Research and Analysis of Tourist Utility Maximization and Playground Profit Maximization

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Abstract: With the improvement of people's living standards and quality, playgrounds need to not only maximize their own profitability as a strategic goal in terms of fare sales and amusement facilities construction, but also need to meet consumer demand for maximum entertainment utility. Based on these two goals, this article uses the daily number of tourists in 2018 as the base period to make consumption behavior and fare predictions, and gives related recommendations. This article first uses the exponential smoothing method to calculate the initial forecast of the number of summer vacation and National Day visitors, and then combine the data from the first five months of the biennium to find the actual forecast value and determine the date with the largest number of people. Then build a gray forecasting model to get the initial forecast value, and finally get the forecast result of the number of visitors on August 5, 2019. Then use AHP method to explore the best scheme to play under the conditions of purchasing a ticket. Finally, compare the pass price and the total cost of the project from the perspective of the operator, and then combine the actual situation to determine that the setting of the ticket is necessary.

1. Introduction

With the improvement of people's living standards and quality, large-scale playgrounds have increasingly become an important place for leisure and entertainment beyond people's work. To meet the entertainment needs of tourists while maximizing operating profit is the goal of corporate development. When tourists spend entertainment in playgrounds, in addition to the seasonal and holiday factors, it is also related to the reservation and play time of the entertainment facilities in the playground. At the same time, the maximum number of people per game in the entertainment facility also affects the tourist's consumption effectiveness. From the perspective of the playground, it is important to know in advance the tourists' ticket purchasing behavior and entertainment needs for a specific period of time in the future. Through the quantitative analysis of the start time and reservation waiting time of entertainment facilities, it can help tourists to reasonably arrange entertainment time and meet the maximum utility of tourists. The analysis of the number of tourists buying tickets in a certain period of time can predict the peak and trough periods of the future number of tourists in the playground, and then set the most reasonable ticket and pass prices, so as to maximize profits and improve the competitiveness of the playground.

2. The establishment and solution of the model for predicting the number of tourists

2.1 Data Preprocessing

First delete the data when the playground is not open during the Spring Festival holiday, delete the data of the number of people who play in a single project over the total number, and supplement it according to the maximum number of people receiving the project. Then according to the time before summer vacation (January to June), the time of summer vacation (July and August) and the time after the summer vacation (September to December), the data is divided into three phases in

time, and the missing values of each phase are implemented by interpolation in matlab.

2.2 Data Analysis

For the processed data, first select the number of tourists in 2018 for data analysis. Since the number of tourists is more on holidays and summer vacations, we need to classify holiday data, summer vacation data and other date data and study them separately. It can be judged that the fluctuation of the year-round data in 2019 should not be much different from 2018, and the day with the largest number of people should be during the National Day.

After comparing the data from 2018 to January to May 2019, it is known that the fluctuation of the number of tourists is basically the same on the corresponding dates of the biennium, and the number of tourists in 2019 has increased compared to 2018. The fluctuation of the number of tourists in July and August 2019 is the same as that in July and August 2018, and the growth rate of the number of tourists is the same as the previous five months. Then, the daily average growth rate of the number of tourists in the biennium can be calculated. It is obtained from the existing data from January to May, and the data with a high number of holidays is excluded to make the calculation result more accurate.

In summary, it can be obtained that to predict the number of tourists for each day of the playground in July and August 2019 and the day when the number of tourists in the second half of the year will most appear, we need to select data for the corresponding date of 2018 for prediction, and calculate daily average growth rate of the number of tourists. By averaging the average daily growth rate data from January to May, the result is 62.513%.

