Tourist flow-control study based on utility

Liu Zhusheng*

Business School, Sichuan University, Wangjiang Road 29, Chengdu 610064, China

Received 1 January 2014, www.tsi.lv

Abstract

The key to solving tourist congestion during peak seasons is to improve the level of management and control the tourist flow in a scientific manner. Scenic capacity is usually set to a fixed value. Consequently, many plans have been developed, but have often produced poor results in practice. The utility concept in economics was introduced in this study, according to the law of diminishing marginal utility; then a scenic spot utility function was proposed. With the aim of maximizing the utility value, a mathematical programming model was developed. Through the process of solving the example problem, it was shown that, in a certain number of tourists, scenic managers can optimize each visitor route to upgrade the tourist experience by effectively managing the flow of visitors.

Keywords: utility; tourist flow control; scenic management; tourism modelling.

1 Introduction

Aiming at the problems in scenic like appearing overcrowded in peak tourist season, hot spots jammed and traffic jams etc. Management authorities issued a variety of responses, such as limiting the number of visitors, adding personnel to guide and maintain order. But in fact, in the face of turbulent flow of tourists, it is ineffectively just to limit the number of visitors or to guide passenger flaw with experience. Therefore, to explore the flowing law of tourists in the scenic area, and to develop scientific controlling measures, become the key to solve the problem. This is not only beneficial to improving the quality of tourists' experience and travel services, but also having great significance for environmental protection and sustainable development of scenic area.

Activities of tourists in the scenic area are related to the protection and resource utilization of the scenic spot. The issue of tourist destination exactly how many people can bear have attracted the attention of ecology and tourism academic circles since very early [1]. Zhang [2] has carried out the measurement of tourist capacity on case of the scenic spot, attaining numbers such as the best capacity, the reasonable capacity, and ultimate capacity. However, in front of the tourists, we should use these numbers to limit tourists or improve management level considering the reality of tourist demand, to achieve the harmonious development of tourism and the environment. How to regulate tourists flow becomes the new problem to be solved. Some scholars have launched research. Niu [3] analysed time and space distribution of the flow of tourists in Beijing and put forward controlling countermeasures. Zhang [4] summarized factors influencing the scenic spot by tourists and concluded they can adjust the time and space distribution of tourists by limiting amount and control tourist flow by improving the management level and other aspects. Wang [5] discussed the problem of controlling the capacity of the Tianchi lake. Feng Gang [6] used Nuorilang restaurant Jiuzhaigou scenic area as an example for empirical research and put forward a series of measures such as splitting flow of tickets entrance guard, emergency and prices and so on. Qiu [7] made Jiuzhaigou as the research object, and have carried on the exploration for a long time, providing ideas of controlling tourist flow for the scenic area. But there are a lot of studies are built on sites based on a fixed capacity. Academic circles have been debated about how much on earth the capacity of "fixed" [8]? Simon [9] concluded that eight problems existed in the conduction, including making sure that capacity are neither static nor fixed. To sum up, the present study of tourism carrying capacity account more, but the tourism carrying capacity involves less .Tourists flow regulation of the existing research is on the premise of static and fixed capacity value and neglected the tourism carrying capacity varying from person to person, and becoming different as the management change.

The following research introduce the utility concept in economics to scenic tourist regulation, set up the utility function closely related to the number of tourists; and scan the process of tourism experience in the whole tour in the perspective of utility instead of the capacity of tourist; The system integration of tourists flow control model was established, the model provides new train of thought for the peak scenic tourist flow regulation. The rest of the article knot is as follows: the second part introduces the concept of the scenic spot of utility; The

* Corresponding author - e-mail: zsliu@scu.edu.cn

third part is the tourists control model and its calculation; The last is the conclusion and prospect.

