basel II regulations), as well as for the assessment of the compliance and its improvement. Goal-oriented models and ISO/IEC 15504 process assessment standard are used for structuring requirements for business process, and together compose a formal framework according to which compliance of business process is assessed.

4 Traceability Support for Compliance

In software engineering, traceability is seen, at general level, as the ability to establish degrees of relationships between two or more products of a software development process [8]. The practice of traceability is argued to be a proof of software development process maturity, and one of the measures of software system quality. However, the wide adoption of this practice is not yet seen, one of important burdens being the overhead of manually creating and maintaining the trace relationships between traceable objects. Model-Driven Engineering (MDE) is endorsed as the opportunity to automate both the creation and discovery of traceability relationships, which first demands for explicit modeling of traceability "problem".

In the survey [16] of past 50 years' research efforts in regulations analysis and modeling, and monitoring compliance, Antón and Otto discuss how traceability gains much greater significance in that context. First, the traceability support should make possible to demonstrate exactly how the produced IS specifications and systems relate to originating laws. Moreover, given the nature of legal text and particularly (intentional and unintentional) ambiguities that may be found within, their analysis and modeling inevitably contains interpretations. Here traces are needed to document, track these interpretations, thus attenuating the impact of analyst's subjectivity. Finally, in the situation of evolving regulation, the established links would facilitate evaluating the impact this evolution has on IS specifications.

In their framework for tracking compliance of organization processes to legislation, Ghanavati et al. [7, 8] propose the support for traceability by a set of links to establish between legislation and organizational models. The traces between elements of legislation goal-models and definitions in legal text are established with source links. Likewise, goal and process models of organization connect with its policies, while process models also have responsibility link towards elements of corresponding goal-model. Compliance is tracked through manually created traceability and compliance links, first linking parts of two goal models between each other, and second referencing to parts of legislation texts, for additional information that cannot be easily reflected in models.

In the approach of Breaux and Antón [3, 4, 5] where rules and obligations are extracted from regulations to align software requirements for compliance, the traceability is maintained across all the artifacts produced from legal text to the corresponding software requirements. However, most of the traceability links needs to be established manually.

5 Conclusion

Most of the existing work from requirements community, although providing very elaborated techniques, concepts and tool support, implicitly relies on the assumption that compliance can be achieved at the requirements level, through the harmonization between IS requirements and those derived from legislation. These different works address the compliance regarding specific security and privacy regulations.

The approaches centered on business process tend to address compliance more at the level of organization, its strategy, policies and process, rather than on the underlying IS level. The focus is on including requirements imposed by specific regulation, to existing business processes, in order to ensure or assess their regulatory compliance. These approaches mostly focus on modeling dynamic aspects of organizational system, where business processes are being designed or redesigned. IS and service engineering require that more aspects, not only business processes, be covered in the corresponding specifications.

To the best of our knowledge, there is no, in the literature, method specific to the design of compliant e-government services.

References

1. Aizenbud-Reshef, N., Nolan, B.T., Rubin, J., Shaham-Gafni, Y.: Model traceability. IBM Systems Journal 45(3), 515–526 (2006)
2. Biagioli, C., et al.: Automatic Semantics Extraction in Law Documents. In: Proc. of the 10th Int. Conf. on AI and Law, pp. 133–140 (June 2005)
3. Breaux, T.D., Vail, M.W., Antón, A.I.: Towards Regulatory Compliance: Extracting Rights and Obligations to Align Requirements with Regulations. In: Proc. of the 13th IEEE Int. Conf. on Requirements Engeering, pp. 46–55 (September 2006)
4. Breaux, T.D., Antón, A.I.: Analyzing Regulatory Rules for Privacy and Security Requirements. IEEE Transactions on Software Engineering 34(1), 5–20 (2008)
5. Breaux, T.D., Antón, A.I., Boucher, K., Dorfman, M.: Legal requirements, compliance and practice: An industry case study in accessibility. In: Proc. of IEEE 16th Int. Requirements Engineering Conf. (RE'08), September 2008, pp. 43–52 (2008)

6. Europe's information society, Thematic portal, e-Government section, http://ec.europa.eu/information_society/activities/egovernment (visited May 29, 2009)
7. Ghanavati, S., Amyot, D., Peyton, L.: Towards a Framework for Tracking Legal Compliance in Healthcare. In: Krogstie, J., Opdahl, A.L., Sindre, G. (eds.) CAiSE 2007 and WES 2007. LNCS, vol. 4495, pp. 218–232. Springer, Heidelberg (2007)
8. Ghanavati, S., Amyot, D., Peyton, L.: A Requirements Management Framework for Privacy Compliance. In: Proc. of the 10th Workshop on Requirements Engineering (WER'07), Canada, May 2007, pp. 149–159 (2007)
9. Giorgini, P., Massacci, F., Zannone, N.: Security and Trust Requirements Engineering. In: Aldini, A., Gorrieri, R., Martinelli, F. (eds.) FOSAD 2005. LNCS, vol. 3655, pp. 237–272. Springer, Heidelberg (2005)
10. Giorgini, P., Massacci, F., Mylopoulos, J., Zannone, N.: Modeling Security Requirements Through Ownership, Permission and Delegation. In: 13th IEEE Int. Conf. on Requirements Engineering (RE 2005), pp. 167–176 (2005)
11. Karagiannis, D.: A Business Process-Based Modelling Extension for Regulatory Compliance. In: Proc. of Multikonferenz Wirtschaftsinformatik, MKWI 2008, February 2008, pp. 1159–1173 (2008)
12. Karagiannis, D., Mylopoulos, J., Schwab, M.: Business Process-Based Regulation Compliance: The Case of Sarbanes-Oxley Act. In: 15th IEEE Int. Requirements Engineering Conf., October 2007, pp. 315–321 (2007)
13. El Kharbili, M., Stein, S., Markovic, I., Pulvermüller, E.: Towards a Framework for Semantic Business Process Compliance Management. In: GRCIS'08 Workshop at CAiSE'08 - Governance, Risk and Compliance: Applications in IS (June 2008)
14. Kiavitskaya, N., Krausova, A., Zannone, N.: Why Eliciting and Managing Legal Requirements is Hard. In: 1st Int. Workshop on Requirements Engineering and Law, In conj. with the 16th IEEE Int. Requirements Engineering Conf. (2008)
15. Kiyavitskaya, N., Zeni, N., Breaux, T.D., Antón, A.I., Cordy, J.R., Mich, L., Mylopoulos, J.: Extracting Rights and Obligations from Regulations: Toward a Tool-Supported Process. In: Proc. of the 22nd IEEE/ACM Int. Conf. on Automated Software Engineering (ASE '07), November 2007, pp. 429–432 (2007)
16. Otto, P.N., Antón, A.I.: Addressing Legal Requirements in Requirements Engineering. In: 15th IEEE Internationl Requirements Engineering Conf., October 2007, pp. 5–14 (2007)
17. Palmirani, M., Brighi, R., Massini, M.: Automated Extraction of Normative References in Legal Texts. In: Proc. of the 9th Int. Conf. on AI and Law, June 2003, pp. 105–106 (2003)
18. Ramesh, B., Jarke, M.: Toward reference models of requirements traceability. IEEE Transactions on Software Engineering 27(1), 58–93 (2001)
19. Rifaut, A.: Goal-Driven Requirements Engineering for Supporting the ISO 15504 Assessment Process. In: Richardson, I., Abrahamsson, P., Messnarz, R. (eds.) EuroSPI 2005. LNCS, vol. 3792, pp. 9–11. Springer, Heidelberg (2005)
20. Zeni, N., Kiyavistkaya, N., Cloudy, J.R., Mich, L., Mylopulos, J.: Annotating regulations using Cerno: An application to Italian documents. In: Proc. of the The Third Int. Conf. on Availability, Reliability and Security, ARES 2008, March 2008, pp. 1437–1442 (2008)

Customer Lifetime Value under Complex Contract Structures

Christoph Heitz[1,2], Andreas Ruckstuhl[1,2], and Marcel Dettling[1,2]

[1] Institute of Data Analysis and Process Design,
Zurich University of Applied Sciences, Switzerland
christoph.heitz@zhaw.ch
[2] Swiss Institute of Service Science
http://www.service-science.ch

Abstract. We analyze the problem of calculating the customer lifetime value (CLV) under contract structures that have an impact on customer dynamics. Typical examples are minimum contract durations, or fixed time points for contract cancellation. We show that classical Markov Chain models are not appropriate and may lead to large errors in the CLV. We propose a Semi-Markov formulation which leads to substantially better results.

