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Developing a passenger-centered airport: a case study of Urumqi Airport in Xinjiang, China

Abstract

An airport's accessibility, facilities and services are significant components of a passenger-centered airport. Evaluating services in these areas will help identify gaps that need to be closed to improve passenger experience. As an ideal connection point for passengers flying to Europe from East Asia, Urumqi Airport has been approved as an international hub at North west of China. This paper investigates the airport's facilities and services and assess how to develop it into a passenger-centered airport. A questionnaire survey is conducted concerning airport departure, arrival and transfer services. The cloud model is used to evaluate service satisfaction and the extended contributive rule (ECR) method is used to determine the degree of importance of each service item. Results show that passengers have great concerns over the safety, baggage and flight delay services. Services for catering, shopping, airport traffic, flight delay, and Internet need to be improved, among which catering, shopping and flight delay services need to be given priority. The overall satisfaction for Terminal 1 is lower than Terminals 2 and 3.

Keywords: Airport service; Passenger satisfaction; Service importance; Cloud model; ECR method

1. Introduction

Outstanding service level has been acknowledged as a key factor for airports to increase their competitive advantages, in terms of achieving higher operating efficiency and attracting more passengers (Allen et al., 2011; Kramer et al., 2013). Hence, it is essential to understand passengers' satisfaction on an airport's service from a systematic perspective. The evaluation of passenger satisfaction level has become an important issue in airport operation and management, and has also been systematically surveyed by airport operators, international agencies and other organizations (Bezerra and Gomes, 2016). However, Wiredja et al. (2019) pointed out most research on airport service performance pays close attention to the departing passengers, only limited research has focused on arrival and transfer passengers or the complete passenger activities in the terminals (Park and Jung, 2011; Chao et al., 2013; Wiredja, 2017). This limitation results in the unbalanced and biased recognition of passengers' perception and evaluation on airport service. This research addresses this literature gap by investigating the airport service performance covering the areas of departure, arrival, and transfer in the terminals.

Customer satisfaction is a post-consumer response, which reflects the overall feelings of like or dislike after the consuming behaviors (Oliver, 1980; Athanassopoulos et al., 2001). Customers will feel satisfied if the actual performance outcomes meet or exceed their expectation, otherwise, they will feel dissatisfied (Falk et al., 2010). Therefore, satisfaction with the same product varies from person to person. In the process of satisfaction evaluation, the selection of satisfaction indicators should be carried out according to specific circumstances.

In order to better demonstrate the effectiveness of the method, this paper takes Urumqi Airport as an example to investigate the airport's landside facilities and services in departure, arrival, and transfer domains, and assess how to develop it into a passenger-centred airport. Urumqi is the capital of Xinjiang Uygur Autonomous Region, an important point in the Silk Road Economic Belt, and an ideal connection point for passengers flying to Europe from East Asia. Urumqi Airport is located in the northwest suburbs of Urumqi, 16.8 kilometers away from the urban area of the city. It has 3 terminals and one runway, handling 24 million passengers and 170,000 tonnes of cargo and mail in 2019. Statistics from Xinjiang Airport Group show that in 2018 and 2019, the number of transfer passengers at Urumqi Airport exceeded 2 million, and the transfer ratio in 2019 reached 8.5%, an increase of 3.5 percentage points from 2015. And in recent years, Urumqi Airport is accelerating the construction of the transfer system, optimizing the transfer process, shortening the MCT time, and improving the transfer service experience.

This research first builds a satisfaction evaluation indictor system through literature review. A survey is then conducted to collect the passengers' judgment on their satisfaction and perceived importance level of airport services. The cloud model is used to evaluate the satisfaction of airport services. The model results can reveal the degree of dispersion and distribution range of the evaluation data to reflect passengers' heterogeneity in the evaluation process. Due to the heterogeneity of passenger's personal attributes and travel attributes, the extended contributive rule (ECR) method is used to determine the degree of importance of each service item. And the satisfaction and importance evaluation results are finally combined to determine the services that need to be improved first. To the best of our knowledge, this is the first attempt that applies these two approaches in the evaluation of service satisfaction in air transport. This study will serve as a useful guidance and reference for air transport service evaluation that wish to capture the heterogeneity of the evaluation results.

The reminder of the paper is organized as below. In next section, the previous relevant studies are reviewed. Section 3 introduces the methodology. The questionnaire design and model results are detailed in Section 4. Finally, conclusion is provided in Section 5.

