Available online at www.sciencedirect.com
ScienceDirect
Tourism Management 29 (2008) 980–993
TOURISM MANAGEMENT
www.elsevier.com/locate/tourman

Do airline self-service check-in kiosks meet the needs of passengers?

Hsin-Li Chang[a,*], Cheng-Hua Yang[b,1]

[a]Department of Transportation Technology and Management, National Chiao Tung University, No. 1001, Ta-Hsueh Road, Hsinchu 300, Taiwan
[b]Department of Airline Management, National Kaohsiung Hospitality College, No.1, Sung-Ho Road, Hsiao-Kang, Kaohsiung 812, Taiwan

Received 13 February 2007; accepted 20 December 2007

Abstract

This study aims to (i) explore the importance and performance of services provided by kiosks and (ii) identify managerial strategies to increase kiosk attractiveness in order to be a viable option for passengers. The service attributes influencing service quality were first determined via the critical incident technique (CIT), following which a questionnaire was designed for data collection. Relative to an identified distribution (Ridit) values were applied to conduct the importance–performance analysis (IPA) rather than the mean values of raw ordinal scores. Our results indicate that potential kiosk users expect their check-in environment to be highly controlled. Airlines may mitigate frequent flyers' resistance to kiosks by providing additional benefits or seat-selecting privileges. Finally, kiosks are expected to be light and compact, and should be installed near the luggage conveyor belt to provide satisfactory service for both airlines and passengers in the limited space available.

Keywords: Self-service kiosks; Ridit analysis; Importance–performance analysis

1. Introduction

The current global economic downturn, combined with soaring fuel prices, has resulted in deteriorating airline profitability. Every major stakeholder understands that his/her business must be made more efficient and the products should be of high quality. This efficiency/effectiveness drive has encouraged the International Air Transport Association (IATA) to announce the "Simplifying the Business" campaign at its 60th annual general meeting (Field, 2004; Pilling, 2005). In practice, IATA has made an effort to implement five initiatives—electronic ticketing, common-use self-service (CUSS) kiosks, bar-coded boarding passes, radio frequency identification, and paperless cargo (IATA Pressroom, 2004). These five innovations are expected to reduce the operating costs and enrich its passengers' travel experience.

Airport infrastructure is the first and the last point of tourist contact at a destination. Thus, airport infrastructure significantly affects tourist perception of service quality (Rendeiro & Cejas, 2006), and can be regarded as a product similar to the promptness of service and on-time programming (Getz, O'Neill, & Carlsen, 2001; Rendeiro & Cejas, 2006). Kiosks (automated self-service check-in machines) are designed as one form of airport infrastructure, and act as a (i) time saver for passengers, (ii) cost saver for airlines, and (iii) space saver for airports (IATA, 2006)—these benefits are achieved through kiosks' multiple functions of letting passengers quickly and easily check in at airports, select or change seats, update their frequent-flyer status, and receive boarding and lounge passes. Air passengers typically spend a great deal of time checking in, especially during peak hours. Airlines are therefore eager to promote the utilization of kiosks to achieve these benefits (notably, reduction of the overall cost of the check-in process and alleviation of passenger queues). Self-service technologies have already been extensively implemented in the airline industry. IATA estimates CUSS savings of US$2.50 per check-in. With a 40% market penetration at every airport, the total annual industry savings add to US$

*Corresponding author. Tel.: +886 3 5731908; fax: +886 3 5712365.
E-mail addresses: hlchang@cc.nctu.edu.tw (H.-L. Chang), edwardyang0920@gmail.com (C.-H. Yang).
[1]Tel.: +886 937 324112.

0261-5177/$ - see front matter
doi:10.1016/j.tourman.2007.12.002

1 billion (Lott, 2005). Most major airlines have already invested in installing self-service kiosks to save expense at check-in, and build an image of maintaining a leading position in electronic service. According to a survey conducted by the Société Internationale de Télécommunications Aéronautiques (SITA), airlines expect the majority of passengers to use kiosks by 2008 (ATCA News, 2005).

As airlines struggle for a widespread adoption of self-service technology, it is increasingly important to understand the factors affecting customers' attitudes toward these kiosks and the consumer adoption behavior for the new technology (Liljander, Gillberg, Gummerus, & Riel, 2006). However, although substantial research has been conducted to study the functions, technologies, and information management of self-service kiosks (Maguire, 1999; Ni & Ho, 2005; Nicholas, Huntington, & Williams, 2003; Tung, 1999), despite their widespread installation throughout the world, little research has been performed to determine whether self-service kiosks provide a sufficiently high-quality service for air passengers.

This study was conducted to explore the importance and performance of service quality provided by self-service kiosks for air passengers. The critical incident technique (CIT) was applied to explore the factors affecting air passengers' satisfaction and dissatisfaction whilst using self-service kiosks. A questionnaire was then formed based on the results of the CIT; the questionnaire was intended to collect opinions on the importance and performance of service quality provided by the self-service kiosks at airports. An empirical study was then undertaken to interview 590 air passengers at the Taiwan Taoyuan International Airport (previously known as Chiang Kai-shek Airport). Finally, the relative to an identified distribution (Ridit) values were computed to compare the relative importance and performance of service items in self-service kiosks. The results not only provide valuable information for improving the service quality of self-service kiosks, but will also assist the industry in developing a CUSS standard that will enable airlines to share kiosks.

2. Applying the critical incident technique for questionnaire design

2.1. Kiosks installed at Taiwan's international airport

The kiosk systems currently employed at most primary airports can be divided into two groups. These are: CUSS kiosks, which comply with the IATA CUSS specifications and are shared by a number of airlines, and dedicated kiosks installed by individual airlines. Amongst the airlines that fly international routes and have their customer service base in Taiwan, three relatively large-scale airlines maintain dedicated kiosks at the Taoyuan Airport; of these three airlines, one is based in America, one in Taiwan, and one in Hong Kong. The Hong Kong- and Taiwan-based airlines have provided kiosk services at the Taoyuan Airport since November 2001 and August 2002, respectively. The kiosk machines of these two airlines are of the same generation, and the service provided and incentive programs for marketing purposes are quite similar. The American airline did not provide any kiosk service at the Taoyuan Airport until January 2005. Therefore, the style of its kiosk machine is more compact and modern than those of the other two competing airlines; although the American airline's kiosk provides services similar to those of the other two airlines, it is placed between the check-in counter and the conveyor belt due to greater compactness and provides more comprehensive functions for luggage check-in.

The American airline operates only one flight daily from Taipei to Detroit through Osaka, and has relatively few passengers, in comparison to the other two airlines. However, the American airline was found to have a higher proportion of American and European passengers who are relatively familiar with the concept of self-service, and thus more likely to use kiosks than the Asian passengers.

2.2. Collecting incidents of kiosk use

The CIT is a set of procedures for gathering and analyzing reports of incidents and behaviors observed first hand, that involve "certain important facts concerning behavior in defined situations" (Flanagan, 1954, p. 335). An incident may be defined as "critical", indicating that the action makes a significant contribution (either positively or negatively) to an activity or phenomenon. The CIT analysis was introduced by Flanagan (1954) in the Aviation Psychology Program of the US Air Force. Initially its primary use was to aid personnel selection and identification of pilot errors. In recent years, CIT analysis has been employed in numerous ways, including: service management (Dwayne, 2004), self-service technologies (Meuter, Ostrom, Bitner, & Roundtree, 2003), and social sciences.

In order to better understand the function and operational procedures of kiosks, an on-site participant observation was approved by the business owners before conducting the CIT interview. Critical incident data were then collected from randomly sampled passengers who had visited the express baggage drop-off counters or the kiosks in the airport. Only those sampled passengers who had used kiosks for check-in were chosen to participate in the follow-up survey. The respondents were then questioned in English, Japanese, or Mandarin by interviewers. These questions included: (i) How many times have you been in contact with kiosks during the past year? (ii) Would you prefer to check in at the kiosks or at the check-in counter? Why? (iii) Do you mind describing the situations that made you feel satisfied or dissatisfied when you were using a kiosk to check-in? After eliminating invalid answers, 564 acceptable cases of satisfying episodes and 580 acceptable cases of dissatisfying episodes comprised our data set.