2 The Problem's Description and Definitions

2.1 UTILITY DEFINITIONS

Utility, one of the commonly used conception in Micro Economics, usually refers to a measure of consumer or enjoy leisure, to meet their own needs, desires. Visitors to meet the physical and mental pleasure purposes by the scenic tourist, scenic spot reflects its value by tourist .If the scenic area meets a person; there is a value. More people means more value. How to describe the relationship between the value of scenic spots and tourists? Under the Theory of calling the tourists' utility as the utility of the scenic, the utility of the area will increase with the increase in visitors at first .And the increase is not a constant, but reduce with reduction of per capita occupancy resources. This change conforms to the law of diminishing marginal utility. There is a need to explain that the number of tourist also cannot be "The more, the better." If the number of visitors exceeded a certain limit, it will take a devastating impact on environment, and a catastrophic experience to visitors. The utility will dramatically reduce then. It is out of the scope of the study to discuss on the limit of the number of visitors. So the following number of visitors is a tourist in the 'limit the number of tourists' within the volume. The above relationship as shown below:

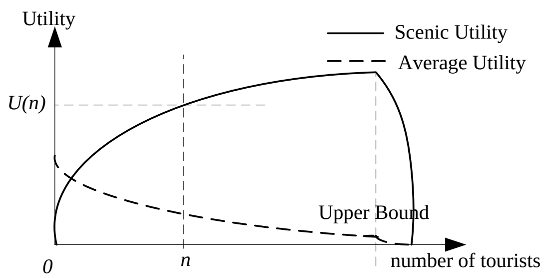

FIGURE 1 The relationship between utility and tourists' number

Assuming the scenic value represented by the two dimensions of time and space. A scenic area is composed of a number of scenic spots; each of the spots is the space resources. Opening time is the time resource. In order to calculate the utility of the area, we should discuss it first.

Definition: The Utility of the scenic spots means the degree of an attraction being able to meet the tourists' experience within a certain period of time and a certain number of people. It can be formulated as follow:

$$U(n) = \sum_{j=1}^{n} \frac{1}{j}, \quad (1)$$

where *n* is the number of tourists.

Suppose the visitors number is *n*, for each additional person lead to the total utility increases *1/(n+1)*, from *(n-1)* to n increased *1/n*. Therefore, with the increase of the number of people, total utility increases gradually. However, the rate of increase is reduced from *1/n* to *1/(n+1)*, it satisfies the law of diminishing marginal utility. Suppose that there are n visitors in order to reach the spots i, leave after the stay time. The number of visitors will continue to change with time; it becomes *2n-1* time slots. Assuming the *K* slot as τ_k, the number of tourists is v_k. The utility will be this:

$$U_i = \sum_{k=1}^{2n-1} \tau_k \cdot \sum_{j=1}^{v_k} \frac{1}{j} = \sum_{k=1}^{2n-1} \sum_{j=1}^{v_k} \frac{\tau_k}{j}. \quad (2)$$

Suppose the visitors' number is m, the Eq. will be this:

$$U = \sum_{i=1}^{m} \sum_{k=1}^{2n-1} \sum_{j=1}^{v_{ik}} \frac{\tau_{ik}}{j}, \quad (3)$$

where τ_{ik} means the slot *K* at spots *i*. v_{ik} is the number of tourists at spots *i*.

2.2 THE RELATIONSHIP BETWEEN ARRIVE TIME AND THE UTILITY

Tourist scenic spot in the time of arrival time and sojourn time distribution of the number of visitors – decision. Differences in the arrival time and sojourn time lead to different scenic utility value. In order to illustrate the different effects of the utility of the arrival time, let's make the single scenic spots as an example. Statistics shows the relationship between the time and utility.

Assume the time of every tourists to stay are the same, the opening time is 10 hours. There are 4 groups arrive in batches. The numbers of people in the groups are the same; the touring time is 2 hours. The arriving time can be the time in the opening time. In order to make the problem easy, suppose the arrival time is the whole point in 1 to 7.

Let us use four digits to express the 4 arrival time, say the number is a sequence. In this case, there are 2401 kinds of arrangement. In order to make the problem easy, there is first group of tourists arrive first hours, the next arrival time can be 0 to 2 hours after the first group. Then the number of arrangement reduces to 27.

Simulating tourists' arriving under various time, we map the distribution of tourists arrival time and utility computing according to the Eq. (Figure 2 to Figure 4).

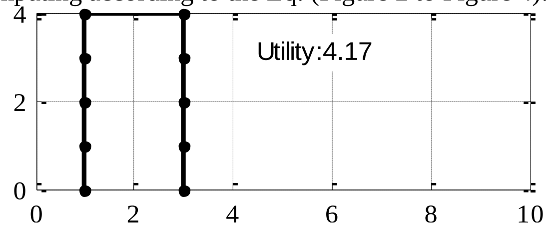

FIGURE 2 Single tourist scenic spots distribution (a, Time series: 1111)

Figure 2 depicts the 1-4 group of tourists arrived at 1:00, the number of visitors peaked 4.