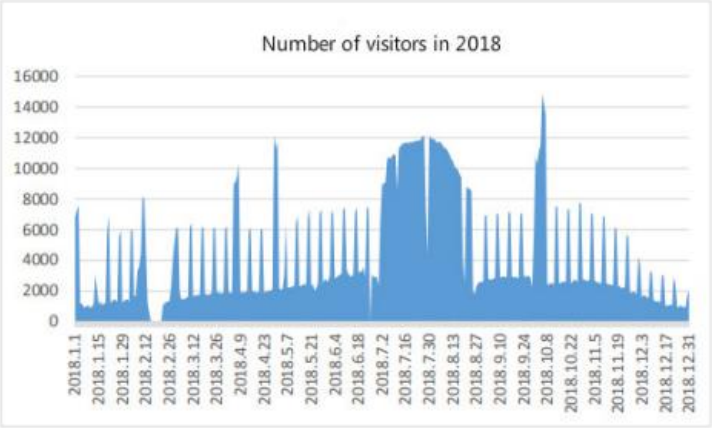

Figure 1. Number of visitors in 2018

2.3 Model Establishment

The exponential smoothing method is a time series analysis and prediction method developed on the basis of the moving average method [1]. By calculating the exponential smoothing value and combining a certain time series prediction model, the future of the phenomenon can be predicted. The principle is any exponential smoothing value of a period is the weighted average of the current period's observed value and the previous period's exponential smoothing value [2]. It is compatible with the advantages of the full period average and moving average, and does not discard the past data. However, it gives the decreasing degree of influence, that is, as the data moves, it gives a weight that gradually converges to zero [3].

When the time series changes show a linear trend, there is still a significant lag bias in the prediction using the exponential smoothing method. Therefore, it must also be revised. The correction method is the same as the trend moving average method, that is, to reset the second exponential smoothing by using the law of lag deviation to establish a linear trend model [4]. This paper uses a second degree smoothing:

(1) The prediction model is:

$$S_t^{(1)} = \alpha y_t + (1-\alpha) S_{t-1}^{(1)}$$

$$S_t^{(2)} = \alpha S_t^{(1)} + (1-\alpha) S_{t-1}^{(2)}$$

Among them, the time series is $y_1, y_2 \ldots\ldots, y_t, \ldots$ where α is the weighting coefficient, $0 < \alpha < 1$, $S_t^{(1)}$ is an exponential smoothing value, $S_t^{(2)}$ is the smoothed value of the quadratic exponent.

(2) Selection of weighting coefficient α

When taking α = 0.2, α = 0.6, and α = 0.9, the predicted values are different. By calculating the prediction standard error s of different weighting coefficients, the value of α that makes s smaller is selected. The standard error of prediction is shown in Table 1:

Table.1. Analysis table of prediction standard error

α	0.2	0.6	0.9
S	4.5029	4.59.8	4.4426

The calculation results show that when α = 0.9, s is small, so take α = 0.9.

2.4 Model Solution

Based on the data from July and August 2018, use the exponential smoothing method to obtain the predicted initial value, and then combine the quantitative relationship between the two years-the daily average growth rate to get the actual predicted value. The formula is as follows:

Actual forecast value = (1 + average daily growth rate) * initial forecast value

The predicted values for July and August 2019 are calculated. According to the data during 2018 and the National Day, the predicted daily number during the National Day in 2019 is also calculated using the exponential smoothing method as shown in Table 2:

Table.2. Forecast of Tourists during National Day

date	Tourists of the day number
2019.10.6	23111
2019.10.5	23089
2019.10.7	22187
2019.10.4	18552
2019.10.3	17817
2019.10.1	17503
2019.10.2	16858

In the predicted value of National Day, you can see that the day with the largest number of visitors in the second half of 2019 is October 6, with 23,111 people.

3. The establishment and solution of the prediction model of the number of players in four projects

3.1 Data Preprocessing

Feature extraction of the a4, b5, b12, and b25 game play data, with August 5, 2019 as the target, and July to August 2018 data were selected for processing. We removed extreme values and outliers and used the time series smoothness feature to fill with the mean value of the data. Based on the average growth rate of the a4, b5, b17, and b25 items calculated in 2018 as the base period, a gray prediction model is established to predict the number of players of project's various items on August 5, 2019.

3.2 Establishment of Grey Prediction Model

The gray prediction model is a prediction method that builds a mathematical model and makes predictions with a small amount of incomplete information [5]. It is a theory that studies and solves gray system analysis, modeling, prediction, decision-making and control. The model requires less

modeling information, is convenient to operate, and has high modeling accuracy. It has a wide range of applications in various prediction fields and is an effective tool for dealing with small sample prediction problems [6].

Written in discrete form as

$$\frac{\Delta x}{\Delta t} = x(k+1) - x(k) = \Delta^{(1)}(x(k+1))$$

After the model is selected, it must be tested to determine whether it is reasonable, and only the model that passes the test can be used for prediction [7]. This paper uses the posterior test to verify the accuracy of the model.

The calculated posterior error ratio is $C = S_2 / S_1$

The index c is an important index for the posterior difference test. A smaller c indicates that although the original data is very discrete, the difference between the calculated value and the actual value obtained by the model is not too discrete [8].

