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A synthesis of semantic social network and attraction theory for innovating community-based e-service

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ABSTRACT

There is a growing market for services and an increasing dominance of services in economies worldwide. From an economic perspective, services grow steadily more important and will be increasingly offered and deployed via the Internet. A good example is a community-based e-service that represents the provision of e-service to a community of individuals or business partners. This paper presents a method that can identify the promising and valuable new service features for innovating a given community e-service. Based on a service ontology and the combination of semantic social network and perception science, the method has three steps. First, through the semantic social network, identify the customer segments based on the same need. Second, to sustain the service attraction to the customers of a customer segment, manipulate the service choice set based on the attraction effect defined in perception science. Third, for service innovation and transformation, identify the new necessary enhanced service components based on a social-network-based analysis of the emergence behavior of customers on the e-service platform. The preliminary evaluation results also justify our claimed contributions for community-based e-services, i.e., a systematic method to manage customer segmentation well, sustain the service attraction, and identify new services required through a combination of semantic social network, perception science, and social network analysis.

1. Introduction

E-service is defined as the provision of service over electronic networks. Technology is an enabler in e-service, and businesses use the opportunity provided by the technological advances to gain competitive advantage (e.g., services to customers with greater conveniences and support). E-service is a customer-oriented concept and its strategic and tactical components focus on increasing customer level value (i.e., meeting customer needs and increasing the markets and revenue) (Rust & Kannan, 2003).

On the other hand, a virtual community is defined as an aggregation of individuals or business partners who interact around a shared interest, where the interactions are mediated by technology and guided by some protocols (Porter, 2004; Preece, 2000). Community-based e-service then represents the provision of e-service to a community of individuals or business partners. The communities addressed in this paper are open environments (i.e., the community individual can come and go without restrictions).

Most existing research on e-service or virtual communities mainly rests on the e-service qualities (Barnes & Vidgen, 2002; Boulding & Kalra, 1993; Kettinger & Lee, 2005; Santos, 2003), community structures (Porter, 2004), or knowledge sharing in communities (Koh & Kim, 2004). However, the recent notion of Service Science emphasizes the importance of being systematic in innovations in services using theories and methods from many different disciplines for problems that are unique to the services (Spohrer, Maglio, Bailey, & Daniel, 2007). Accordingly, in this paper we present a method that can identify the promising and valuable new e-service features for innovating the community e-service in terms of the semantic social network and the attraction theory from the perception science discipline. This is very different from existing relevant works, which mainly are based on quality and structure discussion. In other words, our method is rather an aggressive and offensive approach (Selden & MacMillan, 2006) identifying the customer's new needs and new required capabilities.

In this paper, we present a method for community e-services management and innovation. In a pursuit of the in-depth understanding of what customers want and need and the investigation of how a service provider could fulfill the variable needs for customers on a community-based e-service platform, based on a shared service ontology, this method builds market segments through a semantic social network (i.e., combining the service ontology and a social network analysis), manipulates the attraction effect to keep the service attraction to the customers within their segments, and innovates the service in terms of a social-network-based analysis

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of the emergence behavior of customers on the e-service platform. That is, we utilize the web2.0 idea (collective wisdom being valuable to understand the rules for success on a service platform), given that service innovation is a conceptual innovation process activity which has intangible characteristics and the service innovation process can incorporate the customers to be the co-producers focusing on customer centric and demand driven innovation (Rao, 2005).

The rest of this paper is organized as follows. Section 2 introduces related work. Section 3 presents our method, followed by its evaluation results shown in Section 4. Section 5 then concludes the research and gives directions for future studies.

2. Related research

2.1. Semantic network and ontology

The World Wide Web (WWW) has changed the way people communicate with each other and led to a society of knowledge economy today. Based on the WWW, the Semantic Web can be used to describe the resources on the WWW and the relationships between resources. According to Berners-Lee, Hendler, and Lassila (2001), the inventor of the Semantic Web, it is: "An extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation." This means that the WWW not only provides pure information and some knowledge but also has the ability of reasoning, which we call "wisdom". Fig. 1 shows the evolution of the Semantic Web.

A way to practice the Semantic Web is using an ontology. Gruber (1993) mentioned that: "An ontology is a formal, explicit specification of a shared conceptualization." Studer, Benjamins, and Fensel (1998) explained the definition: "A conceptualization refers to an abstract model of some phenomenon in the world by having identified the relevant concepts of that phenomenon. "Explicit" means that the type of concepts used and the constraints on their use are explicitly defined. "Formal" refers to the fact that the ontology should be machine readable, which excludes natural language. "Shared" reflects the notion that an ontology captures consensual knowledge, that is, it is not private to some individual but accepted by a group." Sharing is a key issue. In this paper, a shared understanding of services on the e-service platform is required to enable customers and service providers to buy and sell services via the Internet. As Gruber (2004) said: "every ontology is a treaty – a social agreement among people with some common motive in sharing." The idea of a semantic social network referred to in this research represents the combination of a shared service ontology with a social network analysis for identifying the market segments of a given e-service.

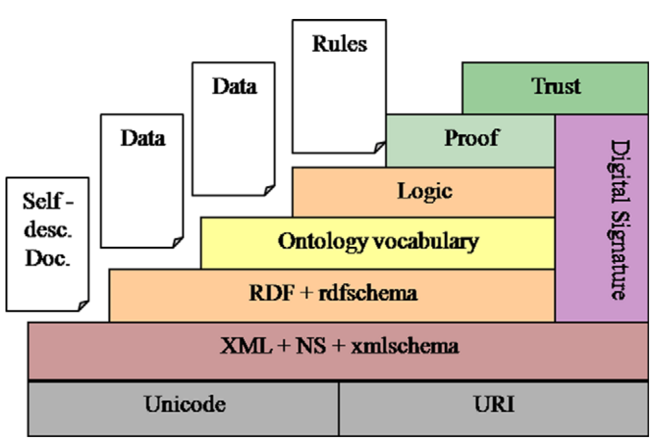

Fig. 1. The evolution of the Semantic Web. (Source: Berners-Lee et al., 2001)

2.2. Social network analysis

Borgatti (1998) suggested that social network analysis is the study of social relations among a set of actors. It is a field of study – a set of phenomena of data which we seek to understand. Previous researchers have developed a set of distinctive theoretical perspectives as well, such as focusing on relationships between actors rather than on attributes of actors, sense of interdependence (e.g., a molecular rather than an atomistic view; structure affects substantive outcomes; and emergent effects). Kotler (1996) said that people will be affected by the reference group. The reference group will not only force an individual to accept new behaviors and life style but also affect the attitude of individuals. Moreover, the pressure to maintain consistency will affect the goods and brand choice of an individual who belongs to that reference group.