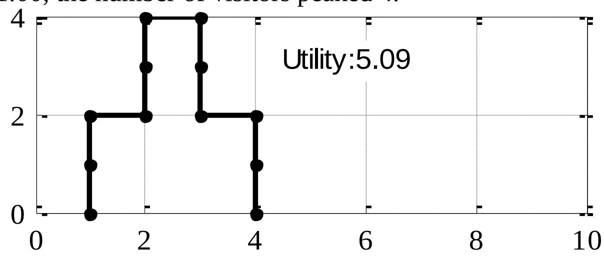

FIGURE 3 Single tourist scenic spots distribution (b, Time series: 1122)

In Figure 3, four groups of tourists arrive at the peak reached in 2 hours, 1 hour, with the first and second group of tourists leave, visitors reduced to two groups. Compare with Figure 2, although the peak value was 4, but the peak of the original duration of 1/2.

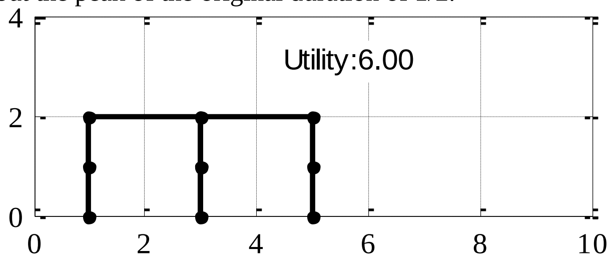

FIGURE 4 Single tourist scenic spots distribution (c, Time series: 1133)

As visitors arriving time dispersing, visitors peak decreasing. If visitors arrive at interval of two hours, then utility value reaches the maximum at this time.

The utility scenic values that the time calculated of the list are as follows.

TABLE 1 The time series and utility of tourists' arrival

Time series	Peak value	Utility	Time series	Peak value	Utility
1111	4	4.17	1124	3	6.34
1112	4	4.92	1133	2	6.00
1113	3	5.67	1134	2	6.50
1122	4	5.09	…	…	…
1123	3	5.84	1357	1	8.00

As can be seen from the table 1, along with changes in the timing of tourists' arrival, tourist scenic spots distributed over time changes. Case of increasing the interval, the peak reduced, the utility increased. Reduced the peak height and the peak holding time help to improve the utility, and vice versa.

2.3 THE UTILITY AND TOUR ROUTE CHOICE

Scenic area is always composed by different spots, and there is a certain degree of spatial distribution. Visitors in the scenic area choose the paths to complete the transfer between the various spots. Tourists accumulate effect in this process, as well as the utility of scenic changes.

According to the above conditions, there are two alternative paths visitors each respectively1→2, 2→1. "1" represents the first line, "2" represents the second line. Cruise line arrangement in four groups of tourists have 2^4=16 kinds of: 1111, 1112, …, 2222. We take the1111, 1122 and 1133 from the 27 kinds timing as examples. Combination of timing and line is a total of 48 kinds of programs.

These programs were simulated, corresponding tourist scenic spots distribution (Figures 5 to 10).

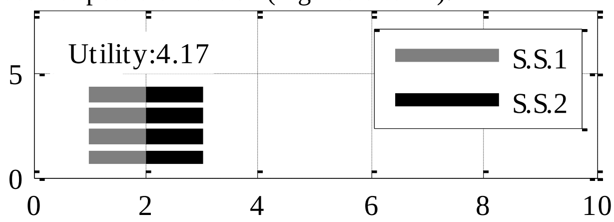

FIGURE 5 Double-Scenic spots Tourist Distribution
(1a, Time series: 1111; Routes: 1111)

Both circuit arrangement and tourists reach timing shown in Figure 5 are same with what in Figure 2, the resulting utility scenic values are equal; Tourists has always maintained the highest peak 4.