2. Related Studies

Passengers' evaluation of airport service performance has attracted attention from both airport management and scholars. The evaluation dimensions and attributes are the key issues

when measuring airport service performance. Yeh and Kuo (2003) generated six service dimensions from the literature including comfort, processing time, convenience, courtesy of staff, information visibility and security. Bezerra and Gomes (2015) identified seven process dimensions for airport service performance, i.e., check-in, security, convenience, ambience, basic facilities, mobility and prices. Although the indicators used may differ in different studies, most studies have considered security, convenience, staff manners, airport environment, airport accessibility on satisfaction (Yeh and Kuo, 2003; Bezerra and Gomes, 2015; Chen et al., 2015).

Some researches delved into the impact of a single dimension on airport service. Moon et al. (2015) studied how airport atmospheric influences passengers' satisfaction such as facility aesthetics, layout accessibility, cleanliness and seating comfort. Brida et al. (2016) examined the influence of information and communication technologies on passenger satisfaction, including airport service scape, airport information system including sound information system, flight information screen and signage. It should be acknowledged that passengers' expectations of airport services may vary by region, time and culture. Hence, the indicators and approaches need to reflect the diversity of the passengers and the heterogeneity of their perceptions.

Factor analysis and structural equation modelling are common techniques used to evaluate the relationship between airport service performance and behavioral intentions (e.g., Park and Jung, 2011; Nesset and Helgesen, 2014; Bezerra and Gomes, 2015; Brida et al., 2016; Prentice and Kadan, 2019). However, the ratings for customer satisfaction can be quite subjective and there can be respondent uncertainty issues if the respondents are not familiar with the topics and scenarios presented to them. The cloud model can accommodate the uncertainty nature of the survey data. It is an uncertainty conversion model between qualitative concepts and quantitative expressions based on the probability theory and fuzzy sets theory (Li et al., 2022), which can reduce the distortion and loss of information in linguistic information processing (Li et al., 2009; Liu et al., 2017) and have been applied in many different fields, including urban public transportation. In this study, the cloud model will be used to evaluate passenger satisfaction of airport services, which not only presents the service satisfaction quantitatively, and also shows the randomness, and fuzziness of the evaluation results visually.

Another issue related to airport service performance assessment is that individuals have different preferences and competing interests for airport services. Sometimes different service items may receive the same satisfaction rating, but the importance or sense of values of these items might vary among the passengers. Therefore, understanding the relative importance of different services is important for service improvement. Importance-performance analysis (IPA) is an effective method to identify the critical improvement factors based on importance and passenger satisfaction, which has been applied to identify the service attributes that airport management should focus on (e.g., Tam and Lam, 2004; Chao et al., 2013; Tseng, 2020; Allen et al., 2021). However, IPA has serious limitations in that the different approaches used to calculate performance and importance scores can result in very different attributes for

improvement (Garver, 2003). Some researchers used analytic hierarchy process (AHP) to obtain the importance ranking (e.g., Yoo and Choi 2006; Tsai et al., 2011), but like the IPA, this approach also ignores the opposing opinions in a group, which can have a significant impact on the results. The extended contributive rule (ECR) method thus has been suggested to help researchers understand the structure of group preferences (Hattori, 1997). It produces the ranking of the preference of a group based on each group member's order of preference (Yamanoto et al., 2004). The ECR considers the relative importance of different attributes, and also the opposing opinions within the group, which makes the decision-making process more prudent (Sawaragi et al., 1978; Liu et al., 2008； Zhu et al., 2011).

3. Methodology

3.1 Cloud Model Theory

The cloud model effectively solves the problems of fuzziness and randomness in the evaluation process, which can be defined and expressed as follows (Liu et al., 2017; Li et al., 2019):

$$\mu: U \to [0,1] \quad \forall x \in U \quad x \to \mu(x) \tag{1}$$

where U is the quantitative domain of discourse. Suppose that T is a qualitative concept defined on domain U. Let x ($x \in U$) be a random instantiation of the concept T and $\mu(x) \in [0,1]$ be the certainty degree of qualitative language expressed by x on T, which corresponds to a stable random number. The distribution of x in the domain U constitutes a cloud, and each x can be called a cloud drop.

The cloud can be depicted by three digital characteristics: expectation *Ex*, entropy *En* and hyper entropy *He.* That is,

$$A=G\,(Ex, En, He) \tag{2}$$

where E_x represents the centre value of the qualitative concept; E_n measures both fuzziness and randomness of the qualitative concept; and H_e represents the uncertainty of entropy, which can reflect the degree of general acceptance of the qualitative concept. Cloud drops can be generated by these three characteristic parameters. Forward cloud generator and reverse cloud generator are two types of cloud generation algorithms: the forward cloud generator transforms the qualitative concept into its quantitative representation using the cloud characteristic parameters, while the reverse cloud generator transforms a quantitative value into the qualitative concept.