Keywords: Marketing, customer lifetime value, Markov Chain Models, Semi-Markov models.

1 Introduction

The concept of customer lifetime value (CLV) has attracted increasing attention in the last decades, especially in the field of marketing. Valuating individual customers with respect to their future expected profit is a key input for many marketing decisions and has become central to relationship management [1,2,3].

Often, the relationship between firm and client is governed by contracts. Examples are telecom, service subscriptions such as TV, newspapers, or video rentals. Such contracts often aim at influencing the future behavior of the customers. For example, a customer signing a contract with minimum duration is effectively bound to the firm for a certain amount of time, thus suppressing cancellation and churn.

In fact, the design of service contracts is typically very much affected by the goal of influencing the future behavior of the signing customer, thus the contract design is a relevant component of the CLV of a signing customer. The focus of this paper is to derive a method for CLV calculation unter contracts that influence the future dynamics of customers.

2 Calculation of CLV

While the concept of CLV is very easy to understand, it can be a very challenging task to actually calculate the CLV in a specific context. Several models have been proposed in the literature. An excellent review is given in [4].

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 276–281, 2010.

For explicitly describing the dynamics of a customer over time, state space models have been shown to be a particularly useful modeling approach. In these models, the state of a customer at time $t > 0$ is described by a stochastic process $X(t)$, where $X(t)$ can have discrete values $i = 1, 2, \ldots, N$, and N is the number of states. In the case of a contractual setting, each state is attributed to a specific contract relation. State changes reflect a change of the contract, such as cancellation of an existing contract, or signing of a new contract.

The most popular state space model is the Markov chain model (MCM) which has been introduced by Pfeifer and Carraway [5]. In the MCM, the dynamics of a customer is defined on discrete time steps $t = 1, 2, \ldots$, where a single time step corresponds to specific time period such as a week, month or year. The dynamics is governed by a matrix of probabilities $p_{ij}, i, j = 1, \ldots, N$ where p_{ij} denotes the probability to change from state i to state j within the time step $t \mapsto t + 1$.

In a state space model, the profit of a customer is typically described by parameters $c(i), i = 1, \ldots, N$, where $c(i)$ is the profit for a single time step if the customer is in state i. For infinite time horizon, the expected CLV is given by the discounted sum

$$CLV = \sum_{t=0}^{\infty} E\left(c\left(X(t)\right)\right)\alpha^t \quad (1)$$

with a discount factor $\alpha < 1$ defining how much future profits should be discounted, and $E()$ denoting the expectation value. For finite time horizon, similar equations can be formulated (see [4]).

MCMs have been proven to be a useful model in different contexts. However, for the case of contract structures that have an impact on customer, MCMs are not appropriate. The reason is that MCMs are based on the Markov property which assumes that the future behavior only depends on the current state, not on the history. In particular, the transition probability p_{ij} must not depend on the time a customer has been in state i. This is a clear contradiction to many contract clauses which explicitly depend on the contract duration. An example is a minimum contract duration rule which requires the transition probability being zero within this time period, and increasing after some time.

In the next section, we propose a new modeling methodology based on Semi-Markov models which allows the easy integration of sojourn dependent dynamics.

3 New Model for CLV Calculation Based on Semi-Markov Approach

In this section we propose a new model for describing the customer dynamics in a state space model. This model explicitly allows the integration of contract rules that depend on the sojourn time in the state.

We use an extension of Markov models, the so-called Semi-Markov models SMM (see e.g. [6] for an introduction). SMMs are an extension of Markov processes. The stochastic process $X(t)$ is divided into two elements: the first element describes the sojourn time within a state, where the second element describes the switching probabilities at the time instant when a state is left.

We use SMM in a discrete time version with the following structure:

– For modeling the sojourn time, we use a discrete time hazard function $h_i(T)$, where $h_i(T), t = 0, 1, \ldots$ specifies the probability of leaving state i after a sojourn time T within the next time step.
– For modeling the switching after leaving a state, we use the switching probability matrix P which also may depend on the sojourn time T: $P = P(T)$.

Note that in the case of P being independent on T, and all hazard functions h_i being constant, we end up in the MCM.

With the above described model parameters $h_i(T)$ and $P(T)$, we are able to model many typical contract rules based on sojourn time. In the following we give some examples, assuming that we use a state space model where each state is coupled to a specific contract:

– **Minimum contract duration:** If the contract belonging to state i has a minimum duration period of T_0, then it is not possible to leave this state for $T < T_0$. This means that $h_i(T) = 0$ for $T < T_0$). An example of such a hazard function is shown in Fig. 1(b). In this example, it is assumed that, for $T > T_0$, the contract can be cancelled at each time, and the cancellation probability is assumed to be constant *after* the minimum duration period T_0.
– **Minimum contract duration with subsequent cancellation peak:** Suppose that a lot of customers become unhappy with the contract during the minimum duration period. This will lead to a cancellation peak directly after the minimum duration time. This might be modeled by a hazard function as shown in Fig. 1(c).
– **Yearly renewal policy:** If the contract allows a cancellation only after a full year, and the contract continues if not cancelled, the hazard function may look like in Fig. 1(d). Here, the cancellation probability is assumed to decrease for longer sojourn time, reflecting the fact that long-time customers tend to be more loyal and have a lower cancellation probability than new customers.

The reference case of a Markovian dynamics with constant cancellation probability and without any contract related impact on customer dynamics is displayed in Fig. 1(a).

In addition to the hazard function, the switching probabilities may depend on the sojourn time as well. For example, suppose a three state model, where state 1 denotes the state "no contract", state 2 denotes "simple contract", and state 3 denotes "extended contract". Assume furthermore, that the simple contract has a minimum contract duration of T_0. However, if the customer wishes to upgrade to the extended contract, this is possible at all times. This leads to switching probabilities that depend on T.

For the calculation of the CLV we assume that the profit $c(i)$ per time step is given for each state i. According to Eq. (1), the CLV can be calculated. With some algebra, closed form expressions for the CLV can be derived which are published elsewhere.

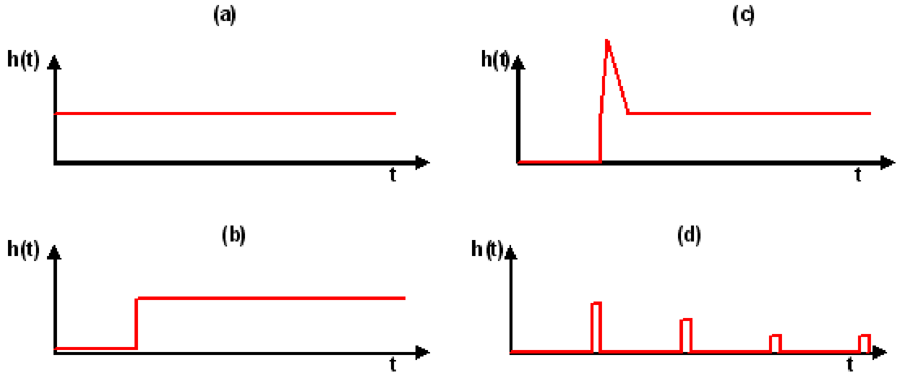

Fig. 1. Hazard functions for different contract types. (a) Reference case of Markovian dynamics, where the contract does not influence the customer dynamics. (b) Contract with minimum duration, afterwards constant cancellation probability. (c) Contract with minimum duration and cancellation peak. (d) Contract with yearly renewal policy.