2.3. Identifying the attributes affecting service satisfaction

The incidents encountered by passengers who had used kiosks were diverse, but some of them were essentially similar. Some manipulation was needed in order to abstract and identify those incidents that may affect kiosk usage satisfaction. Thus, the incidents were further classified and assigned to one of the following five service attribute groups of the ''attribute-based model'' developed from consumer expectations of self-service technologies (Dabholkar, 1996). These five groups include:

- Expected speed of delivery (ESOD): The items in this group emphasize the time waiting for service and the speed of service delivery at the counter.
- Expected ease of use (EEOU): How easy would it be to use the technology-based self-service option?
- Expected reliability (ER): Reliability refers to whether a technology is perceived as reliable and perfect, or whether risk is involved in the process. Ram (1989) suggests four forms of risk make customers more resistant to innovation: (i) functional risk: the fear of performance uncertainty, (ii) economic risk: the fear of economic loss, (iii) social risk: the fear of social obstruction, and (iv) psychological risk: the fear of psychological discomfort.
- Expected enjoyment (EE): This item emphasizes the words ''enjoyable'', ''fun'', ''entertaining'', and ''interesting'' in order to capture the aspect of novelty in this construct before providing the context of service innovation.
- Expected control (EC): This item can be defined as ''the amount of control that a customer expects he/she has or will have over the process or outcome of a service encounter''. The belief of a person that he/she has (or will have) on control (even in the absence of real control), will result in benefits similar to those associated with the actual control (Glass & Singer, 1972; Langer, 1975).

The data classification was executed by three panelists in three stages. In the first stage, each panelist was asked to individually assign each of the collected incidents to one of the five designated groups. Secondly, the incidents within each group were further clustered into several subgroups according to their characteristics. In the last stage, the subgroups generated by the three panelists were pooled and compared, and the discrepancies between panelists' classifications were discussed and modified. Eighteen subgroups were finally obtained, and each subgroup was given a title and described by a statement of its service attributes. The 564 satisfying episodes and 580 dissatisfying episodes were once more assigned to the 18 developed subgroups with the help and cooperation of these three panelists. The frequencies n_i of collected satisfying and dissatisfying episodes for each subgroup i are summarized in Table 1. We observed that a significant proportion of satisfying episodes are concentrated within a few subgroups, including: ''travel information for destination'', ''hot news, promotions and advertisements'', ''one-shot multi-passengers check-in'', ''friendly input interface'', and ''quick response to inquiry''. In contrast, dissatisfaction is concentrated in ''one-stop baggage service'', ''connecting flight check-in'', ''correctness of identity authentication'', and ''incentive programs for using kiosks''.

2.4. Verification for classification reliability and content validity

Although the benefits of the CIT method are considerable, the process of its data classification has been criticized on the basis of reliability (Chell, Elizabeth, & Pittaway, 1998; Singh & Wilkes, 1996). Dwayne (2004) indicated that reliability of data classification would be ensured by panelists' abilities as well as consistency in the classification of incidents into specified groups. In order to verify the reliability of incident classification, another three experts were invited to assign the collected incidents into the 18 developed subgroups once more. If the experts could not find an appropriate subgroup to assign the incidents, they were allowed to form a new subgroup. However, no new subgroups were suggested for either satisfying or dissatisfying episodes by the three new experts.

The inter-judge and intra-judge consistencies of these new experts' incident classifications were also collected to verify the reliability of the developed subgroups. The inter-judge consistency was determined by the regularity of classifications of incidents into specified subgroups, while the intra-judge consistency is measured by individual classifications of incidents into subgroups over time (Weber, 1990).

To measure the inter-judge consistency, this study referred to the formula developed by Holsti (1969). Our experimental results indicated that Holsti's coefficients of reliability for both satisfying and dissatisfying episodes were greater than 0.9, thus implying that the inter-judge reliability was relatively high. For the intra-judge consistency, all three new experts were asked to undertake the incident classification once again 2 weeks after the first incident classification was completed. Amongst the 564 satisfying episodes, the consistent assignments numbered 549, 552, and 557 for the three experts. Of the 580 dissatisfying episodes, there were 568, 573, and 574 consistent assignments for the three experts. These experimental results indicated that the intra-judge consistencies were high and therefore convincing. From the viewpoint of Keaveney (1995), the classification outcome can be trustworthy if the level of the two reliability indices are greater than 0.8.

Besides, the content validity ratio (CVR) method (Lawshe, 1975) was also applied to evaluate the appropriateness of the questionnaire and screen items. Nine experts (including senior executives of the three concerned airlines) were invited to examine the suitability of the items with the use of both qualitative and quantitative analyses. In the qualitative analysis, experts were asked to note their

Table 1
Frequency of episodes for service attribute groups and subgroups during use of self-service kiosks

Service attribute groups and subgroups	Item description	Satisfying episodes		Dissatisfying episodes	
		n_i	$n_i/\sum_{i=1}^{18} n_i$ (%)	n_i	$n_i/\sum_{i=1}^{18} n_i$ (%)
I. Expected speed of delivery (ESOD)					
01. Sufficient quantity of machines	Provide enough kiosks in departure hall	20	4	34	6
02. Quick response to inquiry	Respond the desired information quickly	42	7	17	3
03. Connecting flight check-in	Provide inter/intra-airline connecting flight check-in	14	2	56	10
04. One-shot multi-passenger check-in	Provide the check-in service for all the passengers on the same reservation at one time	50	9	11	2
II. Expected ease of use (EEOU)					
05. Multiple ways to authenticate users	Passengers can log in by passport, frequent-flyer card, credit card, or membership card numbers as well as ATB2 coupon for identification purposes	33	6	26	4
06. Assistance by unfixed customer service receptionist	Provide assistance from attendant for using kiosk in response to request	35	6	14	2
07. Friendly input interface	Provide touch-screen input interface and icon-based menu	46	8	12	2
III. Expected reliability (ER)					
08. Correctness of identity authentication	Provide the right service for the right passengers via kiosks	15	3	54	9
09. Problem solving for service failure	Provide notices and guidance in case of wrong operation, service limitation, or system failure	25	4	42	7
10. System reliability	Provide stable and reliable service	27	5	38	7
IV. Expected enjoyment (EE)					
11. Hot news, promotions, and advertisements	Provide hot news, promotion programs, and duty-free shopping menu through kiosks	54	10	9	2
12. Travel information for destination	Provide the weather, exchange rate, and local contact information for users' destinations and offer printouts if required	65	12	5	1
13. Incentive programs for using kiosks	Provide incentive programs to encourage kiosk usage, such as bonus mileage or discounted fares	17	3	51	9
V. Expected control (EC)					
14. View, update and redeem mileage for award	Provide the function to inquire about or update the mileage accumulation record, and exchange redeemed mileage for awards through kiosks	28	5	37	6
15. One-stop baggage service	Provide step-by-step guidance to instruct passengers to put their luggage on the conveyor belt, print out luggage tags by self-service, and wait for the staff to paste the tags onto the luggage	11	2	63	11
16. Select seats, alter or cancel the reservation	Provide the functions to select seats, change seats, take another flight, or cancel the boarding after receiving the boarding pass	38	7	17	3
17. e-Ticket purchase	Passengers with a confirmed reservation can purchase tickets at the kiosks using credit cards	21	4	49	8
18. Seat-selecting privileges for frequent flyers	Provide the privilege of seat-selecting priority for frequent flyers	23	4	45	8
Total		564	100	580	100

comments on each item and correct the item if necessary. In the quantitative analysis, experts were asked to judge "Is the investigation target measured by this item essential, useful but not essential, or not necessary to the importance or performance of the construct?", we then evaluated the content validity for each of the 18 items using the formula developed by Lawshe (1975). The computed results illustrated the acceptability of all our 18 items.

3. Data collection and validation of measurement scales

3.1. Data collection

Based on the 18 subgroups developed through the CIT procedure, a questionnaire with 18 items, in which each item corresponded to one subgroup of service attribute, was then designed to collect customers' opinions on using kiosks. The respondents were asked to indicate their opinions regarding the "importance" and "satisfactions with the performance" of each service attribute provided by kiosks via a five-point Likert scale. The 18 items on "importance" and "performance" were shuffled in order to avoid possible interference.