Engel, Blackwell, and Miniard (1993) mentioned, if there is absence of enough information to evaluate the targets correctly, or if the products are too complex to evaluate when people make decisions, other people's past experiences will play an important role as an individual evaluates rules. People may seek suggestions from the reference groups. *Perception science* is an idea in which the concept of perception is regarded as a key to understanding customer's behaviors. People's beliefs, values, and needs will interact with the environment. Objects around the targets will disturb the people's perception of reality and affect the relationships between people and groups. Perception also affects observations and judgments of people. Research of perception science addresses several different topics, which are presented as follows:

- *Context effect*: Simonson and Amos (1992) noted that the development of effective marketing strategies requires an understanding of the manner in which consumers choose among alternatives. It is commonly assumed that each alternative has a utility of subjective value and the consumer selects the alternative with the highest value. This assumption is called value maximization and the major implication of value maximization is that the preference between alternatives is independent of the context. They also proposed tradeoff contrast and extremeness aversion to describe the context effect.
- *Tradeoff contrast*: Contrast effects are ubiquitous in perception and judgment. For example, the same circle appears large when surrounded by small circles and small when surrounded by large ones (see Fig. 2). Similarly, the same product (service) may appear attractive on the background of less attractive alternatives and unattractive on the background of more attractive alternatives.
- *Extremeness aversion*: One of the major findings that has emerged from the analysis of both risky and riskless choice is the presence of loss aversion (Simonson & Amos, 1992). Outcomes that are below the reference point (losses) are weighted more heavily than outcomes that are above the reference point (gains). For example, a consumer who considers three CDs that differ in quality and price is likely to evaluate the advantage

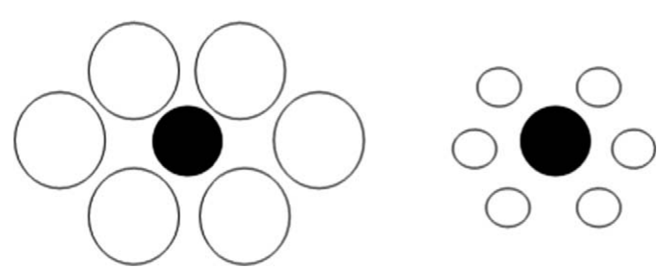

Fig. 2. Diagram of context effect.

and disadvantages of these products in relation to each other. Suppose *A* has the highest quality and price, *C* has the lowest quality and price, and *B* is intermediate in both attributes. The assumption that disadvantages loom larger than the respective advantages tends to favor the intermediate option *B*. This is the extremeness aversion.

- *Attraction effect*: The attraction (or asymmetric dominance) effect, which is proposed by Huber, Payne, and Puto (1982), offers a suitable test problem. It refers to the ability of an asymmetrically dominated or relatively inferior alternative, when added to a set, to increase the attractiveness and choice probability of the dominating alternative. This finding violates regularity (Simonson, 1989). Fig. 3 shows the attributes' relative position of attraction effect. The attraction effect is typically demonstrated in two-attribute space as a preference increase for one of the options (target) in a two-option efficient choice set (core set) upon addition of a third option (decoy) that is dominated by the target but not the other core option (competitor), creating an asymmetrically dominated choice set (extended set).

3. The method

In this section, our method (for enabling service providers to manage and innovate the services on the e-service platform) will be described in terms of the presentation of the framework of the method (Fig. 4) and the descriptions of its component modules.

The framework of our method consists of three modules (segmentation module, context module, and analysis module) that aim to find and manage customer needs through a semantic social network, keep the service attraction to the customers, and build new services based on perception science and social network analysis. The details of the three modules will be provided in the following subsections.

3.1. Segmentation module

Combining the need graph derived from customer need and the data of customer behavior, this module aims to develop a semantic social network and build customer segments based on needs. Because a service represents a value exchange, a customer and a service provider exchange objects of economic value, which are referred to as resources (Baida, 2006). To have the same understanding of a service, this module uses a service ontology proposed by Baida (2006) and combines it with the need graph (as exemplified in Fig. 5a) originated from requirement engineering (Donzelli, 2004). To match the customer demands and the resources which can satisfy these demands, this study applies production rules (Baida, 2006) to solve the matching problem (as exemplified in Fig. 5b). A production rule manifests a matching like "if customers have a demand *D* (i.e., the customer's view), then the resource *R*

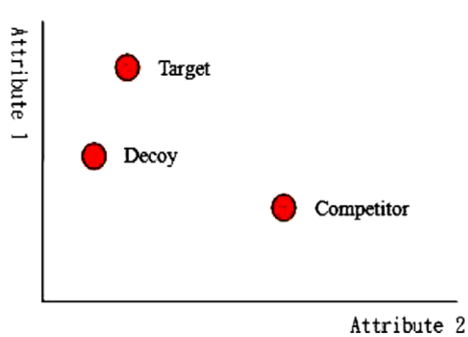

Fig. 3. Attraction effect.

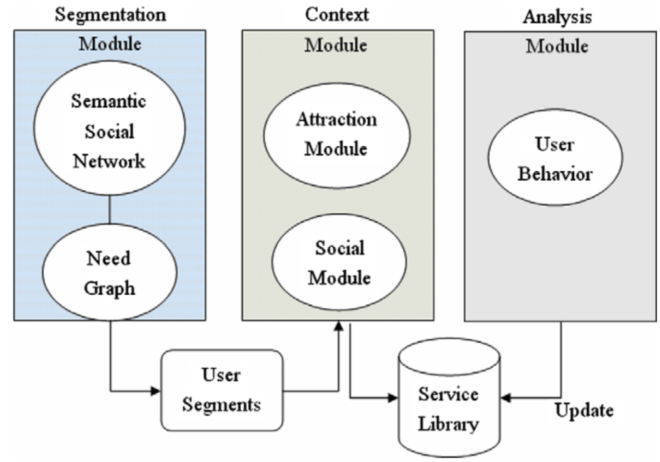

Fig. 4. The framework of the method.

