

Summer 7-26-2022

## Sentiment Analysis of Tourism Online Reviews Using the Deep Learning Method Based on BiLSTM

Kailin Zhou

*School of Economics and Management, Beihang University, Beijing, 100191, China*

Zhong Yao

*School of Economics and Management, Beihang University, Beijing, 100191, China*

Wuhuan Xu

*School of Economics and Management, Beihang University, Beijing, 100191, China, iszhyao@buaa.edu.cn*

Jiaqi Wang

*School of Economics and Management, Beihang University, Beijing, 100191, China*

Follow this and additional works at: <https://aisel.aisnet.org/whiceb2022>

---

### Recommended Citation

Zhou, Kailin; Yao, Zhong; Xu, Wuhuan; and Wang, Jiaqi, "Sentiment Analysis of Tourism Online Reviews Using the Deep Learning Method Based on BiLSTM" (2022). *WHICEB 2022 Proceedings*. 59.  
<https://aisel.aisnet.org/whiceb2022/59>

This material is brought to you by the Wuhan International Conference on e-Business at AIS Electronic Library (AISeL). It has been accepted for inclusion in WHICEB 2022 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact [elibrary@aisnet.org](mailto:elibrary@aisnet.org).

Short Research Paper

# Sentiment Analysis of Tourism Online Reviews Using the Deep Learning Method Based on BiLSTM

Kailin Zhou<sup>1</sup>, Zhong Yao<sup>1\*</sup>, Wuhuan Xu<sup>1</sup>, Jiaqi Wang<sup>1</sup>

<sup>1</sup>School of Economics and Management, Beihang University, Beijing, 100191, China

**Abstract:** The outbreak and spread of COVID-19 have a great impact on the tourism industry. In this paper, we focus on the cultural tourist attractions, and take the Palace Museum as an example to explore and analyze the sentiment from perspective of tourism management under the influence of the epidemic. Firstly, more than 40,000 online reviews before and during the epidemic are crawled from some well-known domestic tourism e-commerce platforms. Then, the deep learning method based on BiLSTM is used to establish the emotion polarity classifier, and the classifier has an accuracy rate of more than 80% on the test set. Afterwards, K-means algorithm is used for the dimension clustering of the review data, and combined with the tourism management factors, the specific and managerial dimension division is carried out. Finally, suggestions for the current epidemic management plan of the Palace Museum and feasible plans for future development are put forward, which can be used as a reference for other cultural tourist attractions.

Keywords: Online reviews, Sentiment analysis, Deep learning, Tourism emotion, COVID-19

## 1. INTRODUCTION

Since the end of 2019, COVID-19 has begun to develop worldwide. Under the influence of epidemic prevention and control measures, tourism has been greatly affected. Tourism can be divided into scenic tourism and cultural tourism. In the past, tourism obtained the optimal income through high tourist volume. However, affected by the epidemic, this factor is bound to be greatly reduced. Additionally, in accordance with the policy of “turning the epidemic prevention and control into a normal life”, it is very likely that the industry will be affected by the special environment for a long time. Therefore, mining and analyzing the specific impact of the epidemic on the tourism industry are great of significance.

In present, the core competitive advantage of tourism industry is to create continuous pleasant experience for tourists. As for tourism experience, some relevant research has been published <sup>[1],[2]</sup>. With the further development of information technology and e-commerce, the amount of review data is growing rapidly <sup>[3]</sup>. Online comments published by lots of real tourists are usually spontaneous and natural, which can express the real feelings and experiences of tourists, not limited by time and space. Therefore, a comprehensive and in-depth analysis of online travel reviews is an efficient and valuable method to understand the tourism experience.

The emotional features based on tourism experience will directly have a great impact on the travel satisfaction and behavior preference of tourists <sup>[4]</sup>. In addition, potential tourist users will also be greatly influenced by the existing online reviews of other tourists <sup>[5]</sup>. Recently, sentiment analysis for text reviews, also known as opinion mining, has been successfully applied in a variety of research backgrounds <sup>[6]</sup>. Particularly, deep learning has achieved great success in the field of sentiment analysis, which is considered to be the most advanced and effective model method in all kinds of language analysis <sup>[7]</sup>. In deep learning, however, the research on tourism sentiment analysis is limited, mainly focusing on hotels and restaurants with clear and characteristic attributes, such as service quality, location, room quality, etc. <sup>[8]</sup>. Up to now, there are few cases in which deep learning is used to study online tourism reviews related to tourism destinations.

