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Expectation-based coopetition approach to service experience design

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ABSTRACT

Service experience design is a key issue in the service industry. Satisfactory service experiences provide customers with good memories and increase customer satisfaction, thus increasing customer loyalty and service provider profitability. However, providing customers with quality service experiences requires considering numerous factors, and thus is a complex and difficult issue both in academia and in real service contexts. Customer satisfaction results from the difference between customer perceptions and customer expectations. Hence, customer expectation management is important in delivering quality service experiences. Additionally, a competitive relationship exists among different service providers as well as between service providers and customers. The service experience delivery process can be regarded as a value co-creation process for service providers and customers who can implement either a competitive or cooperative strategy based on their goals and needs. This study accordingly presents an expectation based coopetition approach by using a real exhibition data of AutoTronics 2009 for simulations. The evaluation results show that this expectation-based coopetition approach can help service providers design and deliver quality service experiences and co-create value with customers, yielding a high performance ecosystem.

1. Introduction

When Pine and Gilmore [23] proposed a novel trend of the experience economy, the service industry has become important in performing economic activities in developed countries. Service providers are paying increasing attention to service experience delivery. The main goal of service providers is to provide customers with satisfactory service experiences. Pullman and Gross [25] proposed defining service experiences as "experiences that occur when a customer derives some sensation or knowledge from interaction with different elements of a context created by a service provider." Successful service experiences can satisfy customers, and also both attract new customers and encourage repeat customers, increasing service provider profit. For example, Disneyland proposes experiential and entertaining journeys that can see families come together and imagine being in a fairy tale. Both children and adults who experience unique journeys in Disneyland can derive wonderful memories from Disneyland. In another example of train scheduling for highly congested railway networks, it is important to provide passengers with either a robust train timetable having less probability of delay propagation [6] or reliable information about the schedule changes and delays because passenger experience and satisfaction is very much related to the information they receive [7].

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That is, service providers can increase customer loyalty and thus maximize profits through developing their abilities in experience design [24,25].

Although the importance of service experience can be realized according to the above statements, providing customers with quality service experiences is complex and difficult whether in academia or real world situations. Numerous critical factors exist, such as service operations, customer emotion, service culture and so on, which influence service experiences. Consequently, how service providers can design quality service experiences by considering the above factors has long been an important topic. According to Parasuraman et al. [22], customer satisfaction results from the difference between customer perception and customer expectation. A customer usually has expectations regarding desired services. After a customer actually experiences a service, they become either satisfied or dissatisfied. If customer perceptions exceed expectations, the customer will be highly satisfied. Customer expectations can directly affect customer satisfaction. Consequently, it is necessary to consider customer expectations when designing quality service experiences.

Although many previous studies stressed the importance of understanding customer expectations [17,9,27,18], few studies have examined how service providers can apply customer expectations to real-time service contexts. Traditional service providers can usually understand customer expectations regarding their services through survey-based questionnaires, but by this stage the service experience has already been delivered. Restated, traditional service providers only design proper service experiences for their customers by analyzing historical customer expectations. Nevertheless, if service providers can offer suitable service experiences to maximize customer satisfaction and profitability in real-time service contexts by understanding customer expectations, their customers become willing to be continuously involved in service activities to explore valuable opportunities to fulfill their needs [23,4,26,16]. Hence, both service providers and customers can benefit through service experience delivery via value co-creation [14].

In addition, the service-dominant logic [30,20] currently is an important concept in different fields (such as service science, information management or marketing). A key characteristic of the service-dominant logic is "value co-creation" [30,20] rather than the traditional "value added" perspective. Service providers can design suitable services, activities or interactive methods by which customers can contribute their knowledge, experiences, and behaviors. Either service providers or customers can co-create and receive useful values through these services, activities or methods of interaction. For example, Apple provides their customers with numerous on-line services integrated via iPods with appropriate value proposing among Apple. The iPod provides a platform whereby users can download and upload their favorite music and other information, and can conveniently acquire useful messages, share personal information and communicate with other users and online service providers, and with Apple itself.

A service experience delivery can also be considered as an ecosystem, in which the design of appropriate interactive activities between service providers and customers remains a tough issue. To proffer solutions regarding service experience design in light of the aforementioned perplexities, this study aims to investigate the research question: How can service providers build to deliver quality service experiences by managing customer expectations and co-creating value with customers in real-time service contexts?

In addition, during the delivery of value co-creation service experience by the two key roles of service providers and customers, the connection between these two roles involves cooperative and competitive relationships which is the coopetition referring to the coexist relationships [5]. Notwithstanding their joint efforts in service experience delivery, customers and service providers still keep contradiction. Both service providers and customers in service experience delivery weight gains and losses from their own perspectives. For value co-creation in service experience delivery, service providers and customers can implement either a collaborative or competitive strategy based on their business objectives and personal needs. For instance, when dealing with customers wishing to save money or guarantee service quality, service providers can consider their profit margins. Consequently, this study is to build a coopetition-based approach that service providers can use to design quality service experiences. Given the aforementioned importance of considering customer expectations in relation to quality service experience delivery, this study applies the idea of managing customer expectations to the coopetition-based approach (hereafter called expectation-based coopetition approach). In other words, the approach links service experience design with customer expectation management to ensure quality service experience delivery via the design of appropriate interactive activities between service providers and customers.

To evaluate the feasibility and the performance of the expectation-based coopetition approach, this study conducts four sets of experiments (including one involving the skill level variables of the customer and provider, about managing customer expectations, about satisfying both providers' and customers' needs and values, and about a high performance service ecosystem). In addition, to illustrate the expectation-based coopetition approach this study takes exhibition as an application service context characterized with being real-time and dynamic, and adopts multi-agent simulations to implement the approach with the purpose of optimizing the value co-creation of the coopetition relationships between service providers and customers. This study uses the exhibition of AutoTronics 2009 in Taiwan as a real case. The choice of the exhibition application context is to emphasize the service delivery perspective that concerns a set of interacting entities involved in the delivery of one or more services in situated contexts. Our evaluation results show that applying the expectation-based coopetition approach to service experience delivery is able to achieve a high performance service ecosystem involving service providers and service customers.

The remainder of this paper is organized as follows. Section 2 reviews the literature. Section 3 further describes the design logic of the expectation-based coopetition approach. Section 4 then details the simulation experiments and analyzes the results. Finally, Section 5 presents conclusions.

2. Literature review

2.1. Service experience design

Pine and Gillmore [23] indicated that service providers must build appropriate customer service experiences to achieve high customer satisfaction in the era of the experience economy. Delivering memorable and exciting service experiences for customers is necessary for fulfilling customer needs. Consequently, service providers can increase customer loyalty and thus achieve long-term profits through cultivating high abilities in service experience design [24,25,28].

Service providers must consider all interactions while designing service experiences. Creating and recognizing clues to customer behavior in service encounters can help achieve an appropriate service experience design [3,15]. The clues that comprise customer experiences are ubiquitous. For instance, employee messages (such as gestures or tones of voice) can be key clues for service experiences. Furthermore, Edvardsson et al. [11] suggested that service providers should use experience rooms where customers can undergo pre-experiences and provide responses to provide data as a basis for further modifying services.

Although designing high-quality service experiences is extremely difficult and time-consuming, the previous literature contains plenty of ideas on service experience design. Most of the literatures about service experience design mainly rest on guidelines, employees or servicescape, lacking systematic ways of managing the service delivery processes. Additionally, real-time customer expectation management is important in helping service providers design and deliver quality service experiences. This implies it is necessary to link service experience design with customer expectation management in real-time to ensure quality service experience delivery.

Meanwhile, a service experience delivery process may include many service encounters. Either service providers or customers can select appropriate strategies (namely cooperation or competition) to negotiate according to their different needs during service encounters involving different situations. That is, service providers and customers are in a coopetition environment. Hence, to achieve high customer satisfaction, service providers must carefully design service experiences by applying customer expectations management to the expectation-based coopetition approach. The following sections describe the importance of managing customer expectations and the idea of coopetition.

2.2. Customer expectation management

According to Parasuraman et al. [22] and Zeithaml et al. [32], customer expectations comprise those things they expect to obtain from service providers. Customer expectations can be to comprise customer desires or wants. That is, customers feel service providers should offer. Two levels of customer expectations exist, desired and adequate expectations [22]. Desired expectations represent the level of service a customer hopes to receive, while adequate expectations represent merely the level of service that they can accept. The area between the desired and adequate expectations is the zone of tolerance. The perceived service falls within customer zone of tolerance, resulting in customer satisfaction. Service providers thus should properly control the length of customer zone of tolerance to match different strategies for expectations management [22].

Furthermore, previous studies have discussed the issue of managing customer expectations. Coye [10] also developed a model of service delivery expectations and interventions to emphasize that cues (for example peripheral components of core services, or initial personal experience of core services) occurring during service encounters can influence customer expectations. To establish and assess models for managing customer expectations can also provide service providers and researchers with fundamental clues and guidelines for achieving high customer satisfaction [8,27]. Consequently, good customer expectation management can help service providers design appropriate service experiences for customers and thus maximize customer satisfaction. Zeithaml et al. [32] established a comprehensive framework of customer expectations based on expectation determinants (as shown in Fig. 1).

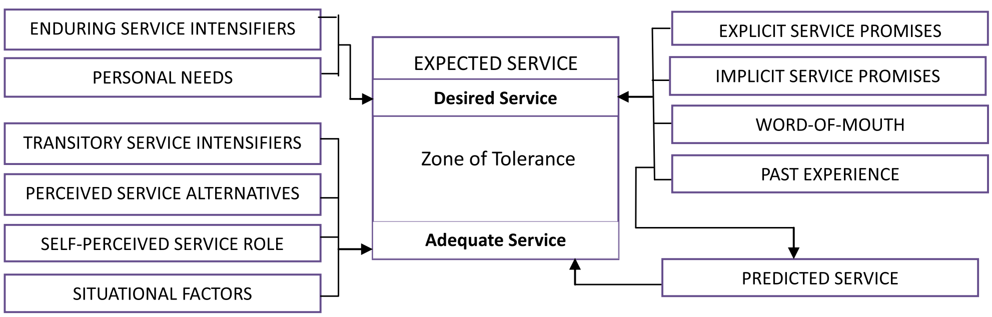


Fig. 1. Nature and determinants of customer expectations of service [32].

