Real-time value of tourist big data: A case study of Red-river Canyon Rafting scenic spot

Jun Li[a], Qi Cheng[b], Huanyu Zuo[c], Bo Yu[b,d*]

[a] Zhou Enlai School of Government, Nankai University, Tianjin, China; [b] College of Electronic Information and Optical Engineering, Nankai University, Tianjin, China; [c] College of Cyber Science, Nankai University, Tianjin, China; [d] Aosheng Transportation Technology Company Limited, Tianjin, China;

ABSTRACT

With the acceleration of the process of "smart tourism", the development of tourist attractions is increasingly inseparable from the support of tourist big data. In the management practice of scenic spots, the big data of tourists has become an important basis for scenic spot managers to make timely decisions. This article analyzes the real-time significance of tourist big data from the relevant perspective of the Information Theory. In terms of evidence, this article takes the Red-river Canyon Rafting scenic spot as a case to investigate its information construction, and expounds the contribution of big data in its economic benefits. Empirically, this article uses regression analysis, causal model and other methods to study the data before and after the information construction of scenic spots, and discusses the important value of real-time big data of tourists for the safety management of tourist scenic spots.

Keywords: Smart tourism, big data, Red-river Canyon Rafting scenic spot, regression analysis, causal model

1. INTRODUCTION

With the advancement of information technology, the big data obtained from hardware devices such as the Internet of Things, has brought massive amounts of information. It increases the workload of information management of scenic spots, while the real-time nature of information is decreasing[1]. Managers need to use software to process, mine, and apply big data to adapt to this developmental law. For the managers of scenic spots, only by using the big data of tourists in time can they avoid the waste of resources due to oversupply, or the overload caused by oversupply. Lastly, through the optimal decision-making of scenic spot's management, the improvement of economic benefits and the guarantee of tourists' safety are realized.

Referring to various researches currently focusing on tourism management informatization, the process of using tourist big data in scenic spots can be summarized into three stages: acquisition, processing, and application, as shown in Figure 1. The stage of acquisition mainly collects big data through the Internet of Things in the scenic spot and the mobile terminal of tourists, and transmits this information to the information management center of the scenic spot. Then in the stage of processing, the time Petri net method[2-4] can be used to simulate the diversion management of tourists in the scenic spot, the Kalman filter algorithm[5-7] can be used to predict the passenger flow in the future, and the ant colony algorithm[8-10] provides route planning for tourists. Finally, in the stage of application, the managers of scenic spot make timely decisions to remotely control the passenger flow of each important points in the scenic spot, or send staff to maintain order on the site.

At present, tourists' big data has been studied and applied in capacity monitoring[11-13], traffic forecasting[14-16], destination management[17-19], marketing[20-22], etc. However, it still lacks of theoretical exploration and practical evidence for the real-time value of big data. In other words, even if previous studies mentioned the real-time utilization of big data, they either focused on a specific technology, or summarized previous studies in the form of literature reviews, especially lacking case support. Therefore, this paper conducts a theoretical analysis from the relevant viewpoints of information theory, takes the Red-river Canyon Rafting scenic spot in Fushun City, Liaoning Province, China as a practical case, investigates the informatization construction and the utilization of big data in the scenic spot, and uses regression analysis, causal model and other methods to study the relevant data before and after the informatization construction of the scenic spot.

[*] 15620641958@163.com

Third International Conference on Computer Science and Communication Technology (ICCSCT 2022)
edited by Yingfa Lu, Changbo Cheng, Proc. of SPIE Vol. 12506, 1250642

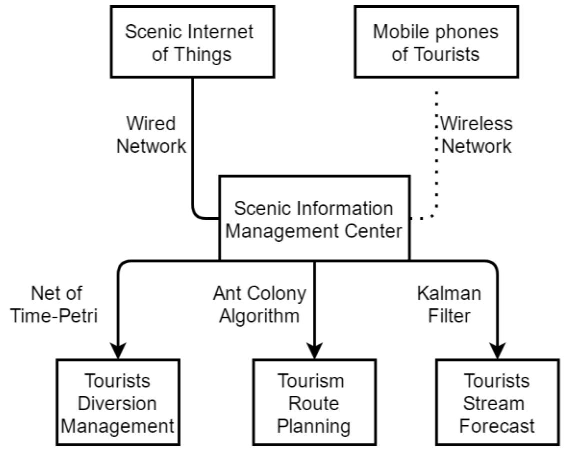

Figure 1. Process chart of using tourists' big data.