---

\*Zhong Yao, iszhyao@buaa.edu.cn

Based on the above analysis, the significance and innovation of this article are as follows: (1) the online comment analysis can more clearly and specifically discover the impact of the epidemic on the tourism industry. The purpose is to optimize the tourist experience and put forward suggestions for the industry to further adapt to the epidemic prevention and control environment and sustainable development. (2) This paper adopts the method of combining with deep learning model, thus strengthening the integration of text analysis and deep learning. Moreover, deep learning and machine learning algorithms are combined to achieve effective processing of the review data. (3) Tourist's satisfaction with tourism experience is defined as a kind of comment emotion score. Specifically, it gives the score of polarity and calculates the emotional score of dimensional comments, which helps to analyze the characteristics and emotion score of attention dimension of tourists more intuitively and effectively. The content of this paper is arranged as follows: Section II details data sources and research methods; Section III introduces the calculation result of emotion score and attention, and then carries on the score analysis; Section IV provides management advice.

## 2. METHODS

### 2.1 Data sources

This paper selects the online travel comments of the Palace Museum from the well-known and popular e-commerce network platforms in China, including Ctrip, Qunar, Meituan, Lvmama, Tripadvisor, Dianping and Baidu travel. We crawled a total of 42,153 comments, and then manually screened out meaningless comments. Manual screening took a total of 1 month, and finally we got 30,072 effective online travel reviews.

### 2.2 Research methods

In this paper, the deep learning method based on BiLSTM and the machine learning algorithm based on K-means are used to recognize the emotion polarity and comment dimension of the processed comment data sets, respectively. According to the emotional polarity and dimension characteristics of the review data obtained from the previous model, the corresponding comment emotion score and dimension feature attention are calculated. Finally, through visualization and comparative analysis, the result analysis and feasible suggestions are provided. The framework of the method is shown in Figure 1. In the following, we will introduce the key technologies.

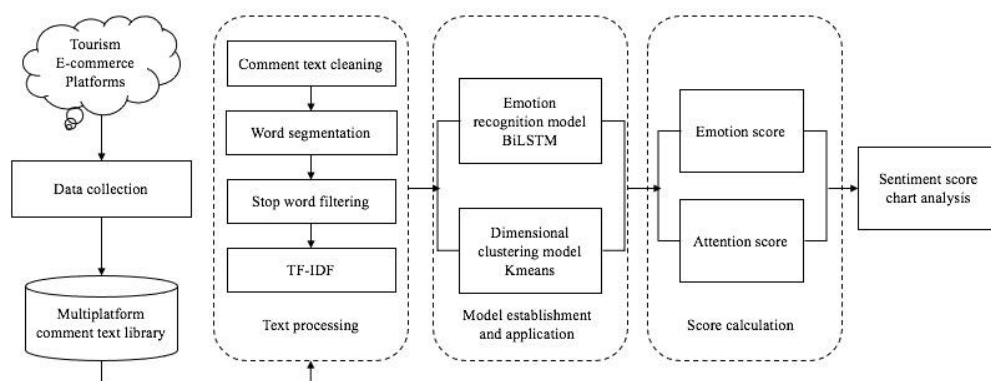


Figure 1. The whole framework of research method

#### 2.2.1 Emotion recognition model

We decide to use BiLSTM model as the core layer of deep learning network. BiLSTM can deal with the context of text more effectively, which helps to preserve the integrity of text meaning, thus making the model training more effective and accurate. Besides, BiLSTM model is very suitable for the research goal of this paper, i.e., the analysis of online comments in cultural tourism areas. In this case, it is necessary to retain the text structure level, because many emotions can only be expressed completely by combining with the whole context.

As shown in the figure 1, the data first goes through a series of cleaning and preprocessing. Then, the data set is divided into training, testing and application sets, and the training and testing sets are manually labeled with emotion polarity (labeled as positive, neutral, and negative). We train a deep emotion recognition model with more than 80% accuracy on test set, which can be used in emotion polarity recognition of application set. In order to confirm the effectiveness of the model recognition results, the labeled comment data set is sampled, and 50% of all negative comments, neutral comments and positive comments are randomly selected for manual verification. The result of sampling inspection is good, and the accuracy of the application result of the model is high. Finally, the tag results are shown in Table 1.