These determinants of expectations thus can alter the zone of tolerance. For example, when a service provider wants to increase the zone of tolerance of a customer, they can offer a price list of services together with customer recommendations (i.e. word-of-mouth) to boost desired and adequate expectations. Service providers must pay attention to these antecedent determinants to dynamically manage customer expectations. As mentioned earlier, the service experience delivery can be considered a process of coopetition between service providers and customers, during which they play either the cooperation or competition roles. To effectively manage customer expectations, service providers must adopt different expectation-based strategic tactics in service operations to interact with customer appropriately. These expectation-based strategic tactics involve the expectation determinants of the comprehensive framework. This study wishes to apply this notion of managing customer expectations to design service operations and experiences. Consequently, the comprehensive framework of customer expectations also provides a basis for this study to build the expectation-based coopetition approach.

2.3. The concept of coopetition

Coopetition, a term combining the ideas of "cooperation" and "competition", describes the arrangement between competing firms to cooperate on specific projects or in certain areas of business for mutual benefit [21]. The players enter into an agreement with the expectation that their cooperation will increase overall returns for each firm. Numerous factors contributed to the increase of coopetition during the late 1990s and early 2000s, including accelerating breakthroughs in information and communication technologies and the development by most major companies of internal and external networks. Each firm recognized that they could increase their margins by entering a temporary alliance, much like the roles of provider and customer in a service interaction. Both companies sometimes compete against each other, such as when they bargain on price. However, provided customers are self-services like cooperation with service provider, they can obtain discounted prices while providers can save on operating costs. Each firm recognized that a temporary alliance would increase overall margins. Coopetition is paradoxical because it combines both common and conflicting interests under a single arrangement. Different arrangements result in different coopetition strategies. The ratio of cooperation versus competition involved in a specific role is condition dependent, meaning the customer uses different cooperative/competitive skill-levels based on service conditions within a service interaction, as do the providers.

Coopetition is a business strategy based on a combination of cooperation and competition, derived from an understanding that business competitors can benefit when they cooperate. The coopetition business model is based on game theory to understand various strategies and outcomes via specifically designed games. The coopetition model begins with a diagramming process called the value net, represented as a diamond (as shown in Fig. 2). Complementors are defined as players whose product adds value to the company, as software products gain value because they co-exist with hardware products, and vice versa. In comparison, competitors are defined as those whose products reduce the value of a company's products, as launching a second brand of toothpaste can reduce the value of the core brand.

A business can then be broken down into its PARTS (i.e. players, added values, rules, tactics, and scope) as a means of viewing practices and strategies [5]:

- *Players* who are participants in the game of business.
- *Added values* focus on ways to improve products and services to find ways of making more money from an existing customer base.
- *Rules* specify ways of attracting customers via strategies such as price-matching.
- *Tactics* are practices sometimes used to steal market share from competitors, for example by announcing an upcoming (and possibly non-existent) new and improved product simultaneously with the release of a competitor's product.
- *Scope* is the final part, used to take a broader perspective and create links between competitor games and interests, and to see how coopetition can benefit players.

This study defines three players (such as service providers, customers and coordinators) during service experience delivery which are also related to the coopetition model and PARTS. For instance, service providers in the exhibition are exhibitors who primarily design and implement their management strategies, executions of customer expectation management and visitor services. Organizers can be considered coordinators who handle the overall exhibition strategies and operations of

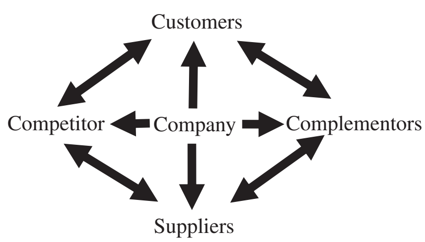


Fig. 2. Value network.

exhibitors and visitors. In the coopetition model, the exhibitors are suppliers and competitors and the coordinators are regarded as complementors. Meanwhile, this study also uses the concept of coopetition to simulate the strategies (including the cooperation strategy and the competition strategy) that service providers and customers wish to implement. Service providers could design proper service experiences for customers to maximize customer satisfaction based on the coopetition strategy.

3. Expectation-based coopetition approach for service experience design

This study is to develop an expectation-based coopetition approach for service experience design via multi-agent simulations. The purpose is to optimize the attraction value of the coopetition relationships between service providers and customers. Service providers can provide customers with services based on the expectation determinants via the optimal recommendations obtained using the expectation-based coopetition approach. The selection and influence of appropriate expectation determinants on service experience design is crucial and contributes to the establishment of the expectation-based coopetition approach as a robust methodology (as shown in Fig. 3).

3.1. The conceptual framework of expectation-based service experience design

To illustrate the expectation-based coopetition approach, a framework of 3-phase strategic process flow for managing customer expectation is introduced first: (1) Selection of customer expectation management strategy (2) Expectation determination and tactic selection (3) Service execution and assessment (as shown in Fig. 3). In other words, this framework would underlay the proposed approach presented in Section 3.2–3.6.

3.1.1. Phase 1: Selection of strategies for managing customer expectations

Service providers must classify their objectives into different strategies for managing customer expectations based on the comprehensive framework of those expectations (as shown in Fig. 2). Each type is associated with an expectation state attempted by influencing adequate and desired expectations. To demonstrate the feasibility of customer expectation management, this study defines several strategy types (namely raising adequate expectations and stabilizing desired expectations, stabilizing adequate expectations and raising desired expectations, decreasing adequate and desired expectations, and raising adequate and desired expectations) based on the classifications of service provider capabilities (i.e. high level and low level) and customer variability (i.e. high level and low level). For instance, stabilizing adequate customer expectations and raising desired expectations is a customer expectations management strategy adopted by low-capability service providers. Low-capability service providers can effectively manage customer expectations to achieve customer satisfaction. Furthermore, this study assumes that the above strategies would be applied to the experiments based on the considerations of service providers and customers. Future researchers and service providers can define suitable customer expectation management strategies based on their specific concerns. Section 3 will detail the principles used to manage customer expectations.

3.1.2. Phase 2: Expectation determinant and tactic selection

Following a strategy of managing customer expectations requires compiling a set of effective determinants of customer expectations. This set of expectation determinants can then be represented expectation tactics to implement in service encounters. Service providers do not need to employ all possible expectation determinants. Service providers can simply assemble some of these determinants into a portfolio (i.e. expectation tactics) in response to customers within service encounters. An expectation tactic is an operational method by which service providers can influence customer expectations,

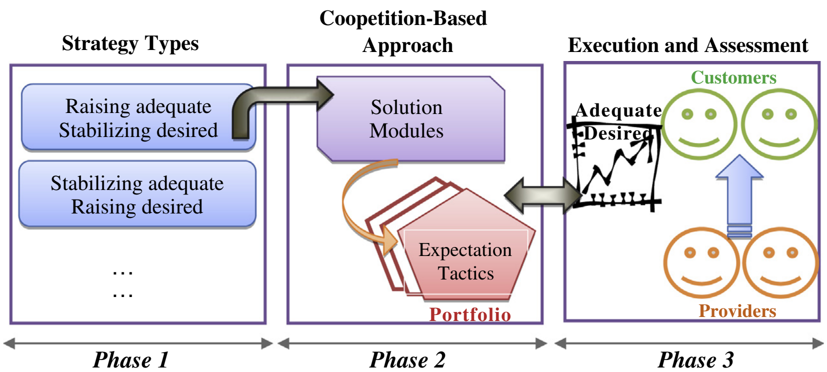


Fig. 3. The conceptual framework of strategic flow.

and combining useful tactics to deliver high-quality service experiences for customers is essential and spontaneous. For example, a service provider may wish to manage customer expectations with an expectation determinant (such as explicit service promises). This expectation determinant includes two expectation tactics (for example advertising and personal selling) that service providers can implement for customers in real-time service contexts.

3.1.3. Phase 3: Service execution and assessment

According to the service encounter triad (Fitzsimmons and Fitzsimmons, [12]), interactions occur among the three roles involved in service encounters, namely service providers, employees and customers. After selecting appropriate expectation tactics, these tactics can be employed by service providers, employees or customers. These actors can then respond to the solution module to further adjust and modify the processing logic and rules according to the results of the service implementation. For example, this study established relevant knowledge databases in the solution module to gather feedback information from the three roles for use in selecting, designing and delivering appropriate service experiences.

The following sections use the description of the proposed approach as an independent case study for service related applications in terms of coopetition value networks, which involve service provider performance, customer feedback, and coordinator regulation. This case study focuses on a closed and wireless communication environment, meaning that a predefined ecosystem is used and that the approach is easy to apply. Fig. 4 then illustrates the system module diagram of the proposed approach.

Initially, the players in the value net, including service providers, customers and coordinators, are viewed as observation objects which provide specialized personal information in Value Identification Module. Second, in the Skill-level Detection Module, the abilities of service providers and customers (namely cooperative-level and competitive-level) are contextually detected from the external environment. Consequently, the above two modules can define suitable strategies for customer expectation management during phase 1 according to player information and service context. The modules in phase 2 of the conceptual framework of strategic flow are the PARTS module and the Measurement Model. The objective function of each player is optimized in the third PARTS module. Fourth, the Measurement Model is designed to transform customer expectations into computable numbers and prepares useful service tactics. Next, the SC Selection Module produces service encounter interactions for service providers. Finally, the Feedback Module helps the proposed approach to learn repeatedly and facilitate dynamic adaptation to the rapidly changing world. Consequently, the last two modules represent the service execution and assessment in phase 3. Without loss of generality, we will use the exhibition application scenario to explain the aforementioned module in the following subsections.