In this study, the entire evaluation indicator system is regarded as a domain of discourse, and each passenger is regarded as a cloud drop. The cloud overall characteristics formed by the evaluation results of all passengers can reflect the satisfaction of airport services. The reverse cloud generator is used to obtain the digital features of the cloud cluster, and the forward cloud generator is used to construct the evaluation grade standard for comparisons.

The passenger satisfaction evaluation process mainly includes the following steps:

(1) Establish an evaluation indicator system and determine the indicator set *U*.

$$U = \{U_1, U_2, U_3, \dots, U_n\} \tag{3}$$

(2) Determine the evaluation set and benchmark cloud. The evaluation set *V* consists of the ratings (satisfaction levels) for the service items in the survey. If there are *d* satisfaction levels in the survey, the evaluation set *V* can be written as:

$$V = \{V_1, V_2, \dots, V_{\mathrm{d}}\} \tag{4}$$

Let T_{min} and T_{max} be the lower and upper bounds of the satisfaction levels, the three digital characteristics can be calculated with Equation (5) under bilateral constraints (Wang et al., 2016). The forward cloud generator is used to generate the benchmark cloud.

$$Ex = \frac{(T_{min}+T_{max})}{2} \quad En = \frac{(T_{min}+T_{max})}{6} \quad He = k \tag{5}$$

where *k* is a constant adjusted according to the fuzzy threshold of the variable itself. Only when the value of $k \in (0, E_n/3)$, can the qualitative concept have a certain consensus. Therefore, in practice, *k* often takes the value of 0.1.

(3) Calculate the weight of each evaluation indicator and determine the weight set. The Criteria Importance Through Intercriteria Correlation (CRITIC) method is used to calculate the weight value of each indicator (Li et al., 2019). The weight set *W* of the entire indicator system can be expressed as

$$W = \{w_1, w_2, \cdots, w_n\} \tag{6}$$

(4) Generate the cloud model of the evaluation results. The actual digital characteristics of each indicator is calculated based on the satisfaction survey data, and the reverse cloud generator is used to obtain the corresponding matrix *Z* of the indicator set (as shown in Equation (7)). The cloud model *C* of the evaluation results can be obtained using Equation (8).

$$Z = \begin{Bmatrix} c_1 \\ c_2 \\ \dots \\ c_n \end{Bmatrix} = \begin{Bmatrix} E_{x1}, E_{n1}, H_{e1} \\ E_{x2}, E_{n2}, H_{e2} \\ \dots \\ E_{xn}, E_{nn}, H_{en} \end{Bmatrix} \tag{7}$$

$$C = W \times Z \tag{8}$$

Since this calculation process involves a mixture of cloud parameters and conventional parameters, the cloud parameters can be calculated using the weighted synthesis method as follows:

$$Ex = \sum Ex_i w_i;\ En = \sqrt{\sum (En_i^2 w_i)};\ He = \sum He_i w_i \tag{9}$$

(5) Compare and evaluate passenger satisfaction. Use forward cloud generator to transform the cloud model *C* of the evaluation results into a normal cloud. And compare the range and shape of the normal cloud with all the benchmark clouds to conclude the corresponding evaluation results.

3.2 Extended Contributive Rule Method (ECR)

The ECR is a group decision support method based on simple contributive rule (SCR), and can be described as follows (Liu et al., 2008； Zhu et al., 2011):

$$a_i R^l a_j \text{ iff } c^l(a_i, a_j) \geq 0 \tag{10}$$

where R^l denotes individual *l*'s preference (order) for alternatives a_i and a_j, $a_i R^l a_j$ shows that individual *l*' s preference for a_i is the same as or more than the preference for a_j. $c^l(a_i, a_j)$ can be presented as c_{ij}^l, which is defined as the intensity of preference of individual *l*, that is, the preference difference between a_i and a_j. If the intensity of preference of *m* individuals is considered, and *g* is defined as the sum of individual preferences, then

$$\mathrm{g}\left(c_{ij}^l, \ldots, c_{ij}^m\right) = \sum_{l=1}^m c_{ij}^l \tag{11}$$

Equation (11) is called SCR.