A survey conducted via face-to-face interviews was conducted in the immigration hall of the Taoyuan Airport in early August 2006. The interviewees were randomly selected and initially asked whether they had used a kiosk to check in at Taiwan's airport so as to identify suitable subjects for the interview. If the interviewees answered "yes", they were first invited to rate (on a five-point Likert scale) how important they felt the 18 service attributes were in motivating them to use kiosks—the possible categories are listed as follows: very important, important, neutral, not important, and not important at all. They were further asked to express their satisfaction with the performance of these 18 service attributes provided by existing kiosks on another five-point Likert scale, also listed as follows: very satisfied, satisfied, neutral, dissatisfied, and very dissatisfied.

As mentioned in Section 2.1, the kiosk provided by the American airline is somewhat different from those provided by the two Asian airlines. In order to avoid a contradiction in passenger behavior because of different types of kiosks, the sampled respondents were segmented into two groups according to the kiosks they had used. The respondents who had used the kiosks provided by the two Asian airlines were assigned to the "old-styled kiosk users" group, and those who had used the kiosks provided by the American airline were assigned to the "new-styled kiosk users" group. A few sampled passengers had used both the new and old-styled kiosks; these participants were assigned to the groups according to the kiosks that they had used more frequently. Of the 590 respondents, the classifications of "old" and "new" style kiosk users were 428 and 162 passengers, respectively.

Amongst the 428 old-style kiosk users, 56.8% were male and 43.2% were female. The primary age group was 31–40, representing 39.7% of the respondents; the other three main age groups were 41–50 (21.0%), 21–30 (19.2%), and 51–60 (10.3%). More than half of the old-style kiosk users were educated to at least college level (55.1%), and 25.5% had high school diplomas. The main destinations of the sampled old-style kiosk users were: Hong Kong and Mainland China (36.9%), Northeast Asia (26.2%), the United States (17.1%), and Southeast Asia (14.5%). With regard to nationality, 77% were from Asian countries, 12% from America and Canada, and 7% from Europe. The distributions of gender, age, and educational background of the 162 sampled users of new-styled kiosks were not significantly different from those of the sampled old-styled kiosk users. However, 68% of the sampled new-styled kiosk users were traveling to Osaka and 32% were leaving for Detroit. With respect to nationality, 47% were from Asian countries, 34% from America and Canada, and 16% from Europe.

3.2. Validation of measurement scales

In order to further ensure that the designed questionnaire can effectively collect passengers' opinions, this study adopted exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to examine the construct validity and reliability of the proposed measurement scales (Anderson & Gerbing, 1988).

Although the respondent passengers in this study were verified to have statistically consistent evaluations on the importance of service attributes by Kendall's *W* test (Kendall & Smith, 1939), no matter using old- or new-styled kiosks, passengers' evaluations on the performance of these two different types of kiosk were somewhat different. That is, the items that were eliminated due to insufficient statistical power in explaining the proposed measurement scales were different in the old and new kiosk models, after conducting EFAs and CFAs. Furthermore, both the "importance" and "performance" for each service attribute item should be measured in order to conduct the importance–performance analysis (IPA). There may be difficulties in guaranteeing that the reserved items are the same and belong to the same construct for both the "importance" and "performance" measurement scales.

As for the purpose of this study, EFAs and CFAs are used to examine whether the measurement scales have reasonable construct validity and reliability rather than to perform the structural models, which validate the relationships among variables. In addition, the "attribute-based model" used in Section 2.3 for incident classification is based on what consumers would expect from technology-based self-service options (Dabholkar, 1996), thus, it provides a systematic approach to explore the important facts concerning kiosk usage from the respondents' perspectives. Therefore, we finally decided to develop a reliable and valid measurement scale for the "importance of service item" first through EFAs and CFAs, and then used the reserved items to measure their corresponding performance.

Kendall's *W* test (Kendall & Smith, 1939) confirmed that the users of different types of kiosks had no significant difference on the entire attitude of importance (Kendall's *W* coefficient of concordance is 0.94, χ^2 value is 32.11, and the *P*-value of asymptotic significance level is 0.015). Thus, the questionnaires for both types of kiosks were combined for follow-up EFAs and CFAs. We first employed the EFAs to explore the possible underlying factor structures of a set of observed variables. Eigenvalues were used to determine the number of factors to be extracted and a five-factor structure was suggested. We used the criteria of eigenvalues greater than 1 and the extracted factors accounted for 77.34% of the total variance (KMO = 0.79). A vari-max rotation method was also performed, where all factors less than 0.5 were suppressed. As a result of the EFAs, we excluded the first item from the questionnaire.

To verify the proposed measurement model, the relationship between the 17 reserved variables, and their underlying latent constructs (five factors), this study used LISREL 8.52 to conduct CFAs and found that the *t*-values of the measurement errors of the 6th and 12th items are less than 1.96, indicating that the estimating parameters of these two items are below the significance level of 0.05. Thus, this study further eliminated these two items from the questionnaire, and conducted a second EFA and CFA. In the new EFA, a five-factor structure was suggested, with eigenvalues of 5.15, 2.78, 1.71, 1.60, and 1.39; its extraction sums of squared loadings are 34.33%, 18.51%, 11.41%, 10.66%, and 9.26%; and the extracted factors accounted for 84.18% of the total variance (KMO = 0.82).

According to Jöreskog and Sörbom (1989), the quality of CFA should be judged by the overall model fitness and internal model fitness. For the evaluation of overall model fit, the significance level of $p = 0.00$ does not support the hypothesis of equal variance, which may be a result of large sample size ($n = 590$); however, the ratio of the χ^2 value to the degree of freedom ($190.44/80 \approx 2.38$) is lesser than the cutoff point of 3, as suggested by Bagozzi and Yi (1989). Furthermore, the goodness-of-fit index (GFI = 0.96), adjusted goodness-of-fit index (AGFI = 0.94), normed-fit index (NFI = 0.98), non-normed-fit index (NNFI = 0.98), comparative-fit index (CFI = 0.99), incremental-fit index (IFI = 0.99), and relative-fit index (RFI = 0.97) are all greater than the marginal acceptance level of 0.9. The root-mean-square residual (RMR = 0.038) and root-mean-square error of approximation (RMSEA = 0.048) are both less than 0.05. Therefore, the empirical data support acceptance of the overall model.

The evaluation of internal model fit included the examination of internal consistency, convergent validity, and discriminant validity. Internal consistency of the constructs was evaluated with composite reliability (CR), as defined by Fornell and Larcker (1981). Previous literatures suggested the level of 0.6 for evaluating CR, which can be used to assess internal consistency (Anderson & Gerbing, 1988; Bagozzi & Yi, 1989). Convergent validity indicates the degree to which multiple items measuring the same construct agree. Convergent validity is adequate when constructs have an average variance extract (AVE) of at least 0.5 (Fornell & Larcker, 1981). Discriminant validity is the degree to which items differentiate between constructs. Each item should correlate more highly with other items of the same construct than with items of other constructs. In Table 2, R^2 values of 15 observed variables are evenly distributed from 0.53 to 0.92, CRs of the five latent constructs are distributed from 0.85 to 0.93, and AVEs are distributed from 0.7 to 0.84. The statistics in the present study meet the requirements. This evidence shows the satisfactory internal consistency and convergent validity of this study.

Regarding discriminant validity, Hairs, Anderson, Tatham, and Black (1998) suggested that a multi-trait/multi-method matrix be used for validation purposes. The square root of AVE for each construct in the validity diagonal should be not only consistent with the highest in the matrix, but also higher than the correlation coefficients lying in its column and row in the same latent construct. As shown in Table 3, the correlation between any two constructs was lesser than the squared root of AVE by the items measuring the constructs, indicating that the measurement model is discriminated adequately between the constructs.

Based on the validation results of the overall model and internal model fit as discussed above, this study is predominantly confirmatory because it determines the

Table 2
Evaluation of internal consistency and convergent validity

Construct	Item number	Item reliability			CR	AVE
		SFL	*T*-value	R^2		
Expected speed of delivery (ESOD)	02	0.88	26.11**	0.77	0.91	0.78
	03	0.90	27.42**	0.81		
	04	0.87	25.70**	0.76		
Expected ease of use (EEOU)	05	0.93	19.67**	0.86	0.91	0.84
	07	0.91	19.30**	0.83		
Expected reliability (ER)	08	0.89	27.18**	0.79	0.93	0.83
	09	0.94	29.97**	0.88		
	10	0.89	27.34**	0.79		
Expected enjoyment (EE)	11	0.92	18.25**	0.85	0.85	0.74
	13	0.80	16.49**	0.64		
Expected control (EC)	14	0.75	21.02**	0.56	0.92	0.70
	15	0.73	20.32**	0.53		
	16	0.90	27.73**	0.81		
	17	0.84	24.92**	0.71		
	18	0.96	31.44**	0.92		

Notes: (1) SFL: standardized factor loading; (2) "**": significant at $p<0.01$, $|t\text{-value}|>2.58$.