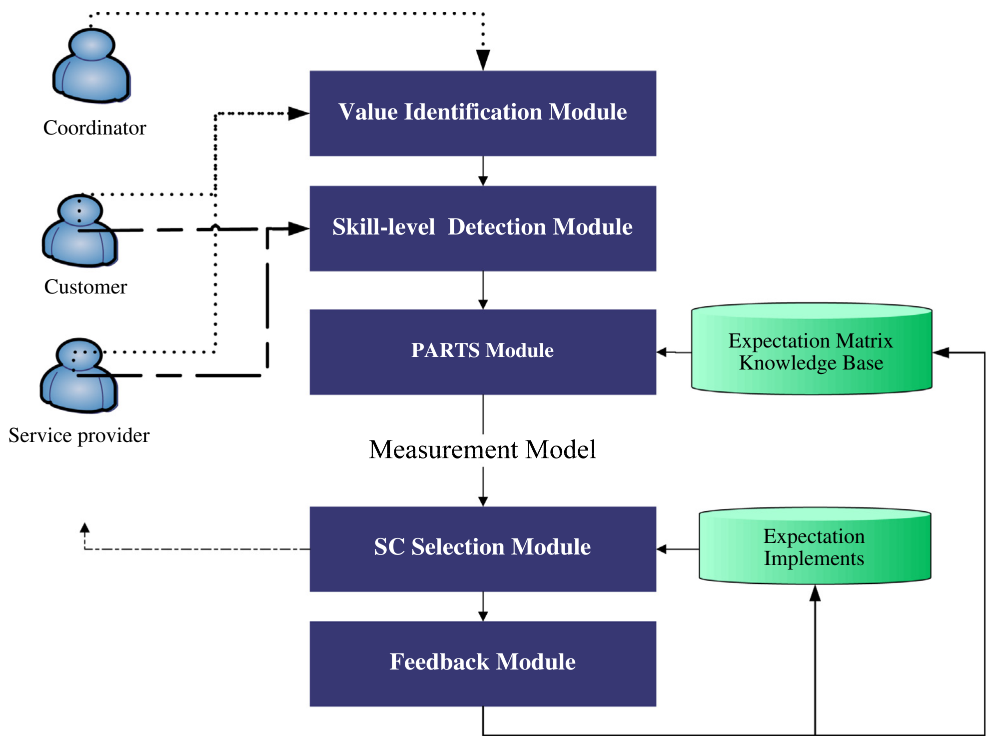


Fig. 4. System modules diagram.

3.2. Value identification module

Initially, the module identifies the needs and information of each player to reveal their personal preferences and thus design appropriate service experiences to attract more customers. Therefore it is necessary to specify the roles in the studied value network.

The exhibition application scenario involves three main types of stakeholders: A is service provider, while B is customer and C is coordinator. Second, the players simultaneously choose the levels of effort they will devote to the cooperation. The cooperative effort level in terms of Player needs is denoted by N_i for $i \in \{A, B, C\}$, which refers to an increase of the total market. The overall market demand function, is $(D + N_A + N_B)$, where D represents initial demand without cooperative effort. The key performance indexes of the coordinator require special attention, and $N_C = KPIs$ assumes to have these indexes transformed into 11 determinant weightings used by the measurement model to tune the expectation matrix of the 11 determinants. The details of the expectation matrix will be provided in Section 3.4. Finally, both players of provider and customer simultaneously choose their levels of competitiveness, which are denoted by V_i. Levels of competitive effort differentiate the competitiveness of individual players in obtaining added value from market share. Without competitive effort, the market divides equally into two roles. Otherwise, the pie share of Player i is determined by the ratio $V_i/(V_A + V_B)$.

For instance, Table 1 exemplifies a way to capture the competitive effort level of players to attain the added values; if a provider player endeavors to consider 6 items in the table among the formation of Added Value, we could have $V_A = 6$; by the same token, if customer endeavors to consider 5 items among the formation of Added Value, we could have $V_B = 5$. Table 2 then summarizes all variables used in this module to further improve the necessary understanding.

3.3. Skill-level detection module

After identifying the needs and potential values of each player, in this skill-level detection module, the module recognizes the service context's four dimensions (physical, cognitive, communicative, and historical events [31]) from the peripheral environment and applies them to the real-time and dynamic situation during service experience delivery in exhibition. Additionally, player competitive and cooperative efforts are also determined simultaneously to denote a domain in which skill levels are important. The module's first objective is to establish a peripheral environment for each interaction based on the real world. Then it is necessary to detect the competitive and cooperative effort levels of each player under this specific interaction circumstance. Only then can the effort players must make to support their expectation matrix used in the next module become clear. However, setting the peripheral environment of each interaction can be difficult because of the dynamics of the real world. Thus, this study views each service interaction as a service context $f(C)$ comprising the aforementioned four dimensions.

The above service context setting facilitates the capture of the competitive/cooperative effort level of each player. For service providers, p_{com} and p_{coo} denote the levels of competitive and cooperative effort, respectively; while c_{com} and c_{coo} represent customer levels of competitive and cooperative effort. We assume the level values of these four denotations are assumed to range from 1 to 10 that could help discriminate the degree to which each player adopts the individual expectation determinant and it will be detailed in Section 3.4).

Under a specific service context, each player has different competitive and cooperative effort levels that are combined into an adoption level by utilizing three heuristic transformation rules, as follows.

Rule 1 $\because$ *competitive effort level > cooperative effort level*
$\therefore$ *adoption is low*
Rule 2 $\because$ *competitive effort level < cooperative effort level*
$\therefore$ *adoption is high*
Rule 3 $\because$ *competitive effort level = cooperative effort level*
$\therefore$ *adoption is neutral*

Table 1
Formation of added values.

	Added values	True = 1; False = 0
01	Time	
02	Convenience	
03	Control	
04	Clarity	
05	Adaptation	
06	Competition	
07	Automation	
08	Amusement	
09	Peace-of-mind	
Total		

Table 2
Variables overview.

Variable	Description
N_i	Needs of player *i*
$(D + N_A + N_B)$	Overall market demand function
N_C = KPIs	Coordinator's key performance indexes
V_i	Added values *V* of Player *i*
$V_i/(V_A + V_B)$	Market share of Player *i*

Once the adoption of individual players under specific service contexts is known, it becomes convenient to figure the strategies that players will adopt. Either a service provider or customer will adopt one of the Tactics to maximize its own Added Value. Table 3 summarizes the variables used in this module.

3.4. PARTS module

After understanding all stakeholder and service context information in previous modules, this module generates feasible and appropriate expectation determinants that not only effectively influence customer expectations but also enable customers to achieve satisfactory service experiences. Meanwhile, this module also considers the coopetition between service providers and customers to define expectation matrixes for each expectation determinant. Accordingly, Fig. 5 shows two major stages in the PARTS module, which aims to choose suitable determinants in terms of controlling customer service expectations based on the maximal demands of each Player (namely service providers and customers).

At the beginning of stage 1, the adoption level of service providers/customers produced from the Skill-level Module becomes the context condition for mapping the coopetition expectation matrix, which resembles the pay-off matrix [19] recording the trade-off values. Each expectation determinant has its own coopetition expectation matrix (as exemplified in Fig. 6) in which each cell is used to store customer expectation variation (that is EV) as a figure ranging from −10 to +10. The coopetition expectation matrix presents all possible variations in customer expectations (i.e. a form of pay-off in terms of expectations), while a service provider applies an expectation determinant to a customer. That is, the influence of the expectation determinant on variations of customer expectations can be reflected by the coopetition expectation matrix utilizing service provider and consumer adoption levels. For a specific expectation determinant, different adoption levels between service providers and customers lead to different variations in customer expectations. When the central point of expectation variation is increasing (decreasing), it is denoted as a positive integer (negative integer). Once the adoption levels of service providers and customers are specified, the cell position in the matrix is also determined. Every expectation matrix is mapped to find an EV integer to serve as stage 2's inputs.

Stage 2 considers individual player demands to find influential determinant portfolios. The determinant portfolios are the combinations of the 11 determinants. With a determinant portfolio, a list of the EV values can be attained based on stage 1's expectation matrixes, and the sum of the EV values could be considered in the demand function of the Player in order to measure how much the Player would desire a service. This study would identify such an influential determinant portfolio of maximized demands and minimized efforts.

The following is the description about how the PARTS Module performs:

Stage 1: Specify the coopetition expectation matrix for each expectation determinant to form the mapping schema (as shown in Fig. 6). Representations include:

- *H* denotes high adoption level; *L* represents low adoption level
- (#) stands for expectation variation which is an integer ranged from [−10, 10]
- According to nature and determinants of customer expectations, 11 expectation determinants could be classified into three categories, namely only influencing desired expectations, only influencing adequate expectations, and both influencing desired and adequate expectations. Based on previous studies [32], adequate expectations are affected more easily than desired expectations. Thus, in the proposed approach, the EV values for desired expectation determinants are made to change more than those of adequate expectation determinants. Particularly, for those determinants which influence both desired and adequate service, expectation trend varies more broadly. Consequently, this study assumes the default EV values for adequate expectation as +6,+3, −3, −6, the default EV values for desired expectation are +3,+1, −1, −3, and the default EV values for desired/adequate service being most variable as +9, +6, −6, −9.

Table 3
Variables overview.