3.3 Model Solution

3.3.1 Forecast of the number of people playing the project

This article selects the data that is relatively stable as a whole for the first few days before August 5, 2018 as the initial value, uses the gray prediction model to obtain the predicted initial value in matlab, and combines the quantitative relationship between the two years-the daily average growth rate. Finally, the actual forecast value of August 5, 2019 was calculated.

Actual forecast value = (1 + average daily growth rate) * initial forecast value

Some project forecast figures are as follows:

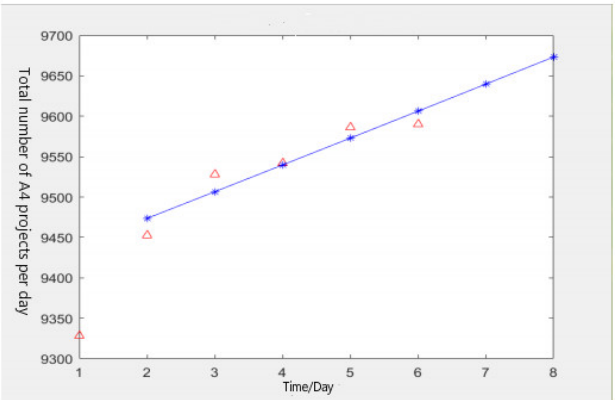

Figure 2. Forecast of the number of tourists of A4 project on August 5, 2019

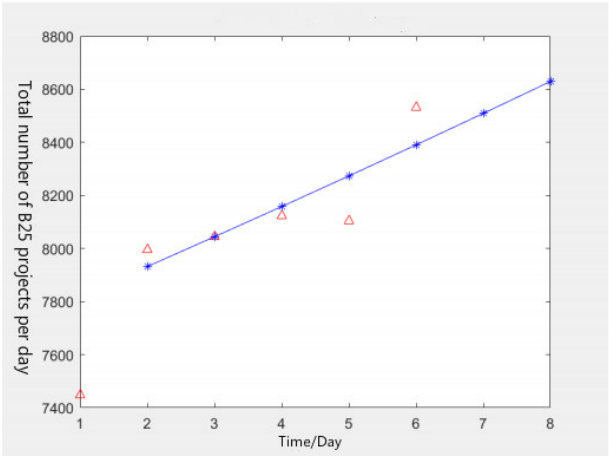

Figure 3. Forecast of the number of tourists of B25 project on August 5, 2019

The calculation results are shown in Table 3:

Table.3. Forecast table of visitor numbers for each project on August 5, 2019

project	Predicting the number of visitors on the day
A4	15904
B5	14471
B12	406
B25	13827.

3.3.2 Forecast of average number of project queues and average waiting time

It can be seen from the analysis that among the a and b series projects (out of a total of 38 projects), the number of tourists in 24 projects has not changed. Therefore, we divided the project into the project of determining the number of tourists on August 5, 2019 and 2019. On August 5th, it is necessary to predict the number of tourists. For the items that determine the number of tourists, the most likely reason is that the number of tourists has reached the peak of the capacity of tourists that can be accepted on the day of operation. Inspection of the maximum capacity on the day can confirm that these items are On August 5, 2018, the number of people per game reached the maximum capacity of the project. It is predicted that the project population growth rate on August 5, 2019 will be 0.

The number of visitors to the remaining 14 projects has changed greatly within a certain period of time. It is necessary to use the average value of each project in July to August 2018 (excluding abnormal values and data values with large fluctuations) to the August 5, 2019 project. According to the above, the daily average growth rate is 62.5%, and the maximum number of people on the day is predicted. By comparing the calculated maximum number of visitors on the day, it can be seen that the values of these items meet the maximum capacity. Therefore, we can simplify the problem, that is, the maximum number of visitors on the day of item a and b can be used to calculate the average number of tourists in the queue and the average waiting time.

The average number of people in the queue needs to consider the single shortest play time of the item, whether an appointment is needed, and the maximum capacity and play time. For the items that need to be reserved, tourists can make an appointment in advance, and use the remaining waiting time to play other items to meet the maximum utility. Therefore, the number of people waiting for a series of projects is 0.

For b-series projects, as the project does not require an appointment, visitors need to wait in line for the start of the project.