ECR is an extension of SCR, which not only gives a group's preference order that reflects individual preferences in the group, but also identity the degree of objections. We define the variable c_{ij}^l of function *g* as

$$\mathrm{g}\left(c_{ij}^l, \ldots, c_{ij}^m\right) = \sum_{l=1}^m w^l c_{ij}^l + \lambda \sum w^l \min\left(0, c_{ij}^l\right) - m\theta \tag{12}$$

where *g* is group preference; w^l is the weight of individual *l*'s utility; $\lambda \geq 0$ is a parameter representing preference consistency in the group. When the value of λ increases, the decision makers' opinions will be distinguished in the preference objective even if the group's preference (the value of first item in the equation) is the same, and the order relation will be eliminated if the objections have a larger percentage than others. $\theta \geq 0$ is introduced to be a threshold to exclude weak relation. It defines a lower limit for the average preference of the group members, and eliminates the preference relations if the preference consistency is lower than others when the degree of preference is considered.

The process of the ECR method can be divided into two steps:

Step 1: When λ and θ are both set to 0, it is simplified to SCR. The importance ranking of the service items can be obtained based on Equation (11). The higher the score, the higher the importance level.

Step 2: Based on the results in step 1, the mean value table of c_{ij}^l for each service item is calculated, and the mean value table of objections for each item is calculated using the survey data. Then the data in the corresponding positions in the two tables are calculated following Equation (12), to obtain the mean value table of preferences.

4. Case Study

4.1 Establishing Service Satisfaction Evaluation Indicator System

We first build a satisfaction evaluation indicator system following Li et al. (2019). The initial evaluation system contained 63 indicators with 13 dimensions obtained from previous

research and in-depth interview. However, in specific applications, not all indicators have significant effects on specific evaluation objects (Fowler, 2009). Therefore, on the basis of initial system, we designed a questionnaire to collect passengers' opinion on the importance of initial indicator system, and then employed the critic ratio method, reliability test, and exploratory factor analysis gradually to screen the indicators. Finally, 41 indicators were determined, which were divided into 13 dimensions as shown in Table 1.

Table 1 Indicator system of passenger satisfaction evaluation for Urumqi Airport

No.	Dimension	Indicator	Clarification
(1)	Airport traffic	Airport access traffic	Convenient and fast access to or leave the airport
(2)		Parking facilities	Sufficient and reasonable parking facility configuration
(3)	Inquiry service	Inquiry staff attitude	Good attitude of the inquiry staff
(4)		Inquiry effect	Responsible, accurate and timely response to inquiries
(5)	Guide signage	Guide signage	Clear and easy-to-find guide signs
(6)	Internet communication service	Internet service	Smooth Internet/WIFI connection, application software is easy to use
(7)	Check-in service	Check-in speed	Convenient and fast check-in procedures
(8)		Baggage check-in service	Convenient and fast luggage consignment services
(9)		Check-in staff attitude	Good attitude of the check-in staff
(10)	Security check service	Security check speed	Security check passes smoothly
(11)		Security check operation	Standardized and orderly security check process
(12)		Security check process	Thorough security check process
(13)		Security check staff attitude	Good attitude of the security check staff
(14)	Joint inspection service	Joint inspection speed	Customs and border quarantine clearance smoothly
(15)	Baggage service	Baggage claim speed	Fast and accurate baggage claim
(16)		Baggage integrity	Intactness of checked baggage
(17)	Transfer service	Transfer procedure speed	Convenient and fast transfer service
(18)		Transfer service staff attitude	Good attitude of transfer service staff
(19)	Flight delay service	Flight delay notification	Timely and accurate information notification when flight is delayed
(20)		Service after delay	Appropriate service arrangements when flight is delayed
(21)	Boarding service	Shuttle bus	Convenient shuttle bus service
(22)		Queuing space for boarding	Adequate queuing space at the boarding gate
(23)		Boarding speed	The waiting time for boarding is suitable
(24)		Boarding service staff attitude	Good attitude of boarding service staff (who scan your boarding pass)
(25)	Terminal facilities and environment	Terminal environment	Clean environment, fresh air and suitable temperature in the terminal

(26)		Broadcast	Clear sound quality, moderate and soft volume of broadcast
(27)		Advertising	Reasonable and well-planned advertising spaces
(28)		Flight information system	Easy-to-find flight information system and accurate flight information
(29)		Trolleys	Sufficient trolleys and convenient to get
(30)		Seats	Sufficient and comfortable seats in the terminal
(31)		Toilets	Sufficient and clean toilets
(32)		Smoking rooms and pantries	Sufficient and convenient smoking rooms, pantries
(33)		Financial service	Convenient and sufficient bank, ATM, currency exchange services
(34)		Baggage storage	Easy-to-find and easy-to-use baggage storage
(35)		Walking facilities	Sufficient, well-planned and comfortable walking facilities (pavement, moving sidewalk, etc.)
(36)		Disability facilities	Sufficient, well-planned and easy-to-use disability facilities
(37)		Emergency medical facilities	Easy-to-find emergency medical facilities
(38)		Terminal order	Good order and strict security in the terminal
(39)		Police service	Easy-to-find police room and quick response to emergency
(40)	Business service	Catering service	Clean dining environment and reasonable prices
(41)		Shopping service	Clean and tidy shopping environment and clearly marked prices