Variable	Description
$f(C)$	The four dimension in service context $f(C)$ = {*physical, cognitive, communicative, historical*}
p_{com}, p_{coo}	Competitive/cooperative effort level for **Player** A (here refers to service providers)
c_{com}, c_{coo}	Competitive/cooperative effort level for **Player** B (here refers to customers)

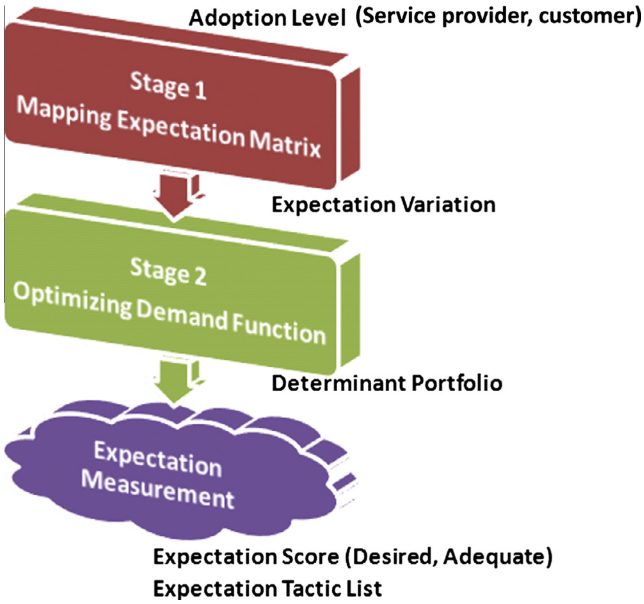


Fig. 5. Flowcharts of PARTS module.

Stage 2: Specify the two demand functions for players (i.e. customers and service providers). Based on Ngo and Okura [21], this study defines the demand function U_B of Player B (representing the customer) as follows:

$$U_B = \sum_{i=1}^{n} EV(D + N_A + N_B)\frac{V_B}{V_A + V_B} - c_{com}V_B - c_{coo}N_B^2$$

The goal is to maximize customer demands while minimizing costs. The formula shows that $(D + N_A + N_B)$ represents the overall market demand function and $V_i/(V_A + V_B)$ represents the market share of Player *i*, and thus both of these values multiplied represent the market demand shares for specific customers. The market demand share multiplied by the summation of the EV values (of a determinant portfolio of *n* determinants) thus symbolizes total customer demand. Additionally, the competitive effort cost (namely $c_{com}V_B$) and cooperative effort cost (i.e. $c_{coo}N_B^2$) are also subtracted to make the demand feasible. Similarly, U_A is defined as the demand function of Player *A* (represented as service providers):

$$U_A = \sum_{i=1}^{n} EV(D + N_A + N_B)\frac{V_A}{V_A + V_B} - p_{com}V_A - p_{coo}N_A^2$$

Running the demand functions of each player during stage 2 aims to maximize all the demand functions simultaneously so as to obtain an optimal determinant portfolio and also decides what service interactions service providers can perform.

3.5. Measurement model

The expectation control mechanism comprises the expectation-based coopetition approach and a computable expectation measurement model [16]. The expectation measurement model fulfills a critical function in realizing customer mental status, and facilitates the integrity and effectiveness of the service experience delivery managed by the expectation-based coopetition approach. The mathematical model used for expectation measurement is theoretically based on Fechner's Law [29] and operational risk [2]. Fig. 7 represents the reasoning process of the expectation measurement model which comprises three separate stages, including expectation determinants, expectation measurement and customer expectations. Furthermore, the measurement model also contains feedback which can continuously refresh the database used to measure customer expectations.

- Expectation determinant input stage

The inputs of the expectation measurement model are the combinations of determinants that service providers propose as to influence customer expectations. According to Zeithaml et al. [32], different combinations of determinants are used as inputs in different situations (including time, customer management objectives or provider capabilities).

Enduring Service Intensifiers
(e.g. customer service philosophies)

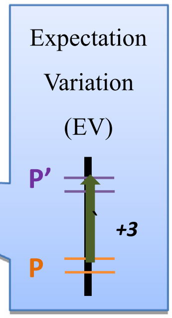
Expectation Variation		Customer H	Customer L
Service Provider	H	-3	+1
	L	-1	+3

Service Provider just has low adoption level while customer's philosophies are pessimistic.

Personal Needs
(e.g. customer needs)

Expectation Variation		Customer H	Customer L
Service Provider	H	+1	-3
	L	+3	-1

Service Provider is capable to make customer adopt with supplying few services.



(a) Desired service with the expectation variations as 3, 1, -1, -3

Transitory Service Intensifiers
(e.g. service problem)

Expectation Variation		Customer H	Customer L
Service Provider	H	+6	-3
	L	+3	-6

When there are a lot of service problem appeared, customer still can adopt the service.

Perceived Service Alternatives
(e.g. various providers)

Expectation Variation		Customer H	Customer L
Service Provider	H	+6	-3
	L	+3	-6

Customers still adopt this single Service Provider among many competitors.

Self-perceived Service Role
(e.g. customer self-services)

Expectation Variation		Customer H	Customer L
Service Provider	H	+6	-3
	L	+3	-6

Customer can adopt to do self-service as much as possible during the service process.

Situational Factors
(e.g. random over-demand)

Expectation Variation		Customer H	Customer L
Service Provider	H	+3	-6
	L	+6	-3

Service Provider cannot adopt to supply random over-demand, but customer still willing to be served.

(b) Adequate service with the expectation variations as 6, 3, -3, -6

Fig. 6. Coopetition expectation matrix of expectation determinants.

- Expectation measurement model stage

This step attempts to calculate expectations regarding desired and minimum service level, while the customer is in contact with external stimuli. First, as mentioned previously, strategies for managing customer expectations include raising adequate expectations and stabilizing desired expectations, stabilizing adequate expectations and raising desired expectations, decreasing adequate and desired expectations, and raising adequate and desired expectations. According to the above strategies and the differences in combinations of expectation determinants relative to the expectation deter-

Explicit Service Promises
(e.g. advertisements)

Expectation Variation		Customer H	Customer L
Service Provider	H	+6	-9
Service Provider	L	+9	-6

Service Provider pays little effort to ads, but customer still adopts the service.

Implicit Service Promises
(e.g. price)

Expectation Variation		Customer H	Customer L
Service Provider	H	+9	-6
Service Provider	L	+6	-9

Service Provider makes a higher price but customer still can adopt this fixed price.

Word-of-Mouth
(e.g. expert consulting)

Expectation Variation		Customer H	Customer L
Service Provider	H	+6	-9
Service Provider	L	+9	-6

Service Provider adopts few experts consulting then customer easily tends to adopt the service.

Past Experience

Expectation Variation		Customer H	Customer L
Service Provider	H	+6	-9
Service Provider	L	+9	-6

Service Provider hardly adopts past experience to adjust while customer welcome different kinds of reference experience.

Predicted Service

Expectation Variation		Customer H	Customer L
Service Provider	H	-9	+6
Service Provider	L	-6	+9

Service Provider supplies few while customers predict less.

(c) Desired service and adequate service with the expectation variations as 9, 6, -6, -9

Fig. 6. (*continued*)

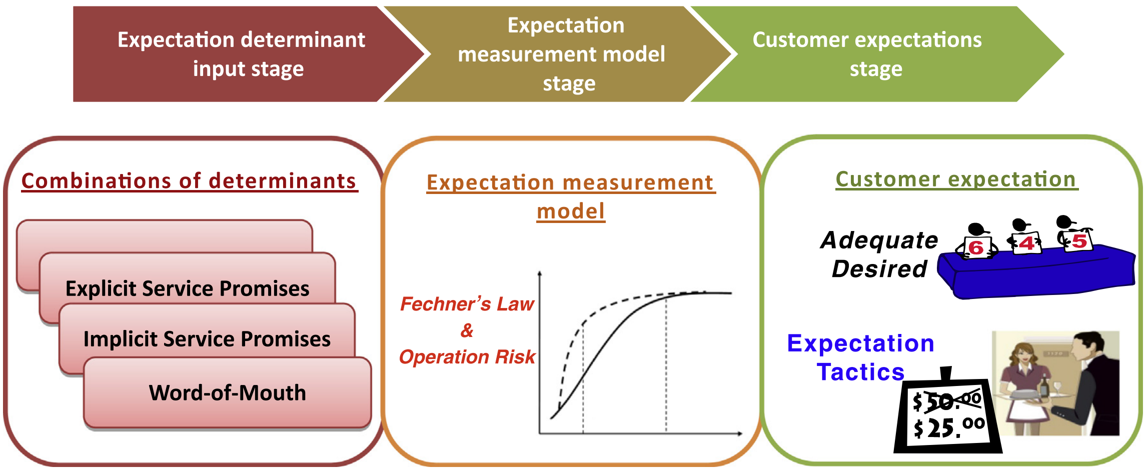


Fig. 7. The process of the expectation measurement model.

minants stage, the value of stimuli can be calculated using the expectation measurement model based on analogical mapping between the factors considered by operational risk and Fechner's Law. After obtaining the value of stimuli, the expectation measurement model calculates the adequate or desired expectation value based on Fechner's Law (that is the magnitude of sensations can be calculated from that of the external stimulus).

• Customer expectations stage

Accordingly, the outputs of the expectation measurement model contain the adequate expectation value, desired expectation value and list of expectation tactics. Once service providers can understand actual customer expectations based on the outputs, they can propose suitable services to their customers to help them achieve their business goals. Additionally, the expectation tactics list, collected from the real-time database, provides a reference. Service providers can employ appropriate expectation tactics to influence customer expectations based on this list. After service providers implement the expectation tactics, they should immediately store the values of expectation variation and their capabilities indicators in the real-time database. Consequently, owing to feedback control, the expectation measurement model can reflect actual customer expectations.

3.6. SC selection module

After implementing the measurement model, a list of expectation scores and tactics can be obtained to assist the expectation-based coopetition approach to select relevant service components (so-called SC) that are appropriate for use during service experience delivery. This module can help service providers provide executable services (i.e. service components) with customers in service contexts. Consequently, this module considers (1) the service context $f(C)$; (2) SC cost, including equipment cost, material cost, and staff cost; and (3) service provider adoption level, namely competitive effort level p_{com} and cooperative effort level p_{coo}, to select proper service components from the pool of tactics, thus assisting service providers to perform the service operation at the appropriate time.

Initially, as described in the previous section, the service context comprises four dimensions. Owing to the dynamic and changing environment, it is essential to consider service context and operate the services using corresponding service components. Furthermore, the cost of a specific service component for service providers covers equipment, material, and staff, and is determined by service providers in advance. Therefore, each service component has a relative cost in the service context.