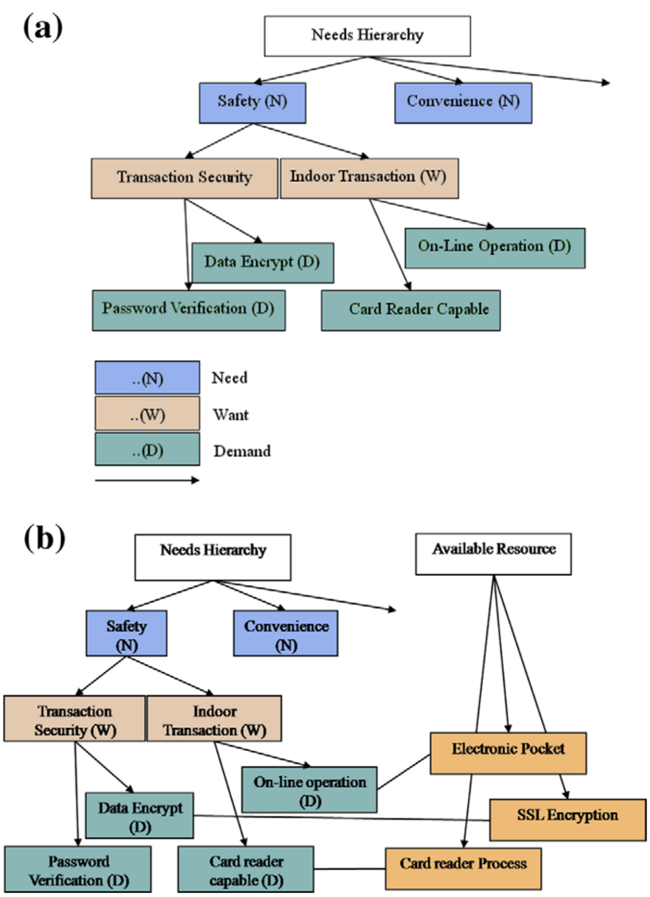

Fig. 5. (a) An example of an online-shopping need graph. (b) An example of an online-shopping need graph with demand–resource pairs using production rules.

can be offered (i.e., the supplier's view)" (as conceptualized in Fig. 6).

There are four types of production rules (Baida, 2006): (1) *Selection*: if the demand *D* exists, the resource *R* must be provided (referred to as SEL(*D*,*R*)). (2) *Rejection*: if the demand *D* exists, the resource *R* must not be provided (referred to as REJ(*D*,*R*)). (3) *Positively influenced by*: the resource *R* has a positive influence on satisfying the demand *D*, but the demand can also be satisfied without the resource *R* (referred to as POS(*D*,*R*)). (4) *Negatively influenced by*: the resource *R* has a negative influence on satisfying the

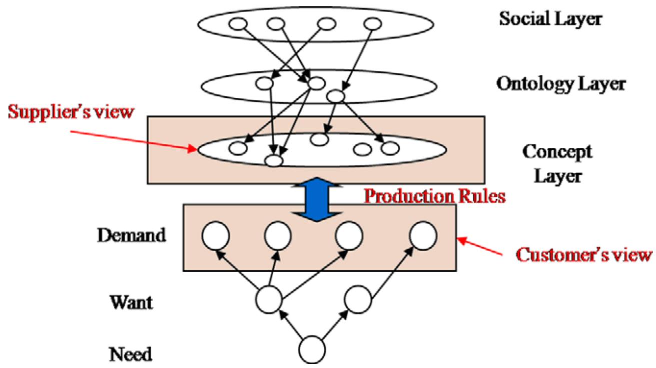

Fig. 6. The use of production rules to match demands with resources.

demand *D*, but the demand can still be satisfied when the resource *R* is available (referred to as NEG(*D*,*R*)).

A semantic social network consists of three layers (social layer, service ontology layer, and concept layer) that can be used to identify the customer segments based on the same needs under a shared service ontology. The social layer is a social network $\langle N_s, E_s^{\text{Knows}} \rangle$ in which nodes and links (undirected but weighted) represent customers and their social relationships $\left(E_s^{\text{Knows}} \in N_s \times N_s\right)$, respectively. The service ontology layer is also a network $\langle N_o, E_o \rangle$ in which nodes and links (bi-directed and unweighted), respectively, represent services and their relationships. The service relationships include Core/Enhancing(*A*,*B*) – CE(*A*,*B*), Core/Supporting(*A*,*B*) – CS(*A*,*B*), Bundled(*A*,*B*) – BU(*A*,*B*), Optional-Bundle(*A*,*B*) – OB(*A*,*B*), Substitute(*A*,*B*) – SU(*A*,*B*), Excluding(*A*,*B*) – EX(*A*,*B*). Links from nodes of the social layer to those of the service ontology layer indicate a USE relationship (i.e., a customer is a user service, Use $\in N_s \times N_o$). The concept layer is then a set of different kinds of resources that can be contained within a service. That is, links from nodes of the service ontology layer to those of the concept layer indicate a CONTAIN relationship (i.e., a resource is contained within a service, Contain $\in N_o \times N_c$).

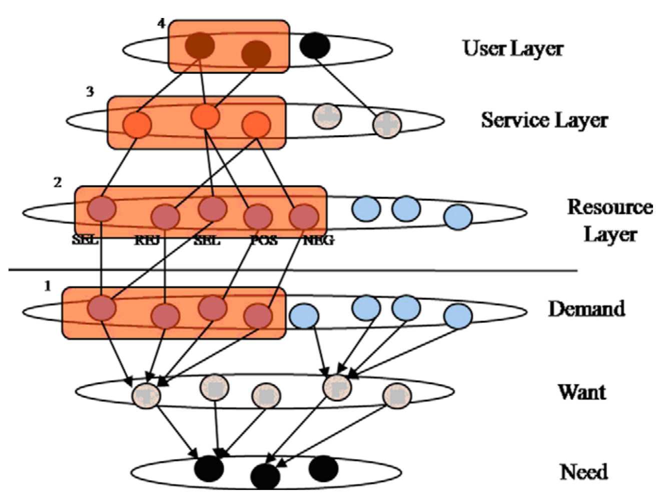

Fig. 7. User groups based on needs.

To help service providers to define customer segments explicitly, Fig. 7 depicts the process of the need-based segmentation. The algorithm that identifies the user groups (i.e., customer segments) based on the same need is then described in Table 1.

3.2. Context module

After completing the stage of customer segmentation, the context module contains two sub-modules (attraction sub-module and social sub-module). The purpose of the attraction sub-module is for a specific customer segment to sustain the service's attraction to the customers and manipulate the service choice set by attraction effect. The description of such manipulation is then provided in Table 2. The purpose of the social sub-module is for a specific customer segment, based on the service they use, to attain the related enhanced service derived from calculating the distance between this specific customer segment and their social relation with other customers on the e-service platform. The descriptions of how to operate the enhanced service is provided in Table 3.

To explain the attraction sub-module, we take the example of Fig. 8. Assume the identified user group *U*1 uses the target service *S*1 (that contains the resources *R*1, *R*2, *R*3, *R*4), the competitor service *S*2 (which has the substitute relationship with *S*1) contains the resources *R*1, *R*2, *R*3, *R*5, and the demand *D*4 can be satisfied by either *R*4 or *R*5. Since the service provider of *S*1 does not contain the resource *R*5 (or *R*4 is a cheaper resource), the provider can then package a decoy service that contains the resources *R*4 and *R*5 to implement the attraction effect on *S*1.