Table 3
Multi-trait/multi-method matrix

	ESOD	EEOU	ER	EE	EC
ESOD	*0.88*				
EEOU	0.13	*0.92*			
ER	0.28	0.22	*0.91*		
EE	0.29	0.17	0.29	*0.86*	
EC	0.06	0.27	0.34	0.24	*0.84*

Notes: Diagonal elements, given in italics, are the square root of average variance extracted.

extent to which the proposed model is consistent with the empirical data.

4. Data analysis

4.1. Ridit analyses

Ridit, an acronym for "relative to an identified distribution" (Bross, 1958), usually assists in analyzing data involving ordinal-scaled variables that fail to meet standards of refined measurement systems. Ridit is an especially helpful statistical approach for items involving self-ratings on a Likert scale; it applies a probability transformation according to an empirical distribution taken as a reference class (Huang & Tsai, 2003; Pouplard, Qannari, & Simon, 1997). Ridit analysis was employed in this study to explore the "importance" and "performance" of the service quality of kiosks, and investigate which items were considered to be important service attributes and determine which service attribute items must be improved in existing kiosks.

Consider an $i \times j$ contingency table, with the ith row representing the ith service attribute item and the jth column representing the jth ordinal-scale value of agreement with the corresponding items. The value of n_{ij} represents the number of observations that rated the jth ordinal-scale value of agreement with the ith service attribute item. In this study, a smaller ordinal value represents lower agreement with "importance" or "satisfaction with the performance" of the corresponding service attributed items for using kiosks. Presumably, there is a standard distribution amongst the five-point scale values for the population $\{\pi_j; j = 1,2,3,4,5\}$. The r_j represents the average accumulated probability up to the jth ordinal response.

Let

$$r_1 = \frac{1}{2}\pi_1, \quad r_j = \left(\sum_{k=1}^{j-1} \pi_k\right) + \frac{1}{2}\pi_j, \quad j = 2, 3, 4, 5,$$

where $\pi_j = n_j/n$, n_j is the number of observations for the specific jth category summed over the 15 items, and $n = n_{.1} + n_{.2} + \cdots + n_{.5}$. Therefore, the relationship of $r_1 < r_2 < r_3 < r_4 < r_5$ is assured according to the rank of the order, and it leads to the result of $R_{ij} = r_j \pi_{ij}$, in which π_{ij} represents the jth ordinal probability of the ith service attribute item.

In order to assess the relative position of the ith service attribute item amongst all 15 items, we fix the ith row and summarize the values of R_{ij} over all five ordinal categories to gain the Ridit value of the ith service attribute item (R_i) by using the formula $R_i = \sum_{j=1}^{5} R_{ij}$. Theoretically, the mean value for the Ridit values of all 15 service attribute items equals 0.5 (Agresti, 1984). Accordingly, the Ridit value of 0.5 will be the threshold to determine whether the corresponding service attribute item is relatively important or satisfactory amongst the 15 items in this study. Higher values of R_i for importance (or performance) indicate that more air passengers feel the ith service attribute kiosk item is important (or satisfactory).

The Ridit values, R_i, and their 95% confidence intervals for both the "importance" and "performance" of the 15 service attribute items are shown in Table 4 for both the old- and new-styled kiosks. Amongst these 15 items, the same 12 items for both the old- and new-styled kiosks were found to have Ridit values of "importance" significantly higher than 0.5 at $\alpha = 0.05$. Therefore, it was verified that differences in passengers' views (i.e., importance) on the nature of services provided by the kiosks appear independent of differences between the new and old kiosks. Further investigation found that amongst these 12 relatively important service attribute items, five items belonged to the "EC" group, three items to the "ESOD", two items to the "ER" group, and one item in both the "EEOU" and "EE" groups. It is apparent that "speed of delivery", "reliability", and "controllability" are the most important criteria concerning respondent kiosk usage.

Regarding the performance of the 15 service attribute items, seven were commonly found to have Ridit values significantly higher than 0.5 ($\alpha = 0.05$) for both the old- and new-styled kiosks. The sole difference between the two styles of kiosks was the excellent performance of the new-style kiosk's 15th item (one-stop baggage service), which provides an additional sense of control for passengers. Amongst these seven well-performing service attribute items, two items each to "ESOD" and "EEOU" and one item each for "ER", "EE", and "EC". The respondents appear more satisfied with the service attribute items belonging to "ESOD" and "EEOU". The results also indicate that the operational interface designs for current kiosks are user friendly and broadly approved by the public. However, passengers were quite disappointed with the items belonging to "EC" when using kiosks.

The Kruskal–Wallis W statistic provides a tool to test the null hypothesis H_0 that the importance (or performance) of all service attribute items is the same. This test statistic W can be calculated as follows:

$$W = \frac{12n}{(n+1)} \sum_{i=1}^{15} n_{i.}(R_i - 0.5)^2.$$

Table 4
Respondents' opinions on the importance and performance of kiosks

Groups	Service attribute items	Old-styled kiosk				New-styled kiosk			
		Importance		Performance		Importance		Performance	
		R_i	CI	R_i	CI	R_i	CI	R_i	CI
Expected speed of delivery	02. Quick response to inquiry	*.50*	*(.47, .52)*	*.64*	*(.62, .67)*	*.50*	*(.46, .54)*	*.65*	*(.61, .68)*
	03. Connecting flight check-in	*.55*	*(.52, .57)*	.36	(.34, .38)	*.53*	*(.49, .57)*	.31	(.28, .34)
	04. One-shot multi-passengers check-in	*.55*	*(.53, .58)*	*.67*	*(.65, .69)*	*.53*	*(.49, .57)*	*.66*	*(.63, .70)*
Expected ease of use	05. Multiple ways to authenticate users	*.52*	*(.49, .54)*	*.57*	*(.55, .60)*	*.51*	*(.47, .55)*	*.60*	*(.57, .64)*
	07. Friendly input interface	.45	(.42, .47)	*.66*	*(.63, .68)*	.43	(.39, .48)	*.64*	*(.61, .68)*
Expected reliability	08. Correctness of identity authentication	*.50*	*(.47, .52)*	.43	(.40, .46)	*.50*	*(.46, .54)*	.42	(.38, .45)
	09. Problem solving for service failure	*.50*	*(.47, .52)*	*.54*	*(.51, .56)*	*.50*	*(.46, .54)*	*.59*	*(.55, .63)*
	10. System reliability	.49	(.46, .52)	.49	(.47, .52)	.48	(.44, .52)	.43	(.39, .46)
Expected enjoyment	11. Hot news, promotions, and advertisements	.21	(.19, .23)	*.70*	*(.68, .72)*	.21	(.18, .25)	*.68*	*(.64, .71)*
	13. Incentive programs for using kiosks	*.52*	*(.50, .55)*	.34	(.32, .36)	*.53*	*(.49, .57)*	.28	(.25, .31)
Expected control	14. View, update and redeem mileage for award	*.52*	*(.49, .54)*	.49	(.47, .52)	*.55*	*(.51, .58)*	.33	(.29, .37)
	15. One-stop baggage service	*.61*	*(.59, .64)*	.31	(.28, .33)	*.60*	*(.57, .63)*	*.67*	*(.64, .70)*
	16. Select seats, alter or cancel the reservation	*.55*	*(.53, .58)*	*.60*	*(.57, .62)*	*.55*	*(.51, .59)*	*.60*	*(.55, .64)*
	17. e-Ticket purchase	*.50*	*(.48, .53)*	.33	(.31, .35)	*.52*	*(.49, .56)*	.33	(.29, .37)
	18. Seat-selecting privileges for frequent flyers	*.53*	*(.50, .55)*	.36	(.34, .39)	*.55*	*(.51, .59)*	.32	(.29, .35)

Notes: (1) Ridit value given in italic is significantly higher than 0.5 at $\alpha = 0.05$.
(2) 'CI'is the abbreviation of '95% confidence interval'.