4.2 Questionnaire Design and Data Collection

4.2.1 Questionnaire design

The questionnaire consists of three parts. The first part is the background information of the respondents, including gender, age, occupation, education level, monthly income, trip purpose, etc. The second part is the satisfaction evaluation of the airport services, and the third part asks the respondents to rate the importance of the service attributes.

The service requirements are different in the departure, arrival and transfer. Therefore, the service items in the second part of the questionnaire for different passenger groups will be different. The five-point Likert scale is used with 1 being strongly dissatisfied and 5 strongly satisfied. Considering that some service items in different areas in Table 1 have a certain degree of overlap, some of them are combined and condensed into the 31 service items when evaluating the importance, as shown in Table 2. The usability testing method (Zhou et al., 2014) was used to perform a small-scale pre-survey, after which minor revision was made to the questionnaire.

Table 2 Service attributes of importance evaluation for airport service

No.	Service items	No.	Service items

(1)	Clear and accurate direction information and guide signs	(17)	Fast and convenient transfer services
(2)	Easy-to-find and accurate flight information	(18)	Passing the customs and border quarantine clearance smoothly
(3)	Friendly attitude from airport staff	(19)	Tidy environment, fresh air and comfortable temperature in the terminal
(4)	Airport staff's professional competence, standard operation and timely, accurate response	(20)	Sufficient and easy-to-use trolleys
(5)	Comfortable and uncrowded queuing space	(21)	Sufficient and comfortable seats
(6)	Clear broadcast with proper volume	(22)	Sufficient and clean toilets
(7)	Convenient and fast to access to or leave airport	(23)	Easy-to-find and available luggage storage
(8)	Sufficient and reasonable parking facilities	(24)	Sufficient and easy-to-use pantries and smoking rooms
(9)	Fast and stable Internet / WIFI connection	(25)	Convenient bank, ATM, currency exchange amenities
(10)	Timely and accurate notification of flight delays	(26)	Tidy catering environment and reasonable prices
(11)	Appropriate service arrangement after flight delays	(27)	Tidy retailing environment and clearly marked prices
(12)	Fast and convenient check-in service	(28)	Convenient shuttle bus service
(13)	Passing the security check smoothly	(29)	Proper number and position of elevators, elastrators, moving sidewalks
(14)	Standardized, orderly and thorough security check process	(30)	Sufficient, easy-to-find and easy-to-use disability facilities
(15)	Fast and accurate checked baggage claim service	(31)	Easy-to-find and quick-reaction of first aid and police services
(16)	No damage to checked luggage		

4.2.2 Data collection

The questionnaire survey was conducted in the departure, arrival and transfer areas of Terminals 1, 2 and 3 from June 28 (Thursday) to June 30 (Saturday), 2018, with the support of the Airport Authorities. There were no public holidays or major events during the investigation period. A total of 2,007 questionnaires were collected, of which 1,260 were collected in the departure area, 567 in the arrival area and 180 in the transfer area. After screening the validity and consistency of the questionnaires, a sample of 1,968 was finally obtained. There were 1,229, 562 and 177 questionnaires for departure, arrival and transfer, respectively. The sample's characteristics (in percentage) are provided in Table 3.

Table 3 Sample characteristics

Attributes		Departure passenger	Arrival passenger	Transit passenger
Gender	Male	52%	65%	56%

	Female	48%	35%	44%
Age	Under 15	8%	7%	1%
	16-30	57%	60%	61%
	31-45	25%	25%	28%
	46-60	7%	7%	6%
	Above 61	3%	1%	4%
Occupation	Student	35%	35%	25%
	Institution employee	18%	17%	15%
	Enterprise employee	22%	27%	24%
	Freelancer	11%	10%	16%
	Individual business	6%	5%	13%
	Others	8%	6%	7%
Education	Senior high school or under	29%	26%	18%
	Bachelor degree	62%	66%	67%
	Master or doctor degree	9%	8%	15%
Monthly income (yuan)	Under 5,000	56%	50%	37%
	5,001-10,000	36%	35%	38%
	10,001-15,000	4%	7%	13%
	15,001-20,000	2%	5%	7%
	Above 20,000	2%	3%	5%
Trip purpose	Tourism	37%	32%	29%
	Business	23%	32%	37%
	Visiting relatives	19%	15%	15%
	Others	21%	21%	19%
Trip alone	Yes	10%	48%	45%
	No	90%	52%	55%
Frequency (per year)	1-2 times	55%	51%	45%
	3-5 times	30%	34%	37%
	6-9 times	8%	8%	6%
	More than 10 times	7%	7%	12%