For instance, *S*1, *S*2, *S*3 are all ATM services. We assume the three services all contain the resources *R*1, *R*2, *R*3. *R*4 represents the ATM service and it could be covering service areas such as World-Wide, Asia, or Taiwan-Only. *R*5 indicates the ATM daily withdrawal limit and it could be \$50K, \$30K, or \$10K. If we assume the *R*4 and *R*5 values for *S*1 and *S*2 are (World-Wide, \$30K) and (Taiwan-Only, \$50K), then the service provider can package a decoy service *S*3 with the resources *R*4 and *R*5 being (Asia, 30K) as depicted in Fig. 9. According to the attraction effect, most of the

Table 1
Algorithm of identifying the user groups.

Pseudo-Code
1. Given Need_Graph, group demands referring to the same needs
2. Given Production_Rule_Library, build up 4 relationships such as SEL(*D*,*R*), REJ(*D*,*R*), POS(*D*,*R*), NEG(*D*,*R*) between demands and resources
3. For grouped demands referring to the same needs, group the related resources based on the previous 4 relationships
4. Given pre-defined service elements that contain resources, for grouped resources, group services containing one group resource
5. Given user behavior, group users that use the same group service
6. Return user groups (*U*1, *U*2, *U*3, ..., *Un*) and resource groups (RG1, RG2, RG3, ..., RG*n*) belonging to the user groups and for every user group that contain production rule relationships (SEL(*Dx*,*Ry*), REJ(*Dx*,*Ry*), POS(*Dx*,*Ry*), NEG(*Dx*,*Ry*)) between demands and resources

Table 2
Algorithm of manipulating the service choice set by the attraction effect.

Pseudo-Code
1. Given specific user group *U*1, and the services they used refer to service set SS1
2. Find out sub-service sets SS1 that match the same demands but contain different resources (such as *S*1, *S*2 at Fig. 8), and the total service attribute value of the services in the sub-service sets fits the same social level customers to use
3. For the services in a sub-service set, model service properties into an attraction effect model
4. Perform decoy services into the service layer to he the choice set for users

Table 3
Algorithm for finding the enhanced service based on social relations.

Pseudo-Code
1. Given *U*l, SS1, Users ∈ *U*1 who use *S*1 are referred as *U_S*1
2. Find the services used by users on the e-service platform who have one degree social relation to the *U_S*1
3. Find out the service that appears the most times as the CE service to *S*1

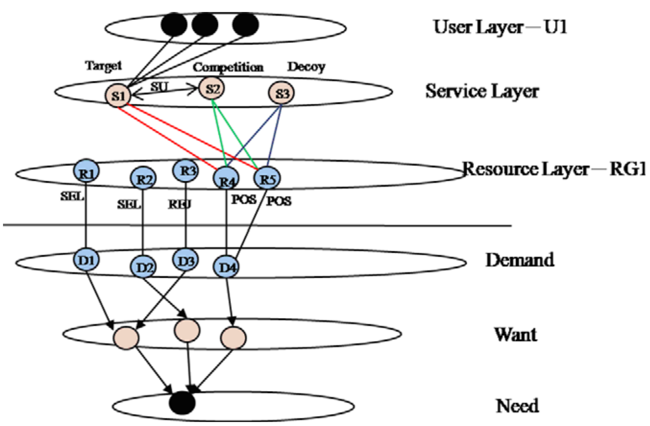

Fig. 8. An example of the attraction effect manipulation.

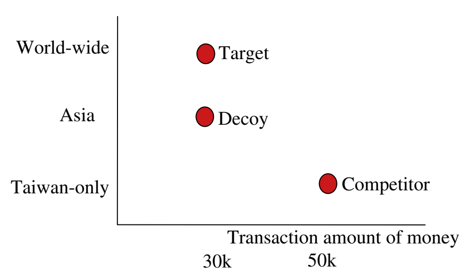

Fig. 9. An example of operating the attraction effect.

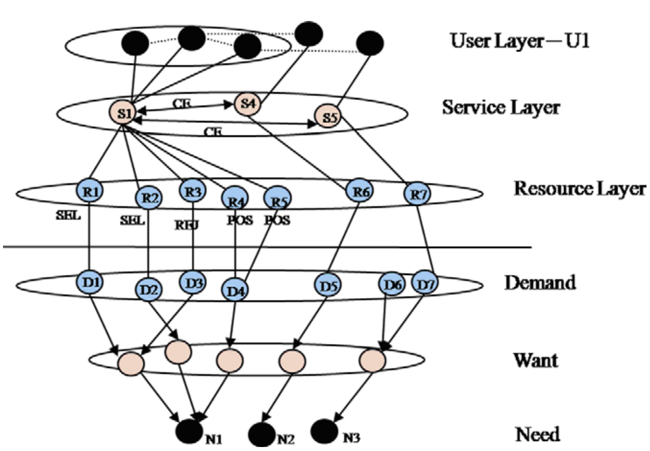

Fig. 10. An example of the core/enhancing service manipulation.

customers will then prefer the choice of *S*1, given the presence of the decoy *S*3.

The purpose of the social sub-module, is to identify the enhanced service for a customer segment based on the services used by the other close-relationship customers (e.g., first-degree social relationship to the customer segment) on the e-service platform.

To explain the service sub-module, we take the example of Fig. 10. Assume within the *U*1 user layer a specific customer segment *U_S*1 uses the target service *S*1 (e.g., ATM service) to which *S*4 (Credit-Card service) and *S*5 (Debit Smart Card service) are *S*1's enhanced service; that is, the CE relationships exist between (*S*1,*S*4) and (*S*1,*S*5) (e.g., either credit-card functions or debit card functions are additional value-adds to the core ATM function) if the other customers on the e-service platform with the first-degree social relationships with the *U_S*1 customers and their most used services are *S*4 and *S*5, respectively, within their user groups.

3.3. Analysis module

The purpose of this module is to analyze the customer's behavior considered in the previous context module (i.e, the attraction sub-module and the social sub-module) to help service providers to manage and innovate the services on the e-service platform.

Given that the attraction sub-module of the context module aims to increase the choice probability of the target service by adding a decoy service in the choice set, the analysis module examines customer behavior before and after the addition of the decoy service to manage the creation of the decoy services. To this end, certain parameters to analyze the customer behavior are defined in this module (as shown in Table 4). If $P_z(x;y)$ (i.e., the probability of customers choosing the target service x when encountering the decoy service z and the competition service y) is smaller than 0.5, it means that after adding a decoy service the probability that a customer will choose the target service relative to the competition service has still not been obviously increased. Consequently, service providers must create another decoy service by revising the service attributes to contain different ones.

Moreover, given that the purpose of the social sub-module of the context module is to provide guidance for service providers to identify required new services based on customers' social relations, this analysis module assesses new possible services based on other customers' past experience. In this research, we assume

Table 4
Parameters used in analyzing the customer behaviors within the attraction sub-module.

