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Performance Evaluation of Airport Operation and Production Based on Entropy Weight-VIKOR Method

Yichi Zhang[1], Wenyi Zhang[1], Shaolin Li[2]

[1]*School of safety science and engineering, Civil Aviation University of China, Tianjin 300300*

[2]*College of air traffic management, Civil Aviation University of China, Tianjin 300300*

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Abstract: The status of airport operation and production is an important factor affecting the efficiency of airport operation. Effective evaluation of airport operation and production performance has important guiding significance for the improvement of airport quality management and the enhancement of market competitiveness. This paper takes the monthly operation of Hangzhou Xiaoshan International Airport in 2018 as an example. By establishing an airport operation production index system, the entropy weight-VIKOR method is used to evaluate the performance of the airport's operation and production. The results show that when different decision-making coefficients are taken, the optimal month for the airport's operational productivity is always October. A sensitivity analysis was conducted on the worst month for operational performance. It was found that the main indicators affecting the month were the number of aircraft movements and passengers. Satisfaction. Airport managers should pay close attention to these two indicators, and seek improvement measures in comparison with internal benchmarks to guide the continuous improvement of airport operation and production performance.

1. Introduction

The status of airport operation and production is an important influencing factor of airport operation efficiency. Effective evaluation of airport operation and production performance by stakeholders has important guiding significance for a clear understanding of airport operation efficiency, correct reflection of quality management level, and enhancement of market competitiveness. Parker(1997)used the fuzzy evaluation method to conduct a comparative study on 9 major airports in East Asia and Southeast Asia [1]; The researches of domestic and foreign experts and scholars mainly focus on operational efficiency, but there are few researches on production efficiency.This paper takes the monthly operation of Hangzhou Xiaoshan International Airport in 2018 as an example. Through the establishment of an airport operation production index system, the entropy weight-VIKOR method is used to evaluate the performance of the airport's operation and production. The research results have important guiding significance for the improvement of airport quality management and market competitiveness.

2. Establishment of indicator framework

Since the 1990s, many experts and scholars at home and abroad have conducted research on the

evaluation of airport operation efficiency. This article refers to the analysis status of domestic and foreign experts and scholars [2], considering the difficulty of the actual airport operations and production work of data collection, the index system as shown in Table 1:

Table 1: Airport Operational Production Index

	Operational production index	Calculation formula and data source	Source reflected content
1	Passenger throughput	Total number of passengers entering and leaving the port during the reporting period	Production and operation level
2	Passenger throughput per terminal	Passenger throughput/passenger terminal area	production efficiency
3	Cargo and mail throughput	The number of cargo and mail entering and leaving the port during the reporting period	Production and operation level
4	Cargo and mail throughput per unit cargo apron	Cargo and mail throughput/freight terminal area	production efficiency
5	Number of aircraft take-offs and landings	The total number of aircraft take-offs and landings during the reporting period	Production and operation level
6	Number of take-offs and landings per parking bay	Number of aircraft take-offs and landings/number of parking bays	Service efficiency
7	Number of take-offs and landings per runway	Number of aircraft take-offs and landings/number of runways	production efficiency
8	Passenger Satisfaction	Randomly selected passenger scores	Service satisfaction
9	Flight regularity rate	Civil aviation flight regularity statistics system	Production efficiency and quality

3. Establishment of evaluation model for airport operation and production capacity

This model combines the entropy method [3] and the VIKOR [4] method. In the evaluation and decision-making process, the entropy weight is used to reduce the influence of the subjective factors of the decision maker in the weighting process, and at the same time, the VIKOR method is used to maximize the group utility so that the evaluator can accept the compromise solution. This model provides airport managers a more objective and simple method for evaluating operational production capacity.

