Application Evaluation Research on the Airport Information System

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Abstract. This paper puts forward an applicable evaluation research method for the information system satisfaction in the small and medium-sized airport. It constructs a multi-dimensional index system, and analyzes the influencing factors and weights based on the multiple linear regression function. The evaluation research method could provide quantitative decision support for optimizing the quality of information system and improving the comprehensive service ability.

Keywords: Evaluation, Information System, Index, Linear Regression Model.

1. Introduction
In recent years, with the rapid development of cloud computing, virtualization, big data and other new generation of information technology, information systems and products are increasingly widely used in airports. On the one hand, the providers use the current advanced information technology to assist the airport to realize the information management and passenger service, and maximize the application value of information systems. On the other hand, they constantly improve the facilities and quality of their own services, aiming at improving the satisfaction of airport users. The satisfaction evaluation of airport users is a benchmark to measure the market competitiveness of systems, and also provides the directions for suppliers to explore new needs and new business [1]. Therefore, it is necessary to establish the satisfaction index evaluation system of airport information systems.

This paper presents an evaluation method for the enterprise’s information systems. It is based on the multiple linear regression model [2] and firstly applied to the information system for the small and medium-sized airport [3]. There are about 50 small and medium-sized airports involved in the evaluation and their actual needs are explored. The evaluation procedure can be briefly summarized as follows. Firstly, it constructs the informational system satisfaction index system for small and medium-sized airports. Secondly, it calculates and analyzes the indicators based on the collected multi-dimensional user evaluation data to comprehensively evaluate the current situation of system satisfaction. Then it uses the linear regression function to fit the index variables of user feedback, and analyzes the factors and weights that affect the satisfaction of small and medium-sized airports. Finally, based on the index weight, it considers the application achievements in public welfare and benefit and puts forward reasonable suggestions for small and medium-sized airports. Quantitative strategies can be made based on the above evaluation method and used to improve the informational system competitiveness for the small and medium-sized airports. It provides great support for optimizing the quality of informational systems and improving the comprehensive service ability.
2. Construction of Evaluation Index

System evaluation index is not only an important reference standard for scientific measurement and performance evaluation, but also a key factor to promote the continuous optimization of systems. The construction of system evaluation index needs to be combined with the operation characteristics of the system and the actual needs of users [4, 5]. From a broader perspective, it needs to take into account the use value and commercial value of the system. In terms of the use value, the design index should be able to measure whether the system meets the actual application needs of small and medium-sized airports and to what extent. In terms of the commercial value, it is necessary to comprehensively consider the characteristics of small and medium-sized airports, which mainly includes two aspects. One aspect is that the transport capacity is small and the capital investment is limited, so the cost control of systems is stricter. The other aspect is that the ability of the technical support, operation and maintenance is relatively weak, so the airports highly depend on the system after-sales service. Based on the above considerations and the principle that the index should reflect the most important and comprehensive information with as few indicators as possible, this paper puts forward a two-level index system for the evaluation of information system satisfaction for small and medium-sized airports, as shown in Figure 1.

(1) Function Index. It refers to whether the functions meet the needs of users or solve some types of problems of users. Taking the departure systems as an example, the functional indicators include check-in, boarding, statistical query and other indicators directly related to user needs.

(2) Technical Index. It refers to whether the function solves the user's problem with high quality. It is the standard to measure the "good" and "bad" of the system itself. Taking passenger travel systems as an example, the technical indicators include response speed, check-in efficiency, information accuracy, etc.

(3) O&M Service Index. O&M Service means the operation and maintenance service. O&M service index refers to whether the supplier has brought satisfactory solution to users in the whole life cycle, while not only solves a certain problem at a certain stage. The service indexes of systems include maintenance service level, software upgrade service level, etc.

(4) Economic Performance Index. It refers to all costs paid by users to purchase systems, including direct costs (such as equipment purchase costs) and derivative costs (such as labor costs, maintenance costs, etc.) generated in the use process. Different airports have different demands for the same system and they are willing to pay different costs. In addition, the scale and operational situation of airports are quite different. Therefore, the input-output ratio and economic benefits of the same system in different airports are different, which constitutes the economic benefit index.

3. Satisfaction Analysis

3.1. The establishment of the satisfaction evaluation model

Around 50 small and medium-sized airports participated in the system satisfaction evaluation and gave effective feedback. The research systems cover the mainstream system lines of passenger travel service,
departure service, security inspection, flight operation, etc. Taking self-service check-in system as an example, the scoring results are shown in Table 1, where “I” represents importance and “S” represents satisfaction.