**Table 1. Emotional polarity recognition results of tourists' comments**

Total comments	Positive comments	Neutral comments	Negative comments	Proportion of polarity
30072	25320	4202	550	84.1:13.9:2

### 2.2.2 Dimensional clustering model

After data cleaning and processing, we get the comment feature matrix, and then use K-means algorithm to implement dimension clustering of the review data. To determine the the appropriate number of clusters, we compare the sum of squared error trend with elbow method. Then, it is observed that when  $k = 5$ , the maximum SSE decline range is obtained, which means the real number of clusters is closest to 5. Therefore,  $k = 5$  is taken as the optimal number of clusters. The final clustering results are displayed in Table 2.

**Table 2. Feature keywords of each dimension of online review data set**

Dimension label	Number of comments	Feature keywords
0	1306	门 (gate)、方便 (convenient)、快捷 (fast)、刷身份证 (ID card)、网上预约 (online appointment)、排队 (in line)、提前 (in advance)、便宜 (cheap)、性价比 (cost-effective)、价格 (price)、订票 (booking)、划算 (good deals)
1	25792	文物 (cultural relic)、文化 (culture)、文明 (civilization)、千百年 (thousands of years)、感慨 (feelings)、精髓 (essence)、中国 (China)、智慧 (intelligence)、历史 (history)、结晶 (treasure)
2	1012	导游 (tour guide)、讲解 (explanation)、X 导 (Guide X)、大福晋 (Daifukujin)、人工讲解 (manual explanation)、电子讲解 (electronic explanation)、租 (hire)、生动 (vivid)、有趣 (interesting)、详细 (in detail)、服务 (service)、智能 (smart)
3	556	珍宝馆 (Treasure Hall)、钟表馆 (Clock Museum)、展馆 (pavilion)、九龙壁 (Nine-Dragon Wall)、大戏台 (Big Stage)、珍品 (treasure)、单独买票 (buy tickets separately)、值 (deserve)、推荐 (recommend)
4	1406	宫殿 (palace)、建筑 (building)、壮观 (spectacular)、震撼 (humbling)、皇家建筑 (royal building)、恢弘 (magnificent)、紫禁城 (Forbidden City)、中轴线 (central axis)、午门 (Meridian Gate)、宏伟 (imposing)

Through the feature keyword extraction of each dimension, according to the relationship between keywords and the meaning of the feature words themselves, this paper gives the naming definition of all the dimension categories, i.e., dimension label 0: convenience experience and cost performance; Dimension label 1: cultural atmosphere; Dimension label 2: guide explanation; Dimension label 3: treasure museum collection; Dimension 4: architectural atmosphere.

### 2.2.3 Emotional score calculation

Emotional score refers to the Saliency and Valence analysis method proposed by Ref. [9], which can be used to describe tourist satisfaction to a certain extent. According to the results of emotional polarity and dimension division identification, we develop the following methods to calculate the review sentiment score of the overall and each dimension.

The three categories of emotional polarity of tourist reviews are given their own scores, i.e., 1 for positive reviews, 0.5 for neutral reviews, and 0 for negative reviews. The meaning is that the higher the score, the higher the degree of positive experience and the higher the degree of satisfaction. The emotional score of a certain dimension is defined as follows.

Let  $V_A$  be the emotional score of the dimension  $A$ ,  $V_{Ai}$  be the emotional score of the  $i$ th comment in  $A$ ,  $N$  be the total number of comments in  $A$ , then

$$V_A = \frac{\sum_{i=1}^N V_{Ai}}{N}. \quad (1)$$

### 2.2.4 Attention calculation

Dimension attention refers to the degree of tourists' attention to a certain dimension of the tourism environment, which is reflected in the concentration degree of comment dimensions. The dimensions with high attention have realistic value and are the tourists' focus, so they should be dealt with first in decision-making. After observing the structure of comment data, this paper decides to calculate the dimension attention from the perspective of the number of comments.

(1) In general, the same tourist tends to make more comments on the dimension that he/she pays more attention to and, tends to give priority to making comments on the dimension of concern.

(2) Considering all the tourist groups as a whole, the higher the degree of attention, the more the number of comments in the dimension.