3.7. Feedback module

This module stores the planned operations of service providers, storing them as service components and predicted expectation score minus former expectation score, both of which can record real-time data and also help the expectation-based coopetition approach to make regular updates, thus becoming more flexible and adaptive to the rapidly changing world. Service providers thus can dynamically receive all customer feedback and service context information to respond to customers in real-time. This module thus can be considered necessary to assist the expectation-based coopetition approach in continuous learning and to make adjustments to improve service experience delivery.

The first data, service components, selected from the pool of tactics to assist service providers with service operations, is stored in the expectation implementation database not only to record the implementation result, but also to let the measurement model be well refined depending on the frequency of service usage. The second data, expectation variation, calculated by subtracting the previous expectation score from the expectation score derived from the measurement model, is stored in the customer pattern database to record the path point information. However, the proposed approach also stores expectation variation in the expectation matrix knowledge base. In accordance with customer and service provider adoption level, and determinant portfolio, average expectation variation is added to the correspondent determinant expectation matrix.

4. Experiment and evaluation

To evaluate the feasibility and performance of the expectation-based coopetition approach, this study adopts multi-agent simulations to implement the approach and conduct several experiments to simulate possible customer expectation management situations for investigating the attraction value of the coopetition relationships between service providers and customers during service experience delivery. Table 4 lists the experiment settings.

This study utilizes micro and macroviews of simulation experiments to evaluate the expectation-based coopetition approach. Within the expectation-based coopetition approach, the microview focuses on appropriate competitive/cooperative effort setting used to model stakeholders in response to the dynamic service contexts, and the macroview assesses the approach's effectiveness in delivering satisfactory service experience and examines the service productivity and overall ecosystem performance. Without loss of generality, we will use the exhibition application scenario to demonstrate the evaluations in the following subsections.

There are four sets of simulation experiments that investigate the following important questions related to feasibility and performance:

Table 4
The experiment settings.

- *Define the service context*: To simulate an exhibition service context, there are three key roles of participants including organizers, exhibitors and visitors that should be modeled and each role can interact with each other. The data was collected from the exhibition of AutoTronics 2009 in Taiwan.
- *Define the service interaction*: Either organizers or exhibitors can directly deliver real-time service experiences to visitors in the exhibition through the proposed approach. In other words, visitors can dynamically select and acquire proper services from organizers or exhibitors according to their needs. Service interactions among three roles would be implemented by a real-time exhibition service system working with exhibition devices.
- *Define the strategy of customer expectation management*: As mentioned earlier, there are four main strategies of customer expectation management. In order to demonstrate the feasibility of our expectation-based coopetition approach, without loss of generality this study uses the strategy of raising adequate and desired expectations to customer expectation management in the exhibition service context.
- *Define the service components*: A service component can be defined as a service which visitors can select and employ during the exhibition. Meanwhile, the service components are also designed and built tailored to the characteristics of various expectation determinants of customer expectation related to the real-time exhibition service context.

Microview:

(1) Investigate if the skill levels of customer and provider adopted in the expectation-based coopetition approach could embody different competitive/cooperative efforts to cope with the dynamic service context? Within dynamic and changeable service environments, different service contexts make customers and providers possess different competitive or cooperative effort levels leading to various interactions. Therefore, a set of various skill-levels tested to better represent stakeholders' different competitive/cooperative levels in various service context circumstances is our objective; for instance, in exhibition the values for visitor's and exhibitor's competitive/cooperative levels should vary with the dynamic service context as much as possible. This set of experiments then aims to find the appropriate skill-level settings.

Macroview:

(1) Examine if the proposed approach can manage customers' mental status toward the wanted trends? Better service providers intuitively can cope with the greater diversity in customers' expectations. A possible resolution is to well manage customer expectations in order to shape the customers' expectation diversity into a similar status. Although this is a difficult and challenging issue for service providers, leading providers still want to maintain their competitive positions by delivering satisfactory service experience, managing the customers' mental statuses to shift along the trend as planned. This set of experiments then attempts to examine the approach's capability in customer expectations.
(2) Assess if the proposed approach can design service interactions satisfying both providers' and customers' needs and values? For service providers, traditional service interactions are standardized and lack of deep consideration of customers' requirements during dynamic service context. This set of experiments aims to examine if the approach's design of each service interaction during service encounter can fulfill the stakeholders' requirements like needs and values via benchmarking.
(3) Check if the proposed approach can help attain a service ecosystem's high performance? This set of experiments is to validate whether the service interactions derived by the approach can yield a high performance service ecosystem. The set of experiments utilizes the performance measurement model of service ecosystem as a validation standard to check if the expectation-based coopetitive interactions indeed improve the performance by influencing the decision-making of stakeholders.

4.1. Experiments for testing skill levels of customer and provider

4.1.1. Experiment objective

Real world service environments are dynamic and changeable. Particularly, different service contexts lead customers and providers to expend different levels of competitive or cooperative effort and to interact in different ways. This study assumes various skill levels suitable for different circumstances. In other words, the values set for visitor and exhibitor competitive/cooperative levels should be linked to the dynamic exhibition service context.

4.1.2. Experiment process

Owing to the numerous competitive/cooperative levels in the real world, this study simplifies the measurement of skill level by using a scale ranging from 1 to 5 (as exemplified in Table 5). For instance, in exhibition the scale 1 represents the lowest level for an exhibitor or visitor and 5 represents the highest level. The experiments assume the skill-level values set for different service context variables called settings (as exemplified in Table 6). Taking the example of Setting I, both exhibitor and visitor have equal skill-levels in relation to specific service context variables. In Table 6(a), when *4.visitingDuration* is long, the sum of visitor competitive skill-level value and visitor cooperative skill-level value is the same as that of the

Table 5
Skill-level settings corresponding to exemplar service context variables in exhibition.

Considerable Variables	Conceptual Definition	Operational Definition	Visitor		Exhibitor	
			c_{com}	c_{coo}	p_{com}	p_{coo}
1. pathDistance	Distance between two booths	Near	1	5	5	1
		Medium	3	3	3	3
		Far	5	1	1	5
2. boothSize	The extent for one booth area	Large	1	5	5	1
		Medium	3	3	3	3
		Small	5	1	1	5
3. productAmount	The number of exhibited products	Many	1	5	5	1
		Average	3	3	3	3
		Few	5	1	1	5
4. visitingDuration	Average visiting time for one booth	Long	5	1	1	5
		Average	3	3	3	3
		Short	1	5	5	1
5. discussion	Discussion number (visitor-visitor)	Many	5	1	1	5
		Average	3	3	3	3
		Few	1	5	5	1
6. question	Question number (visitor-exhibitor)	Many	5	1	1	5
		Average	3	3	3	3
		Few	1	5	5	1
7. crowdDensity	Crowd density of one booth	High	5	1	1	5
		Medium	3	3	3	3
		Low	1	5	5	1
8. SPnumber	Sales person number of one booth	Many	1	5	5	1
		Average	3	3	3	3
		Few	5	1	1	5
9. recommendation	Recommendation number of one booth	Many	5	1	1	5
		Average	3	3	3	3
		Few	1	5	5	1

c_{com}: Visitor's competitive level; c_{coo}: Visitor's cooperative level.
p_{com}: Exhibitor's competitive level; p_{coo}: Exhibitor's cooperative level.
Solution Number = Unrepeatable Combinations of c_{com}, c_{coo}, p_{com}, p_{coo}.
That is, more solutions means the skill-levels of visitor/exhibitor are more various in responses to dynamic service contexts. Restated, more variation in skills will be closer to both actual abilities of stakeholders in real world.

exhibitor's (calculated as 5 + 1 = 1 + 5). In this setting, both visitors and exhibitors have equal skill-levels despite using opposite approaches in competition or cooperation.

After defining the different settings of skill-level values for Table 5's nine variables, the average c_{com}, c_{coo}, p_{com}, and p_{coo} are calculated based on random operational definition; the average c_{com}, c_{coo}, p_{com}, and p_{coo} thus are recorded as the first solution. This process is then repeated for 15 runs to obtain the unrepeatable solution number. To obtain a general solution number, 15 runs are repeated three times to obtain the mean solution number.

In Setting II, the visitor is more skilled than the exhibitor; that is, the sum of visitor skill-level values (c_{com}, c_{coo}) for the operational definition of Long (*4.visitingDuration*) is bigger than exhibitor's (p_{com}, p_{coo}) calculated as 5 + 2 > 2 + 4. In Setting III, the exhibitor is more skilled than the visitor; that is, the sum of visitor competitive/cooperative skill-level values for the operational definition of Long (*4.visitingDuration*) is smaller than that of exhibitor competitive/cooperative skill-level, which is calculated as 4 + 2 < 2 + 5.

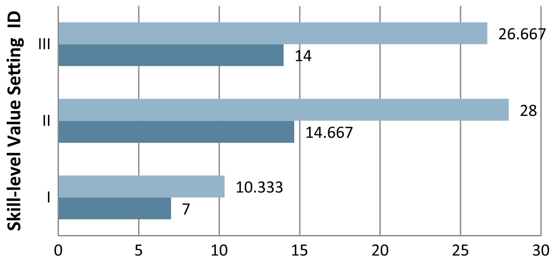
4.1.3. Simulation results

Following the above experiment process, three sets of 15 runs are performed for three skill-level settings to obtain an average solution number. The solution number indicates the number of unrepeatable combinations of c_{com}, c_{coo}, p_{com}, and p_{coo}. Additionally, three sets of 30 runs are conducted in three different settings to help analyze the simulation consequences (as depicted in Fig. 8).

This diagram shows that skill-level Setting I performs the worst in terms of number of solutions attained. The number of solutions for Setting I in either 15 or 30 runs is less than those of other settings, indicating that the equal skill-level situation leads to too few variability in solutions compared to the real world. Thus, after testing the different skill-level values, this study obtain the best setting is Setting II. This setting shows a considerable variation between 14.667 and 28. Subsequently, this study uses this setting as the default skill-level values in performing the following experiments.

Table 6
Skill-level settings with corresponding service context variables.

