A Model Transformation for Increasing Value in Service Networks through Intangible Value Exchanges

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***Abstract*—One of the main goals in service science is to find efficient ways to analyze and increment the value in a service network. The approach we propose in this paper is to increase the agility of the system in such a way that the network and the underlying business processes are able to spontaneously react to changes in the requirements or in the environment. This is done by making extensive use of knowledge transfer and intangible interactions among network participants. The final outcome is a transformation and analysis methodology that may be applied to a wide variety of service networks with the aim of finding possible reconfigurations for increasing customer satisfaction, reducing transaction risks, and therefore increasing the overall value of the network.**

Keywords-component; value networks, business process management, service networks, value analysis

I. INTRODUCTION

Modern business systems are becoming more complex over time since the cost and speed of storing and exchanging information is becoming lower and the number of participants is becoming higher. These systems are not only large, but they are set in an environment that is always changing both in requirements and in the number of participants. Therefore we need an intelligent way to analyze them and provide a methodology to keep or improve the value of participation into the system even in such dynamic conditions. The ability of the system to react to environmental perturbations is defined as the agility of the system. In this context we propose a methodology for transforming a business network, known also as a *service network*, to improve the value for their participants even if their requirements change over time or some participant acts in a way that decreases the value of the network. The two key technologies that we are exploiting are: (1) value estimation based on revenues and offerings from each participant; (2) risk reduction and transparency that emerges after making extensive use of intangible interactions and knowledge transfers. The methodology we propose has been applied in the context of a traditional car sharing company [20] and its possible transformation into a more "agile" network. The final result is that a business network designer has now a method for taking strategic decisions whether to modify its business network or not, basing his decisions on the environment/participants characteristics gathered over a certain period of time.

Related work on this type of business networks, known also as service value networks, or simply service networks may be found in [15, 14, 8, 16, 5, 4, 13]. In these networks entities are either companies or different roles within a company, connections are offerings from one entity to another. These networks may be agile, in such a case agility is their level of flexibility in dealing with changing requirements [17]. In [7] we can also find a definition of value as "*benefits of an agent accrued by his participation in the network minus any costs involved in setting up the network links directly and indirectly*". However there is a problem with the actual evaluation of this "*amount of benefits*". The evaluation method we will base the rest of the paper is explained in [9]: in this work all the interactions are expressed as offerings and payments occurred per time unit, then the total revenues for all offerings exported by each participants are computed and used to estimate future revenues. However according to this work the total value is not simply a subtraction of revenues minus costs, but there is another value-contributing component called *Satisfaction Index*: it measures the perceived preference for a relationship.

Other metrics for evaluating service networks are proposed in the following works: the work from Parolini [15] describes a methodology called "Value NET" for taking strategic decisions on the service network by doing a qualitative analysis over it to identify bottlenecks, dominant relationships, and to predict the effects of possible structure/relationship modifications; in Allee works [1,2,3,4] there are other metrics related to the structure of the network such as stability and risk, she also points out an analysis methodology that focuses on the intangible exchanges from the network; additional works that try to understand and evaluate the value of services networks may be found in [19,5,8,18].

Our way for evaluating value takes some inspiration from all the works above, especially [9,1] since structure is not stable in an agile dynamic network, therefore we will focus on the measurement on actual revenues, costs, and satisfaction of each participant of the network.

Another concept that this work relates to is the concept of business ecosystem coordination mechanism [12], in which business networks are kept together by so-called "*keystone companies*" (for example eBay and Amazon) whose objective is not to remove competitors, but to cooperate with them by establishing some value-creating virtuous circles and obtain an emergent value [11].

The final key concept taken from literature is the concept of trust, defined as "*an attitude of positive expectation that one's vulnerabilities will not be exploited*" [10]. In this context trust is needed when dealing with risk, and the usual way to reduce risk is to increase the knowledge transfers (intangible interactions) in the system. A possible way that we will use for evaluating trust is to define it as *the willingness to pay for not having the risk* (insurance), and representing it as a value transfer (offering) from the Trustee to another entity that guarantees for the Trustor.