Let  $Attention_j$  be the attention of dimension  $j$ ,  $N_j$  be the total number of comments in  $j$ ,  $N$  be the total number of comments collected, then

$$Attention_j = \frac{N_j}{N} \cdot 100. \quad (2)$$

## 3. RESULTS AND ANALYSIS OF EMOTIONAL SCORE AND ATTENTION

### 3.1 Emotional outcome analysis of five dimensions

Figure 3 is the statistical chart of the attention and emotional scores of the five main dimensions defined above. It can be seen from the figure 3 a) that the attention of "cultural atmosphere" is far ahead in terms of tourists' attention, which is probably related to the fact that the Palace Museum is a famous cultural tourist attraction, and the primary attraction is its long-standing cultural charm. Contrast, the attention of the other four dimensions is almost the same. In particular, the attention of "treasure museum collection" dimension is very low, which may be related to the establishment of separate ticket. Most tourists are no longer willing to pay for separate tickets. Therefore, there are relatively few online tourist comments related to it, resulting in the low attention.

Comprehensive emotion score is shown in the figure 3 b). The overall average emotional score of online

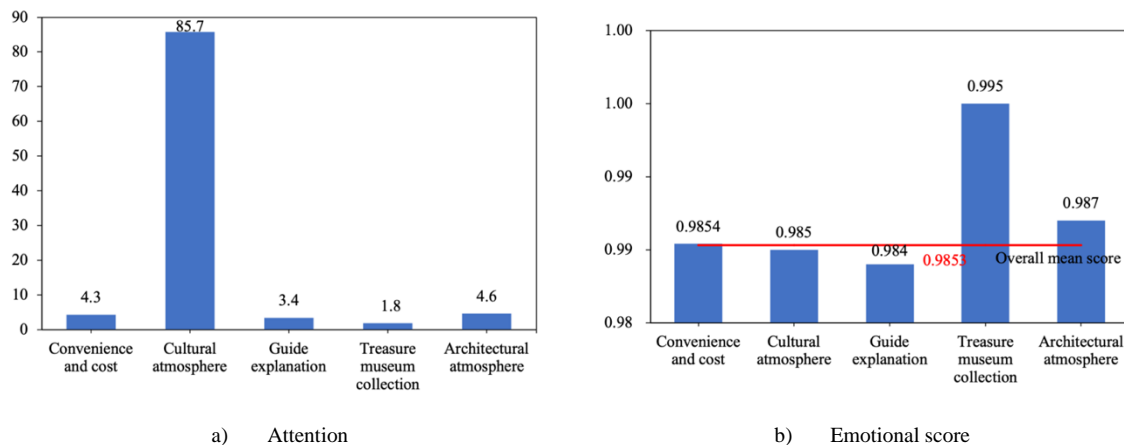


Figure 2. Emotional outcome of five dimensions

(1) “Cultural atmosphere” and “guide explanation” are below the overall mean line. However, “cultural atmosphere”, as the dimension of most concern, has a significant impact on the overall emotional score; “guide explanation” is an effective channel to help tourists who lack relevant historical knowledge to optimize their cultural tourism experience.

(2) “Convenience experience and cost performance” are close to the mean line and, has no significant negative or positive impact on the overall emotional score. It mainly includes the comparison between the cost paid by tourists and the tourism experience gained, as well as the convenient service experience in the tourist attraction, such as queuing, booking and so forth.

(3) “Treasure museum collection” and “architectural atmosphere” are above the mean line, belonging to the promotion area of the overall emotional score. The dimension of “treasure house collection” accounts for a very low degree of attention in the whole, but on the contrary, has quite high emotional score. These two points show that “treasure museum collection” has considerable development potential. Although the current tourists' attention is insufficient, the experience feedback is very good. If the attention can be improved, the overall emotional score will be greatly improved. Additionally, the Palace Museum takes ancient buildings as main scenery, so the “architectural atmosphere” dimension is also an important link. The preliminary analysis shows that the maintenance and preservation of the buildings are relatively complete, which can be recognized by most tourists, and has positive significance.

Notably, for the sub features of the five dimensions as shown in Table 2 (i.e., “Feature keywords” column), by doing the similar statistical analysis of attention-emotion score as well as screening specific sub feature comments, we will find out the hidden influence factors of the epidemic situation and, put forward detailed and clear problems and improvement points. As the analysis process is similar to that of five main dimensions, we omit that to save space and the results are summarized in Section 4.