4 Applications

In this section we study the CLV of customers for two simple cases under a contract with minimum contract duration. We assume that the Semi-Markov model with a sojourn dependent hazard function models the CLV correctly. We compare the results to the results which would have obtained when using a standard MCM. For this comparison, we use a MCM with the same switching probability matrix and the same mean sojourn time as the SMM.

For the sake of simplicity, we restrict our discussion to a case of two states 0 and 1, where state 0 denotes the state "no contract", and state 1 means "having a contract". The initial state at t=0 is X(0)=1, and the customer is assumed to have been in state 1 already for a time T when the CLV analysis is made. We further assume that there is no recurrence from state 0 to state 1, i.e. $h_0(T) = 0$ for all T. Also, we set $\alpha = 1$ thus ignoring discounting.

Note, however, that the derived theory can be used in more complex situations including more states, recurrence, and even more complex autonomous dynamics between these states, and discount factors $\alpha < 1$.

For all examples, we use a time step of one month for $t \mapsto t + 1$, and a profit of 1 per month as long as the contract is running (state 1) and 0 if there is no contract (state 0).

4.1 Contract with Minimum Contract Duration

We study a contract with minimum duration period of one year, i.e. $h_1(T) = 0$ for $T < 12$. We assume that the hazard function is constant after the minimum duration period with $h_1(T) = 1/36$ for $T \geq 12$. Thus, the mean contract time is 36 months plus the minimum duration period, which equals 48 months. In

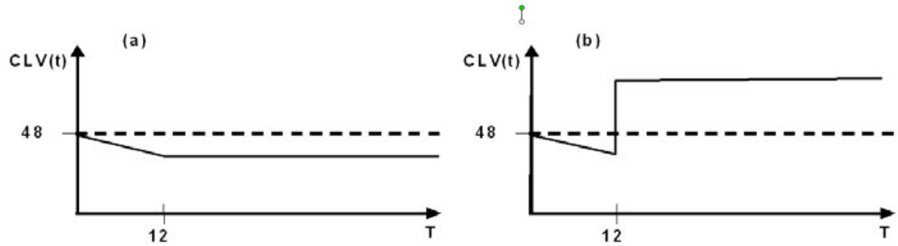

Fig. 2. CLV as a function of lifetime T. (a) Contract with 12 month minimum duration and constant hazard function afterwards. (b) Contract with 12 month minimum duration where 50% of the customers cancel after 12 months. Solid line: true CLV. Dashed line: CLV calculated with MCM.

Fig. 2 (a), the true CLV as a function of the current sojourn time T is shown as a solid line. For $T = 0$, the CLV equals a profit of 4 years, i.e. CLV=48. The CLV decreases until $T = 12$, and then stays constant at a value of 36 due to the Markovian dynamics for $T > 12$ which means that the CLV must be independent on the sojourn time.

If we had used a Markov Chain model, we would have set $p_{10} = 1/48$, since this results in the correct mean contract time of 48 months. Accordingly, the CLV that we would have calculated with a MCM would be 48 independent on T. This is denoted by the dashed line. Apparently, for $T > 12$, the MCM leads to an overestimation of the CLV of 33%. This is a consequence of the incorrect model assumptions of Markovian dynamics.

4.2 Contract with Minimum Duration and Cancellation Peak

Now we study a contract with the same minimum duration as in the last section, but where 50% of the customers become unhappy with the contract during the minimum contract period, such that they cancel the contract after 12 months. The happy customers are assumed to continue the contract for another 6 years on the average.

The mean contract duration is $0.5 \cdot 12 + 0.5 \cdot 72 = 48$ which is the same value as in the last section. However, the CLV as a function of T behaves quite differently. At the end of the first year the CLV is $0.5 \cdot 72 = 36$, since 50% of the customers will stay in the contract with an average remaining lifetime of 72 months, but the other 50% cancel and thus have a remaining lifetime of 0. However, just after the cancellation peak (i.e. $T > 12$), the CLV increases to 72 since for all customers with $T > 12$ the remaining lifetime in the contract is 72 months. In Fig. 2 (b), the CLV as a function of T is displayed. A MCM would use again $p_{10} = 1/48$, and the CLV would be assumed to be 48 independent on T. Thus, the CLV would be underestimated by 50% in this case.

It can easily be seen that, depending on the values for the cancellation peak after the minimum duration period, and the remaining contract time afterwards, the difference between the CLV calculated with a MCM and the true CLV can be arbitrarily large. Thus, simplifying the true dynamics of the customers by assuming a Markovian dynamics may lead to significantly wrong CLVs.

5 Conclusion

The examples described above show that the classical Markov Chain Models are not able to describe the resulting dynamics correctly. Moreover, we have shown with some simple examples that if the CLV is calculated by wrongly using MCM in such situations, the obtained CLV may be arbitrarily wrong, depending on the context. Errors of 50% and more are to be expected even in very simple cases. Any marketing decisions which are based on CLV calculations tend to be significantly suboptimum in these cases. Thus, simplifying the customer dynamics by assuming a Markovian dynamics may lead to large errors with a possibly huge impact on the marketing effectivity.

In contrast, a Semi-Markov approach is able to model correctly sojourn time dependent dynamics of customer. Using this approach, many popular contract types can be modeled explicitly, and the effect of the contract on customer dynamics can be taken into account correctly. The formulae for calculating the CLV have been given.

We have applied the model to the case of direct marketing for newspaper subscription of a leading Swiss newspaper. The results will be published in a forthcoming paper.

Acknowledgements. This work has been supported by the Swiss innovation agency CTI under grant no. 10192.1 PFES-ES.

References

1. Berger, P.D., Nasr, N.I.: Customer lifetime value: Marketing models and applications. Journal of Interactive Marketing 12(1), 17–30 (1998)
2. Kotler, P., Armstrong, G.: Principles of Marketing, 7th edn. Prentice Hall, Englewood Cliffs (1996)
3. Jain, D., Singh, S.S.: Customer lifetime value research in marketing: A review and future directions. Journal of Interactive Marketing 16(2), 34–46 (2002)
4. Gupta, S., Hanssens, D., Hardie, B., Kahn, W., Kumar, V., Lin, N., Sriram, N.R.S.: Modeling customer lifetime value. Journal of Service Research 9(2), 139–155 (2006)
5. Pfeifer, P.E., Carraway, R.L.: Modeling Customer Relationships with Markov Chains. Journal of interactive Marketing 14, 43–55 (2000)
6. Ross, S.M.: Stochastic Processes. Wiley, Chichester (1995)

Total Cost of Service Life: The Need for Decision Support in Selecting, Comparing and Orchestrating Services

Jörg Becker, Daniel Beverungen, Martin Matzner, and Oliver Müller

Westfälische Wilhelms-Universität Münster, Germany,
European Research Center for Information Systems (ERCIS)
{joerg.becker,daniel.beverungen,martin.matzner,
oliver.mueller}@ercis.uni-muenster.de

Abstract. Conventional services as well as web services are explored and discovered by descriptions of their properties. Such properties are either functional or non-functional. Amongst the non-functional properties is the price for service consumption. Evaluating the price of a service is difficult due to a huge variety of existing pricing models and conditions. But still, it is important to a service consumer to evaluate arising costs, esp. in scenarios of long-term usage and if combining several services. In theory and practice so far there exists no method that sufficiently guides the decision of selecting specific services regarding the non-functional property price. This paper strives to promote research-in-progress for such a method, which is based on the TCO concept and on insights from capital budgeting in investment theory. The method is indented to support service consumers in selecting a specific service, in comparing several functionally similar services, and finally in evaluating complete service orchestrations.

Keywords: Service Selection, Service Orchestration, Cost Calculation.