$P(x;y)$	$P(x,\{x,y\})$: x is the target service; y is the competition service; $P(x,y)$ represents the probability the customer will choose the target service under the choice set $\{x,y\}$
$P(x;y,z)$	$P(x,\{x,y,z\})$: x is the target service; y is the competition service; z is the decoy service; $P(x;y,z)$ represents the probability that the customer will choose the target service when adding a decoy service into the choice set
$P_z(x;y)$	$\frac{P(x;y,z)}{P(x;y,z)+P(y;x,z)}$: this represents the probability that customers choose the target service's probability when a decoy service (relative to the competition service) is added into the choice set

Table 5
Parameters used in analyzing the customer behaviors within the social sub-module.

d_{ij}	The social distance between the two users i and j (i.e., the number of edges in the shortest path between node i and j within the social layer network)
U	The emergent specific user group derived from the semantic social network
*U_S*1	Within the customer segment U the users who use the target service *S*1
*F_U_S*1	The users of the e-service who have the first degree of social relationship with *U_S*1
ESS	The set of the services used by anyone in *F_U_S*1 and called the enhanced service set
ES	The enhanced service to *S*1 as the most frequently used service from ESS

Table 6
Algorithm of assessing new possible services based on other customers past experience.

1. For each target service in the service set based on need *N*1 to the user group *U*1, and users who use *S*1 referred as *U_S*1, findout *S*1's core/enhanced service (i.e., *S*4, *S*5 in Fig. 10)
2. For users on the e-service platform who have one degree social relation (i.e., $d_{ij} = 1$) to *U_S*1 referred as *F_U_S*1 find all the services *F_U_S*1 use as ESS
3. Calculate the service which appears most times as ES which belongs to ESS
4. Set ES as the enhanced service to the *S*1

that for a specific customer, if there is a steadily increasing number of close friends near this customer who use a service *A*, this customer will be influenced to use service *A*. This study also defines some parameters (as shown in Table 5) for this part of the analysis as described in Table 6.

4. Performance analysis

This paper presents a method for community-based e-services management and innovation by way of need-based customer segmentation, attraction effect manipulation, and enhanced service identification. To justify the method, this research uses a simulation model (Section 4.1) followed by several sets of experiments to examine the performance of the proposed method. With the simulation model, we aim to investigate the following questions:

(1) Does the need-based segmentation of customers on the community-based e-service platforms outperform the general segmentation approaches (e.g., preference-based or social-rank based)?
(2) Does the manipulation of attraction effect influence customer service choices (i.e., changing from the competitor service to the target service)?
(3) What are the characteristics of the enhanced services derived from the social-network-based analysis of the emergence behavior of customers on the e-service platform?

4.1. Simulation model

In the simulation model, without loss of generality there are certain assumed parameter values and assumptions:

- In the need graph, we adopt Abraham Maslow's theory and there are five types (Need_Type) of needs (Need_Name) (i.e., physiological, safety, love and belonging, esteem, self-actualization). To satisfy a need, a want (Want_Name) is the means (Want_Type) that could be a product or service. For demand (Demand_Name), this research assumes that each customer can afford any service provided in the community but the willingness-to-pay (Demand_Type) depends on the customer's preference toward the service.
- A service is considered as a function transforming from the input resources (e.g., the resources of money payment and Internet connection required for an online book-ordering service) to the output resources (e.g., the resources of the book purchased and the time saved from the online book-ordering service). Seven categories of resources are considered in this research: Physical Goods, Human Resources, Monetary Resources, Information

Table 8
Watts and Strogatz model for a small-world social network.

1. Each vertex *i* is chosen in turn, along with the edge that connects it to its nearest neighbor in a clockwise sense $(i, i+1)$
2. A uniform random deviate *r* is generated. If $r \geqslant \beta$, then the edge $(i, i+1)$ is unaltered. If $r < \beta$, then $(i, i+1)$ is deleted and rewired such that *i* is connected to another vertex *j*, which is chosen uniformly at random from the entire graph (excluding self-connections and repeated connections)
3. When all vertices have been considered once, the procedure is repeated for edges that connect each vertex to its next-nearest neighbor (that is, $i+2$), and so on. In total $k/2$ such rounds are completed, until all edges in the graph have been considered for rewiring exactly once

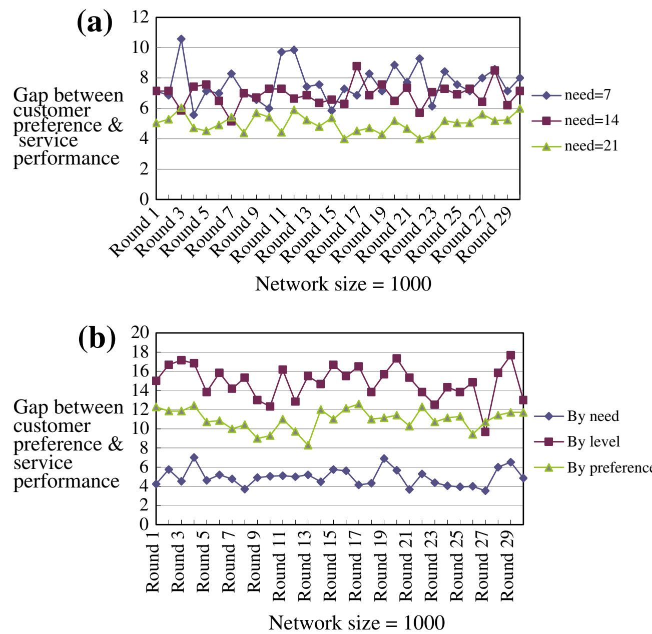

Fig. 11. Comparison of the three segmentation approaches (by need, social rank and cognition perception). (a) Rationale behind the choice of need instances of size 21. (b) The performance comparison of the three segmentation approaches.

Table 7
The seven service quality attributes.

Resource quality attribute	Parameter	Values	Description
Service time	STime	1–10	An indicator for the amount of time to accomplish the service (assuming the bigger the better)
Service operation constraint	SOC	1–10	An indicator for the amount of service operation time allowed (assuming the bigger the better)
Service performance	SP	1–10	An indicator for the performance of the service (assuming the bigger the better)
Service human need	SHN	1–10	An indicator for the number of encounters an employee is allowed to connect with (assuming the bigger the better)
Service risk	SR	1–10	An indicator for the chance of not risking the service operation upper bound time (assuming the bigger the better)
Service fee	SF	1–10	An monetary indicator required for attaining the service (assuming the bigger the better)
Service type	SType	1–10	The type of service adopted by the customer (assuming the bigger the better)

Resources, Capability Resources, Experience Resources, and State-Change Resources. Each resource is assumed to have the seven quality attributes as described in Table 7.