Table 1. Sample of System Satisfaction Index Score Results

| Self-Service Check-in System | Function Index | Technical Index | O&M Service Index | Economic Performance Index |
|-----------------------------|----------------|-----------------|-------------------|---------------------------|
| Fujian Airport              | 4.5            | 5               | 1                 | 4                         |
| Chifeng Airport             | 4              | 5               | 1.5               | 4                         |
| Qingyang Airport            | 5              | 5.5             | 3                 | 4                         |
| Shi Hei Airport             | 3.5            | 4               | 2                 | 4                         |
| Guangzhou Airport           | 4.5            | 5               | 1                 | 4                         |
| Xu Er Le Airport            | 5              | 5.5             | 3                 | 4                         |
| San Qingshan Airport        | 5              | 4               | 2                 | 4                         |
| Tengchong Airport           | 4              | 5               | 1                 | 4                         |
| Qingyang Airport            | 5              | 5               | 1                 | 4                         |

The evaluation purpose is to guide system improvement and other related decisions with quantifiable user feedback and strengthen the market application. The detailed research ideas are as follows. Firstly, it determines the influencing factors of satisfaction and calculates the influence weight of each factor. Second, according to the weight, the index with higher influence level is obtained which is supported by data to guide how to improve the comprehensive satisfaction. In this study, we need to determine the influence weight of multiple index variables. Therefore, we use multiple linear regression analysis method to construct characteristics from the original data, select training samples, fit the relationship between multiple index variables, and get the weight coefficient. Specifically, this paper selects the primary indexes of satisfaction (function, technology, service, economic benefits) as the characteristics. Also, it takes the primary indexes as the training sample, inputs the sample value into the linear regression model, and obtains the corresponding weight of each index, as the basis for evaluating the influence level of the index on the comprehensive satisfaction. The analysis results of linear regression method are intuitive, which can meet the continuous change characteristics of dependent variables (i.e., comprehensive satisfaction) and the relatively independent characteristics between independent variables (i.e., each index). Furthermore, this paper uses Python software to execute linear regression function (calling linear in sklearn module)[6]. The least square approximation is used to fit the characteristics of the model and the weight of satisfaction is calculated. The multiple linear regression function model is as follows:

$$Y_k = a_0 + a_1X_{k1} + a_2X_{k2} + a_3X_{k3} + a_4X_{k4}$$

(1)

$$k \in [1, n], \ n \ is \ the \ number \ of \ investigated \ airports. \ X_{k1}, \ X_{k2}, \ X_{k3} \ and \ X_{k4} \ represent \ four \ primary \ indexes \ of \ an \ airport \ to \ target \ systems.$$
3.2. Calculation of Primary Satisfaction Index

Taking the self-service check-in system as an example, the system scoring results of Chifeng Airport are selected to calculate the primary index of satisfaction, as shown in Table 2. The normalized value is the result of normalization of the weight value, namely

\[ I'_y = \frac{I_y}{\sum_j I_y}, \quad i = 1, ..., 4. \]  

(2)

\( i \) is the subscripts of the four primary indexes. \( j \) is the subscript of the secondary index. \( K_y = S_y \times I'_y \) is the secondary index, and \( X_i = \sum_j K_y \) is the primary index.

Table 2. The Satisfaction Index Evaluation of the Sample Airport

| Primary Index | Secondary Index | Index Value (S) | Weight Value (I) | Normalized Value (I') | Secondary Index (K) | Primary Index (X) | Comprehensive Satisfaction (Y) |
|---------------|----------------|----------------|-----------------|-----------------------|---------------------|-------------------|-------------------------------|
| Function      | Daily Business  | 3              | 5               | 0.169                 | 0.507               |                   |                               |
|               | Business Customization | 4          | 3               | 0.102                 | 0.408               |                   |                               |
|               | Travel Extraction | 1             | 4               | 0.135                 | 0.35                |                   |                               |
|               | Self Service Seat Selection | 5          | 5               | 0.169                 | 0.85                |                   |                               |
|               | Frequent Flyer Mileage Points | 5          | 4.5             | 0.152                 | 0.76                |                   |                               |
|               | Important Information Tips | 5          | 5               | 0.169                 | 0.85                |                   |                               |
|               | Multi-Person Check-In | 5             | 3               | 0.102                 | 0.51                |                   |                               |
| Technique     | Data Synchronization | 5             | 5               | 0.286                 | 1.43                |                   |                               |
|               | Information Accuracy | 4             | 5               | 0.286                 | 1.44                |                   |                               |
|               | Friendly Self-Service Interface | 5          | 4               | 0.128                 | 1.28                |                   |                               |
|               | System Automation | 4             | 3.5             | 0.2                    | 0.8                 |                   |                               |
|               | Software Upgrade Service | 4          | 4               | 0.32                  | 1.28                |                   |                               |
|               | Maintenance Service | 3             | 4               | 0.32                  | 0.64                |                   |                               |
|               | System Operation and Maintenance Cost | 4          | 4.5             | 0.36                  | 1.44                |                   |                               |
|               | Software Maintenance Cost | 4          | 5               | 0.5                    | 2                   |                   |                               |
|               | Equipment Purchase Cost | 4          | 5               | 0.5                    | 2                   |                   |                               |

In the same way, according to the collected 250 airport user sample data (excluding the unused and invalid sample data), we can get the primary index results of satisfaction of all participating airports, as shown in Table 3.