Agresti (1984) indicated that if the sample sizes are large enough, W can be simplified to $12 \times \sum_{i=1}^{15} n_{i.}(R_i - 0.5)^2$. Our calculated values of the W statistic for the "importance" and "performance" of the 15 service attribute items are, respectively, 556.7 and 1363.6 for the old-styled kiosks, and 212.8 and 663.5 for the new-styled kiosks. All were greater than $\chi^2_{0.05}(14) = 23.7$, thus indicating that the 15 service attribute items were not of equal importance or performance. The meanings and comparisons of the relative importance and performance of the 15 service items are further analyzed and explained by the IPA in the following section.

4.2. *Importance–performance analysis*

IPA was originally introduced by Martilla and James (1977) and has become a broadly used analytical technique that yields prescriptions for the management of customer satisfaction (Anderson & Mittal, 2000; Matzler & Sauerwein, 2002; Matzler, Sauerwein, & Heischmidt, 2003). Typically, data from satisfaction surveys are used to construct a two-dimensioned matrix where importance is depicted along the y-axis and performance along the x-axis. Respondents are asked to rate each attribute on its importance and performance. Attribute importance/performance is measured via a form of self-stated importance/performance (e.g., rating scales, constant sum scales) or derived importance (e.g., multiple regression weights). The mean scores of importance and performance divide the matrix into four quadrants (Matzler, Bailom, Hinterhuber, Renzl, & Pichler, 2004). In practice, IPA is helpful in deciding the allocation of scarce resources to improve a company's performance and increase customer satisfaction (Bei & Shang, 2006; Magal & Levenburg, 2005).

Most of the traditional IPAs treat Likert scale data (which is based on the discrete nature of ordinal responses) as interval data to measure a continuous latent variable. Although common in practice, the treatment of ordinal data as interval data can produce biased statistical results that threaten the validity of resulting inferences (Antonucci, Teresa, & Paolucci, 2002; Clason & Dormody, 1994). For this reason, Ridit values (which are interval scores between 0 and 1, as converted from respondents' ordinal opinions, and provide statistical inferential properties for further comparison) were adopted in this study to improve the traditional IPA technique. For all 15 service attribute items in Table 4, the Ridit values and their 95% confidence intervals for "importance" and "performance" can be transferred onto importance–performance grids. This both (i) provides a straightforward, graphical illustration of those service attribute items which respondents consider to be salient and well addressed by current applications, and (ii) offers a heuristic decisional guide to aid the aviation industry organize their limited resources for strategic investment in kiosks.

According to the procedure of conducting IPA (Zhang & Chow, 2004), the importance–performance matrix can be further divided into four quadrants, as shown in Fig. 1, by using the mean scores (i.e., $R_i = 0.5$) of each axis as the dividing point. The service attribute items located in different quadrants have their corresponding managerial implications, and accordingly, different recommendations

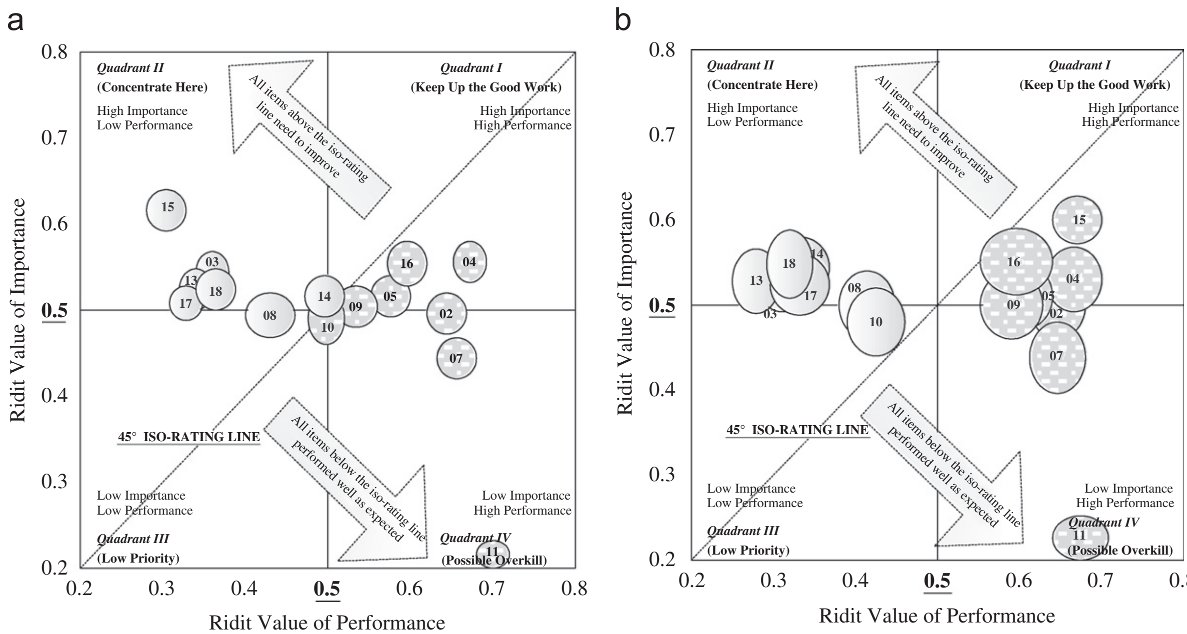

Fig. 1. Modified importance–performance analysis grids for (a) old-styled and (b) new-styled kiosks.

will be suggested for improving service quality (Bei & Shang, 2006; Chu & Choi, 2000). These four quadrants are:

(1) Quadrant I: This quadrant indicates not only those service attribute items deemed important to respondents, but also that performance could meet respondents' expectations. The message indicated here is to "maintain the good work".
(2) Quadrant II: Service attribute items are perceived to be important for respondents; however, performance levels are low. This suggests that improvement efforts should be concentrated here.
(3) Quadrant III: Service attribute items are rated as having low importance and low performance. All items in this cell are indicative of low salience and require no additional or immediate resources.
(4) Quadrant IV: This cell contains items of low importance, but the performance is relatively high. This quadrant possesses overly used resources and unneeded performance as perceived by prospective customers.

Each ellipse (joint confidence region) in Fig. 1 represents its service attribute item with the same number. The coordinate for the centroid of each ellipse indicates the Ridit values of the "performance" and "importance" for its corresponding service attribute item, and the height and width of each ellipse represent the 95% confidence intervals for the estimated Ridit values of the "importance" and "performance" for its corresponding service attribute item.

In Fig. 1, we find the Ridit values of "importance" for most service attribute items are relatively concentrated between 0.4 and 0.6 along the vertical axis, but those of "performance" are relatively dispersed between 0.2 and 0.7 along the horizontal axis. It is possible the respondents are easily able to distinguish whether items are important or not, but are not easily able to differentiate the relative importance of those "important" items. On the contrary, respondents find it relatively easy to compare differences in their satisfaction amongst all service attribute items. The psychological implications of this phenomenon may warrant further study. Furthermore, the ellipses of new-styled kiosks in Fig. 1(b) were found to be larger than those of old-styled kiosks in Fig. 1(a), due to their larger variances caused by the smaller sample.

Additionally, an iso-rating line that connects all points where the Ridit values of performance and importance are equal was also employed to divide the importance–performance matrix into two regions with different priorities for administrative consideration (Magal & Levenburg, 2005). Service attribute items that are located above the iso-rating line have higher priorities for improvement; it is recommended that those service attribute items located below the iso-rating line are maintained at their original service level (Skok, Kophamel, & Richardson, 2001; Slack, 1994). The messages of the service items located in the four different quadrants are introduced as follows.

4.2.1. Service items located in Quadrant I (the "maintain the good work" quadrant)

In Fig. 1(a), three items are located in Quadrant I (for the old-styled kiosks). They are: 4 (one-shot multi-passenger check-in), 5 (multiple ways to authenticate users), and 16 (select seats, alter or cancel the reservation). We also find that the three items are below the iso-rating line, indicating that these items outperformed the passengers' expectations and do not need further improvement. In Fig. 1(b), the items included in Quadrant I are almost identical for the new- and old-styled kiosks. The exception is the 15th item, which is located in Quadrant I for the new-styled kiosk and Quadrant II for the old-styled kiosk. In addition, items 2 and 9 overlap and are located at the border between Quadrant I and Quadrant IV. No further improvement is required for these two service items.