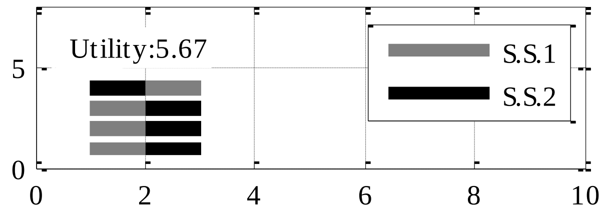

FIGURE 6 Double-Scenic spots Tourist Distribution
(1b, Time series: 1111; Routes: 1112)

Figure 6 shows the front of the three groups selected Line 1, Line 2 followed by group1. As can be seen the peak of each attraction are 3, compared with the previous Routing congestion relief.

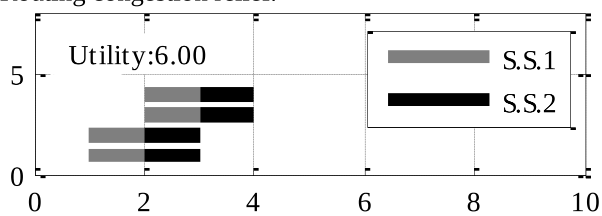

FIGURE 7 Double-Scenic spots Tourist Distribution
(2a, Time series: 1122; Routes: 1111)

Figure 7 shows the distribution under the condition whose tourists arrival time meet 1122 timing, all of four groups select line1. As can be seen the peak of each attraction are 2, compared with the previous Routing congestion-relief.

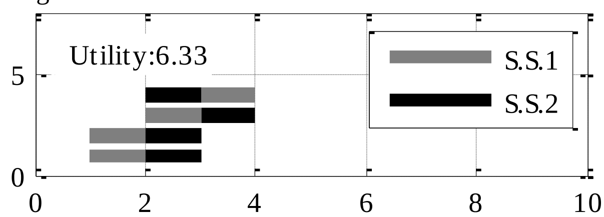

FIGURE 8 Double-Scenic spots Tourist Distribution
(2b, Time series: 1122; Routes: 1112)

Chosen tour route 1112, tourist's distribution shown in figure 8 is slightly different between former, an increase of a peak at a time, the ultimate utility of a small increase.

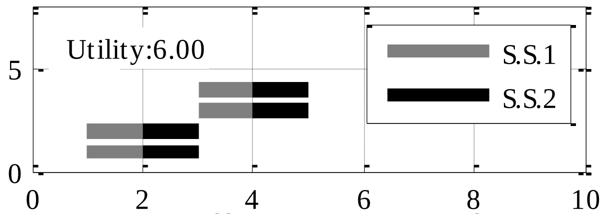

FIGURE 9 Double-Scenic spots Tourist Distribution
(3a, Time series: 1133; Routes: 1111)

Under the timing of 1133, four groups tourists arrive at two batches, the arrival times of the first two groups and the latter's are shifted, no overlap, in this way, we can reach the objective of diversion, the main problem at this time focused on the inside of each batch of two group among Tourists. Obviously, you can choose a route batches. Diversion program will not form a tourist's accumulation. The tourist-distribution of the peak does not exceed 2.

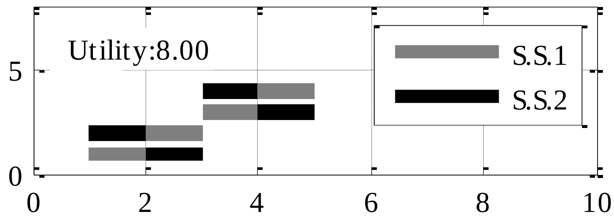

FIGURE 10 Double-Scenic spots Tourist Distribution
(3b, Time series: 1133; Routes: 1212)

Figure 10 achieve the optimal combination of timing and route, and the peak of each attribution is 1.Calculate the utility under scenic route and timing combinations, and obtain the following data:

TABLE 2 The utility under part routes combine with time series

Routes	Time series		
	1111	1122	1133
1111	4.17	6.00	6.00
1112	5.67	6.33	7.00
1212	6.00	7.00	8.00
…	…	…	…

The table data show, choose the same timings and different tour routes, obtain different utility value; Likewise, the same path selection, because the different timing of tourists arrive, get a different tourist - distribution as well as different utility values.

Observe the above situation, if all tourists arrive simultaneously, it will cause a lot of pressure to the scenic under the first timing, and it is very important to control tourist flow by choosing tour route. Similarly, even if reached 1133, the best timing, triage has a positive meaning, by path optimization to improve the scenic utility.