4. Results and case analysis

4.1 Evaluation of the monthly operation and production status of Hangzhou Xiaoshan International Airport in 2018

Using the data in the literature [5], the monthly operation and production status of Hangzhou Xiaoshan International Airport in 2018 was evaluated by the entropy weight-VIKOR method.This paper use Matlab to solve the model. In this example, all indicators are positive indicators. Using the entropy method to obtain the weights of 9 indicators is shown in the following matrix:

$$W = (0.130473 \quad 0.130172 \quad 0.072136 \quad 0.072259 \quad 0.101034 \quad 0.101031 \quad 0.103254 \quad 0.17684 \quad 0.112801)$$

Table 2: Standardized values and ideal solutions of various indicators

	Index1	Index2	Index3	Index4	Index5	Index6	Index7	Index8	Index9
January	0	0	0.982979	0.977778	0.258065	0.258091	0.266667	0.25	0.877121
February	0.187135	0.1875	0	0	0	0	0	0.25	0.603393
March	0.678055	0.681818	0.876596	0.866667	0.709677	0.709545	0.733333	0.25	0.698762
April	0.676054	0.676136	0.753191	0.755556	0.612903	0.612864	0.6	0.125	0.596057
May	0.545245	0.545455	0.834043	0.822222	0.645161	0.645227	0.666667	0.75	0.495186
June	0.454294	0.454545	0.855319	0.844444	0.483871	0.483818	0.466667	0	0.503897
July	0.839181	0.840909	0.53617	0.533333	1	1	1	0.375	0
August	1	1	0.582979	0.577778	0.935484	0.935682	0.933333	1	0.134801
September	0.562173	0.5625	0.880851	0.866667	0.709677	0.709545	0.733333	0.375	0.564878
October	0.847799	0.846591	0.765957	0.755556	0.83871	0.838591	0.866667	1	1
November	0.273315	0.272727	1	1	0.419355	0.4195	0.4	0.5	0.55204
December	0.280394	0.284091	0.978723	0.977778	0.483871	0.483818	0.466667	0.625	0.917928
Positive ideal solution	1	1	1	1	1	1	1	1	1
Negative ideal solution	0	0	0	0	0	0	0	0	0

Taking into account the impact of the actual significance of the airport operation and production evaluation, the decision coefficient v is selected as 0.5, 0.2, 0.8. The results are shown in Table 3:

Table 3: R, S, Q values and sorting results of each month

	R	S	Q	S value sort	v=0.5 Q sort	v=0.8 Q sort	v=0.2 Q sort
January	0.132630	0.635605	0.717546	11	10	11	9
February	0.132630	0.838904	0.859088	12	12	12	10
March	0.132630	0.354782	0.522030	5	8	6	8
April	0.154735	0.439716	0.651620	8	9	9	11
May	0.059333	0.350585	0.285486	4	2	3	2
June	0.176840	0.556046	0.803068	10	11	10	12
July	0.112801	0.332197	0.443102	3	4	4	6
August	0.097595	0.178087	0.287342	2	3	1	3
September	0.110525	0.378123	0.467825	6	6	5	7
October	0.019970	0.120744	0.000000	1	1	1	1
November	0.094813	0.507699	0.507958	9	7	8	5
December	0.093889	0.425159	0.447548	7	5	7	4

The results show that when the decision-making coefficient v=0.5, which is a trade-off between maximizing group benefit and minimizing individual regret, the maximum operating production capacity of Hangzhou Xiaoshan International Airport is October, followed by May. The performance of operational production capacity in February and June was poor. When the decision-making coefficient v=0.8, that is, when the evaluation is based on the principle of maximizing group benefits, the optimal operation and production capacity of the airport is in October and August, and the worst is January and February. When the decision coefficient v=0.2, that is, when sorting based on the principle of minimizing individual regret, the best operating productivity of the airport is October and May, and the worst is April and June.

From the above analysis, it can be seen that regardless of the value of the decision-making coefficient, the operation and production capacity of Hangzhou Xiaoshan International Airport will always rank first in October in 2018. Therefore, the airport should use October as the benchmark, analyze the main influencing factors, and propose appropriate solutions and improvement methods.