4.2.2. Service items located in Quadrant II ("concentrate here" quadrant)

All items in Quadrant II are above the iso-rating line, and performed poorly compared to their relative importance. These items should be improved, and the necessity of improvement is proportional to the horizontal distance from the iso-rating line. The five service attribute items in Quadrant II (for old-styled kiosks) could be further divided into two groups according to their dispersion (see Fig. 1(a)). The 15th item (one-stop baggage service) belongs to that group which has the most urgent need for improvement due to its horizontal distance to the iso-rating line. Items 3 (connecting flight check-in), 13 (incentive programs for using kiosks), 17 (e-ticket purchase), and 18 (seat-selecting privilege for frequent flyers), which overlap one another, should be assigned to the group demonstrating the second most urgent need for action. In addition, items 10 and 14 overlap and are located at the border amongst the four quadrants; these can be treated as another group, requiring the lowest priority.

The new-styled kiosk items located in Quadrant II, including the items 3, 13, 14, 17, and 18, which overlap one another, are assigned to the same group (see Fig. 1(b)), and have the same priority for improvement.

4.2.3. Service items located in Quadrant III ("low priority" quadrant)

For both types of kiosk, item 8 (good identity authentication) is located at the boundary between Quadrant II and Quadrant III. However, its 95% confidence intervals for "importance" is (0.46, 0.52) and (0.47, 0.52), respectively, meaning the respondents' attitude tends to be neutral on "importance". However, the Ridit values of performance are rated lower than importance, and the location of item 8 is above the iso-rating line, indicating that this item has space for improvement under the presupposition that the airlines try to strengthen its service quality. In addition, the location of the 10th item of new-styled kiosk is situated between Quadrant II and Quadrant III, and is additionally assigned to Quadrant III by its R_i values. Therefore, it can be interpreted that relatively fewer resources should be expended in this low-priority item in terms of managerial function.

4.2.4. Service items located in Quadrant IV ("possible overkill" quadrant)

Two items, including the 7th item (friendly input interface) and the 11th (hot news, promotions, and advertisements) are commonly found in Quadrant IV. The Ridit values of importance for these two items are rated as being lower than average while their performances are rated as being above average. They are viewed as a "possible overkill" and appear to be useless in the traditional IPA. Therefore, no improvements are required for these items.

4.3. Some findings for different demographic characteristics of kiosk users

A further investigation found that some differences of behavior exist amongst demographically segmented kiosk users. These included:

(1) Nationality: While all other respondents consider item 3 (connecting flight check-in) important and do not exhibit satisfaction at its execution, Asian respondents who had used either style of kiosks neither considered it important nor felt satisfied with item 3. This may be due to around 70% of the Asian passengers departing from Taiwan being bound for regional destinations via short-haul/medium-haul direct flight or a simple-connected flight. Therefore, whether kiosks can process connecting flight service properly was not considered important. However, further studies are needed to properly understand the cause of this discrepancy.
(2) Gender: Female passengers were satisfied with item 2 (quick response to inquiry), yet regarded this service as unimportant. However, males considered that item 2 met their expectations. This indicates that males and females have different demands on the response time of machines. This phenomenon happens to agree with the finding "males have more negative wait expectations than females" in Grewal, Baker, Levy, and Voss (2003). Interestingly, while both male and female passengers were dissatisfied with item 13 (incentive programs for using kiosks), male passengers are less concerned (than female passengers) whether airlines can offer sufficient rewards for incentives to use kiosks. This phenomenon has the same ideas as the research of gender differences in price and promotion response in the Mazumdar and Papatla (1995), study which concludes that females are more sensitive to the incentive programs.
(3) Age: Whether using new or old kiosks, passengers of age 21–30 placed importance on item 11 (hot news, promotions, and advertisements), and were satisfied with the performance. However, other passengers considered item 11 as unimportant but were satisfied with the performance. This may inspire marketers to take note that visual effects, multi-media programs, and the scrolling text marquee displayed on kiosks may attract young adults' attention, and serve the purposes of informing, educating, promoting, and servicing.
(4) Trip purpose: Passengers who listed the primary objective of their trip as "sight seeing" found that the performance of item 16 (select seats, alter or cancel the reservation) exceeded their expectations. They were also dissatisfied and unconcerned with item 17 (e-ticket

purchase). However, other passengers labeled that item 16 met their demand, and item 17 did not meet their expectations. A possible explanation of these findings is that tourists may tend to arrange their trips and purchase tickets in advance; thus, when the airport is finally arrived at, the services of items 16 and 17 are superfluous.

(5) Users' experience: Frequent passengers who use kiosks more than five times per year considered item 7 (friendly input interface) unimportant but commended its performance. All other respondents agreed that item 7 meets their expectations. First-time kiosk users were neither concerned nor unsatisfied with the service of item 13 (incentive programs for using kiosks), but other passengers felt that item 13 did not meet their expectations. This indicates that while incentive programs are often used by airlines to encourage passengers to use kiosks, first-time kiosk users are not concerned with incentives. First-time users are more concerned with kiosk interface and user-centered design.

The above-mentioned findings can aid airlines to better analyze whether kiosks meet demographically different passengers' needs, and thus improve the services provided by their kiosks in order to increase kiosk attractiveness. Furthermore, different marketing strategies can also be applied to attract passengers with different demographic characteristics.

5. Discussion

In order to comprehensively investigate the management implications for the items located in different quadrants in Fig. 1, a meeting of focus group discussions (FGDs; Blanchard, Rose, Taylor, McEntee, & Latchaw, 1999; Kathleen, 2005) was conducted through the invitation of kiosk dealers and related personnel to discuss the study findings and their implications for management. The meeting was divided into two phases and hosted by the representative manager of a study airline. Participants addressed their opinions regarding the study findings in the first stage and raised their suggestions to improve the performance of kiosks (and encourage passenger use) in the second. Based on the study results obtained from passengers' viewpoints, as well as the suggestions of service providers derived from FGDs, we identified the following issues and developed the following recommendations to help airlines improve their service platforms and fill the gap between enterprise and customer expectations.

5.1. Highly controllable environment

According to the Ridit values illustrated in Table 4, all five items belonging to the ''EC'' group were rated as relatively important items. This implies that the primary incentives attracting air passengers to check in using kiosks include autonomy and privacy in handling seat selection, mileage accumulation, luggage check-in, and e-ticket purchase. However, only numbers one and two of the five ''EC'' items were relatively well performed and satisfactory for the old- and new-styled kiosk users, respectively. Therefore almost half of the items located in Quadrant II (the items most urgently needing improvement) belong to the ''EC'' group for old- or new-styled kiosks. It is obvious that providing a more controllable environment appears to be the most important issue in increasing kiosk usage.

The 15th item (one-step baggage service) was located in Quadrant II for the old-styled kiosks, but in Quadrant I for the new-styled kiosks. Further investigation found that the Hong Kong and Taiwanese airlines installed their kiosks at both sides of the information center in Taoyuan Airport. This is some distance from the ''conveyor belt'' areas, and passengers must get their boarding pass from the kiosk first before returning to the check-in counter to check in their luggage. This means that passengers are unable to fully enjoy the self-service facility. The representative managers of these two airlines complained that they were constrained by the large size of the kiosks. If they were stationed next to the conveyor belt, it would reduce the available space for the check-in counter and affect passenger queues. However, compact machine design and accessibility had been considered for the new model of kiosk by the American airline in 2005. Moreover, with some modification and a certain degree of integration into the processes of luggage conveyance and the scaling system, much smoother operations are observed by those passengers using the new model. Comparing the performance of the 15th item of the new- and old-styled kiosks, it is concluded that reducing the size of the kiosk and enhancing the user friendliness of its ''one-stop baggage service'' would be the optimal method of improvement.

Therefore, apart from constantly upgrading the internal functions of a kiosk, airlines and kiosk dealers should pay greater attention to develop light and compact kiosks that provide satisfactory services for both airlines and passengers in the limited space available within an airport. Furthermore, airport administration should consider combining all the kiosks for various airlines and providing a specific area with exclusive conveyor belts for kiosk use, or promote the CUSS concept. This ''food-court-like'' managerial method not only satisfies the needs of both passengers and airlines, but also effectively utilizes the building floor space of the airport.