There is no difficulty to infer that if the length of stay of two scenic spots are different, the transfer time between two attribution taken into account , the timing of tourists arrival time more than three kinds, then the distribution of tourists in the scenic areas will become complicated, optimizing space will be greater.

3 The model of scheduling about tourists in a scenic area based on utility

3.1 THE DESCRIPTION OF SCHEDULING ABOUT TOURISTS IN A SCENIC AREA

When tourists travel in a scenic, which consist of several scenic spots, there is a way to link. It is a kind of way to travel, such as by foot or by bus. Network is shown in figure 11. Node 1 is the point of starting and returning. There are two ways that can be chosen. One is 1-2-3-1, the other is 1-3-2-1. In order to maximize the whole utility, managers need to design the best order to go sightseeing for tourists. If there are 10 tourists and every tourist has two choices, there are 210=1024 kinds of order combinations for sightseeing.

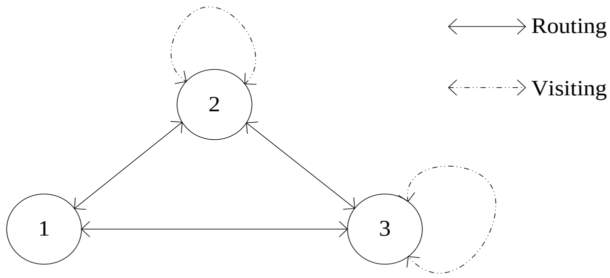

FIGURE11 Single path network of travel mode

The fact is more complicated, the way to travel that a tourist goes sightseeing from an attraction to another attraction can also be different. (It is shown in fig.12). If there is consumption of physical strength by foot, sightseeing will be limited greatly in a relatively large scenic area. When many scenic areas provide different transports for tourists to choose, the need of sightseeing bus will appear.

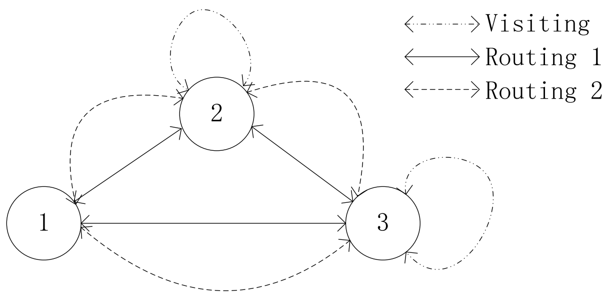

FIGURE 12 The path network Of alternative way to travel

This problem is similar to Open Shop Schedule Problem (OSSP). It is described as that *n* workpieces are processed on m machines. Every workpiece include m processes, every process has determined processing time. Every machine can only process a workpiece in the given time. What's more, every workpiece can only be processed by one machine. The processing sequence of workpieces on the same machine is random and the processing sequence of every workpiece is also not limited. However, the process cannot be interrupted in the processing time. The purpose of scheduling is to determine all the sequence combination of workpieces and machines and minimize the makespan. At the same time, it has to satisfy above constraints. Therefore, the related algorithm can be used to solve the new problem.

However, the problem of scheduling sightseeing ways has its own characteristics: the resources of scenic spots belong to cumulative resources and the capacity cannot be fixed as one unit; there are differences between goal settings. The goals of OSSP usually are the whole scheduling time, the average completion time or the minimal value about other time value. However, the scheduling of sightseeing ways cannot simply pursue the short time of processing. As what above described, its goal is to maximize the utility of tourists.

So far, there are three kinds of methods to solve OSSP. They are exact algorithms (branch and bound methods, cutting plane methods), heuristic methods based on rules, metaheuristic algorithms [10, 11] and other hybrid algorithms. When m>3, it belongs to NP difficult problem. Compared with the schedule problem in a shop, this problem has wider space for searching. It can use exact algorithms such as branch and bound methods to get the optimal solution at a Comparison smaller scale. But it will cost a lot of time. When it is at a large scale, it is difficult to find out the optimal solution by polynomial algorithm or pseudo- polynomial algorithm. Although the algorithms based on assignment rules is very fast, but it is usually partly optimal and the structure-dependent is strong. The heuristic algorithms based on artificial intelligence are widely used.