2. THEORY

Based on the viewpoints[23] of information theory, information only exists in a four-dimensional space without time. It is a regular arrangement of information particles existing in the four-dimensional space, that is an imaginary existence in the four-dimensional space to form the basic unit of information, and the "information" that we can see in the three-dimensional space in our daily life is only the shadows of real information in four-dimensional space. Simply put, information is a projection from a four-dimensional space to a three-dimensional space, as shown in Figure 2. It means that the propagation speed of information can exceed the speed of light and reach infinity, that propagates directly through the projection from high-dimensional space to low-dimensional space.

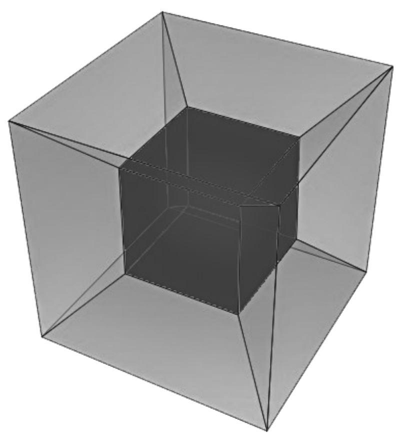

Figure 2. Projection from four-dimensional space to three-dimensional space.

Therefore, what really determines the different values of the same information is the time interval and efficiency of receiving, processing, transmitting and applying the information after it is sent from the information source. That is, the real-time nature of information[24]. That is the shorter time and the higher efficiency, the more timely using and the higher value. In contrast, the value of information decreases accordingly over time. Then, the value measurement of information can be determined by this time interval, which means the time interval is negatively correlated with the value of information. As a result, obtaining accurate information as soon as possible plays a critical role for correct decision-making.

For scenic spots operating continuously, the earlier the big data of tourists is mastered, the higher its value will be, which is reflected in two aspects. The first is to grasp the rules of passenger flow through big data, so as to improve the reception process, reduce material consumption, reduce operating costs, and improve economic benefits; The second is to analyze crowded spots through big data, improve the environment layout to avoid safety accidents, and dispatch staff in real time to provide guidance and help for tourists. However, with time flows, the value of tourist big data will gradually decrease unless it is re-acquired and processed.

3. CASES

This paper selects the Red-river Canyon Rafting scenic spot in Fushun, Liaoning, China as a case, investigating its informatization construction. Here are the reasons why the rafting scenic spot is used as a research sample. Initially, because of the nature of the rafting projects in the scenic spot, the tourist route is essentially a one-dimensional and one-way model, which simplifies the law of the study. Moreover, compared with ordinary scenic spots lacking risks and incentives, rafting scenic spots have more urgent demand for real-time big data to ensure the safety of tourists and the order of scenic spot. These make it closer to the research motivation of the real-time value of big data.

In addition, among many rafting scenic spots, the reason why we choose Red-river Canyon Rafting scenic spot as the case is that its comparative advantages are shown in the following three aspects: First, its long operation time can provide sufficient data for time series analysis; Second, the proxy data of the effect brought by its informatization construction is collectable, and this change is in the forefront in the same industry, and has the value of promotion; Third, its large-scale characteristics support its typicality as a case, which can produce more observable effects.

The Red-river Canyon Drifting scenic spot is a national AAAA-level scenic spot. It was once rated as a sports tourism boutique scenic spot of the China Sports Tourism Exhibition and a leading enterprise of the service industry in Liaoning Province. Since operation in 2004, it has developed into a comprehensive scenic spot providing rafting, dining, rooming and entertaining. It consists of five distant but highly information-based service areas, with the reception capacity of 10,000 tourists per hour and 40,000 tourists per day. Nowadays, the Red-river Canyon Drifting scenic spot attracts nearly one million tourists every summer, and it is an essential engine for local economic development, which offers more than 10,000 employed positions and more than half of the tax.

However, its development was not all smooth sailing, especially before the start of informatization construction in 2015. One day, the number of passengers reached ten times of the capacity of the scenic spot. There were people everywhere, and cars everywhere, so there was a seriously potential safety hazard. And due to the lack of ability to manage and control the river at that time, several safety incidents occurred in some stimulating river basins every year. As stated in its internal report, this is a dynamic scenic spot, and the "water flow, vehicle flow, passenger flow, and equipment flow are always in high dynamics" involved in the operation, which puts forward higher requirements for the dynamic management of the scenic spot. In 2015, in order to solve the dilemma of real-time management, the scenic spot invested a total of 10 million RMB directly used for purchasing information equipment and system development, as listed in Table 1.