The rest of this paper is organized as follows. Section 2 discusses the problem. In section 3 we propose a possible methodology for dealing with such problem. Section 4 gives an example of how the methodology may be applied in the context of a car sharing company. Finally section 5 concludes the paper and gives an overview of possible new research directions.

II. Problem Statement

In this section we define a common pattern in service networks and provide a problem formalization.

A. Model and Assumptions

Under the same definition of service network discussed in Section 1, we will consider the following simplified pattern in which there are only two entities: a service provider and a user (See Figure 1). The provider offers a service and the user buys that service, obviously there may be many competing providers and customers. The main assumptions in this network is that the environment is not controllable by participants (risk), there is lack of knowledge for matching users to the most suitable service providers (no transparency), and lack of knowledge for allowing a user to act as a provider (no information flow).

B. The Problem

The problem we are facing is to find a qualitative and quantitative way to decide if a network transformation that tries to reduce risk, that tries to increase transparency among participants, and that allows knowledge transfer, may be more profitable than the original one. In particular we focus our attention to the insertion of a new entity in the network with the role of "matchmaker" between providers and users. Its purpose is to reduce risk and allow knowledge transfer using a reputation management system.

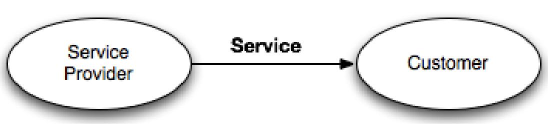

Figure 1. Service Network Fragment.

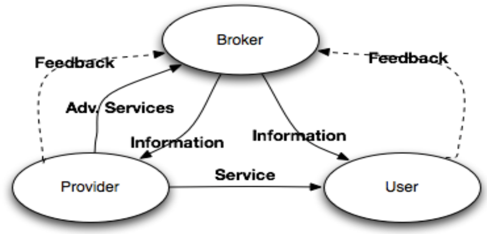

Figure 2. Transformed Network Fragment.

III. Model Transformation

In this section we explain how the original network transfer discussed in the previous section may be transformed into a new fragment.

A. General Idea

The first model represents one of the traditional ways of creating value. Common firms tend to focus on their products and/or their services without sharing knowledge or having an efficient feedback mechanism from their customers. This way of business organization makes them unable to self-adapt to market condition and therefore to quickly respond to new challenges. To address these issues and provide a possible transformation we had an idea of a second network where each participant focuses on its core competencies and on the appropriate alliances to increase its profitability and flexibility to changes. These participants will still act as (more specialized) service providers and customers, but with a third type of participants that focuses on the transfer or knowledge, on managing feedbacks, and on making the emergence of such "agility" possible.

B. The Transformation

In the first network we have two roles: the service provider who offers a service and the user who receives the service (see Figure 1).

In the second model we have one new entity: a broker who supports and coordinates the interactions between the provider and the user. The broker provides to the user all the possible providers of the service he asked. Moreover the broker cooperates with the providers who advertise their services or products via the broker. In addition the broker collects user feedbacks and informs future users about the quality of available service providers using a reputation mechanism. This is very important because it reduces the risk for the users of being cheated. Furthermore the services offered above increase users' satisfaction and loyalty, which means more value for the network. To keep the network simple we are omitting some entities that produce some costs and revenues (for example labor costs, depreciation, utilities, and government incentives), however the associated value exchanges will be considered as inner costs and revenues.

C. Value Evaluation

In this subsection we show how to estimate the value in several situations, this information will then be used to take decisions about the profitability of participating in the network. The outcome of these calculations will be to find out under which circumstances it is profitable for an entity to participate in the network. We define first some parameters that will be used in the final analytical definition of value. Each of these parameters is evaluated after every specified time interval that should be properly chosen by the business process manager based on the situation. To distinguish different time intervals we use the notation $T_1, T_2, \ldots T_N$. We define also c_{ij}^{k} as the cost component k that participant i pays to j to consume his services, Ic_{ij}^{k} as the *inner costs* associated to the same transaction (which correspond to payments to entities that are not represented in the network, such as labor cost and utilities), and finally Ip_{ji}^{k} as the inner profits that come from external entities involved in the process such as, for example, government incentives.