The formula for calculating the number of people in the queue is: the number of people in the queue= the maximum capacity at a time − the number of visitors per minute

The calculation of the average queuing time needs to consider which of the playing time and the single shortest time is more suitable as a time variable. In order to ensure that the number of people playing this item on the day is close to the maximum number of people playing on the day, we first select the time of play as a variable to calculate and it cannot meet the needs of the number of tourists. In the second time, we selected the single minimum duration as a time variable. In the calculation process, b21 has no time limit and reservation duration, and tourists can play at any time, so there is no average waiting time requirement. For the b7 project items that do not limit the number of tourists, we uniformly calculate the number of people per game according to the number of games that meet the needs of the day's tourists.

After sorting the projects, we finally predicted the average number of people waiting and the average waiting time for each project (except b21) on August 5, 2019.

Table 4. Forecast table of average number of people and time for each project on August 5, 2019

project	Per game wait People	Average wait per person time	project	Per game wait People	Average wait per person time	project	Per game wait People	Average wait per person time
A1	0	15.5	B3	64	3	B16	40	3
A2	0	13	B4	68	3	B17	316	13

A3	0	15.5	B5	96	2.88	B18	24	3
A4	0	20.5	B6	387	15.5	B19	317	8
A5	0	13	B7	639	15.5	B20	105	4.5
A6	0	18	B8	57	2.5	B21		
A7	0	18	B9	35	4.5	B22	157	5.5
A8	0	15.5	B10	108	5.5	B23	144	5.5
A9	0	15.5	B11	32	2	B24	148	5.5
A10	0	5.5	B12	3	2.88	B25	80	3
A11	0	15.5	B13	3	2.88	B26	162	5.5
B1	84	4.5	B14	64	3	B27	68	3
B2	60	2.5	B15	105	4.5			

4. Model establishment and solution of the best game plan

4.1 Establishment of Project Evaluation Index System

Analytic Hierarchy Process (AHP) is a hierarchical weighted decision analysis method. Analytic Hierarchy Process decomposes a problem into different constituent factors according to the nature of the problem and the overall goal to be achieved, and uses the interrelationship between the factors and the membership relationship to that factors are aggregated and combined according to different levels to form a multi-level analysis structure model, so that the problem is ultimately reduced to the determination or relative weight of the relatively important weights of the lowest level (programs, measures, etc. for decision-making) relative to the highest level (total goal) priority ranking [9].

The characteristics of this method are based on in-depth analysis of the nature, influencing factors and internal relationships of complex decision-making problems, and use less quantitative information to mathematicalize the thinking process of decision-making. Structural decision-making for complex decision-making problems provides a simple decision-making method, and is a model and method for making decisions on complex systems that are difficult to fully quantify [10].

According to the data of each project, the factors that this article will influence the tourists to choose the project are divided into the following three categories: price, entertainment experience, and objective conditions of the project, and set it as the project-level evaluation index, and then determine that factors they have an affiliation relationship, set as secondary evaluation indicators.

After analysis, the identified project evaluation indicators are as follows: first-level evaluation indicators: price A, play experience B, project objective conditions C; second-level evaluation indicators: cost a, average waiting time b1, single play duration b2, single maximum capacity c1, indoor and outdoor c2, whether need to make an appointment c3.

In order to make the judgment matrix more reasonable and the results more convincing, by conducting field surveys in some playgrounds, asking visitors which of the above evaluation indicators will have an impact on themselves in the process of choosing a project to play, and order them according to the degree of impact. Based on the results of most tourists, the importance of different indicators is finally evaluated to build a judgment matrix. The results are as follows:

First-level evaluation index judgment matrix:

$$E=\begin{bmatrix} 1 & 1/2 & 5 \\ 2 & 1 & 6 \\ 1/5 & 1/6 & 1 \end{bmatrix}$$

Judgment matrix for secondary evaluation indicators:

$$A=A \qquad B=\begin{bmatrix} 1 & 3 \\ 1/3 & 1 \end{bmatrix} \qquad C=\begin{bmatrix} 1 & 1/3 & 3/2 \\ 3 & 1 & 4 \\ 2/3 & 1/4 & 1 \end{bmatrix}$$

4.2 Model Solution

Input the judgment matrix value into matlab, run the program, and calculate CI and CR. The results show that the consistency check of the judgment matrix is acceptable. On the premise that the

consistency of the matrix is acceptable, the weight of each evaluation index is finally obtained.

The calculation results show that the project's play experience and cost will have a greater impact on consumers' choice of play items, accounting for 57.60% and 34.20%, respectively, and the objective conditions of the project only account for 8.11%, which has a small impact. According to the corresponding, it can be seen from the absolute weight of the secondary indicators that the cost and average waiting time have a significant impact on the choice of tourists' projects. It also reflects that in the actual situation, the number of playgrounds during the summer vacation is at a peak, and everyone has a short waiting time in line to achieve multi-play items, and playing a single expensive item will make tourists feel "higher value". So in considering the optimal scheme of project play, you will choose from these two aspects.