4.3 Results and Discussion

4.3.1 Evaluation of airport service satisfaction

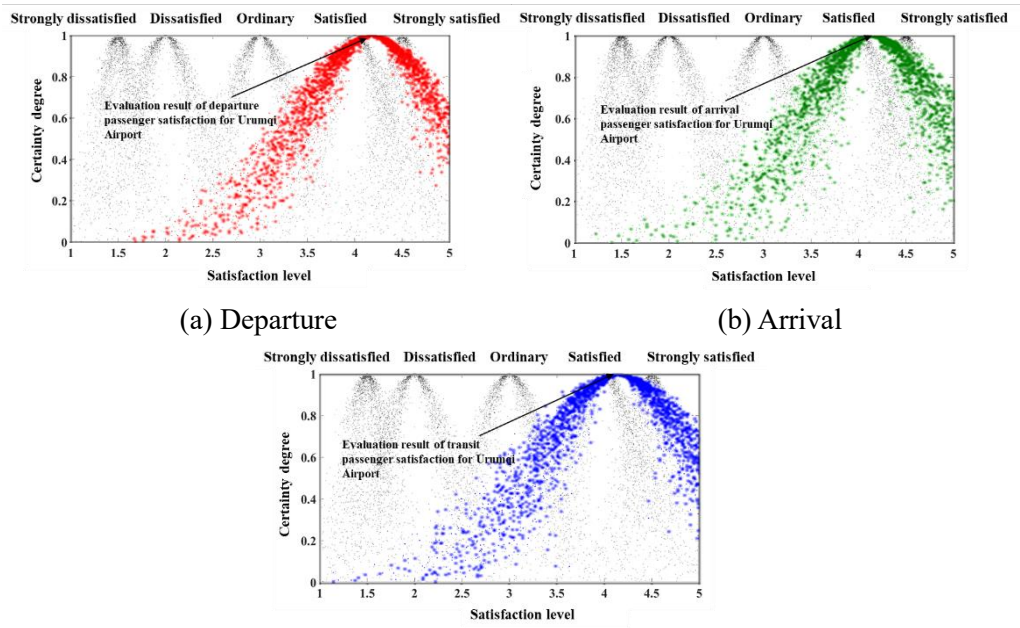
Following Equation (5), the benchmark cloud parameters are derived as follows: strongly dissatisfied (1.500, 0.167, 0.100), dissatisfied (2.000, 0.333, 0.100), ordinary (3.000, 0.333, 0.100), satisfied (4.000, 0.333, 0.100), strongly satisfied (4.500, 0.167, 0.100). The CRITIC

method is then used to calculate the weight value of each indicator, and generate the corresponding cloud parameter matrix of the indicator set Z by reverse cloud generator. The cloud parameters of evaluation results are presented in Table 4.

Table 4 Cloud parameters of evaluation results

Evaluation of cloud parameters	E_x	E_n	H_e
Airport departure service	4.179	0.746	0.140
Airport arrival service	4.133	0.727	0.182
Airport transfer service	4.144	0.815	0.170
Terminal 1 departure service	3.866	0.701	0.307
Terminal 1 arrival service	4.059	0.864	0.128
Terminal 2 departure service	4.252	0.806	0.086
Terminal 2 arrival service	4.153	0.725	0.140
Terminal 3 departure service	4.219	0.721	0.120
Terminal 3 arrival service	4.128	0.701	0.219

To see the evaluation results more intuitively, we use the forward cloud generator to convert the cloud model C to a normal cloud, and place it in the benchmark clouds. The final result is obtained by observing and comparing the position and shape of the cloud C in the benchmarks clouds. In order to ensure the error less than 0.01, the number of cloud drops N = 2000 is selected to generate a normal cloud. The evaluation results of the airport are shown as follows.