Revenues are the payments that each participant receives for the services he offers. Revenues of an entity i coming from another participant j are defined as the amount the other participant pays to consume services that come from entity i, plus the inner profits associated to the same transaction:

$$R_{ij}(T_N) = \sum_{K} (c_{ji}^{k} + Ip_{ji}^{k})$$

Costs are the amount of money each participant has to pay to be able to participate in the network and offer his services. Costs of an entity i coming from another participant j are the payments for the services that node i consumes from j during his participation in the network, plus the inner costs associated to the same transaction:

$$C_{ij}(T_N) = \sum_{k} (c_{ij}^{k} + Ic_{ij}^{k})$$

Satisfaction index is an important factor that measures the importance of a relationship and the willingness to repeat it. Its analytical definition and evaluation depends on the actual problem.

Past values of Revenues, Costs, and Satisfaction index can be used to predict future expected values of the same parameters using, for example, autoregressive with mobile average models as done in [9], or simply using the last actual evaluation of the parameters, as we have done in Section 4 since past data information is limited. To refer to the expected values we simply put a dash on top of the parameter name.

Finally the **total value** for each participant i at time T_N is the sum of the value that comes from the relationship with any other participant j:

$$v_i(T_N) = \sum_{j} v_{ij}(T_N)$$

Where the definition of the relationship value v_{ij} is different for customers (entities that do not have direct revenues) and other entities. For customers it is defined this way:

$$v_{ij} := u_{ij}^{k}(\overline{\delta SAT_{ij}^{k}}, C_{ij}^{k})$$

where $u(\ldots,\ldots)$ represents the utility function that measures the value of the customer who uses the service.
For all the other entities it is defined this other way:

$$v_{ij}(T_N) = \overline{\delta SAT_{ij}}(\overline{R_{ij}(T_N)} - \overline{C_{ij}}(T_N))$$

These definitions are different because the final purpose of a customer is simply to obtain the service in the most convenient way, and the convenience is expressed by the (problem-dependent) utility function definition. For the other entities it is measured by the expected profits (defined as expected revenues minus costs) times the value of the relationship (expressed by the satisfaction index). If the expected profits are smaller than the ones of competing networks, then the potential participants will not enter and the service system has a questionable future. It is important to note that the time horizon considered for deriving the value of a service system is a parameter that has to be properly set; it must be long enough to compensate for the changes of the dynamic system and short enough to offer the right incentives for updating the participants' strategies.

IV. Case Study: A Car Sharing Company

This section shows how the methodology we described in the previous section can be applied to estimate the value of each participant. In our example we will use the car sharing company of Milan. The car sharing system is a system for motorized personal mobility that is alternative to traditional public/private transportation. The system gives the opportunity to the customers to use a car from half a hour to several days and the access to the service is completely automatic.

A. *Traditional Car Sharing*

The traditional car sharing has two entities. The car sharing provider, who offers car sharing services and owns all the cars; and the user who consumes the service. In this case the provider is unique and the customer may either cooperate with him or leave the network.

B. *Car Sharing after Transformation*

In the second model we have three different roles: a *provider*, who offers his car(s) for sharing and can be either a single car owner or a company; a *user*, who chooses to use car sharing service system instead of buying a car; a *broker*, who collects information from both the providers and the users and coordinates their cooperation. The broker gives to the users information about the availability of cars, and to the providers information about the availability of customers. After this transformation, more participants will be able to join because any car owner may become a provider and therefore the network will be able to spontaneously grow and serve more users with a more differentiated offer.