The acquisition, processing and application of tourist big data in Red-river Canyon Drifting scenic spot reduces operating costs and improves economic benefits. On one hand, it is the improvement of work efficiency. Using big data to improve the tourist reception process, the work efficiency of each post has been significantly improved, and the number of workers employed in the scenic spot has decreased year by year, from 476 in 2015 to 400 in 2019, a reduction ratio of 15.9%, which decreases the cost of human resources. On the other hand, it reduces the loss of materials and equipment. Using big data to analyze the frequency of use of materials, the scenic spot has standardized the management of materials and equipment and reduced their losses. For example, the average daily maintenance rate of ships has been reduced from 12% in 2015 to 8% in 2019, and the average daily maintenance rate of life jackets has reduced from 9% in 2015 fell to 5% in 2019, decreasing maintenance and replacement costs.

4. ANALYSIS

In the case of the Red-river scenic spot, the safety factor of tourists rafting can be quantified by the ratio of the number of people falling into the water to the total number of tourists. Therefore, this paper collected the data of tourists falling into the water in all years after 2015, and the data of tourists falling into the water in some years before 2015, as listed in Table 2. Data for some years was lost due to two floods in the scenic spot. The ratio of people falling into the water in the nth year is $R_n=D_n/S_n$, where S_n is the number of tourists received by the scenic spot in the n^{th} year, and D_n is the number of tourists who fell into the water in the nth year.

Table 1. Details of information construction in 2015.

Project	Spend/RMB	Details
Monitoring system	6,850,000	Build a monitoring system with big data center based on the Internet of Things. Through the real-time monitoring of the scenic area, the visualized management of tourists and staff can be realized. In the big data center, the tourist flow or vehicle flow screen of the river course and five service areas can be observed in real time, which provides a basis for the management personnel to implement real-time scheduling.
Electronic ticketing	1,700,000	Develop an electronic ticketing system to realize the electronic one-ticket pass for ticket purchase, boarding, and dining in the scenic spot. According to the booking data, conducting reasonable scheduling of the tourist flow with the assistance of monitoring system. Through electronic ticketing, it could also obtain the distribution of the tourists' number in each reception process in time, which is the big data support for the receiving 10,000 people per hour.
Communication system	1,580,000	Install a wireless intercom system. The rapid spot in the river could be interconnected with five service areas. In particular, it solved the problem of weak mobile signals during the drifting. Once there is an emergency safety incident, it could be responded timely and immediately.
Parking lot license plate recognition	1,300,000	Complete the construction of a self-driving parking lot management system, shown as Figure 3. The system can display the number of vacant parking spaces in the parking lot, record the license plate number, and record the time of vehicle entry and exit.
Information release system	1,000,000	Build an information release system. A large LED screen and a broadcasting system are installed in the waiting area. The large screen scrolls to broadcast the safety instructions for drifting.

Figure 3. Aerial photography of self-driving tour parking lot.

Before the informatization construction of the scenic spot, the proportion of falling water Rn will be reduced as much as possible through various manual methods. According to the data in Table 2, with the number of years of operation of the scenic spot n as the independent variable, and the falling water ratio Rn as the dependent variable, the trend statistics of Rn around 2015 is shown in Figure 4.

Using regression analysis for $R_n \geq 13$, the linear regression equation is obtained, R_n=-0.000119078n+0.00321, R_2=0.95883, as shown in Figure 5.

Table 2. Data of falling tourists.

Year	Total Years n	Numbers of Tourists S_n	Numbers of Falling Tourists D_n	Falling Rate R_n
2006	3	130,000	360	0.002769
2007	4	188,069	510	0.002712
2009	6	606,595	1,607	0.002649
2014	11	259,481	468	0.001805
2015	12	295,955	535	0.001807
2016	13	200,408	54	0.000269
2017	14	276,980	53	0.000191
2018	15	288,420	137	0.000475
2019	16	240,903	95	0.000394
2020	17	116,795	35	0.000300

As a result, according to this linear trend, we can estimate the number of drowning tourists and the proportion of drowning tourists after 2015 without information construction, as listed in Table 3. It can be found that the actual value of R_n after 2016 is significantly smaller than the simulated value, so we can think that information construction is the main reason for the cliff-like decrease of R_{13}.