1 Selecting, Comparing and Orchestrating Services

For offering services online, service providers are demanded to enrich their services by additional information, allowing service consumers to reason about services, e.g. for configuring complex services out of more elementary ones, i.e. service orchestration [1]. Services can be described by properties they feature. In Computer Science the notion of existing functional and non-functional aspects leading the rationale for the various choices in a software engineering process is well-established [2]. While the functional requirements specify the process and outcome of a service, non-functional requirements reflect on the performance, reliability and economics of the software usage. Research in Business Science and Information Systems acknowledges the existence of these concepts [1]. Recently, in the context of web services, these non-functional properties have been identified as a fundamental "prerequisite for service discovery and engagement" [3].

Amongst the non-functional properties prescribing the economics of utilizing a service is the service provider's pricing model that the service is subject to. This property can be described in taxonomies that hold for both, technical (web) services

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 282–288, 2010.

and conventional (business) services [3]. But even if described explicitly, an analysis of the monetary implications of service usage is required, for (1) valuating a specific service, (2) comparing several services to each other, and (3) valuating / comparing orchestrations comprising several services.

Evaluating the price of a specific service and esp. comparing financial implications of different services is demanding due to a huge variety of pricing models and conditions existing in business practice and due to the existence of derivated payments that are implied by the decision for or against a service. We argue, that so far in theory and practice there exists no methodological guidance for the decision process of selecting specific services that considers the non-functional property "price" in an adequate way. This paper strives to promote research-in-progress that is intended to design a Total-Costs-of-Ownership (TCO) based calculation method that embodies methods from investment theory. Therefore, we exhibit the challenges in selecting, comparing and orchestrating (web) services regarding their non-functional property price (2.1). We then explore the existing broad variety of service pricing models (2.2) and introduce approaches to the decision problem in theory (2.3) and practice (2.4). We close with a brief presentation of our proposal for a finance plan-based decision support for service marketplaces that provide "conventional" and web services.

2 The Decision Problem

2.1 Functional and Non-functional Perspectives on Services

Drawing from Alexander's [4] observation that design problems have to be decomposed in terms of function on the one hand and economics on the other hand, the selection of services has to be performed in two respects: In terms of function, the outcome fulfilled by a service has to be specified by the service provider, and needs to be assessed and accepted by a consumer. Technological parameters might be either functional ("Which functionality is provided by the service?") or non-functional (e.g. availability, response times, security). In terms of economics, the financial consequences of selecting a service have to be specified by the service provider in order to sell a service, while a service consumer needs to evaluate functionally suitable services from an economic perspective to purposefully select the "best" service for his needs. Economical aspects especially cover the monetary implications of such decision, i.e. the resulting cash-flows from service engagement [5].

In highly competitive markets, many services might claim to offer the same value proposition [6] to the service consumer. Consistent with this observation, selecting specific services amongst several functionally comparable and sufficient ones is a profound decision problem. So far, the discussion in academia as well as in practice is heavily dominated by a technology-centered perspective on the concept of service orientation [7]. Standards and their technical specifications for describing the functional aspects and orchestrations of services dominate the debate. Accordingly, detailed methods and tools for evaluating economical consequences related to specific services are missing.

Fig. 1 depicts a conceptual framework to systematize scopes for designing a more adequate decision support in selecting services. In the horizontal dimension, the functional and economic aspects proposed by Alexander [4] have been transferred to the service domain. In the vertical dimension, different design problems can be identified for the stakeholders involved in the process of selling/buying "conventional" and web services. The group of stakeholders comprises a service provider and a service consumer. In addition, services might be traded on platforms (allowing for discovering, orchestrating and operating services), which introduces an additional mediating role into the framework [8].

	Service provider's point of view	Marketplace operator's point of view	Service consumer's point of view
Selection with respect to functional criteria	(I) Description of the function of a service or web service in an unambiguous format (such as WSDL).	(II) Publication of a repository of services or web services along with their functional criteria in a machine-computable format.	(III) Search for a service or web service on the marketplace with predefined functional criteria.
Selection with respect to economic evaluations	(IV) Specification of a business model, payment sequence and terms of contract for using a service or web service.	(V) Provision of functionality to search for and compare financial conditions and terms of contract of equivalent services or web services. Functionality to finalize the contract and start the delivery of the service.	(VI) Search, comparison and selection of services or web services with expected behaviour, the predifined business model, payment sequence and terms of contract.

Fig. 1. Conceptualization of decision problems

2.2 The Complexity of the Phenomenon "Price"

Recent publications discuss approaches for finding functionally sufficient services referring to service discovery [9] [10]. However, there exist only few analyses of the cost perspective representing monetary consequences of such decisions. For a profound service selection, methods from IT controlling and investment appraisal should be considered ([11] gives an overview). IT controlling methods, esp. the TCO concept, have been applied to calculate investments into "traditional" application system as well as more service-oriented concepts like Application Service Providing (ASP) [12] or Software-as-a-Service (SaaS) [13]. Though, existing approaches frequently regard only single alternatives, comprising only components of a specific provider. However, when measuring the costs of a system that is orchestrated from services of a multitude of providers several licence models and payment conditions have to be integrated [14].

From the service consumer's perspective the decision problem is complex as he is facing two categories of price opaqueness: a multitude of different pricing models and payment conditions and the existence of derivative payments (Sec. 2.3) that are unapparent to the consumer at a first glance but are causatively linked to the decision. We here use mobile phone metaphors to illustrate the main categories of pricing models that can be observed in practice [15] [16]:

- *Flat-Pricing*: A user might use a service within a certain period of time without constraints in frequency or intensity (cf. Internet or mobile phone flat rates).

- *Per-packet Pricing*: A user pays for a specific number of service executions. If the user pays for each service execution this is called pay-per-use (cf. sending short messages).
- *Parametric Pricing*: The price is linked to the extent and the characteristics of the parameters that are input to the service. It might be that the price can be calculated only ex-post after service execution (cf. a translation service that charges depending on the number of words).
- *Resource-based Pricing*: The price is linked to the resources occupied by service execution, e.g. by CPU time, memory, bandwidth (cf. mobile data transfer).
- *Lump-sum Pricing*: A user can use a service without constraints after having paid a fee.
- *Commission/Brokerage*: A user pays a share of the earnings generated by utilizing a service to the service provider.
- *Hybrid Pricing Models*: Hybrid pricing models represent any combination of the aforementioned pricing models. In case of intensity-based licenses, for example, a specific amount of service calls within a fixed time period is covered (cf. monthly short message packages).

2.3 Payment-Oriented Economic Analysis for IT Investments

There is considerable related work in the IS discipline addressing IT investment decisions and IT investment profitability analysis [17] [18]. Here we argue that a long-term analysis of specific service orchestrations' monetary consequences should preferably regard payments (instead of costs). That implies the need to include capital lockup, payment of interests (based on the opportunity rate of interest of the internal funds and the outside capital rate of interests), and tax payments or refunds. These payment categories are derivated monetary consequences of a service selection [19] that are neglected in existing models [20]. They are of less obvious nature to the service consumer, but causally linked to the selection. Capital budgeting provides well-established methods that are a means to this kind of decision problems in investment analysis [21]. In turn, conventional models, e.g. the TCO approach as presented by Gartner, dominate the practice of IT investment decisions, but ignore this notion [22]. TCO comprises a class of controlling instruments, which can be used for an economical evaluation of investment objects, not only based on the initial once-off costs, but on all costs incurring along the entire life-cycle of the controlling object [20].

However, the traditional TCO approaches for evaluating IT artifacts neglect the described effects of capital budgeting. One aspect is that the opportunity interest rate on internal capital and the outside capital interest rate remain unaddressed. As a consequence, the option of not buying a service, but investing the money at the capital market is not calculated and compared to the financial consequences of buying a service [22]. This effect might influence decisions in service selection, as the omission of initial investments into infrastructure and software licenses is a leading motivator for a shift towards more service-oriented architectures. Furthermore, the traditional TCO model just sums up the costs that accrue during the life time of the IT investment object, but ignores the time value of money, which might be substantial in long-term analyses.