C. *Model of Value*

In this section we present the equations we used to estimate the value of this service system. All the symbols are explained in Table 1 and costs/revenues/values, which are partly derived from publicly available data [20], are in Euros. For the traditional model revenues of the provider depend on the usage of the cars from the customers:

$$R_{provider} = (\mathrm{Fc} + \mathrm{Ph} \times \mathrm{h} + \mathrm{Pk} \times \mathrm{g}) \times \mathrm{Nu} + \mathrm{i} \times \mathrm{Nc})$$

The costs of the provider depend on the number of customers and the car maintenance cost:

$$C_{provider} = Nc\times(Pi+Pp+a+m)+k\times Nc\times g+Pm\times k\times Nc+(P_b+Pc+p)\times v\times Nu+Of+Oc\times Nc+Or\times r\times Nu+Ou\times Nu$$

The expected value of the provider is the difference between the revenues and the costs times a satisfaction index of 1 since there is only one provider and customers are assumed equal. The expected value of the user, defined using the custom utility function below, depends on his satisfaction and other parameters that have to do with the cost of using the service:

$$\mathrm{v_c} = u_{ij}^{k}(\delta\overline{SAT_{ij}^{k}}, C_{ij}^{k}) := \frac{\mathrm{Sup}}{((\mathrm{Fc+Ph\times h+Pk\times k})\times \mathrm{Nu}}$$

In the new model we have 3 entities. So we will estimate values and costs for each one of them. Total revenues of the provider are the sum of all the revenues he receives from both user and broker. Revenues of the provider coming from the broker are $R_{p,b}$=0, revenues of the provider coming from the user depend on the number of the users, the hours and the kilometers that the each user will use the car:

$$\mathrm{R_{p,u} = Pk\times k\times Nc + h\times Nc\times Ph + Ou\times Nc}$$

Total costs of the provider are the sum of the costs coming from the broker and the user. Costs due to the broker are the annual fee paid from the provider to the broker and the commission that the broker receives for any transaction between the provider and the user:

$$\mathrm{C_{p,b}} = Fp + c\times R_{p,u}$$

Costs due to the user are the costs of the depreciation of the car due to the car sharing with the user:

$$\mathrm{C_{p,u} = Nc\times(a+m+Pp)+k\times Nu\times Pm + (P_b+p+Pc)\times v\times Nu}$$

Consequently total costs of the provider are:

$$C_p = \mathrm{C_{p,u} + C_{p,b}}$$

Expected revenues of the provider are:

$$\overline{R_p} = \mathrm{R_{p,u}\times Ssu + R_{p,b}\times Spb}$$

The expected costs of the provider are:

$$\overline{C_p} = \mathrm{C_{p,b}\times Spb + C_{p,u}\times Ssu}$$

Total revenues of the broker are the sum of the revenues coming from the other 2 entities. The revenues of the broker due to the provider are:

$$R_{b,p} = \mathrm{Fp\times Np + c\times R_{p,u}}$$

and the revenues coming from the user are:

$$R_{b,u} = \mathrm{Nu + Fc}$$

consequently:

$$R_b = R_{b,p} + R_{b,u}$$

Total cost of the broker is the sum of any costs that broker has, to have the ability to offer his services to the other participants:

$$\mathrm{C_b = Of + Or\times r\times i + Ou\times i}$$

The expected cost of the broker is the cost due to the user multiplied by the satisfaction of user from their relationship plus the costs due to the provider multiplied with its satisfaction:

$$\overline{C_b} = C_{b,u}\times Sbu + C_{b,p}\times Sbp$$

TABLE I. PARAMETERS USED IN THE CAR SHARING MODELS

Name	Sym.	Values Mod. 1	Values Mod. 2
Number of cars	**Nc**	200	200
Insurance	**Pi**	2000	1000
Number of customers	**Nu**	4000	4000
Depreciation per car	**a**	3600	900
Maintenance per car	**m**	1500	375
Annual cost of parking per car	**Pp**	4000	1000
Total km per car	**k**	5000	5000
Annual fee of the customer	**Fc**	120	60
Annual fee of the provider	**Fp**	0	60
Price per hour	**Ph**	2.50	2.50
Hours per year	**h**	300	300
Price per km	**Pk**	0.60	0.60
Gas consumption per km per car	**g**	0.20	0.20
Price km maintenance per car	**Pm**	0.05	0.05
Bank fee per invoice	$\mathbf{P_b}$	0.10	0.10
Controvercy management per invoice	**Pc**	1	1
Total invoices per customer	**v**	6	6
Fixed operational costs (information system)	**Of**	40000	40000
Operational costs per car	**Oc**	200	200
Operational costs per customer	**Ou**	50	50
Government incentives per car	**i**	1000	1000
Operational costs per reservation	**Or**	1	1
Reservations per customer	**r**	50	30
Postage cost per invoice	**p**	0.50	0.50
Number of providers	**Np**	50	50
Commission of broker	**c**	0.30	0.30
SAT index of broker (from provider)	**Sbp**	1	1
SAT index of broker (from user)	**Sbu**	1	1
SAT index of provider (from broker)	**Spb**	1	1
SAT index of provider or seller (from user)	**Ssu**	1	1
SAT index of user (from provider or seller)	**Sup**	0.1	0.2
SAT index of user (from broker)	**Sub**	0.2	0.2

Expected revenues of the broker are:

$$\overline{R_b} = \mathrm{R_{b,p}\times Spb + R_{b,u}\times Sub}$$

Finally the cost of the user is the sum of the costs that are due to the provider and the broker. The cost of the user due to the broker is:

$$\mathrm{C_{u.b} = Fc\times Nu}$$

The cost of the user due to the provider depends on the kilometers and the hours he will use the car sharing service and the gas he will consume:

$$C_{u,p} = k \times Pk \times Nc + Ph \times h \times Nc + g \times k \times Nc + Pi \times Nc$$

The expected value of the user is calculated with this custom utility function:

$$v_c = u_{ij}^{k}(\delta \overline{SAT_{ij}^{k}}, C_{ij}^{k}) := \frac{Sup}{C_{u.b}} + \frac{Sub}{C_{u.p}}$$

D. Value Analysis

We calculated all the values for both models using the values of Table 1. Then we have seen that the variation of some parameters of such table is able to change the analysis results, and therefore the winning network.

The variation example we will show focuses on the fixed costs (maintenance, insurance, parking, and depreciation): in the first network all these costs are charged to the user, while in the second network it is assumed to be lower since the car is not shared 100% of the time (providers in the second model can decide when to share their car and when to reserve it for their personal use). So if it is shared for example 25% of the time (and the rest of the time is used for their personal use), we can assume that fixed costs are 75% less with respect to the first model. The results of the simulation (as can be seen in Table 2) show that if fixed costs in the second model are 25% of the first model, then the second model is more profitable for all the participants, while if the fixed costs are 50%, than the first model would be better (because some participants have negative value). In conclusion we expect that the second network would become better than the traditional one if users that already own a car, start sharing their car when they are not going to use it, so that only a relatively small amount of fixed costs is charged to other users.

TABLE II. EXPERIMENTS ON VALUES WHEN CHANGING THE COSTS

Increase in Expected Values w.r.t. to the first	**Fixed costs of 2nd model are 25% w.r.t. the first**	**Fixed costs of 2nd model are 50% w.r.t. the first**
User 1st model	65 (normalized)	65 (normalized)
User 2nd model	1439 (normalized)	1258 (normalized)
Provider 2nd model	121540 (Eur)	-333460 (Eur)
Broker 2nd model	168000 (Eur)	168000 (Eur)

V. CONCLUSIONS

In this paper we presented a methodology for transforming a recurrent pattern in service networks to increase the agility of the network. The study is supported by a technique for estimating the value and therefore to support the final decision whether to reconfigure the network or not. Possible future research is the development of software modules to automate such transformation in current Business Process Management architectures. Another possible research direction can be to find and study new transformation patterns and to improve the value estimation technique.

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