5.2. Providing benefits or privileges for frequent flyers

Frequent flyers are usually VIP members and likely to expect special privileges and courteous treatment. However, from the CIT interview, frequent flyers were found to prefer choosing check-in counters and gain service from staff familiar with the system, rather than facing cold, incommunicable machines—the exception being the case when there is a long queue at the check-in counter.

If airlines want to mitigate frequent flyers' resistance to kiosks, they should consider providing extra benefits such as seat-selecting privileges.

5.3. Improvement in inter-organizational technology and communication

Because "connecting flight check-in" (the 3rd item) and "e-ticket purchase" (the 17th item) always involve different organizations (e.g., air carriers, credit card issuers) and countries, it is not currently easy to operate these services through kiosks due to unresolved problems of operating technology, resource integrated strategy, inter-organizational information systems, and so on. More effort should be made to improve inter-organizational communication, the technology bottleneck related to the connecting flight service, and the financial security or personal identification problems with e-ticket sales in order to enhance consumers' satisfaction with kiosk usage.

5.4. Positive reinforcement vs. negative reinforcement

The idea of adopting this new technology is definitely innovative to many enterprises. However, from the standpoint of many customers, this innovation will cost extra and impose additional burdens (Hall & Khan, 2002). Without obvious benefits (the 13th item) to themselves, passengers will feel reluctant to use this kiosk unless there are no other alternatives available. According to the theory of "Operant Conditioning" constructed by Skinner (1904–1990), positive reinforcement occurs when a behavior is followed by a favorable stimulus (which in turn increases the frequency of that behavior). At the same time, negative reinforcement occurs when a behavior is followed by the removal of an aversive stimulus (thereby increasing that behavior's frequency; Butterworth & Harris, 1994). Therefore, if airlines hope to transfer customers from traditional check-in counters to kiosks, they could consider using Skinner's positive reinforcement (such as incentive programs) and negative reinforcement (such as increasing perceived service complexity if alternative means are used) to encourage customers to change their check-in habits.

Indeed, incentive programs have already been employed by some airlines to encourage passengers to use this new facility, but they do not appear attractive enough to encourage kiosk usage. Though incentive programs are temporarily and substantially helpful to new product promotion and marketing, they should not be regarded as a normal promotion strategy in the long term. Nevertheless, kiosks are still considered to be a "trendy" facility for passengers traveling back and forth to Taiwan. Airlines could encourage passengers to use kiosks by providing several irresistible benefits. In the future, once the Taiwanese have been educated to accept self-service, airlines could consider downscaling the available options for customers not using kiosks and increasing perceived service complexity (Shostack, 1987; Simon & Usunier, 2005). For example, airlines can aim to gradually reduce the number of traditional check-in counters and intentionally create queuing lines, thus taking the opportunity to ease consumer dependence on personnel-in-contact services.

5.5. Correctness of identity authentication

In response to the problem reflected by the 8th item located at the border between "Quadrant II" and "Quadrant III", further investigation found that some passengers using kiosk check-in failed to receive the correct boarding passes. This caused double seating, incorrect seating and complaints at the boarding gate or cabin.

Based on discussions with managers of these airlines, we found that both the kiosks and check-in counters use the same "Departure Control System (DCS)" for seating management. The check-in counter uses the SITA network, which is a fast and stable network and widely adopted by the aviation industry to transmit, store, and load the information, to connect with the DCS. However, when a kiosk connects DCS through the data transmission protocol of the local telecommunications industry, its speed becomes reduced if the network is congested, and external variables are not easily controlled. Therefore the system response is delayed due to the slow network transmission speed of the kiosk.

Occasionally a passenger selects a seat from a kiosk and confirms that he had chosen the seat through local communication to connect with DCS, but there is a machine delay with the supply of printed boarding passes. In such a situation, the passenger returns to the check-in counter and asks the service staff to re-issue a hand-written boarding pass for the seat that he/she had selected. The next passenger using the kiosk's seat-election function may receive the stuck boarding pass that belonged to the previous passenger and had remained inside the machine. When this occurs, the passenger will wrongly think that the machine cannot correctly identify his or her name. However, according to the information obtained from FGDs, the achievement of such connectivity of service without interruption when any access networks are unavailable or congested would be challenging.

6. Concluding remarks

Airlines are eager to streamline their organization and apply new information technology to face the challenge of a competitive global market. However, the implementation of new technology is time consuming and requires human resources and enormous capital investment. Furthermore, the implementation of new technology involves innovation in organizational operation and even changes in its competitive mode. Although previous studies have indicated that the widespread application of technology-based services have benefited consumers, consumers do not possess entirely positive attitudes toward them (Parasuraman & Grewal, 2000). Thus exploring the potential obstacles to applying kiosks at check-in services is an issue of critical concern to the aviation industry.

This study has collected and analyzed the satisfying and dissatisfying elements of kiosk usage, and from these constructed a questionnaire to aid identification and exploration of the importance and performance of service attributes, to increase kiosk usage. This study introduces Ridit values rather than the raw mean scores of ordinal data, and replaces the mean point values by joint confidence regions to conduct IPA. It provides an efficient visual tool for presenting the study results, and helps indicate managerial implications for the promotion of kiosk usage. We have learned that potential kiosk users expect to have a highly controllable environment during kiosk usage. Airlines may mitigate frequent flyers' resistance to kiosks by providing extra benefits or seat-selecting privileges. The technology bottleneck related to the connected flight service and e-ticket purchases must also be improved. Airlines may consider using both positive and negative reinforcements to gradually induce customers to accept self-service. Also, kiosks are expected to be light and compact, and should be installed near the luggage conveyor belt to provide satisfactory services for both airlines and passengers in the limited space available at airports. These findings and their implications could be used to guide managerial strategy as well as future research.

According to the studies of Lovelock and Wright (1998) as well as Srinivasan, Anderson, and Ponnavolu (2002), identifying customers and providing customized products and services for their needs are the determinants that warrant the success of e-commerce promotion. Therefore, kiosk function and interface design could be further customized in response to the preferences of customers segmented by demographic characteristics. For example, customers are allowed to create individual content for kiosk operational interfaces and obtain those services personally desired, thus satisfying their demand for "EC".

Importance–performance analysis (IPA) has been widely used to collect customers' opinions on the importance and performance of a certain product's features, in order to best allocate the available resources for marketing. However, the evaluation of performance can only be collected once that product has been experienced (Sampson & Showalter, 1999). Although passengers who had rejected the kiosks or had some obstacle to using kiosks were not included in this study, the results still provide valuable information on how to reinforce the loyalty of current users through improvement of those items that are rated by users as important but unsatisfactorily performed; through these improvements, more passengers would be attracted to use kiosks by word-of-mouth reputation. Nevertheless, encouraging those passengers who have not yet used kiosks is still the most important issue in increasing overall kiosk usage. Further studies are required to explore the reasons kiosks are refused, so as to provide a reference for airlines engaged in strategic planning concerning user interface design, marketing, advertisements, education, and so forth.

Acknowledgments

The authors would like to express their gratitude to the three anonymous reviewers whose comments have considerably improved the quality of this work. Furthermore, financial support provided by the National Science Council of Taiwan (Grant no. NSC 95-2415-H-328-003) is gratefully acknowledged.

References

Agresti, A. (1984). *Analysis of ordinal categorical data*. New York: Wiley.

ATCA News. (2005). *Change is in the air*. Air Traffic Control Association News, 14 March 2005.

Anderson, E. W., & Mittal, V. (2000). Strengthening the satisfaction–profit chain. *Journal of Service Research*, *3*(2), 107–120.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, *103*(3), 411–423.

Antonucci, G., Teresa, A. T., & Paolucci, S. (2002). Rasch analysis of the rivermead mobility index: A study using mobility measures of first-stroke inpatients. *Archives of Physical Medicine and Rehabilitation*, *83*(10), 1442–1449.

Bagozzi, R. P., & Yi, Y. (1989). On the use of structural equation model in experimental designs. *Journal of Marketing Research*, *26*(3), 271–284.

Bei, L. T., & Shang, C. F. (2006). Building marketing strategies for state-owned enterprises against private ones based on the perspectives of customer satisfaction and service quality. *Journal of Retailing and Consumer Services*, *13*(1), 1–13.

Blanchard, M. A., Rose, L. E., Taylor, J., McEntee, M. A., & Latchaw, L. L. (1999). Using a focus group to design a diabetes education program for an African American population. *Diabetes Education*, *25*(6), 917–924.