2.4 Approaches Observed in Practice

Some of the major service providers already provide decision support for their users. The most mature approach is offered by Amazon, one of the biggest service providers on the Internet. The *Simple Monthly Calculator* supports the definition of propositions on the expected pattern-of-use and accordingly estimates resulting costs. However, the tool considers only one (referential) time period. The analysis of a dynamic development of the service usage is not supported. The calculation is also provided only for two out of the overall 15 services provided by Amazon. The major share of the other providers, like market-leading StrikeIron, provides only static price lists to their users. Other providers (e.g. Michelin) inform about their prices just on request. There exists no calculation support which regards license models of different service providers instead of a vendor-specific consideration at all. We conclude that few service providers (e.g. Amazon) have already seen that there exists the challenge of an economical evaluation of services. But the implementations in practice are so far methodologically insufficient.

3 Towards a Finance Plan-Based Decision Support in Service Selection

We illustrated the complexity of the decision problem in selecting amongst functionally comparable services. The multitude and heterogeneity of license models and shortcomings of prevalent IT investment leads to the following challenge: How to integrate the different costs that are related to particular services along the entire service lifecycle in a systematic and methodically grounded way incorporating financial implications of taxes, interest rates and depreciations? Currently, we develop a method that utilizes finance plans as an instrument from investment theory to address these challenges.

The method is intended to be applied in service marketplaces, which allow for offering traditional services as well as web services via a single infrastructure. The method will serve as a means to increase transparency for service consumers in such ecosystems. If there exists a multitude of services in such marketplaces, consumers may find themselves overwhelmed with viable alternatives that address their needs. Consumers tend not to feel that they “benefit” from too many options, but instead it is likely that they do not buy any service at all [23] or customers are less satisfied with their choice [24]. To foster acceptance of the marketplace, the operator therefore should provide methodological guidance to his users to support them in the decision problem. Elsewise, service consumers tend to resort to very simple and non-optimal strategies in choosing services [24] which is likely to negatively affect the success of the platform in the long run. We believe that our integrated decision support approach can serve as such an instrument - advancing the acceptance of the marketplace.

Acknowledgements. This paper was written in the context of the research project FlexNet (Flexible Information System Architectures for Hybrid Value Networks). This project is funded by the German Federal Ministry of Education and Research (BMBF) under the reference number 01FD0629. We thank the project management agency German Aerospace Center (PT-DLR) for its support.

References

1. Baida, Z., Gordijn, J., Omelayenko, B.: A shared service terminology for online service provisioning. In: Proceedings of the 6th international conference on Electronic commerce - ICEC 2004, Delft, The Netherlands (2004)
2. Perry, D.E., Wolf, A.L.: Foundations for the study of software architecture. ACM SigSOFT Software Engineering Notes 17(4), 40–52 (1992)
3. O'Sullivan, J., Edmond, D., ter Hofstede, A.: The Price of Services. In: Proceedings of Service-Oriented Computing – ISCO 2005, Belfast, Northern Ireland, pp. 564–569 (2005)
4. Alexander, C.: Notes on the synthesis of form, 5th edn. Harvard University Press, Cambridge (1970)
5. Brocke, J., Thomas, O., Sonnenberg, C.: Towards an Economic Justification of Service Oriented Architectures – Measuring the Financial Impact. In: Proceedings of the 14th Americas Conference on Information Systems, Toronto, ON, Canada (2008)
6. Cohen, J., Darlington, J., Lee, W.: Payment and Negotiation for the Next Generation Grid and Web. Concurrency and Computation 20(3), 239–251 (2008)
7. Kontogiannis, K., Lewis, K., Smith, D., Litoiu, M., Müller, H., Schuster, S., Stroulia, E.: The Landscape of Service-oriented Systems. In: Proceedings of International Workshop on Systems Development in SOA Environments, SDSOA 2007 (2007)
8. Hoyer, V., Stanoevska-Slabeva, K.: Towards a Reference Model for Grassroots Enterprise Mashup Environments. In: Proceedings of the 17th European Conference on Information Systems (ECIS 2009), Verona, Italy (2009)
9. Garofalakis, J., Panagis, Y., Sakkopoulos, E., Tsakalidis, A.: Contemporary Web Service Discovery Mechanisms. Journal of Web Engineering 5(3), 265–290 (2006)
10. Knackstedt, R., Kuropka, D., Müller, O., Polyvyanyy, A.: An Ontology-based Service Discovery Approach for the Provisioning of Product-Service Bundles. In: Proceedings of the 16th European Conference on Information Systems (ECIS 2008), Galway, Ireland (2008)
11. Walter, S.G., Spitta, T.: Approaches to the Ex-Ante Evaluations of Investments into Information Systems. Wirtschaftsinformatik 46(3), 171–180 (2004)
12. Cheng, H., Koehler, G.: Optimal pricing policies of webenabled application services. Decision Support Systems 35(3), 259–272 (2003)
13. Serva, M.A., Sherer, S.A., Sipior, J.C.: When Do You ASP? Information Systems Frontiers 5(2), 219–232 (2003)
14. Gupta, A., Stahl, D., Whinston, A.: A stochastic equilibrium model of Internet pricing. J. Econom. Dynamics Control 21(4-5), 697–722 (1997)
15. Clark, M.: Selling Web Services. In: Fletcher, P., Waterhouse, M. (eds.) Web Services Business Strategies and Architectures. Expert Bress, Birmingham (2002)
16. Harmon, R., Demirkan, H., Hefley, B., Auseklis, N.: Pricing Strategies for Information Technology Services: A Value-Based Approach. In: Proceedings of the 42nd Hawaii International Conference on Information Systems (HICSS 2009), Waikoloa, Hawaii, USA (2009)
17. Im, K.S., Dow, K.E., Grover, V.: Research Report: A Reexamination of IT Investment and the Market Value of the Firm. Information Systems Research 12(1), 103–117 (2001)
18. Hitt, L.M., Brynjolfsson, E.: Productivity, Business Profitability, and Customer Surplus. MIS Quarterly 20(2), 121–142 (1996)
19. Becker, J., Beverungen, D., Knackstedt, R., Müller, O.: Modeling, Customer-Specific Configuration and Calculation of Value Bundles. In: Proceedings of the 14th Americas Conference on Information Systems (AMCIS 2008), Toronto, Canada (2008)

20. Brocke, J., Grob, H.L., Buddendick, C., Strauch, G.: Return on Security Investments. In: Proceedings of the 13th Americas Conference on Information Systems, Keystone, CO, USA (2007)
21. Shapiro, A.C.: Capital budgeting and investment analysis. Prentice-Hall, Englewood Cliffs (2004)
22. Bensberg, F., Dewanto, B.L.: TCO VOFI for e-Learning Plattforms. In: ITI Poster Abstracts of the 25th International Conference on Information Technology Interfaces (ITI), Zagreb (2003)
23. Iyengar, S.S., Lepper, M.R.: When choice is demotivating: Can one desire too much of a good thing? Journal of Personality and Social Psychology 79(6), 995–1006 (2000)
24. McKee, P., Taylor, S., Surridge, M., Lowe, R.C.: Strategies for the Service Market Place. In: Veit, D.J., Altmann, J. (eds.) GECON 2007. LNCS, vol. 4685, pp. 58–70. Springer, Heidelberg (2007)

A Cross Disciplinary Approach to Analyze the Effects of Digitalized Service Implementation

Thècle Alix[1] and David Reymond[2]

[1] IMS, University of Bordeaux / CNRS, 351 Cours de la Libration, 33405 Talence Cedex, France
thecle.alix@ims-bordeaux.fr

[2] MICA - GRESIC, University of Bordeaux, Maison des Sciences de l'Homme d'Aquitaine, Esplanade des Antilles, 33607 Pessac Cedex, France
david.reymond@iut.u-bordeaux3.fr

Abstract. Service orientation has become through the year a practice that many organizations use to gain a competitive advantage whatever their sector of activity. Most of them are digital services that replace prior services or allow innovation. In all cases, they generate deep changes in the organization information system that are often not managed. In this short paper, we propose a methodology to appreciate the incidence of digitalized service implementation taking the functional needs of customers to satisfy and the internal organizational changes into account.