- In addition to the required resources (Contain_Resource) and their quality attributes (Service_Quality), a service (Service_Name) is assumed to be associated with its competitor

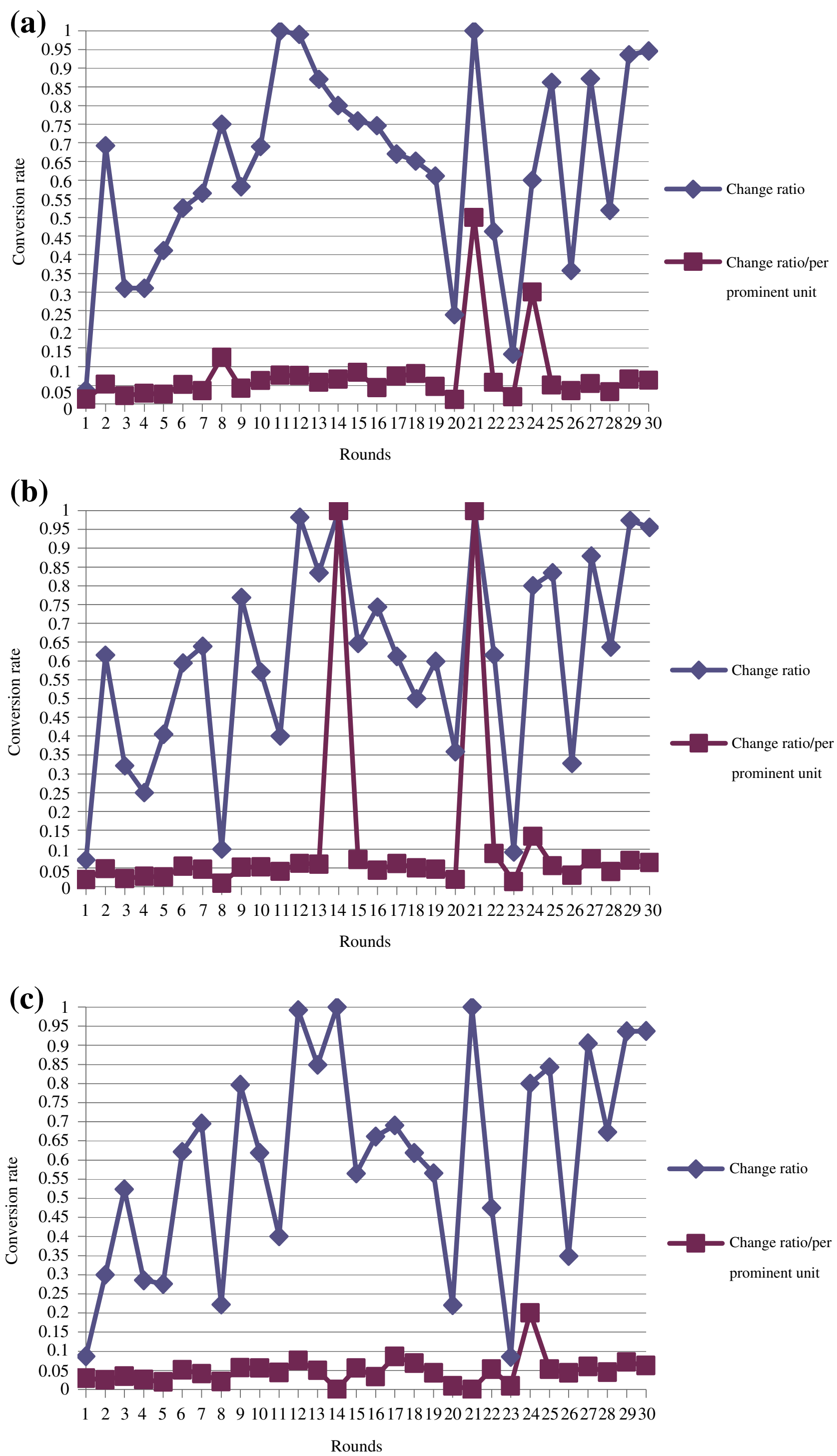

Fig. 12. The performance of the conversion rate and per-unit conversion rate for a given service quality attribute size of 4 among three networks (network 1, 2, 3) of size 1000. (a) The performance of network 1. (b) The performance of network 2. (c) The performance of network 3.

Table 9
Summarized performance results on the average conversion rate and the average per-unit conversion rate across different sizes of service quality attributes.

Service quality attribute size	2	3	4	5
Average conversion rate (%)	25.27	42.14	61.14	65.67
Average conversion rate per unit of increase on a service attribute (%)	4.1	8.5	7.8	5.8

Table 10
The details of the service quality attributes for Enhance(*S*10), Enhance(*S*20), Enhance(*S*30).

Service name	Enhance(*S*10)	Enhance(*S*20)	Enhance(*S*30)
Service time	5	3	4
Service operation constraint	4	2	6
Service performance	4	6	5
Service human need	4	5	2
Service risk	7	3	2
Service fee	6	2	3
Service time	6	3	3
Total of attribute	36/70	24/70	25/70

services (SU_Service) (i.e., all the other services used by the customers of the same social layer) and its enhanced services (CE_Service) (i.e., the most frequently appearing services) used by the other close-relationship customers (i.e., first-degree social relationship) on the e-service platform.

- This research assumes that the service preference of a customer could be affected by three factors – cultural and social rank (User_Level), first-degree social peers impact (User_Reference-Group), or the customer cognitive perception (Cognitive_Preference). We assume there are six levels of social ranks, and customer cognitive perception can be represented simply by weighting the seven service quality attributes.
- In this research, a community-based e-service is considered as a small-world social network of the nodes and links representing the users and their relationships, respectively. To simulate a community network, we adopt the Watts and Strogatz model (Watts & Strogatz, 1998) that is a random graph generation model (as described in Table 8) producing graphs with the small-world properties (i.e., short average path lengths and high