4.2 Sensitivity analysis

From the perspective of sensitivity analysis, this section studies the impact of changes in different index variables on the output of the model. Take the monthly operational production level ranking of the airport when the decision coefficient is 0.5 as an example. Set the monthly operational production capacity score of the first ranked month as 90 points, and each decrease in the ranking below will reduce the score by 4 points. The analysis shows that the monthly operating production scores from January to December are: 74, 66, 90, 70, 82, 78, 50, 86, 58, 62, 46, 54.

Set 60 as the minimum acceptable level of airport operation and production. It can be seen that the operation and production performance of the airport in January, February, April, and June did not reach this level. The manager needs to use October as the internal benchmark and use benchmark management to analyze the reasons and carry out rectification, so as to effectively improve the performance of airport operation and production.

Take the month with the lowest production performance score as an example for sensitivity analysis. Since the airport's terminal area, apron area, number of parking spaces and number of runways cannot be changed in a short time, indicators 1 and 2, indicators 3 and 4, indicators 5, 6, and 7 influence each other. Let each of the above indicators range from 0% to 25%, and the percentage change of indicator 8 from 0% to 1%, then the sensitivity analysis line chart of the airport operation and production performance ranking in February 2018 is as follows:

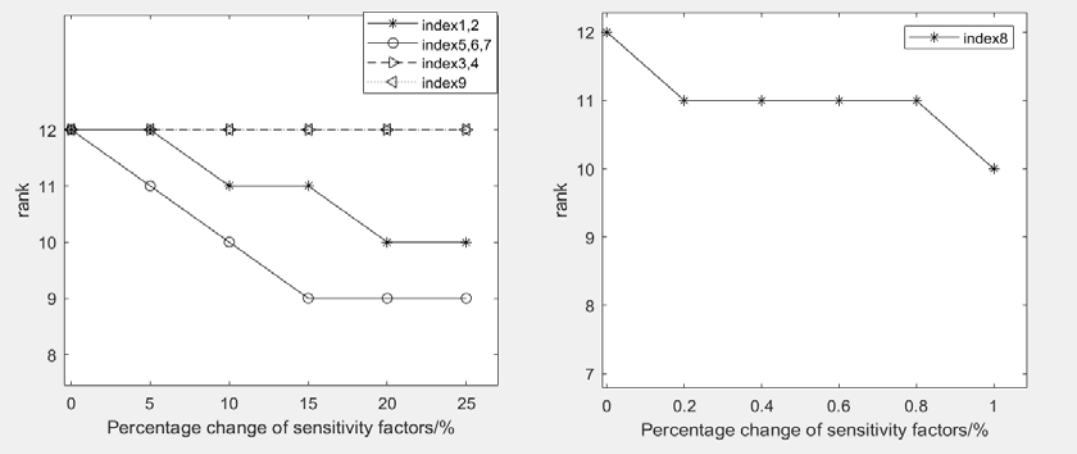

Figure 1: Line graph of sensitivity analysis

From the sensitivity analysis, we can see that the indicators that can have a greater impact on the airport's operational and production performance in February are mainly aircraft movements and passenger satisfaction. Therefore, airport managers should pay close attention to these two indicators. Managers should carefully analyze the airport's flight area capacity, runway utilization efficiency, airport operation command capabilities, air traffic management capabilities, and the completeness of airport equipment and facilities, as well as the airport staff's service attitude, and compare these content with the benchmark month to find differences. Look for corresponding countermeasures and set reasonable and credible targets to guide the continuous improvement of airport operation and production performance.

5. Discussion and conclusion

In this paper, the entropy weight-VIKOR method is used to evaluate the performance of airport operation and production, and the 2018 Hangzhou Xiaoshan International Airport is taken as an

example for empirical analysis. When different decision coefficients are used, the best month for the airport's operational productivity is always October. A sensitivity analysis is conducted on the worst month of operational performance. The main indicators that affect this month are the number of aircraft takeoffs and landings and passenger satisfaction. Airport managers should pay close attention to these two indicators, compare with internal benchmarks, seek improvement measures, and guide the continuous improvement of airport operation and production performance.

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