Keywords: Service science, web service, service performance measurement, social integration perspective.

1 Introduction

Manufacturers associate a customer-oriented added value to the products they deliver by the way of services. A survey done in summer 2008 has shown that services are performed internally by manufacturing firm for 95% of them and concern home delivery, after sales services, studies, training, payment in several times, command follow up and for big companies, legal services and hotline assistance [3]. Information and Communication Technologies (ICT) are the underlying means used to perform these services. While many methods and tools have been developed in production science to optimize the manufacturing firms' potential and increase at the same time its productivity, quality and flexibility, the service orientation impacts organization, management, and control but also people's focus and skills that must be less technology oriented and rather customer oriented.

At the same time, the report concerning the ratio of force between the manufacturing industry and the tertiary sector shows that this latest mainly benefits from service activities and that the tertiary sector generates many employments and gather new companies. Consequently, service providers have to face challenges relative to: ($\imath$) the innovation expansion, ($\imath\imath$) the systemization of service

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 289–294, 2010.

delivery process and (*iii*) the management of the offer value from design to delivery. A current way to innovate consists in supporting the service offer using ICT. A study carried out in 2005 by the OEDC has shown that the service sector is the main consumer of ICT [12]. Many innovations coming from this sector are linked to the purchasing or adaptation of new ICT [6]. These latest, impact the economical functions and processes of the organization as well as its internal organization and investments. The key competitive advantage generated allow to: (*i*) automate the internal and external relations of organizations, (*ii*) manage the exchanges with multiple partners, (*iii*) speed up the production, communication, commercialization process, (*iv*) increase productivity, (*v*) valorize the immaterial capital of the company and (*vi*) remain competitive by detecting market opportunities. While many works have been done in service research to address the three challenges of innovation, value management and systemization in traditional service delivery, only few models address these problematic in the context of service offers through ICT as well as its consequences on the service delivery system and on whole organization.

Here, we propose to analyze the impacts of a new service development or a service digitalization, on the internal organization of an organization regarding its actors, its strategy, and the interrelations between the inner business processes, etc. in addition to the user and usage perspective. The organization we consider is a public organization i.e. a university and the main service concerned, generalized by a Content Management System (CMS), is a web publication service. This service is a well known IT system used to provide not only contents but also digital services in a portal front-end. CMS are very intrusive regarding the whole information system due to the needs in interoperability between data, in portal cases, between services that is in every component of the system to become operative. CMS are critical in term of security because they provide a wide access to public or private content all in one [11]. According to the analysis needs, two discussions can derive: one from the digital service point of view and another one from the data edited using the CMS service point of view. In another perspective, university portals supplied by the CMS consumers are decisive at the strategic level, let show through the IT organizational policy and allows us to consider the content production services as classical business processes. In the next section, we will deeper present the context of our works and the underlying project. The two steps of the work planned to respond to the project purpose are discussed in section three before concluding.

2 The Reformation of the University Practices

The academic research has not focused on or been organized to meet the needs of service businesses. Major challenges to services industries that could be taken up by universities include: (*i*) the adaptation and application of systems and industrial engineering concepts, methodologies, and quality-control processes to service functions and businesses, (*ii*) the integration of technological research and social science, management, and policy research and (*iii*) the education and training of engineering and science graduates prepared to deal with management, policy, and social issues [14]. Spohrer and his co-authors note that the universities must adapt and apply the concepts of engineering method and quality control of processes [14].

Since, some IT services have been settled up one can report: the dematerialization of the central services of the university (registration, multi access card which covers a huge variety of services: form the payment as a credit card or the access to the rooms, to the library, the transportation, etc.) and the implementation of support service by the way of computer frameworks that involve a mobilization of means and a reconversion of the missions of individuals. In other words, the universities, whose activities are classified in the third sector of activity, are currently offering a huge amount of services to their members; from the most basicone that allows a student to follow a course in a face to face relation with a professor to IT supported services allowing the same student to follow the same course online, and to have access to other sophisticated functionalities such as data personal storage, or shared data storage, personal agenda and their sharing, etc. Supported by business process, these services are settled by individuals on their own voluntarily or by internal administrative components of the universities pushed by their representative without method. Most of the time, following global policy [13], these services are proposed independently from the existing one, often without consideration on the interactions that can happen, on the implications onto the information system and often without analysis of the efficiency and effectiveness of the whole organization. The lack of consideration is most of the time explained by the size of the organization and the numerous actors implied. Then, the main objective during service design is reduced to the fulfillment of users or creators needs from a functional point of view. We argue that a way to counter these difficulties occurring in the design phase is to identify performance indicators based on these considerations during the evaluation cycle of the delivered service.

This dematerialization requires the interoperability of the whole information system as well as the reorganization of the internal processes which were delivering these services in the past and the reconversion of the operators toward new tasks relative to users' management. In our works, operators of the editorial chain supplanted by the CMS are generally switched in a users' assistance employment which lead them to have knowledge on the efficiency of the IT service. The quality of these new processes can be measured using average standards but often the reconversion of human actors from their initial mission is neglected even more forgotten. Thus the major incidences of service digitalization (based on digital service implementation) can be perceived as a benefit regarding the possibility to share the means, to reduce the information system supply chain and reduce consequently to reduce the total cost , as well as source of innovation and almost feedback on service usability. However rejections due to human maladjustment can occur and weaken the system on the long term. What does really happen? Which are the means to integrate this human dimension into the service life of a durable and accepted policy quality supporting this adaptation of our institutions?

The starting assumption is that the facility of adaptation of actors depends on their ability to use the web technologies. The verification of this assumption will lead to the definition of qualitative indicators of the population concerned by the introduction of these services and will make it possible the specification of accompaniment plans to support the changes. Our study is planned in two steps: first, we propose to measure, by the way of a questionnaire, the degree of use and appropriateness of web interfaces by the different categories of individuals who compose the university organization (except the student which belong, for most services, to the customer category). Objective is to identify within the internal organization, population having singular practices on the web, from non users, to interface friendly users; to users with selfpublication capability. More than two thousand people in the corpus organization are concerned by the questionnaire that will lead to categorize behaviors and attach them to one or more components of the organization, in order to reduce the primary complexity. The second part of the study aims at questioning, by individual talks, some of the actors of the components previously associated with singularities. Actors will be interviewed if the component is attached to a digital service, as replacement of an old internal service or as a new service. To deliver those interviews, we propose to cross different kinds of population to observe the hierarchy inside the organization: from the operators using the service to the strategists, to appreciate the maturation of the interest of the service set up (required for competitiveness, resolution of recurring problems of inconsistency of IS by too long data processing sequences and consequently leading to innovation service). The crossing of the two studies will lead to the production of indicators useful a priori for the appreciation of the incidence of the service implementation on supplanted actors with objectives of recommendations of accompaniment for this implementation.

3 Raudin and the Inter Disciplinary Perspective

The RAUDIN: axis 3 is a project funded by the Feder, the University of Bordeaux 3 and Regional Council of Aquitaine. The original idea has came from the notice that traditional web analysis fails in global sense: there is no way to infer on the organization of content production and publication processes from the several audience measures that can be performed. A key to accede this issue is to use the information produced by webometrics techniques to evaluate sites bases on linked data and content published. Our approach is to distinguish in the editorial zone specifics classes of websites (by missions or activities they present or function they propose). We will apply to those classes Bib14 well known webometrics characterizations such as linking count and classical websites indicators such as size, impact or visibility. Our objective is to make statistics of discriminated sub-organizations websites and hence to produce a more precise view on content published in order to develop communication policy.

Actually only specific services, websites or content are measured independently from their inscription on the global organization processes. We propose to use an exploratory method to enlarge the view of web audience using a triangulation of the web communication based on:

- the communication objectives and the way the publishing structure is organized to edit content and assume several on-line services,
- the result of the organized data (hypertext topology, relationships between contents and classified contents, statistical data on the site will furnish metrics [2] and contextual indicators). We develop a tool [7] for helping webmaster in achieving this goal.
- the customers usage [5] of content edited which will be analyzed by user's tests derived from psychology and ergonomics studies.