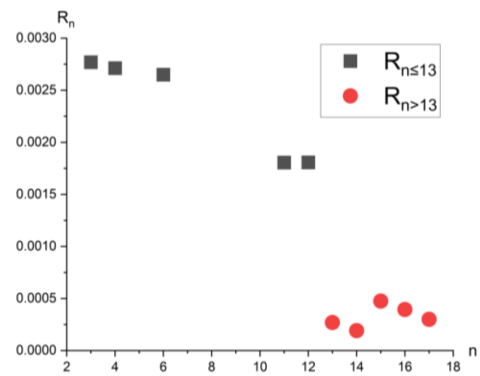

Figure 4. Statistics chart of falling ratio from 2006 to 2020.

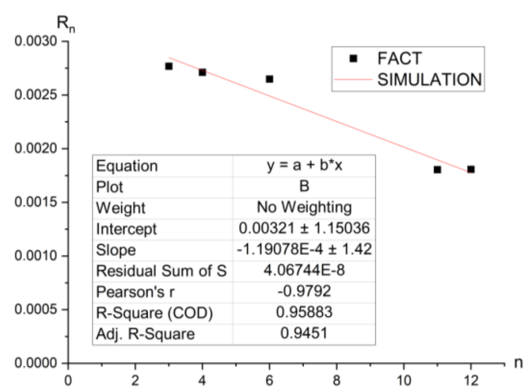

Figure 5. Regression analysis from 2006 to 2015.

Table 3. Estimation of linear regression.

Year	Total Years n	Numbers of Tourists S_n	Numbers of Falling Tourists D_n	Falling Rate R_n
2016	13	200,408	333(>54)	0.001660
2017	14	276,980	427(>53)	0.001540
2018	15	288,420	411(>137)	0.001420
2019	16	240,903	315(>95)	0.001300
2020	17	116,795	138(>35)	0.001190

As shown in Figure 6, from the end of 2015 to the pre-business period of 2016, the R_{13} plummeted to 0.00043 after informatization construction and renovation of the environmental layout. After that, R_n began to rebound again until the environmental layout was renovated before opening in late 2018 to 2019.Therefore, the reduction of R_n brought about by the transformation of the environment layout will rebound over time, and after re-acquisition, processing, and application of big data, R_n will decrease again, thus forming a cyclical trend. The changing trend, the trend of reducing the proportion of falling water in the original artificial method of the scenic spot, and the trend of reducing the proportion of falling water by real-time dispatching staff, together lead to the nonlinear change of R_n>13.

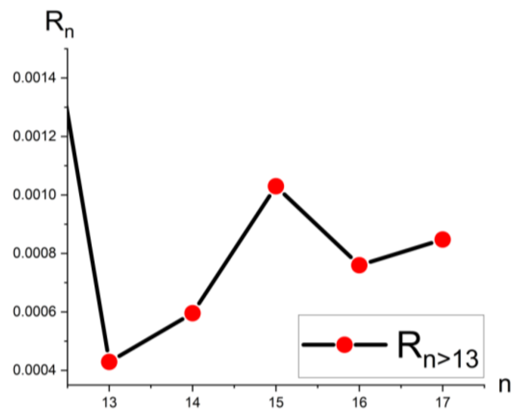

Figure 6. Changing trend of $R_{n>13}$.

All in all, the case of Red-river scenic spot demonstrates the positive impact of the use of tourist big data on scenic spot management, which not only improves economic benefits, but also ensures the safety of tourists. At the same time, this scenic spot with efficient and comprehensive application of big data has brought practical evidence support for real-time research on the value of real-time big data for tourists. That is to say, the more timely utilization of tourist big data, the higher value, and the lower value as time passes.

5. CONCLUSIONS

By summarizing previous research, this paper summarizes a model, based on the Internet of Things in scenic spots and tourist mobile terminals, of big data utilization process with time Petri net, Kalman filter, and ant colony algorithm. Through the relevant viewpoints of information theory, the real-time value of tourists' big data is interpreted. Finally, through the case of Red-river Scenic Spot, the relevant data before and after its informatization construction are investigated and analyzed, and the importance of real-time big data of tourists in the management of scenic spots is demonstrated. In conclusion, the value of effective information can be maximized only through the timely utilization of tourist big data.

REFERENCES

[1] Li, J.-J., Xu, L.-Z., Tang, L., Wang, S.-Y. and Li, L., "Big data in tourism research: A literature review," Tourism Management, 68, 301-323(2018).

[2] Pop, M., Dobra, M., Domuta, C., Hulea, M. and Astilean, A., "Two stage scheduling method of touristic transport in multimodal networks," Proceeding of 2016 IEEE International Conference on Automation, Quality and Testing, Robotics, 315-319(2016).