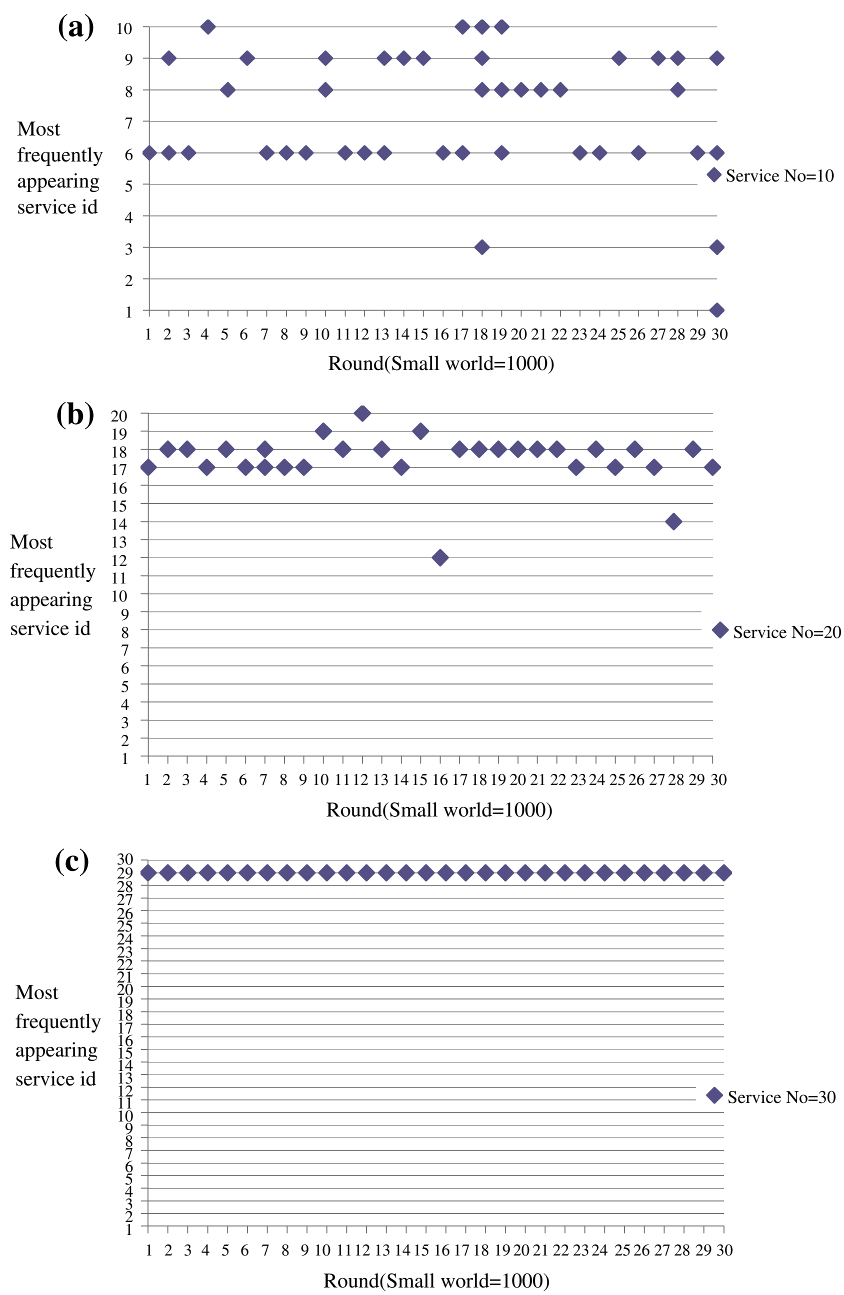

Fig. 13. Distribution of the enhanced services across different service set sizes (10, 20, 30) with different social networks. (a) The distribution for a service set size of 10. (b) The distribution for a service set size of 20. (c) The distribution for a service set size of 30.

clustering) and with the three given parameters (N: the number of customers in the network and initialized to be 1000; K: the number of links for each node to connect with its neighbors and initialized to be 4; β: for every node $n_i = n_0 \cdots n_{N-1}$ taking every edge (n_i, n_j) with $i < j$, β is the probability of rewiring the edge).

4.2. Experimental results

With the simulation model described in Section 4.1, this section then provides the experimental results with respect to the aforementioned three research questions:

- Does the need-based segmentation of customers on the community-based e-service platforms outperform the general segmentation approaches (e.g., preference-based or social-rank based)?

This set of experiments uses 3 sets of need instances (of sizes 7, 14, and 21, respectively) corresponding to 3 service sets (of sizes 10, 20, and 30, respectively) to produce the community social networks (of size 1000 customer nodes) 30 rounds for each need instances size and its corresponding service-set size. We first find a good set of network parameters (i.e., need-instance size and service-set size) with the minimal average difference between the customers preferences ranking toward the service quality attributes within a segment and the service quality attributes ranking within the services in the segment. Fig. 11a shows that the need instances of size 21 have the minimal difference between customer preference and service performance within a segment. We therefore compare the performance of the three approaches of customer segmentation (i.e., need-based, social-rank based and cognition-perception based) using the need instances of size 21 and subsequently observe that the need-based approach outperforms the other two approaches in terms of better capturing the customer preferences and behavior within the segments as shown in Fig. 11b.

- Does the manipulation of attraction effect influence customer service choices (i.e., changing from the competitor service to the target service)?

This set of experiments uses a service set of size 30 and considers 4 sets of service quality attributes (of sizes 2, 3, 4, 5, respectively) on which the attraction effects are implemented. For each service attribute set, three community social networks (of size 1000 customer nodes) are created and for each network (of different social groups) there are 30 rounds of attraction effects, each of which uses 1000 randomly-generated decoy services (from which we select the decoy service with the maximal number of customers changing from the adoption of a competitor service to that of a target service to compute the conversion rate of the selected attraction effect). The conversion rate is the ratio of the number of customers making the service change (from a competitor service to a target service). Moreover, we can further examine the conversion rate per unit increase of a service quality attribute.

For instance, for an ISP broadband service considering 2 service quality attributes (bandwidth, charge) with the target service being the Fiber-based (10M/2M, price 1) and a competitor service being the ADSL-based of (2M/256K, price 2) (assumed originally having 100 users) and price 2 < price 1, the ISP provider can then package the decoy services on the bandwidth of the ADSL-based of 6M/384K (assumed 4 units of increase on the bandwidth attribute giving rise to a conversion rate of 20%, i.e., the per-unit conversion rate being 5%) and the ADSL-based of 8M/640K (assumed 6 units of increase on the bandwidth attribute giving rise to a conversion rate of 60%, i.e., the per-unit conversion rate being 10%) to strengthen the cost-efficiency of the target service (i.e., manipulating the attraction of the target service).

Fig. 12 shows the conversion rates (and the per-unit conversion rate) for a service quality attribute size of 4 in three social networks each of which is of the 1000 customer nodes. We can then compute the average conversion rate and average per-unit conversion rate as 61.4% and 7.8%, respectively. Table 9 then summarizes the performance of the average conversion rate and average per-unit conversion rate for the service quality attribute sizes of 2, 3, 4, 5. We observe that the greater the total values of the service quality attributes to implement the attraction effect, the greater the average conversion rate and that the average per-unit conversion rate performs the best (i.e., 8.5%) with the service quality attribute size of 3.

- What are the characteristics of the enhanced services derived from the social-network-based analysis of the emergence behavior of customers on the e-service platform?