Hence the web field is here as a multidisciplinary terrain [8], [10] and could appear as an information science terrain or as a media as in communication science. We defend here a building method from the complexity theory [9] to observe and qualify a global system without pretending characterizing all the faces. Production scientists are involved to model and rationalize the view of the organization and of course of the several studied processes. Psychologists are present to introduce human variables in the model characterizing the actors' appropriation of digital web services.

The first perspective of the triangulation of this general research project is used here as a terrain material: we focus on the organization editing process as previously indicated. The University of Bordeaux is historically divided in four disciplines universities (Sciences, Health, Humanities and Economics) and rounded by several high schools. In the global RAUDIN::axe3 project we delimit our area to the two most important establishments that have the oldest history in CMS introduction in their information system. The questionnaire is settled in digital form and will be addressed by email to the population of the two universities of the corpus at the first days of January. We expect through this step to obtain a categorization of general web use and profile kinds of use in order to launch the second part of the analysis to restricted population.

4 Conclusion

The position defended here is that Service Science has to consider actors of the support background to digital services not only on the basis of their functional interest but also as members and actors of the service delivery process.In consequent, those members experience should be significantly included in quality measurement process as valuable information. The experiment in progress will define new quality indicators to be included in the service value chain framework presented by the author [4]. We expect to add a human perspective to the two-sided view of service processes based on the common observation that services are typically coproduced by service providers and customers.

Acknowledgments. This interdisciplinary research has been supported by RAUDIN project, Feder N°31462, Conseil Rgional Aquitaine and University of Bordeaux 3.

References

1. Aguillo, I.: Web, webometrics and the ranking of universities. In: Proceedings of the 3rd European Network of Indicators Designers Conference on STI Indicators for Policymaking and strategic decision, CNAM, Paris (to appear, 2010)
2. Aguillo, I.: Web characterization for cybermetric purposes: Terminology and definitions. In: UvA, UPatras (eds.) Development of Web-Indicators, Amsterdam, Pays-Bas, pp. 12–18
3. Alix, T., Touzi, T., Vallespir, B.: Product-service value analysis: two complementary points of view. In: 13th IFAC Symposium on Information Control Problems in Manufacturing, Moscow, Russia (2009)
4. Alter, S.: Service system fundamentals: Work system, value chain, and life cycle. IBM Systems Journal 47(1), 71–85 (2008)
5. Beauvisage, T.: Sémantique des parcours des utilisateurs sur le Web. Thèse de doctorat - spécialité sciences du langage. Université de Paris X Nanterre (2004)
6. Hamdouch, A., Samuelides, E.: Innovation, concurrence et stratgie d'attraction de la demande dans les secteurs de service lis aux NTIC. in Djellal, F., Gallouj F.: la nouvelle conomie des services et de l'innovation. Ed. L'Harmattan (2002)
7. Khalil-Rebaï, B., Zacharewitz, G., Reymond, D., Corbé, P.: Ancaras: a new webometrics web-spider; g-devs-based validation of concepts. In: Proceeding of the Symposium on Theory of Modeling and Simulation (DEVS'10) (DEVS 2010), Orlando, ON (to appear, 2010)
8. F. Kourilsky : Ingnierie de l'interdisciplinarit. Un nouvel esprit scientifique. Paris, L'Harmattan (2002)
9. Morin, E., LeMoigne, J.L.: L'intelligence de la complexit. Ed L'Harmattan (1999)
10. Nicolescu, B. : La transdisciplinarité. Ed. du Rocher (1996)
11. Pedauque, R.T.: La redocumentarisation du monde. Cépaduès éditions (2007)
12. OECD: Promoting innovation in services. Working party on innovation and technology policy (2005)
13. Reymond, D., Dib, K.: Mesure d'usage et organisations multi-échelles: indicateurs et méta indicateurs d'usage des ENT, Actes du colloque international "l'Université à l'ére du numérique" (CIUEN 10), Strasbourg France (June 2010) (to appear)
14. Spohrer, J., Maglio, P., Bailey, J., Gruhl, D.: Steps Toward a Science of Service Systems. Computer, 40, 1, 71–77 (2007) Patras, Gréce, 2002. EICSTES-IST, Projet Europèen EICSTES.

Towards a Unifying Process Framework for Services Knowledge Management

Vikram Sorathia, Marten van Sinderen, and Luís Ferreira Pires

University of Twente, Enschede, The Netherlands
{v.s.sorathia,m.j.vansinderen,l.ferreirapires}@ewi.utwente.nl

Abstract. Activities concerned with the design, planning and execution of services are becoming increasingly complex. This is due to the involvement of many different stakeholders, the complexity of the service systems themselves, and the dynamic nature of their organizational and ICT environments. Service knowledge management helps share and reuse relevant knowledge among the different stakeholders, and therefore emerges as a critical factor to perform service activities with required efficiency and quality. Recent advances in knowledge management provide promising opportunities to support individual service activities within a single domain. Yet, sharing knowledge throughout the service life-cycle and across service domains is still very challenging. The source of service knowledge, its usage, update frequency, encoding and associated stakeholders may vary depending upon the service activity and the service domain. Based on a critical analysis of currently proposed frameworks, we argue that a process framework approach is beneficial for service knowledge management. To support our claim, we offer an abstract template and a typical service life-cycle that can be adopted to integrate heterogeneous service knowledge from diverse sources.

Keywords: Unified Process, Process Framework, Knowledge Management Framework, Service Life-cycle, Service Knowledge Management.

1 Introduction

Services are playing an important role in our current economies. In general, experts from different disciplines are involved in the various service activities, such as the design, planning, offering, execution and regulation of services. Knowledge management throughout the service life-cycle and across service domains becomes very challenging with the increasing complexity of these service activities and with particular terminology, semantics, artifacts, information sources, analytical methods and decision tools for each activity and from each domain. Depending on the service activity and the service domain, experts may engage in knowledge creation using different environments with different update frequency, system support, encoding and usage scenarios. Consequently, the integration, management and provisioning of such knowledge is hard to achieve. This is particularly the case for small enterprises that would prefer to reuse available knowledge. This calls for a knowledge management

J.-H. Morin, J. Ralyté, and M. Snene (Eds.): IESS 2010, LNBIP 53, pp. 295–299, 2010.

strategy that allows the creation, sharing and reuse of service knowledge in interoperable, collaborative and dynamic environments.

2 Service Knowledge Management Requirement

In the literature one can observe that many developments exist that can support service knowledge management [1-7]. We claim that it is questionable whether these developments can be qualified as frameworks. A framework is a research tool employed to identify general concepts of a field of enquiry along with inter-relations among them [1]. The Activity Based Framework for Services (ABFS) is a framework being proposed to support integration of multi-disciplinary work in the service science community [1]. In this work, services are seen as processes with various actors and attributes. The Service System Framework [2] is a similar effort, which characterizes services under a systems view. In [3], a discipline-by-life-cycle matrix is proposed for identifying professional skills requirements during the entire service life-cycle. TRIZ [4] is an example of an existing framework, employed to aid in services innovation by applying the 40 TRIZ principles. The Zachman framework has been applied to service description and service engineering in the enterprise architecture viewpoint in [5] and [6], respectively. Finally, combined advances in semantic web and knowledge management approaches provide a strong basis for collaboration and reuse. For example, emerging results in semantic web and knowledge management can be used as a basis for a knowledge management framework in the health domain [7].

By studying these ongoing efforts towards service knowledge management we identified some knowledge integration issues. Each framework is proposed to meet the need of a special discipline or domain. In case, knowledge sources from different disciplines and domains are integrated in a single knowledge repository, disambiguation of some terms is necessary to create a unified logical namespace. Identification and establishment of multi-disciplinary indicators and criteria for this disambiguation activity may require consensus among contributors. Comprehensive coverage of the complete service life-cycle is highly desirable. This can be particularly challenging as the knowledge management framework should not only act as a repository of heterogeneous knowledge artifacts, but should ensure complete tractability, configurability, extensibility and coverage, so that it can be reused in different dynamic collaborative environments.