3.2 Tourists flow regulation mathematical programming model

To solve the above problem, establish the following planning model. Assuming a scenic area consisting of m scenic spots, the total number of visitors for the opening period is n; S_i is the time as a starting point to scenic spots *i* need, but also is the time that return to the starting point of *i* scenic spots; O_{ij} represents the time that tourist *j* stay in attraction *I*; scenic area pen at 0 and close at *T*; Visitors *j* reach each scenic at time R_j; the time to reach attraction i is a_{ij}; and the leaving time is d_{ij}; every tourist only visit every attraction once, but the tour order is not fixed. Scenic spots are connected by roads and trails. The ways tourists go from attraction *i* to the next attraction k can be walk or ride. The time need is respectively B_{ik} and F_{ik}.

When the number of scenic spots *t* is calculated for each time, the $m*n*T$ dimensional unit time interval index is introduced. When tourist *j* gets to scenic spots *i* at *t*, the value is $A_{ijt}=1$.

When tourist *j* leave attraction *I* at the time of *t*, the result is $D_{ijt}=1$. *V* represents the number of tourists in attraction *i* at *t*. The number of tourists at *t* unit is defined the number of tourists between *t* and *t+1*. The number of tourists at present is that the arrivals minus the number of leaving.

Attraction *i* is defined under time index, the calculation expression in the number of tourists at the time of *t*:

$$V_{it}=\sum_{\tau=1}^{t}\sum_{j=1}^{n}(A_{ij\tau}-D_{ij\tau}), \tag{4}$$

$$X_{ijk}=\begin{cases}1,\text{If tourist j visit site i , then k}\\0,\text{else}\end{cases}, \tag{5}$$

$$Y_{ijk}=\begin{cases}1,\text{If tourist j go to site k from i}\\0,\text{else}\end{cases}, \tag{6}$$

$$A_{ijt}=\begin{cases}1,\text{If tourist j arrive site i at time t}\\0,\text{else}\end{cases}, \tag{7}$$

$$D_{ijt}=\begin{cases}1,\text{If tourist j leave site i at time t}\\0,\text{else}\end{cases}, \tag{8}$$

$$\max U=\sum_{i=1}^{m}\sum_{k=1}^{2n-1}\sum_{j=1}^{v_{ik}}\frac{\tau_{ik}}{j}, \tag{9}$$

$$a_{ij}\geq R_j+S_i, \tag{10}$$

$$d_{ij}=a_{ij}+O_{ij}, \tag{11}$$

$$d_{ij}+S_i\leq T, \tag{12}$$

$$Z_{ijk}=(1\text{-}Y_{ijk})F_{ik}+Y_{ijk}B_{ik}, \tag{13}$$

$$d_{kj}-O_{kj}-Z_{ijk}+M(1-X_{ijk})\geq d_{ij}, \tag{14}$$

$$d_{ij}-Z_{kji}-O_{ij}+MX_{ijk}\geq d_{kj}, \tag{15}$$

$$\sum_{t=1}^{T}A_{ijt}t=a_{ij}, \tag{16}$$

$$\sum_{t=1}^{T}D_{ijt}t=d_{ij}, \tag{17}$$

$$\sum_{t=1}^{T}A_{ijt}=1, \tag{18}$$

$$\sum_{t=1}^{T}D_{ijt}=1, \tag{19}$$

There are no special instructions in the above Eq., but the conditions are $1\leq i\leq m$; $1\leq j\leq n$; $0\leq\tau\leq t\leq T$. Eq. 10 shows that the arrival time of tourist j at attraction i is greater than the time of arriving at scenic or equal to it. Eq. stands that tourists arrive at some scenic spots and finish the sightseeing and leave this attraction; Eq. 11 represents the tourist stay at the attraction for some time before leaving. Eq. 12 shows that the sightseeing need finishing before the scenic is closed. Eq. 13 decides the way to travel from an attraction to another. Eq. 14 and 15 (i≠k) define the order of visit. Eq. 16, 17, 18 and 19 are time indexes.

Supposing that tourists choose to take the single way to travel in the scenic with m scenic spots and there are interconnections between scenic spots, every tourist has $m!$ ways to travel. And n tourists have $(m!)^N$ choices. If the way to travel can be chosen (add a path between scenic spots), every tourist has $2^{(m-1)}m!$ choices. And N tourists have $(2^{(m-1)}m!)^N$ choices. Adjustable degree becomes unsolvable. Therefore, it is necessary to simplify the model. There are two ways. One is to decrease the number of indexes, the other is to decrease the base.