Bross, I. (1958). How to use Ridit analysis. *Biometrics*, *14*(1), 18–38.

Butterworth, G., & Harris, M. (1994). *Principles of developmental psychology (Principles of psychology)*. UK: Psychology Press Ltd. Publishers.

Chell, Elizabeth, & Pittaway, L. (1998). A study of entrepreneurship in the restaurant and café industry: Exploratory work using the critical incident technique as a methodology. *International Journal of Hospitality Management*, *17*(1), 23–32.

Chu, R. K. S., & Choi, T. (2000). An importance–performance analysis of hotel selection factors in the Hong Kong hotel industry: A comparison of business and leisure travelers. *Tourism Management*, *21*(4), 363–377.

Clason, D. L., & Dormody, T. J. (1994). Analyzing data measured by individual Likert-type items. *Journal of Agricultural Education*, *35*(4), 31–35.

Dabholkar, P. A. (1996). Consumer evaluation of new technology-based self-service options: An investigation of alternative models of service quality. *International Journal of Research in Marketing*, *13*(1), 29–51.

Dwayne, D. G. (2004). The critical incident technique in service research. *Journal of Service Research*, *7*(1), 65–90.

Field, D. (2004). A paperless world. *Airline Business*, *20*(7), 58.

Flanagan, J. C. (1954). The critical incident technique. *Psychological Bulletin*, *51*(4), 327–358.

Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39–50.

Getz, D., O'Neill, M., & Carlsen, J. (2001). Service quality evaluation at events through service mapping. *Journal of Travel Research*, *39*(5), 380–390.

Glass, D. C., & Singer, J. E. (1972). *Urban stress: Experiments on noise and social stressors*. New York: Academic Press.

Grewal, D., Baker, J., Levy, M., & Voss, G. B. (2003). The effects of wait expectations and store atmosphere evaluations on patronage intentions in service-intensive retail stores. *Journal of Retailing*, *79*(4), 259–268.

Hairs, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis* (5th ed.). New York: Macmillan.

Hall, B. H., & Khan, B. (2002). *Adoption of new technology, new economy handbook*. California: Berkeley University.

Holsti, O. R. (1969). *Content analysis for the social sciences and humanities*. Reading, MA: Addison-Wesley.

Huang, L., & Tsai, H. T. (2003). The study of senior traveler behavior in Taiwan. *Tourism Management*, *24*(5), 561–574.

IATA. (2006). *Simplifying the business: 2006 StB horizontal campaign*. Montreal: International Air Transport Association.

IATA Pressroom. (2004). *Simplifying the business: industry revolution kicks off*. Montreal: International Air Transport Association News no. 31.

Jöreskog, K. G., & Sörbom, D. (1989). *LISREL 7: A guide to the program and applications* (2nd ed.). Chicago, IL: SPSS Inc.

Kathleen, P. S. (2005). The use of focus groups in pediatric and adolescent research. *Journal of Pediatric Health Care*, *19*(2), 104–110.

Keaveney, S. M. (1995). Customer switching behavior in service industries: An exploratory study. *Journal of Marketing*, *59*(2), 71–82.

Kendall, M. G., & Smith, B. B. (1939). The problem of *m* rankings. *The Annals of Mathematical Statistics*, *10*(3), 275–287.

Langer, E. J. (1975). The illusion of control. *Journal of Personality and Social Psychology*, *32*(2), 311–328.

Lawshe, C. H. (1975). A quantitative approach to content validity. *Personal Psychology*, *28*(4), 563–575.

Liljander, V., Gillberg, F., Gummerus, J., & Riel, A. V. (2006). Technology readiness and the evaluation and adoption of self-service technologies. *Journal of Retailing and Consumer Services*, *13*(3), 177–191.

Lott, S. (2005). IATA, Sydney sign deal to test common use kiosks. *Aviation Daily*, *362*(11), 3.

Lovelock, C., & Wright, L. (1998). *Principles of service marketing and management*. New Jersey: Prentice-Hall.

Magal, S. R., & Levenburg, N. M. (2005). Using importance–performance analysis to evaluate e-business strategies among small businesses. In *Proceedings of the 38th Hawaii international conference on system sciences*.

Maguire, M. C. (1999). A review of user-interface design guidelines for public information kiosk systems. *International Journal of Human–Computer Studies*, *50*(3), 263–286.

Martilla, J. A., & James, J. C. (1977). Importance–performance analysis. *Journal of Marketing*, *41*(1), 77–79.

Matzler, K., Bailom, F., Hinterhuber, H. H., Renzl, B., & Pichler, J. (2004). The asymmetric relationship between attribute-level performance and overall customer satisfaction: A reconsideration of the importance–performance analysis. *Industrial Marketing Management*, *33*(4), 271–277.

Matzler, K., & Sauerwein, E. (2002). The factor structure of customer satisfaction: An empirical test of the importance grid and the penalty–reward–contrast analysis. *International Journal of Service Industry Management*, *13*(4), 314–332.

Matzler, K., Sauerwein, E., & Heischmidt, K. A. (2003). Importance–performance analysis revisited: The role of the factor structure of customer satisfaction. *Service Industries Journal*, *23*(2), 112–129.

Mazumdar, T., & Papatla, P. (1995). Gender differences in price and promotion response. *Pricing Strategy and Practice: An International Journal*, *3*(1), 21–33.

Meuter, M. L., Ostrom, A. L., Bitner, M. J., & Roundtree, R. (2003). The influence of technology anxiety on consumer use and experiences with self-service technologies. *Journal of Business Research*, *56*(11), 899–906.

Ni, A. Y., & Ho, A. T. K. (2005). Challenges in e-government development: Lessons from two information kiosk projects. *Government Information Quarterly*, *22*(1), 58–74.

Nicholas, D., Huntington, P., & Williams, P. (2003). Three years of digital consumer health information: A longitudinal study of the touch screen health kiosk. *Information Processing and Management*, *39*(3), 479–502.

Parasuraman, A., & Grewal, D. (2000). The impact of technology on the quality–value–loyalty chain: A research agenda. *Journal of the Academy of Marketing Science*, *28*(4), 168–174.

Pilling, M. (2005). Efficiency drive. *Airline Business*, *21*(5), 70–72.

Pouplard, N., Qannari, E. M., & Simon, S. (1997). Use of Ridits to analyze categorical data in preference studies. *Food Quality and Preference*, *8*(5/6), 419–422.

Ram, S. (1989). Successful innovation using strategies to reduce consumer resistance: An empirical test. *Journal of Product Innovation Management*, *6*(1), 20–34.

Rendeiro, R., & Cejas, M. (2006). Tourism service quality begins at the airport. *Tourism Management*, *27*(5), 874–877.

Sampson, S., & Showalter, M. (1999). The performance–importance response function: Observations and implications. *The Service Industries Journal*, *19*(3), 1–25.

Shostack, G. L. (1987). Service positioning through structural change. *Journal of Marketing*, *51*(1), 35–43.

Simon, F., & Usunier, J. C. (2005). *Choice of technology versus personnel-in-contact by service customers: An exploratory study*. Switzerland: University of Lausanne.

Singh, J., & Wilkes, R. E. (1996). When consumers complain: A path analysis of the key antecedents of consumer complaint response estimates. *Journal of the Academy of Marketing Science*, *24*(4), 350–365.

Skok, W., Kophamel, A., & Richardson, I. (2001). Diagnosing information systems success: Importance–performance maps in the health club industry. *Information and Management*, *38*(1), 409–419.

Slack, N. (1994). The importance–performance matrix as a determinant of improvement priority. *International Journal of Operations and Production Management*, *14*(5), 59–76.

Srinivasan, S. S., Anderson, R., & Ponnavolu, K. (2002). Customer loyalty in e-commerce: An exploration of its antecedents and consequences. *Journal of Retailing*, *78*(1), 41–50.

Tung, L. L. (1999). The implementation of information kiosks in Singapore: An exploratory study. *International Journal of Information Management*, *19*(3), 237–252.

Weber, R. P. (1990). *Basic content analysis*. California: Sage.

Zhang, H. Q., & Chow, I. (2004). Application of importance–performance model in tour guides' performance: Evidence from mainland Chinese outbound visitors in Hong Kong. *Tourism Management*, *25*(1), 81–91.