Considerable Variables	Operational Definition	Visitor		Exhibitor	
		c_{com}	c_{coo}	p_{com}	p_{coo}
(a)					
Setting I: Both have equal skill-level					
4. isitingDuration	Long	5	1	1	5
	Average	3	3	3	3
	Short	1	5	5	1
8. SPnumber	Many	1	5	5	1
	Average	3	3	3	3
	Few	5	1	1	5
(b)					
Setting II: Visitor has over all stronger skill-level					
4. visitingDuration	Long	5	2	2	4
	Average	3	3	3	3
	Short	2	4	4	1
8. SPnumber	Many	2	5	4	2
	Average	3	3	3	3
	Few	4	2	1	4
(c)					
Setting III: Exhibitor has stronger skill-level					
4. visitingDuration	Long	4	2	2	5
	Average	3	3	3	3
	Short	1	4	4	2
8. SPnumber	Many	2	4	5	2
	Average	3	3	3	3
	Few	4	1	2	4



	I	II	III
30 Run	10.333	28	26.667
15 Run	7	14.667	14

Fig. 8. Solution number after 15 and 30 interactions.

4.2. Experiments for evaluating customer expectation management

4.2.1. Experiment objective

Customer expectations diversify with improving service provider performance; thus, managing customer expectations to maintain a constant trend is difficult for service providers. For instance, to manage diverse visitor expectations and maintain the competitiveness of leading exhibitors, visitor expectations must be manipulated to match the desired trend which means simultaneously increasing the levels of adequate/desired expectations and narrowing the zone of tolerance.

4.2.2. Experiment process

Five indicators of customer variability exist, including arrival, request, capability, effort and subjective preference (Frei [13]). This study used 265 visitor samples from the exhibition of AutoTronics 2009 to classify the visitors into three customer stereotypes. Visitor attendance is designed not only to understand current events and thus expand individual knowledge, but also to search and collect competitor information and thus obtain collaboration opportunities, which indicates that this kind of visitors (i.e. Stereotype A) can be characterized with the following variability: frequent arrival variability, medium capability variability, medium effort variability, growth request and low subjective preference variability. Without loss of generality, this set of experiments focus on the visitor stereotype A and examine if the proposed approach can manage customers' mental status toward the wanted increasing trends so as to create satisfactory service experiences. Besides, experiments are also conducted for the other two visitor stereotypes including the opposite type to Stereotype A, denoted as Stereotype C (looking forward to essential demand like existence request with high expectation and low responsiveness), and the average type, denoted as Stereotype B (looking forward to social activity like relation request with less expectation and high responsiveness), in the simulated environment.

4.2.3. Simulation results

This study attempts to find the tendencies of customer expectation management. As shown in Fig. 9, three adequate level expectation curves exist for three different visitor stereotypes. Although these curves are not particularly smooth due to unsuccessful interactions, the trend resembles the proposed, namely adequate minimum level of customer expectations. Unlike other stereotypes, the line for stereotype A rises higher than all the other stereotypes following 15 interactions, and is located above the other two after the 12th interaction.

Regarding the desired level of customer expectations (as depicted in Fig. 10), all the curves are slowly changing among three visitor stereotypes and indicating that the desired level is less influenced by external stimulation given the flatter slopes in comparison with Fig. 9. That is, the simulation results present the evidences illustrating the claims of Zeithaml et al. [32] that desired services are less manageable than adequate services. However, the overall desired level can still be managed following a rise trend by the interactive method of expectation-based coopetition approach.

Additionally, the zone of tolerance of each stereotype can be calculated using the adequate and desired levels for the corresponding 15 interactions (i.e. using desired expectations score minus minimum expectations score falling in the same zone as tolerance score). Overall, the tolerance zone has a narrowing trend. Although the curves sometimes resemble saw edges, the visitor stereotype A can still be assumed to be better managed than the other two stereotypes based on the line denoting stereotype A being at the bottom of Fig. 11. That is, comparing all the stereotypes among the last five interactions (starting from the 11th interaction), stereotype A has the lowest zone. That is, the proposed approach performs the best for this group of visitors.

To summarize this set of experiments, the average tendency represented in these result diagrams, including adequate level, desired level, and zone of tolerance, follow the proposed trend for all the visitor stereotypes A, B and C. However, in contrast to the curves of stereotypes B and C, the expectation status of stereotypes A remains on a steady path towards fulfilling the objective of increasing the adequate/desired expectation level while simultaneously narrowing the zone of tolerance. The stereotype A visitors are characterized by spiritual demands such as growth requests, lowered expectations and medium responsiveness, resulting in a coopetition strategy. Such individuals can sometimes corporate or compete with exhibitors

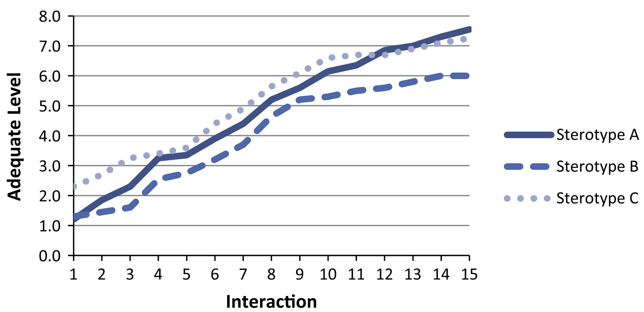


Fig. 9. Adequate level for 3 stereotypes after 15 interactions.

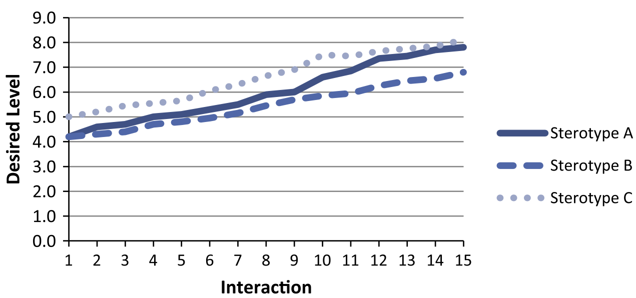


Fig. 10. Desired level for 3 stereotypes after 15 interactions.

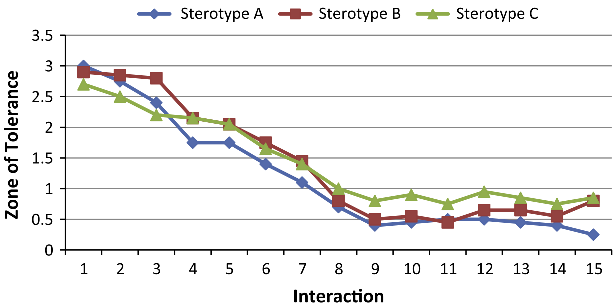


Fig. 11. Zone of tolerance for 3 stereotypes after 15 interactions.

to pursue their own mind value. Particularly after the 14th interaction of Fig. 11, this study infers that the trend of stereotype A continues to narrow the zone of tolerance. Regarding stereotype C, individuals belonging to this stereotype are the opposite of stereotype A, who are looking forward to essential demand with high expectation and low responsiveness. The expectation of stereotype C is not effectively managed, so the slope of stereotype C is flatter than others. Thus it can be inferred that visitors with existing requests and high expectations are least willing to adopt a coopetition strategy. Because they are only concerned with demand, individuals fitting stereotype C do not want to sometimes compete or co-work with providers. In addition, the line of stereotype C is positioned the highest, meaning this zone of tolerance is wider than the others, indicating the expectation-based coopetition approach least affects this group of visitors. Meanwhile, the stereotype B, comprising individuals looking forward to enjoying social activities like relation requests, and who have low expectations and high responsiveness, are in between stereotypes A and C. The line of stereotype B is located between stereotypes C and A after the 8th interaction. Thus it can be inferred that highly responsive visitors with relation request tend to sometimes compete or cooperate with providers. In short, it is fair to say that the proposed approach is capable of managing customer expectations (adequate/desired level) in a way of the wanted trend, and performs the best for the stereotype A visitors.

4.3. Experiments for dealing with sensitivity and specificity

4.3.1. Experiment objective

For service providers, traditional service interactions are standardized and lack deep consideration of customer requirements within a dynamic service context. To assess if the proposed approach can design service interactions satisfying both providers' and customers' needs and values, this experiment scenario involves considering leading exhibitor and visitor conditions in designing each interaction involved in a service encounter. With the expectation-based coopetition approach for service experience design, the results of both advised services (i.e., the interactive solution controlled by the proposed approach as the intervention group) and random services (i.e., the interactive solution without our approach's controlling as the control group) are compared to see whether the services meet user requirements, such as needs and values. Random services refer to all possible services selected by different types of visitors, which can be represented as random choices of services for simplicity. That is, these random choices emulate all of the service choices that visitors potentially might be engaged in.

4.3.2. Experiment process

This study uses sensitivity and specificity as statistical measures of performance on a binary classification test. These two measures are the most widely used statistics for describing a diagnostic test [1]. The sensitivity (called recall rate in some fields) measures the proportion of correctly identified positives (e.g. the percentage of desired services really advised to exhibitor as services); the specificity measures the proportion of correctly identified negatives (e.g. the percentage of undesired services which are not advised as services) (as shown in Table 7).

Two-hundred and sixty-five visitor samples from the AutoTronics Exhibition in 2009 were used to define 20 service components (i.e. services) to each of which a visitor would give a score of 0–100. Visitors tend to highly rate services that meet their needs and values. Conversely, visitors tend to assign low scores to services that do not meet their needs. Therefore, this set of experiments use three score standards: low demand (above 90, under 10), medium demand (above 80, under 20), and high demand (above 70, under 30) for service classification. The following is to take the first score standard (above 90, under 10) to give the descriptions and explanations. In this standard, services of the scores exceeding 90 would be marked with wanted services, and this standard is assumed to be of low demand. If these wanted services are properly advised by the approach, the amount of services is denoted as *TP*.