(a) Departure (b) Arrival

(c) Transfer

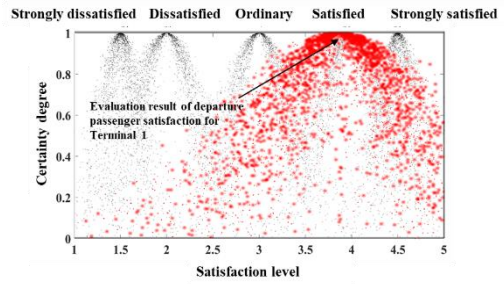
Figure 1 Normal cloud of evaluation results for Urumqi Airport

As can be seen from Figure 1, the normal clouds of the evaluation results of departure, arrival and transfer services are all located between “satisfied” and “strongly satisfied”, and slightly skewed towards “satisfied”. The normal clouds have a larger span than the benchmark

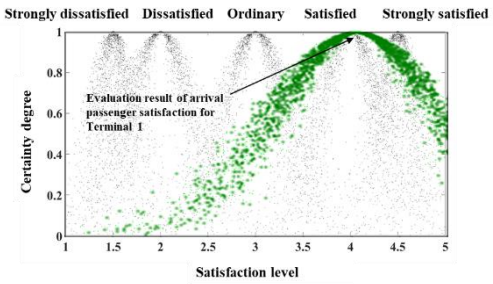
clouds in all the panels, which reflects that there are many differences of opinion on satisfaction with the service performance of Urumqi Airport. Further analysis based on the evaluation of cloud parameters in Table 4 shows that the satisfaction evaluation results of airport departure, arrival and transfer services are close, but the evaluation result of departure service is slightly better, the result of arrival service is relatively poor.

Then the satisfaction evaluation results of departure and arrival services of each terminal are shown in Figure 2. The departure services in Terminal 1 have the lowest satisfaction, as shown in Figure 2(a). The normal cloud of departure services for Terminal 1 is between the benchmark clouds of “ordinary” and “satisfied”, and is skewed towards “satisfied”. The span of the evaluation result cloud is much larger than that of the benchmark clouds in the figure, reflecting that there is a large cognitive spread of passengers' satisfaction for the departure services of Terminal 1. Passengers give the best evaluation results for the departure services in Terminal 2 (Figure 2(c)). The result cloud is between “satisfied” and “strongly satisfied”, and slightly biased towards “satisfied”. And the degree of dispersion and thickness of the result cloud is slightly smaller than benchmark clouds, suggesting that passengers have a good consensus on the evaluation results.

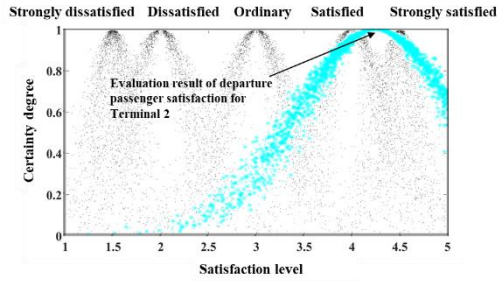
In general, passengers' satisfaction with arrival services of each terminal is similar, but their satisfaction with departure services varies widely. The satisfaction of Terminal 1 is slightly lower than that of Terminals 2 and 3, and the satisfaction evaluation of Terminal 2 is the best.



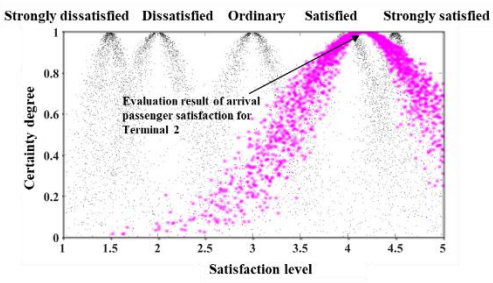
(a) Terminal 1 departure



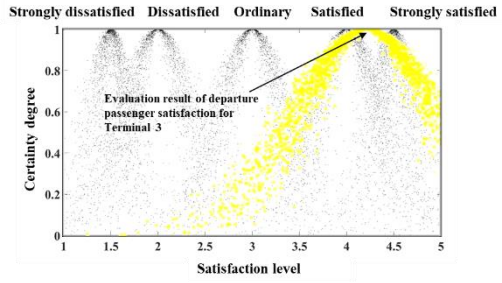
(b) Terminal 1 arrival



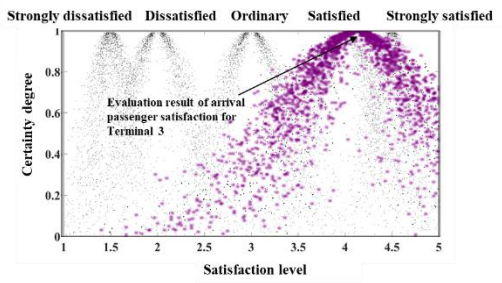
(c) Terminal 2 departure



(d) Terminal 2 arrival



(e) Terminal 3 departure



(f) Terminal 3 arrival

Figure 2 Normal cloud of evaluation result for each terminal

4.3.2 Evaluation of service demand importance

The analysis results of ECR method give an importance ranking of different services by passenger groups, and it can be interpreted as follows:

The departure passenger group, arrival passenger group and transfer passenger group all concern about safety, baggage and flight delay service, thus the items "(31) Easy-to-find and quick-reaction of first aid and police services", "(16) No damage to checked luggage", "(10) Timely and accurate notification of flight delays" and "(11) Appropriate service arrangement after flight delays" are highly valued. But they give the least concern to service items such as "(5) Comfortable and uncrowded queuing space", "(9) Fast and stable Internet / WIFI connection", "(8) Sufficient and reasonable parking facilities" and "(14) Standardized, orderly and thorough security check process".

The difference is that transfer passengers place a high importance on items "(1) Clear and accurate direction information and guide signs" and "(4) Airport staff's professional competence, standard operation and timely, accurate response", suggesting that they need more guidance at the airport. While departure and transfer passengers pay more attention to services such as retailing, seats and smoking rooms than arrival passengers. These findings can help the airport management adjust the relevant facility layout in the terminals.

It is worth noting that for service items "(6) Clear broadcast with proper volume" and "(7) Convenient and fast to access to or leave airport", departure passengers consider that item (7) is more important than (6), while arrival passengers think that (6) is more important than (7). Interestingly, transfer passengers believe that both are equally important.

4.3.3 Comparative analysis of satisfaction evaluation and importance evaluation results

Service satisfaction evaluation results can identify the airport services which do not meet passengers' expectations. The cloud parameter *Ex* represents the average value of passengers' evaluation of airport service. The smaller *Ex* is, the lower the satisfaction, and the more the service needs to be improved. Table 5 summaries ten lowest satisfaction indicators. It shows that catering and shopping, flight delay services, Internet service, airport traffic service, some terminal facilities and baggage service perform poorly, and need to be improved.

Table 5 Ten lowest satisfaction indicators

Departure		Arrival		Transfer	
Indicator	***Ex***	**Indicator**	***Ex***	**Indicator**	***Ex***
Catering service	3.908	Catering service	3.858	Catering service	3.653
Shopping service	3.986	Shopping service	3.942	Service after delay	3.792
Service after delay	4.013	Internet service	3.992	Internet service	3.802
Internet service	4.038	Service after delay	4.011	Flight delay notification	3.802
Flight delay notification	4.072	Financial service	4.022	Shopping service	3.881
Smoking rooms and pantries	4.083	Smoking rooms and pantries	4.028	Financial service	3.921
Financial service	4.084	Flight delay notification	4.033	Smoking rooms and pantries	3.97
Parking facilities	4.091	Parking facilities	4.039	Baggage claim speed	4.03
Seats	4.094	Baggage claim speed	4.064	Baggage integrity	4.089
Boarding speed	4.168	Airport access traffic	4.078	Baggage storage	4.129

Combining the satisfaction evaluation and service item importance rating, the results show that the catering and shopping services, flight delay services including “flight delay notification” and “service after delay” have low satisfaction rating but they are deemed as highly important. Passengers also place great importance on baggage related services, smoking rooms and pantries, but these services do not receive high ratings in satisfaction. Therefore, it is worth investing more resources to improve the performance of these services.

Conversely, although airport traffic service, Internet service and financial service perform poorly in satisfaction evaluation, they also ranked relatively low in the importance evaluation. It suggests that the airport management should pay attention to these areas, but there is no urgency to put resources in these areas if the airport faces tight budget constraints.

5. Conclusion

This paper combines the satisfaction evaluation and importance analysis to establish a comprehensive evaluation indicator system for airport services. A survey was conducted concerning airport departure, arrival and transfer services at Urumqi Airport. The cloud model combined with the CRITIC objective weighting method was used to reveal the passengers’ satisfaction on airport services. The ECR method was applied to determine the degree of importance of each service item. The satisfaction evaluation results show that the departure services are better than the arrival and transfer services at Urumqi Airport. The arrival services are the least satisfied. The overall satisfaction for Terminal 1 is lower than that for Terminals 2 and 3. The importance evaluation results indicate that passengers place a high value on the security, baggage and flight delay related services. Putting together, we can see that catering, shopping, flight delay, baggage services and smoking rooms and pantries need to be prioritized for improvement. The methodology proposed in this paper can provide a useful guidance in evaluating airport services, as it can help airport operators and managers analyze the satisfaction

and importance of service attributes, and give priority to service items with high importance but low satisfaction.

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