[3] Kodym, O., Kodymova, J. and Matuskova, S., "Information support for sustainable tourism," 18th International Scientific Conference-LOGI 2017, 134, 00023(2017).

[4] Bi, W.-S., [Study on the Spatio-temporal Shunt Management of Tourists in Tourist Peak Scenic Spots], Hefei University of Technology, Master Theis, (2018).

[5] Wu, K.-L. and Dai, B., "Golden week tourist flow forecasting based on neural network," 2006 IEEE International Conference on Industrial Technology, VOLS, 1-6, 1103(2006).

[6] Suciptawati, P., Sukarsa, K.-G. and Kencana, E.-N., 1st International Conference on Mathematics - Education, Theory and Application, 855, 012047(2017).

[7] Zhang, H.-Q. and Xu, Y.-M., "Simulation of real-time tracking and prediction of tourist flow data in scenic spots under cloud computing," Computer Simulation, 36(10), 467-471(2019).

[8] Chen, C.-C. and Tsai, J.-L., "Determinants of behavioral intention to use the personalized location-based mobile tourism application: An empirical study by integrating TAM with ISSM," Future Generation Computer Systems-the International Journal of Science, 96, 628-638(2019).

[9] Zhang, W.-R., "Application of an improved ant colony algorithm in coastal tourism route optimization," Journal of Coastal Research, 98, 84-87(2019).

[10] Liang, S.-B., Jiao, T.-T., Du, W.-C., and Qu, S.-M., "An improved ant colony optimization algorithm based on context for tourism route planning," Plos One, 16(9), e0257317(2021).

[11] Li, D.-M., Deng, L.-B. and Cai, Z.-M., "Statistical analysis of tourist flow in tourist spots based on big data platform and DA-HKRVM algorithms," Personal and Ubiquitous Computing, 24(1), 87-101(2020).

[12] Emili, S., Gardini, A. and Foscolo, E., "High spatial and temporal detail in timely prediction of tourism demand," International Journal of Tourism Research, 22(4), 451-463(2020).

[13] Caruso, M. C., Giuliano, R., Pompei, F. and Mazzenga, F., "Mobility management for smart sightseeing," 2017 International Conference of Electrical and Electronic Technologies for Automotive, 1-6(2017).

[14] Qin, S.-Y., Man, J. and Wang, X.-Z., "Applying big data analytics to monitor tourist flow for the scenic area operation management," Discrete Dynamics in Nature and Society, 2019, 8239047(2019).

[15] Aleknavicius, M., Aleknavicius, A. and Kurowska, K., "Analysis of spatial interactions of tourism in Lithuanian-Polish cross-border region using gravity models," Geodetski Vestnik, 64(3), 361-375(2020).

[16] Liu, Y.-Y., Tseng, F.-M. and Tseng, Y.-H., "Big Data analytics for forecasting tourism destination arrivals with the applied Vector Autoregression model," Technological Forecasting and Social Change, 130, 123-134(2018).

[17] Estevao, J., Carneiro, M.-J. and Teixeira, L., "Destination management systems' adoption and management model: Proposal of a framework," Journal of Organizational Computing and Electronic Commerce, 30(2), 89-110(2020).

[18] Mou, N.-X., Zheng, Y.-H., Makkonen, T., Yang, T.-F., Tang, J.-W. and Song, Y., "Tourists' digital footprint: The spatial patterns of tourist flows in Qingdao, China," Tourism Management, 81, 104151(2020).

[19] Gu, Q.-S., Zhang, H.-P., Chen, M. and Chen, C.-C., "Regionalization analysis and mapping for the source and sink of tourist flows," ISPRS International Journal of Geo-Information, 8(7), 314(2019).

[20] Vavpotic, D., Knavs, K. and Cvelbar, L. K., "Using a market basket analysis in tourism studies," Tourism Economics, 27(8), 1801-1819(2020).

[21] Zhang, J.-L., Wu, T. and Fan, Z.-P., "Research on precision marketing model of tourism industry based on user's mobile behavior trajectory," Mobile Information Systems, 2019, 6560848(2019).

[22] Tsai, S.-P., "E-loyalty driven by website quality: The case of destination marketing organization websites," Journal of Organizational Computing and Electronic Commerce, 27(3), 262-279(2017).

[23] Kak, S., "Information theory and dimensionality of space," Scientific Reports, 10(1), 20733(2020).

[24] Mayer, A. L., Donovan, R. P. and Pawlowski, C. W., "Information and entropy theory for the sustainability of coupled human and natural systems," Ecology and Society, 19(3), 11(2014).