3 Salient Features of a Process Framework

Process frameworks have been extensively used by the software development community in dynamic collaborative team environments. Rational Unified Process (RUP) is an example of a widely accepted process framework [8]. A process framework is employed as an integrative tool for defining various actors, their attributes, skills, activities, outcomes and related information. It provides guidance in the form of checklists, white papers, concept definitions, tool mentors and related references to aid the activity. As an important feature, it also helps document the work distribution in the form of work breakdown structures. Identified tasks are grouped to form disciplines, identified work products are grouped to form domains, and, identified work breakdown structures are grouped to form capability patterns [9]. In this manner it integrates various elements involved in different phases of the software development life-cycle. Once the process is well defined, the individual teams can utilize required process subsets or the entire process and also may customize these to meet individual requirements.

4 Proposal

Considering the reusability and the integrative capability of a process framework, we are investigating its applicability to the service knowledge management problem. The RUP has already been extended to support the development of computational services according to the Service-Oriented Architecture (SOA) paradigm in [10]. Table 1 identifies service knowledge elements that are often found in the literature on services science [1-6], process framework elements identified in [8-10], and the possible mappings between these elements.

Table 1. Mapping between service knowledge elements process framework elements

	Service knowledge elements	Process framework elements
1	Actor (Stakeholder), Skill	Role, Role set
2	Process	Task, Discipline
3	Service Life-cycle phase	Capability pattern, Delivery process
4	Value, experience	Work product, Domain
5	Technology support	Tool mentor
6	Recommendation	Guidance, Checklist, Templates, etc.
7	Traceability	Process editor / viewer / IDE
8	Customization	Process authoring/custom fragment

Employing the concept of framework in a service knowledge context, we selected the most salient service knowledge elements and defined how each of them is related to other service elements in the abstract model depicted in Fig. 1. A service process is associated to operations, roles, outcomes, and work products. Each service process can be evaluated by some measure and may be governed by some business rule. Work products of a service process can be of many forms as defined in a typical process framework. Such elements can be identified for all processes in various phases of service life-cycle. A typical service life-cycle may include phases like service identification, requirements and analysis, knowledge management, planning, configuration, execution, monitoring, analysis, control, governance, upgrade, promotion and innovation. Fig. 2 depicts the logical progression of life-cycle phases for a service instance that we are considering in our work. Depending upon the nature of the service and decisions of related stakeholders, the service instance may exhibit different stages and iterations.

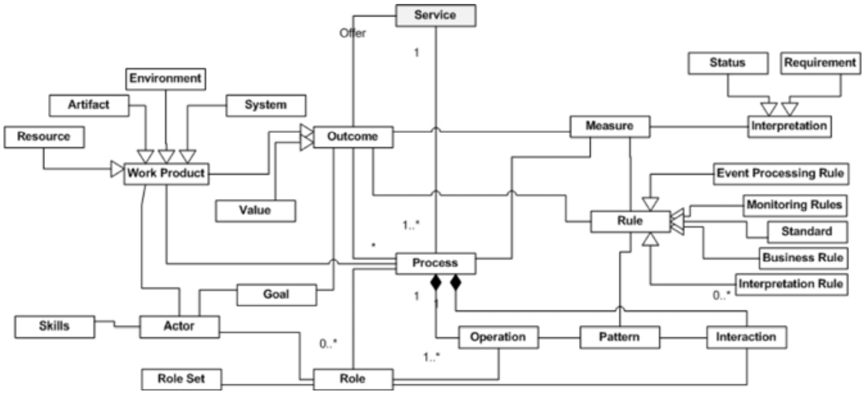

Fig. 1. Typical service elements

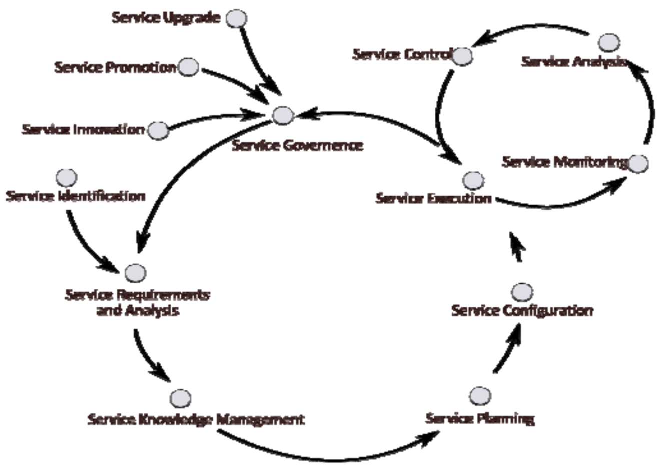

Fig. 2. Typical service life-cycle

5 Discussion

Elements depicted in Fig. 1 can be identified for each phase of the service life-cycle depicted in Fig. 2. For example, the knowledge encoding can be carried out using a process authoring tool. Eclipse Processing Framework (EPF) [9] is an open source tool that can be used for this, while the Rational Method Composer (RMC) is a commercial tool widely employed to author and share a process with additional capabilities to integrate with software development tools and environments. We argue that these capabilities can help support service knowledge management. Work products like service blueprints, governance policies, and similar documents are knowledge artifacts that can be created, shared and reused among service instances. The process framework enables the integration of these artifacts as guidance and can associate them with specific process stakeholders and their work environments. The stakeholders can reuse relevant shared processes or fragments and can also author customized processes according to their requirements. In this manner, this approach is advantageous over other approaches where integration of heterogeneous knowledge forms is difficult due to various representational constraints.

6 Conclusion

In this paper we characterize the challenging problem of knowledge management in complex service systems. We studied ongoing research efforts that address this problem and identified some common limitations of these efforts. We investigated the suitability of a process framework for multi-disciplinary service knowledge management. To support our suitability claim, we identified mappings between common elements of service knowledge and elements of a process framework, and we presented a typical service life-cycle. Our current efforts are on the development of method plug-ins to cover a generic service life-cycle. The future work will aim at integrating discipline-specific tools and environments according to appropriate method content.

References

1. Wild, P.J., Clarkson, P.J., McFarlane, D.C.: A Framework for Cross Disciplinary Efforts in Services Research. In: 1st CIRP Industrial Product-Service Systems (IPS2) Conference, Cranfield University (2009)
2. Mora, M., et al.: Toward an Integrated Conceptualization of the Service and Service System Concepts: a Systems Approach. International Journal of Information Systems in the Service Sector 1(2), 36–57 (2009)
3. Glushko, R.J.: Designing a service science discipline with discipline. IBM Systems Journal 47(1), 15–27 (2008)
4. Karni, R., Kaner, M.: Integration of a Service Taxonomy. The TRIZ Journal 10(04) (2007)
5. Scheithauer, G., Augustin, S., Wirtz, G.: Describing Services for Service Ecosystems. In: Feuerlicht, G., Lamersdorf, W. (eds.) ICSOC 2008. LNCS, vol. 5472, pp. 242–255. Springer, Heidelberg (2009)
6. Cardoso, J., Voigt, K., Winkler, M.: Service Engineering for The Internet of Services. In: Enterprise Information Systems. Springer, Heidelberg (2009)
7. Lytras, M.D., Sakkopoulos, E., Pablos, P.O.d.: Semantic Web and Knowledge Management for the health domain: state of the art and challenges for the Seventh Framework Programme FP7 of the European Union 2007-2013. International Journal of Technology Management 47, 239–249 (2009)
8. Kruchten, P.: The rational unified process: an introduction. Addison-Wesley Longman Publishing Co., Boston (2000)
9. Haumer, P.: Eclipse Process Framework Composer: Part 1: Key Concepts. Eclipse Foundation (2007)
10. Arsanjani, A., et al.: SOMA: A method for developing service-oriented solutions. IBM Systems Journal 47(3), 377–396 (2008)

Author Index