This set of experiments uses a service set (of sizes 10, 20, 30, respectively) and considers all three kinds of customer preference (need-based, social-rank based, cognition-perception based). For each size of service set, 30 community social networks (of size 1000 customer nodes) are created and in each one any service will be associated with its enhanced service attained by finding the most frequently appearing service used by the other close-relationship customers (i.e., first-degree social relationship to the service's user group). Let Enhance($S10$), Enhance($S20$), Enhance($S30$) represent the most frequently appearing services for the service sets of sizes 10, 20, and 30, respectively. Table 10 then shows the details of the service quality attributes for Enhance($S10$),

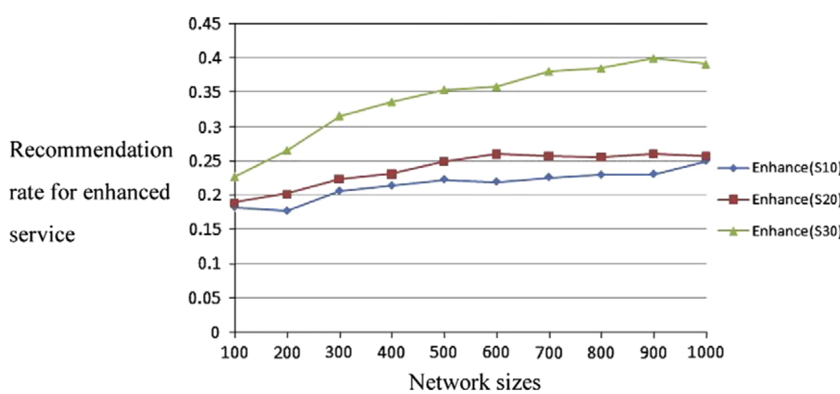

Fig. 14. Recommendation rate for enhanced services according to network sizes.

Enhance(*S*20), Enhance(*S*30), and we observe that each enhance service has 2–3 service quality attributes with good performance (rather than all the 7 attributes and their service's total quality values in general being not high). This implies that customers tend to select services with certain specific service quality attributes with good performance. On the other hand, from Fig. 13 we observe that the bigger the service-set size, the more stable the emerged enhanced services (i.e., emerging hot services). Furthermore, these enhanced services will be more highly recommended when the size of the community network increases (as shown in Fig. 14).

5. Conclusion

For a community-based e-service, based on a shared service ontology, this paper associates customer needs and demands to the services on the e-service platform, and based on the attraction theory and social network analysis, provides a way to help the service provider manage and innovate the services on the e-service platform. This paper also provides guidance for the service provider to sustain the attraction of the services supplied to customers and further provides a way to build new and enhanced services in order to innovate the community-based e-service based on the social relations between customers on the e-service platform. This paper echoes an important issue addressed in Service Science about finding systematic ways of innovating services using theories and methods from multiple disciplines for problems that are unique to the services.

Our future works include three directions of further investigation:

(1) *Customer segmentation*: this paper proposes a method to identify the customer segmentations based on the same needs on the semantic social network. Since this research differs from previous market research, it is interesting to compare the customer segments between the two different ways.
(2) *Choice probability of the target service*: previous research about physical goods, the operation strategies about the attributes of physical goods, such as price, length, weight, etc., provides a fundamental base for customer choice theory on services. Further theoretical investigation of customer choice behavior should be performed when the choice objects are services.
(3) *Customer satisfaction of new service components*: the four service characteristics (intangible, heterogeneous, simultaneous production, and perishable) make customers not perceive the service quality in advance and have a high perception of risk. It is necessary to further evaluate the new service components suggested by our method through close customer segments and assess how they impact the level of customer satisfaction.

References

Baida, Z. (2006). *Software-aided service bundling-intelligent methods and tools for graphical service modeling.* PhD thesis. Vrije Universiteit, Amsterdam.
Barnes, S. J., & Vidgen, T. R. (2002). An integrative approach to the assessment of e-commerce quality. *Journal of Electronic Commerce Research, 3*(3), 114–127.
Berners-Lee, T., Hendler, J., & Lassila, O. (2001). *The semantic web*. Scientific American<http://tinyurl.com/i59p>.
Borgatti, S. P. (1998). *What is social network analysis?* <http://www.analytictech.com/networks/whatis.htm>.
Boulding, W., & Kalra, A. (1993). A dynamic process model of service quality: From expectations to behavioral intentions. *Journal of Marketing Research, 30*(1), 7–27.
Donzelli, P. (2004). A goal-driven and agent-based requirements engineering framework. *Requirements Engineering, 9*, 16–39.
Engel, J. F., Blackwell, R. D., & Miniard, P. W. (1993). *Consumer behavior* (7th ed.). Chicago, IL: Dryden Press.
Gruber, T. R. (1993). A translation approach to portable ontology specifications. *Knowledge Acquisition, 5*(2), 199–220.
Gruber, T. R. (2004). Interview with Tom Gruber. *Bulletin of AIS Special Interest Group on Semantic Web and Information Systems, 1*(3)<http://www.research.ibm.com/ssme/>.
Huber, J., Payne, C. W., & Puto, C. (1982). Adding asymmetrically dominated alternatives: Violations of regularity and the similarity hypothesis. *Journal of Consumer Research, 9*, 90–98.
Kettinger, W. J., & Lee, C. C. (2005). Zones of tolerance: Alternative scales of measuring information systems service quality. *MIS Quarterly, 29*(4), 607–623.
Koh, J., & Kim, Y. G. (2004). Knowledge sharing in virtual communities: An e-business perspective. *Expert Systems with Applications, 26*(2), 155–166.
Kotler, P. (1996). *Marketing management* (8th ed., pp. 203–237). Prentice Hall.
Porter, C. E. (2004). A typology of virtual communities: A multi-disciplinary foundation for future research. *Journal of Computer-Mediated Communication, 10*(1) <http://jcmc.indiana.edu/vol10/issue1/porter.html>.
Preece, J. (2000). *Online communities: Designing usability, supporting sociability*. Chichester, UK: John Wiley & Sons, Ltd.
Rao, X. M. (2005). On the study of service innovation for service enterprises. *Journal of Panyu Polytechnic, 4*(2).
Rust, R. T., & Kannan, P. K. (2003). E-service: A new paradigm for business in the electronic environment. *Communication of the ACM, 46*(6), 37–42.
Santos, J. (2003). E-service quality: A model of virtual service quality dimensions. *Managing Service Quality, 13*(3), 233–246.
Selden, L., & MacMillan, I. C. (2006). Manage customer-centric innovation—Systematically. *Harvard Business Review*(April), 108–116.
Simonson, I. (1989). Choice based on reasons: The case of attraction and compromise effects. *Journal of Consumer Research, 16*(September), 158–174.
Simonson, I., & Amos, T. (1992). Choice in context: Tradeoff contrast and extremeness aversion. *Journal of Marketing Research, 29*(August), 281–295.
Spohrer, J., Maglio, P., Bailey, J. B., & Daniel, G. (2007). Steps toward a science of service systems. *IEEE Computer, 1*, 71–77.
Studer, R., Benjamins, V., & Fensel, D. (1998). Knowledge engineering, principles, and methods. *Data and Knowledge Engineering, 25*(1–2), 161–197.
Watts, D. J., & Strogatz, S. H. (1998). Collective dynamics of 'small world' networks. *Nature, 393*, 440–442.