Firstly, the number of tasks can be reduced. The specific method is to divide tourists into n groups and arrange guide and the line for every group. This allows the total number of the order scheduling Eq. to reduce from N to I, $\left(n=\lceil N/G\rceil\right)$, G is the number of every group.

According to management experience, scenic spots in the scenic are not all interconnected. What's more, the paths that tourists are like limited. Some paths can be picked out to be discussed. These paths are effective paths. So it is feasible to select k path to travel from $2^{(m-1)}m!$ paths. The k paths include the choices of transportation between scenic spots. And now, the number of solutions for the above problems reduces to k^n. It is also difficult, and it need heuristic algorithm to solve.

3.3 TOURISTS FLOW-CONTROL MODEL FOR SOLVING NUMERICAL EXAMPLE

Just as the scenic network of fig. 12 shows, Suppose there are 10 groups of tourists reach the entrance 1 in interval of five minutes, tourists start to walk or ride from 1 to 2(attraction 1) or 3(attraction 2), and return to start-point 1 after visiting 3 or 2. The time that tourists need to visit and travel is shown in the below table. The value of the diagonal in the table represents the staying time at 2 or 3. The value on the upper right of diagonal is the time of walk. The number of bottom left is the time of ride.

TABLE 3 Node time matrix

Node	1	2	3
1	0	10	20
2	2	20	15
3	4	3	30

It is easy to work out there are 16 paths to choose (shown in fig.4), 0 in the way column of the table represents walk, 1 stands ride. The first line represents that tourists choose to walk, and the order is to travel from attraction 1 to 2 and then return to 1. Every group of tourists have 16 kinds of different choices, 10 groups tourists have 16^{10} choices in all.

TABLE 4 Part of an alternative tour route list

Number	Node	Way	Node	Way	Node	Way	Node
1	1	0	2	0	3	0	1
2	1	0	2	0	3	1	1
3	1	0	2	1	3	0	1
…	…	…	…	…	…	…	…
16	1	1	3	1	2	1	1

Heuristics (herein abbreviated) is designed to solve the problem. The choices of 10 groups of tourists are respectively 15,7,13,2,9,13,10,2,10 and 2. Compared with the tourist group which take the fixed line (they are all choose the path 16). It means all tourists first ride to 3 and to 2, at last return to 1. Tourist scenic spots distributed as shown below. It can be found that optimized peak of tourist in both scenic spots is better than the compared program.

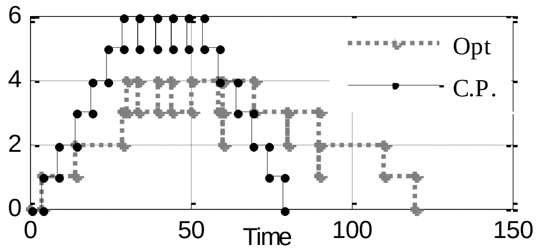

FIGURE 13 Comparison of distribution of tourists on scenic spot2

When contrasting the mean number of tourists and variance, they are also improved significantly. The utility of goals optimization reached 17.429 while the utility of the contrasted group which takes the fixed line is only 13.225. It shows that the above model is effective in tourists controlling.

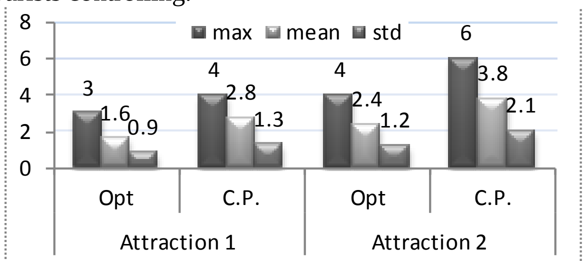

FIGURE 14 Comparison between optimized program and control program indicators

Although the model just change the path that tourists take, in fact, it adjusts the timing of tourists arrive scenic spots. And the purpose achieved by staggering the timing of changes. If the control measures are taken in the arrival rate, the distribution of visitors could be further improved. In fact the use of the vehicle can be understood as increasing the path selection, and under the information technology' support, dynamic scheduling control will make more space.