Meanwhile, if these wanted services are not advised by the approach, the amount is denoted as *FN*. Similarly, services of the scores under 10 would be marked with non-wanted services. Once these unwanted services are falsely classified as advised services, this amount of services is denoted as *FP*. If the unwanted services are correctly considered as not advised by the approach, this amount of services is denoted as *TN*. Therefore, the percentages of sensitivity and specificity could be cal-

Table 7
Formula of performance evaluation.

	Advised services	Non-advised services
Wanted services	*TP*	*FN*
Non-wanted services	*FP*	*TN*
Sensitivity	$\frac{TP}{TP+FN}$	
Specificity	$\frac{TN}{FP+TN}$	

culated to assess whether the approach's interaction design really provide suitable services that exhibitors can offer to visitors. Furthermore, advised services (intervention group) are replaced with random services (control group) to serve as a proper benchmark comparison. As for score standards like medium demand (above 80, under 20) and high demand (above 70, under 30), the same rule is used to calculate the percentages of sensitivity and specificity. Regardless of the score standards, higher percentages in sensitivity and specificity are more preferred than the lower ones. Additionally, this study compares the percentages of sensitivity and specificity between the intervention group and the control group.

4.3.3. Simulation results

Based on the aforementioned experiment design, the experiments classify 20 services into defined variables to obtain the percentages of sensitivity and specificity for three different runs: for the low demand standard (above 90, under 10), for the medium demand standard (above 80, under 20), and for the high demand standard (above 70, under 30). For each standard, this study uses the feedback of five users (randomly selected from the two-hundred and sixty-five visitor samples) as an input. Accordingly a total of 15 visitors are randomly selected and there are three sets of feedback data. Each data set is tested independently and no correlation exists between the three mentioned sets and the three visitors stereotypes. This is because the objective of the experiments is to assess the approach's service interaction performance (as shown in Figures 14) regardless of whoever visitor is engaged in the service interactions.

However, the experiment results indicate that the proposed approach's advised services perform better in deciding the service components for the higher sensitivity/specificity attained in comparison with those of using random services. That is, the proposed approach's advised services perform much better in fulfilling the demands of visitors and exhibitors. The proposed approach can directly satisfy exhibitor and visitor needs/values in terms of the exhibitors being facilitated to offer the advised services to the visitors, reaching an over 55% of the advised services being the actually wanted services by the sensitivity performance measure.

By examining those bars of advised services in Fig. 12, low demand standard (above 90, under 10) and medium demand standard (above 80, under 20) demonstrate that the proposed approach's sensitivity and specificity are higher than that of random services. This phenomenon indicates that visitors who have more strict scoring rules respond better to the proposed approach. In these cases, the proposed approach develops effective services that exhibitors can use to conduct interactions with visitors to fulfill both needs and values.

4.4. Experiments for assessing a high performance ecosystem

4.4.1. Experiment objective

This set of experiments aims to examine if the proposed approach can help build a high performance service ecosystem to create desirable solutions. Consequently, the model used to measure service ecosystem performance is used as a validation standard to validate the proposed approach can improve the performance by influencing stakeholders' decision-making.

4.4.2. Experiment process

Service ecosystem performance is evaluated using the concepts of surplus value, Pareto Optimal solutions, and customer expectations theory as described in Table 8. This model has two objective functions: maximizing the surplus value of service providers and that of customers. That is, these two objective functions are used to validate whether the proposed approach can build a high-performance service ecosystem.

Based on two objective functions, we attempt to find a pareto optimal solution satisfying the two objective functions, which means that both providers and customers can obtain high surplus values in term of the solution reaching an equilibrium between providers and customers within the eco-system.

To conduct the experiments, this study uses 15 visitors' complete journey results that are tallied to see if the proposed approach can simultaneously identify the maximum provider surplus and customer surplus to draw a frontier line. For each visitor completing the journey, the zone of tolerance (Z') is recorded following the approach's expectation management, and divided by the zone of tolerance (Z) before the approach's expectation management, thus deriving P_p. The utilization level of service components is denoted as $(C+V)_p$. This set of experiments also uses the visitors' survey data from AutoTronics 2009 to indicate the real customer feedback regarding their satisfaction with the present exhibition journey, denoted as P_c. In the survey data, the visitor scores all the service components used in the journey and the average score for all used service components is used to represent real customer feedback. $(C+V)_c$ denotes customer participation, including the number of cus-

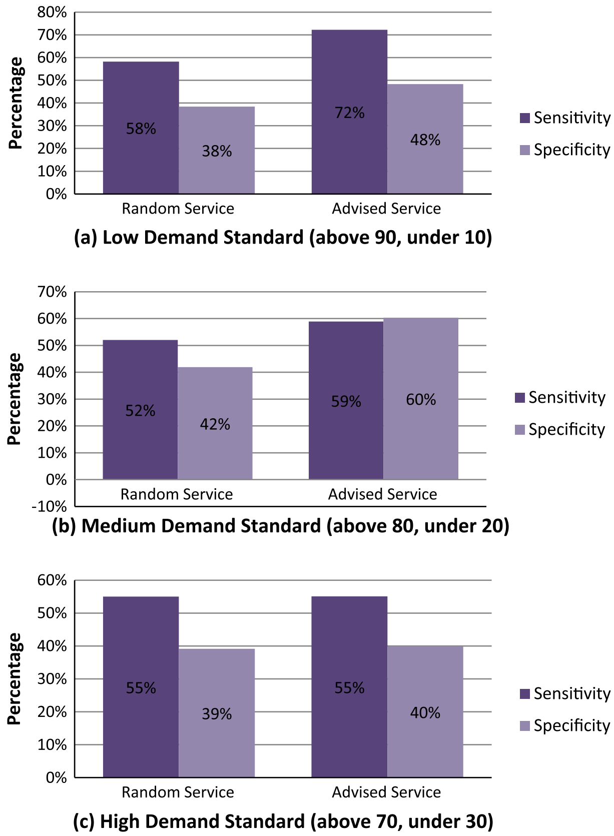


Fig. 12. Results of sensitivity and specificity for the three demand standards.

Table 8
Objective functions of high performances eco-system.

$$\begin{cases} Maximum : S_p = P_p - (C+V)_p \\ Maximum : S_c = P_c - (C+V)_c \end{cases}$$

S_p	Surplus value from providers' aspect	
P_p	Zone of tolerance after expectation management / Zone of tolerance before expectation management	30–40%
$(C+V)_p$	Providers' participations • Levels of supporting existing service components	10–40%
S_c	Surplus value from customers' aspect	
P_c	Customers' feedback from questionnaire	20–50 scores
$(C+V)_c$	Customers' participations • Proportion of willingness to respond to the service interaction	10–15 times

tomer recommendations of the service components during a journey with a setting up threshold (e.g., if the rating score of a service component exceeds 60, then the customer is assumed to recommend the service). The threshold is set on the basis of visitor "effort variability" which means (1) visitors expending high effort tend to endure a higher percentage of 50% to respond to the service interactions (2) visitors expending medium effort tend to endure a less percentage of 40% to respond to the service interactions (3) visitors expending low effort tend to endure the lowest percentage of 30% to respond to the service interactions.

A scatter diagram is prepared with dots corresponding to the values of all the objective functions. This action is repeated for 15 times to examine the trend of Pareto Optimal solutions derived by the proposed approach. In addition, this study also assesses another random group of visitor journeys as a comparison group. This random group indicates that the existent exhibition servicescape refers to the possible behaviors of random visitors within an exhibition hall where exhibitors have difficulties in catering to every visitor. Therefore, according to the definition of the two objective functions, the variable values for the behavior of random visitors are heuristically limited in the ranges as shown in Table 8 according to exhibition experts' opinions.

4.4.3. Simulation results

This subsection presents the simulation results (as depicted in Fig. 13) based on the aforementioned experiment design. After a visitor completes journey, a dot is placed at the relative *X*, *Y* coordinates. That is, for each specific journey, the values of provider surplus and customer surplus can be obtained and create a corresponding dot in Fig. 13. In the figure, there are 30 complete journey results of which 15 results are from the coopetition interactions (diamond dots) and 15 results are from the random visits (square dots).

From Fig. 13, the solutions produced using the proposed approach are located in the mid-right area of the plot while the random visit solutions are located in the lower-left part of the plot. Conditions of Pareto Optimality to occur to the diamond dots; that is, no one can be made better off without making someone else worse off. Besides, almost all the diamond dots produced using the proposed approach have more S_c (customer surplus) than the square dots produced by the random visits.

Restated, for any diamond dot, if there exist square dots with better performance in S_p, then those square dots must have worse performance in S_c. This means the proposed approach creates the Pareto Optimal provider and customer surplus values, indicating the proposed approach is capable of achieving high service ecosystem in terms of the Pareto Optimal performance.

4.5. Discussion

Based on the simulation results obtained by the above four set of experiments, the following evaluations and insights can be obtained.

1. The skill-level values of competition and cooperation for customers and service providers can vary with dynamic service contexts.
2. It is difficult to fully quantify the skill-level between service providers and customers. After some experiments were performed using different skill-level value settings, the skill-level values of competition and cooperation can be set to approach reality, revealing different coopetition strategies of customers and service providers.
3. Customer expectations can be effectively managed in real-time service contexts in accord with service provider goals.
4. By offering different service components corresponding to determinants of expectations, customer expectations can be better managed and a narrower zone of tolerance can be achieved (as shown in Figs. 9–11). The simulation results also show that not only are customer expectations regarding the focal stereotype A obviously affected, but those of stereotypes B and C can also be managed using the expectation-based coopetition approach. According to the simulation results, the expectation-based coopetition approach can help service providers dynamically deliver suitable service experiences to customers by managing customer expectations in real-time service contexts. When service providers manage customer expectations well, their competitiveness improves as they become the exclusive providers to customers. Service providers can then attract more customers to use their services, solving the problem of finding potential customers' discovery.
5. The needs and values of each stakeholder can easily be accomplished.
6. Initially the expectation-based coopetition approach aims to identify the added value for each stakeholder to explore the optimal solutions. The experimental results indicate that the proposed solutions can truly fulfill customer needs (as depicted in Fig. 12). Service providers have a significant opportunity to offer appropriate services to match customer preferences.
7. Applying the expectation-based coopetition approach in service experience delivery service contexts can achieve a high performance ecosystem.