According to the average waiting time obtained from the above solution and known cost data, the tourist utility of each item is calculated and calculated. The formula is as follows:

Project play utility = 0.3420 * project cost-0.4327 * average waiting time

According to the results of the formula calculation, the utility of all the items in the playground is sorted in order from high to low, and the optimal solution is selected according to the maximum utility and combined with the length of the project and the length of the tourists.

This article combines the actual conditions of tourists' one-day play in real life. When discussing the optimal play plan, we considered the following points:

1) Visitors will enter the playground before the 9 o'clock project is fully open.

2) Tourists will leave at 8pm.

3) Tourists need to spend time in the playground for lunch and dinner.

4) Tourists will spend some time on the journey between projects.

5) Other personal needs of tourists (rest, taking photos, etc.) and handling of emergencies take time.

6) Tourists are rational adult players.

Combining the above 6 considerations with the field visit of the actual playground, we calculated that the total time spent by tourists in the playground project is about 6 hours. According to the principle of maximum utility, the optimal solution is finally obtained:

B9——B10——A1——B20—B8——B5——B1——A5——B17——B23——B11——B15——A 10——B22——B26——B3——B16——B7——A2——B24——B2——A9——B12——B23

(The order in which the items are played for the same duration can be interchanged. This article only shows this order, and the plan is not unique.)

5. Price rationality solution

Combined with the above game plan, the total cost of these items is calculated: 570 yuan.

5.1 Pass Price Evaluation

Compared with the price of 570, the price of the 225 yuan pass is about 40% off the total price. Combined with consumer psychology, we can see that consumers will choose to buy more tickets because of the huge discount, thereby increasing the number of tourists in the playground and achieving "Thin profits but quick turnover". But comparing the two sets of data of the prediction result of the first question and the sum of the maximum daily capacity of each project of the playground, it was found that the number of people who can participate in the project is basically close to the upper limit or even reached the maximum daily. So even if the playground does not limit the number of tourists entering, rational tourists will not give up purchasing pass because they cannot participate in the project.

According to the above analysis, as an operator, the price of the playground pass can be appropriately increased, and the number of tourists will not decrease significantly, and at the same time, profits can be increased. In addition, it is found through the search of information that the playground pass on the market is currently on the market. If the price does not exceed 300 yuan, in order to stabilize the market competitiveness of the playground, it is considered that the increased price can be within 280 yuan.

5.2 Ticket Price Evaluation

The analysis found that a small number of tourists choose to buy tickets. For this type of consumer, they will choose the entertainment project based on the lower the item price and the shorter the waiting time, the better the combination of the above evaluation system to calculate such consumers' utility to get a play plan (the items included are: b12, b13, b14, b2, b4, b18, b25, b3, b16, b27, b19, b24, b11, b15, a10, b22, b26, b8, b5, (b1, b23, a3, b6, b20, a6, a7), and finally calculate the total cost of these items as: 405 yuan. Plus the 10 yuan ticket, the cost is much higher than the pass price of 225, so it is considered that there is a ticket necessary.

6. Conclusion

In order to better predict the number of tourists and the fare purchase behavior of tourists on a specific number of days in the future, in order to maximize the consumption utility and maximize the profit of the playground, this article first starts with tourists from the beginning of January 2018 to the end of May 2019. The data of the number of passengers is pre-processed, invalid data is eliminated, and necessary indicators are supplemented, and a period of practical significance is selected as the base period to calculate the average daily growth rate, and the exponential smoothing method is used to predict the maximum number of tourists in 2019. Then use the calculation based on the average daily growth rate of the project, a gray forecasting model is established to predict the number of players in projects a and b on the day of August 5, 2019. While meeting some basic assumptions, the average number of players and the average number of players on the day of 38 projects is predicted and analyzed. Then the average waiting time of tourists for each item is combined with the actual situation of the tourists during the day to build a mathematical model to study the order of the tourists to maximize the entertainment utility. Finally, the comprehensive analysis results are used to calculate the tourist entertainment utility. Maximizing operating profit as the goal, compare the consumer price and pass price of tourists buying tickets after the fare, determine the price that has been increased should be in less than 280 yuan.

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