Table 3. Primary Indexes and Comprehensive Satisfaction of the Self-Service Check-In System

| Airport List | Function Index (X1) | Technical Index (X2) | O&M Service Index (X3) | Economic Performance Index (X4) | Comprehensive Satisfaction (Y) |
|--------------|---------------------|----------------------|------------------------|-------------------------------|-------------------------------|
| Airport 1    | 4.01                | 4.514                | 3.36                   | 4                             | 4                             |
| Airport 2    | 4.4286              | 5                    | 5                      | 4                             | 4.5                           |
| Airport 3    | 4.4286              | 4.5                  | 5                      | 5                             | 4.5                           |
| Airport 4    | 3.5714              | 3.25                 | 2                      | 3                             | 3                             |
| Airport 5    | 4.2414              | 4.75                 | 5                      | 5                             | 4.5                           |
| Airport 6    | 4.2857              | 4.75                 | 4                      | 4                             | 4                             |
| Airport 7    | 4.8824              | 4.5586               | 4                      | 4                             | 4                             |
| Airport 8    | 2.7143              | 3.5                  | 3                      | 3                             | 3                             |
| ……           |                     |                      |                        |                               |                               |
3.3. Calculation of Satisfaction Weight

This paper uses multiple linear regression model to fit the multiple indexes of system satisfaction, calculates the index coefficients $a_1, a_2, a_3, a_4$, and analyze the weight of influencing factors of satisfaction. In the typical information systems, self-service check-in, self-service luggage check-in, paperless travel, security check and passenger transit are selected as representatives for data analysis. The experimental results are shown in the figure 2.

![Figure 2. Weight of Influencing Factors for the Information System](image)

For the above-mentioned systems, the economic performance index and the function index have great impact on the satisfaction degree. In terms of economic performance, the small and medium-sized airports are limited by the scale of transport capacity and capital budget, so their cost budget of information systems is limited. Furthermore their daily business operation is relatively regular and stable, and they hardly pursue system innovation. Therefore, in the process of purchasing and using the new system, the small and medium-sized airports will attach great importance to whether it is economical and cost saving. In terms of function, the system function is closely related to the normal operation of airport business. The function index is not only the concentrated embodiment of users' basic demands, but also the basic benchmark to measure whether the actual problems of users are solved. The functional failure will cause users' strong dissatisfaction. Therefore, the small and medium-sized airports attach great importance to the function index. Compared with the economic performance index and function index, the impact weight of technical index value and O&M service index value is low. Combined with the actual investigation situation, small and medium-sized airports generally do not pay much attention to the high-performance system. The choice to apply the innovative technology depends on their actual demand. Meanwhile, most of the suppliers have already formed a stable and normalized after-sales cooperation model with the small and medium-sized airports. Therefore, there’s no additional service demand for the small and medium-sized airports.

4. Improvement Suggestion

Based on the above analysis results, this paper puts forward some suggestions for suppliers and airports.

(1) Supplier "cloud server" + Airport "front end leasing" mode. The small and medium-sized airports adopt the resource leasing method. Take the departure system as an example, the suppliers deploy functional servers in the cloud. Airport users order services from manufacturers according to their actual needs, and pay the suppliers fees according to the service scope and service duration. This
model not only saves the development cost of small and medium-sized airports, but also provides a system platform of on-demand services for small and medium-sized airports.

(2) Systematic products strategy. According to the scale of the airport, daily transport capacity, supporting from the authority, and some other conditions, small and medium-sized airports deploy their information systems with different sizes and price range. Suppliers implement the scheme of "member price" and "package price" to attract more airport users.

(3) Enhanced communication frequency. Airports and suppliers strengthen substantive communication. On the one hand, airports get as more information about the innovative system as possible. One the other hand, suppliers issue product manuals regularly, and extent their new system to airports as early as possible. Meanwhile, both sides diversify the form of communication. For example, on-site support, regular research by a third party and so on.

(4) Detail optimization. In order to meet the strict demands of users, continuous optimization of system function is necessary. For example, if the passenger information is temporarily modified or cancelled before boarding, the data needs to be synchronized to the boarding front-end system in time. Voice function is suggested to be added to the self-service check-in system, so as to make it more convenient to use. For the self-service luggage check-in system, it is better to accurately input the weight and automatically handle the overweight payment when the luggage is overweight.

(5) Unified Interface. When a new system is going to be developed, it is better to investigate the airports’ demand in advance. It is particularly important to pay attention to the unified data exchange standard between the new systems and the existing systems, avoiding system interface inconsistency. It is suggested to keep the consistency of interface coding logic to improve system compatibility.

5. Conclusion
This paper presents the evaluation research method for the small and medium-sized airport information system satisfaction. Based on the constructed multi-dimensional index system, it deeply analyzes the influencing factors and influence weights of the information system satisfaction. From the calculation results of the satisfaction weight, improvement suggestions are put forwarded in order to promote the systems’ competitiveness and service ability.

Acknowledgements
This work was supported in part by the National Key Research and Development Program of China (No. 2018YFB1601200), supported in part by Guangdong Airport Baiyun Information Technology Co., Ltd.-CAMIC, and supported in part by the Safety Capacity Building project of Civil Aviation Administration of China: “Research on Intelligent Technologies and Application Scenarios of Civil Aviation Emergency Disposal” (No. OMSA1907).

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