4. The conclusion and prospect

When scenic spot management authorities face turbulent flow of tourists in the tourist season, not simply because of the bearing capacity of the scenic spot turn them away. To solve the contradiction need strengthen the environmental protection consciousness of tourists, also call for management innovation.

It is a new attempt to introduce the concept of economic utility into a scenic tourist flow controlling. It is simple and clear to set up the utility function following the law of diminishing marginal utility. The above analysis shows potential in regulating peak visitors with the model of maximizing the scenic spot of the utility. The factors influencing utility in the model include arrival time, sojourn time. In practice, managers need to focus on these two kinds of time. Although it is inconvenience to control tourists arrival time in the scenic area , but can regulate the time-space distribution of tourist flow in tourist scenic spot .Measures include offering visitors the selection of travelling way and arranging touring line .It will be of reference value to improve tourist experience. Because the scenic areas (spots) capacity itself is an adjustable object, it were deliberately ignored in the model. If scenic spot have bottleneck in the peak, the model can be applied to the scenic spots alone.

The paper assumes that the increasing or decreasing in the number of tourists in scenic spot makes the same contribution to the utility. In fact, the differences between these need researching. As to the problem of large-scale tourist flow regulation, it needs to explore more efficient algorithm.

Acknowledgments

This research was supported by the Major International Joint Research Program of the National Natural Science Foundation of China (Grant No. 71020107027), Humanities and Social Sciences project of The Ministry of education of China (Grant no.12YJC630023), Social sciences program of Chengdu (Grant no. SKNHR13-07).

References

[1] Wagar J A 1964 The carrying capacity of wildlands for recreation *Forest Science Monographs* 7 1-23
[2] Zhang Xiaoping, Zhu Zhongfu 2007 Jiuzhaigou Tourism Environmental Capacity Study *Tourism Tribune* **22**(9) 50-57 *(in Chinese)*
[3] Niu Yafei, Xie Libo, Liu Chunfeng 2005 Beijing tourist flow characteristics of spatial and temporal distribution and control countermeasures *Geographical Research* **24**(2) 283-91 *(in Chinese)*
[4] Zhang Jianhua, Jian-Hui Yu 2006 Tourist attractions tourists environmental impact analysis and its regulation *Beijing Second Foreign Language Institute* **1** 95 – 98 *(in Chinese)*
[5] Wang Hui, Yang Zhaoping 2008 Xinjiang Tianchi Regulation of Tourism Environmental Capacity *Arid Land Resources and Environment* **22**(9) 193-96 *(in Chinese)*
[6] Feng Gang, Ren Peiyu, Xiaowei Yang, et.al. 2009 *Research on Ecological Protection scenic RFID-based mode – Jiuzhaigou Nuorilang restaurant dining diversion for example* Southwest University for Nationalities, Humanities and Social Sciences Edition **11** 151-54 *(in Chinese)*
[7] Qiu YanQing, Ge Peng, Liu Zhusheng, et al. 2011 Research shunt Tourists and space-based navigation management control of complex systems *Soft Science* **25**(9) 54-57 *(in Chinese)*
[8] Lindberg K, McCool S, Stankey G 1997 Rethinking carrying capacity. Research Notes and Reports *Annals of Tourism Research* **24**(2) 461–65
[9] Simon F J G, Narangajavana Y, Marques D P 2004 Carrying capacity in the tourism industry: a case study of Hengistbury Head *Tourism Management* **25** 275-83
[10] Liaw C F 1998 An iterative improvement approach for the nonpreemptive open shop scheduling problem *European Journal of Operational Research* **111** 509-17
[11] Gao Liang, Gao HaiBin, Zhou Chi 2006 Based on open-shop scheduling particle swarm optimization *Journal of Mechanical Engineering* **42**(2) 129-34

Author

Liu Zhusheng, March 16, 1969, Chongqing China

University studies: Ph.D., student of Sichuan University.
Scientific interest: computer simulation modelling, planning and scheduling optimization in manufacturing and services.
Publications: 10 publications.
Experience: Computer Integrated Manufacturing System; Applied Research of RFID Technology in the Nature Reserves & Earthquake Ruins and Sites based on Spatiotemporal Separation Management Pattern, which are projects of National High Technology R&D of China (863 Program).