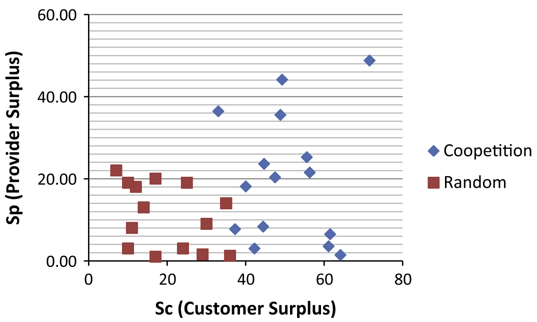


Fig. 13. Results of 15 visitors' journeys respectively after the coopetition interactions and the random visits.

8. Delivery of services to customers by different service providers within different service encounters can be considered a service ecosystem. The solution produced using the proposed approach has a good performance which indicates that the service ecosystem is in a high performance state that optimizes stakeholder satisfaction (as depicted in Fig. 13). Accordingly, both service providers and customers can derive value during service experience delivery through the proposed approach. For instance, service providers can derive profits and have repeat customers, and customers can be satisfied with expected services.
9. The managerial implications for service providers.
10. Despite high human adoption of information technology throughout the globe, room remains for information technology to learn from humans. Furthermore, competition generally exists among different service providers rather than between service providers and customers. This study proposes an innovative means of coopetition between service providers and customers that both service providers and academic researchers can utilize for improving service experience design and delivery. Service providers and academic researchers can adopt this coopetition perspective to examine possible interactive behaviors of service providers and customers during service experience delivery. Furthermore, because service providers dynamically deliver appropriate services to customers to maximize customer satisfaction by managing customer expectations in real-time service contexts via the expectation-based coopetition approach, they can flexibly adjust existing resources (including service cost, employees, service operations, time and, etc.) to design and deliver the above services. Consequently, service providers can optimize performance using the expectation-based coopetition approach in real-time service contexts.

5. Conclusion

In the era of the experience economy, service providers must create and design quality services that provide customers with positive and memorable experiences and thus achieve customer satisfaction. Service providers can effectively maintain customer loyalty by continuously increasing customer satisfaction through quality service experiences. Consequently, how to design quality service experiences is a crucial topic for service providers. According to Parasuraman et al. [22] and Zeithaml et al. [32], understanding customer expectations cannot only help service providers to deliver suitable service experiences to customers, but can also easily increase customer satisfaction. Customer expectation management is a useful method in designing service experiences. Although previous studies have extensively discussed customer expectation management, few studies have applied the idea of customer expectation management to real-time service contexts. Meanwhile, it is extremely tough to dynamically deliver high quality service experiences to carefully targeted customers by managing customer expectations.

In addition, while service providers must understand customer needs before they can provide suitable service experiences, they must also consider their own capabilities, resource allocation and business goals. Service providers may not completely fulfill customer wants. However, customers must also consider their own expectations to determine whether they can accept the service experiences delivered to them. In service experience delivery, service providers and customers interact by playing different strategic roles (i.e. the collaboration and competition strategies). To explore helpful solutions for responding to the above research questions, the key considerations are that service providers should properly design and deliver appropriate service experiences through which they can work together with customers to co-create values, and that service providers must dynamically manage customer expectations in real-time service contexts. Consequently, this study presents a novel expectation-based coopetition approach to design service experiences based on customer expectation management.

To evaluate the feasibility and the performance of the expectation-based coopetition approach, this study conducted four sets of experiment using mutli-agent simulations. The simulation results show that the desired and adequate expectations of customers can be effectively managed by the expectation-based coopetition approach in real-time service contexts, and that customers also have high satisfaction after service experience delivery. As mentioned earlier, the service experience delivery process can be considered as an ecosystem. A high performance ecosystem can be established through the expectation-based coopetition approach. Consequently, the expectation-based coopetition approach represents an appropriate method to help service providers design and deliver quality service experiences and co-create value with customers. That is, service providers can effectively manage customer expectations in real-time service contexts to offer quality service experiences.

However, this study still has some limitations. First, to illustrate the feasibility of the proposed approach, this study conducted several experimental simulations, yet real field testing is required to apply the approach into something practical and workable. To analyze environmental variation and customer feedback results requires adjusting the proposed approach iteratively to refine the approach in the future. Second, it is necessary to increase the number of simultaneous customer interactions. Service contexts are dynamic and difficult to pin down. Thus a future study should attempt to build a real-time system to design quality service experiences and thus create value for both service providers and customers. However, the service context variables are complex with various stimuli. In the future, to improve the simulations, multiple methods can be used simultaneously to simulate the service ecosystem and expected to accurately emulate real world conditions.

References

[1] D.G. Altman, J.M. Bland, Statistics notes: diagnostic tests 1: sensitivity and specificity, British Medical Journal 308 (6943) (1994) 1552.
[2] Basel Committee on Banking Supervision, Operational Risk, Basel, Report, January 2001, pp. 1–30.
[3] L.L. Berry, L.P. Carbone, S.H. Haeckel, Managing the total customer experience, Sloan Management Review 43 (3) (2002) 85–89.
[4] M.J. Bitner, S.W. Brown, M.L. Meuter, Technology infusion in service encounters, Journal of the Academy of Marketing Science 28 (138) (2000) 138–149.
[5] A.M. Brandenburger, B.J. Nalebuff, Co-opetition, Doubleday, New York, 1996.
[6] V. Cacchiani, A. Caprara, M. Fischetti, A Lagrangian heuristic for robustness, with an application to train timetabling, Transportation Science 46 (1) (2012) 124–133.
[7] V. Cacchiani, P. Toth, Nominal and robust train timetabling problems, European Journal of Operational Research 219 (3) (2012) 727–737.
[8] K.E. Clow, J.L. Beisel, Managing consumer expectations of low-margin, high-volume services, Journal of Services Marketing 9 (1) (1995) 33–46.
[9] K.E. Clow, D.L. Kurtz, J. Ozment, B.S. Ong, The antecedents of consumer expectations of services: an empirical study across four industries, Journal of Service Marketing 11 (4) (1997) 230–248.
[10] R.W. Coye, Managing customer expectations in the service encounter, International Journal of Services Industry Management 15 (1) (2004) 54–71.
[11] B. Edvardsson, B. Enqulst, R. Johnston, Cocreating customer value through hyperreality in the prepurchase service experience, Journal of Service Research 8 (2) (2005) 149–161.
[12] J.A. Fitzsimmons, M.J. Fitzsimmons, Service Management: Operations, Strategy, Information Technology, third ed., McGraw-Hill Irwin, New York, 2006.
[13] F. Frei, Breaking the trade-off between efficiency and service, Harvard Business Review 84 (11) (2006) 92–101.
[14] R.H. Glitho, F. Khendek, A. De Marco, Creating value added services in Internet telephony: an overview and a case study on a high-level service creation environment, IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews 33 (4) (2003) 446–457.
[15] S. Haeckel, L. Carbone, L. Berry, How to lead the customer experience, Marketing Management 12 (1) (2003) 18–23.
[16] Y.H. Hsieh, S.T. Yuan, Design of the customer expectation measurement model in dynamic service experience delivery, Pacific Asia Journal of the Association for Information Systems 2 (3) (2010) 1–19.
[17] D.L. Kurtz, K.E. Clow, Managing consumer expectations of services, The Journal of Marketing Management 2 (2) (1993) 19–25.
[18] Y. Lee, O. Kwon, Intimacy, familiarity and continuance intention: an extended expectation–confirmation model in web-based services, Electronic Commerce Research and Applications 10 (3) (2011) 342–357.
[19] C. Loebecke, P.C.V. Fenema, P. Powell, Coopetition and knowledge transfer, The Database for Advances in Information Systems 30 (2) (1999) 14–25.
[20] R.F. Lusch, S.L. Vargo, The Service-Dominant Logic of Marketing: Dialog, Debate and Directions, M.E. Sharpe, Armonk, NY, 2006.
[21] D.C. Ngo, M. Okura, Coopetition in a mixed duopoly market, Economics Bulletin 12 (21) (2008) 1–9.
[22] A. Parasuraman, L.L. Berry, V.A. Zeithaml, Understanding customer expectations of service, Sloan Management Review 32 (3) (1991) 39–48.
[23] B.J. Pine, J.H. Gilmore, Welcome to the experience economy, Harvard Business Review 76 (4) (1998) 97–105.
[24] M.E. Pullman, M.A. Gross, Welcome to your experience: where you can check out anytime you'd like, but you can never leave, Journal of Business Management 9 (3) (2003) 215–232.
[25] M.E. Pullman, M.A. Gross, Ability of experience design elements to elicit emotions and loyalty behaviors, Decision Science 35 (3) (2003) 531–576.
[26] R.T. Rust, K.N. Lemon, E-service and the consumer, International Journal of Electronic Commerce 5 (3) (2001) 85–102.
[27] J.N. Sheth, B. Mittal, A framework for managing customer expectations, Journal of Market-Focused Management 1 (2) (1996) 137–158.
[28] M.J. Sanchez-Franco, F.J. Rondan-Cataluna, Virtual travel communities and customer loyalty: customer purchase involvement and web site design, Electronic Commerce Research and Applications 9 (2) (2010) 171–182.
[29] L.L. Thurstone, Fechner's law and the method of equal appearing intervals, Journal of Experimental Psychological 12 (1929) 214–224.
[30] S.L. Vargo, R.F. Lusch, Evolving to a new dominant logic for marketing, Journal of Marketing 68 (January) (2004) 1–17.
[31] K. Wägar, A contingency approach to a customer loyalty model: An application to the mobile service context, Managing Service Quality 17 (6) (2007) 635–655.
[32] V.A. Zeithaml, L.L. Berry, A. Parasuraman, The nature and determinants of customer expectations of service, Journal of the Academy of Marketing Science 20 (1993) 1–12.