### 3.2 Emotional outcome analysis of epidemic intuitive impact features

This section analyzes the emotional outcome of the intuitive impact features of the epidemic situation from the online comments. Five features are extracted from the key words of the epidemic obtained in the unsupervised clustering process, including “epidemic situation”, “flow restriction”, “closing”, “temperature measurement” and “mask wearing”. Here, “epidemic situation” refers to tourists' views on the epidemic situation and the Palace Museum under the influence of epidemic prevention and control. The other four features are tourists' feedback on the specific management measures during the epidemic. Then, matching the comments closest to these five feature words, we can get their emotional score and attention respectively. The statistical results are shown in Figure 5.

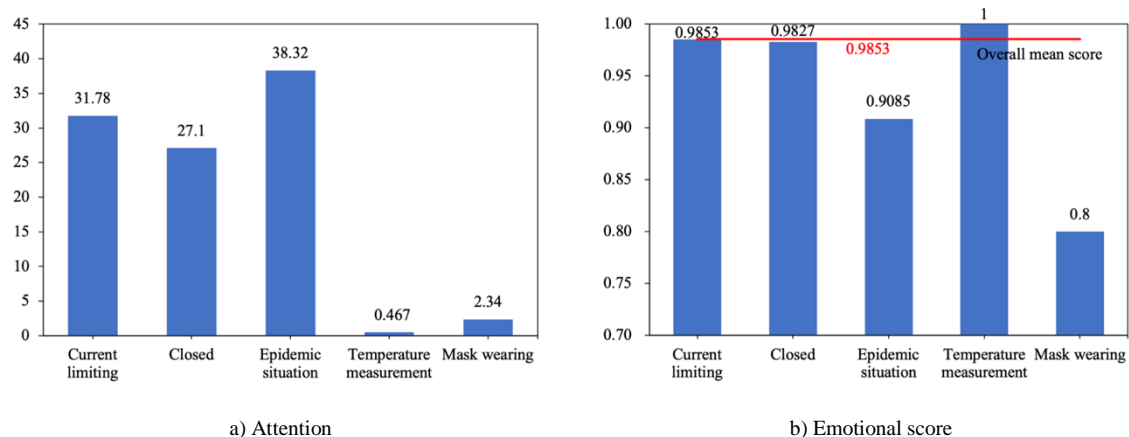


Figure 3. Emotional outcome of epidemic intuitive impact features

In terms of attention, the “epidemic situation” representing overall sensory feature is still on the high side, indicating that tourists are concerned about the epidemic environment. Less attention is paid to “temperature

measurement” and “mask wearing”, which may be since tourists are used to the two requirements. We can clearly observe from Figure 5 b) that the comprehensive emotional scores of “temperature measurement”, “closing” and “flow restriction” are relatively high. In contrast, the emotional score of the general feature “epidemic” dropped sharply. It can be intuitively realized that the epidemic has caused great damage to the overall tourism experience of tourists. In the above analysis process, the epidemic prevention and control measures show a certain degree of positive effect on the tourism experience, but overall, the impact is still very negative, which requires the management of the Palace Museum to seriously formulate strategies. Noting that tourists show a very low emotion score for the feature “wearing masks”, which needs to be paid special attention to by specific comment analysis.

#### **4. CONCLUSION AND MANAGEMENT SUGGESTIONS**

In this section, based on all the above information, combined with the current management situation, some practical suggestions are put forward.

##### **4.1 Suggestions for cultural atmosphere**

For the dimension of cultural atmosphere with high tourist attention, the priority of improvement should be the highest.

(1) As for the poor experience caused by insufficient historical and cultural knowledge of tourists, the Palace Museum should strengthen cultural guidance. It should set up sufficient introductions, such as explanation of wooden cards and manual customer service. Besides, it should strengthen the cooperation with tour guide service providers or cultivate their own high-quality tour guide service team.

(2) It should strengthen the restrictions on the free movement area in the exhibition hall, reduce the random walking behavior of tourists, and prevent it from interfering with the travel experience of other tourist groups; For the exhibition halls that can be visited from the inside, a fixed feasible green zone should be set to keep a certain distance from the exhibits and cultural relics.

(3) More attention should be paid to the protection and maintenance of cultural relics in the exhibition hall. To slow down the damage and aging of cultural relics, it is necessary to shorten the maintenance cycle and increase the maintenance frequency on the premise of ensuring the appropriate cost.

##### **4.2 Suggestions for current epidemic prevention and control measures and other dimensions**

(1) Improve the use guidance of electronic interpreter because the current manual cannot better complete the guidance of tourists. For contemporary middle-aged and elderly people, there should be simple to understand courses. If necessary, practical assistance should be provided to these tourists by the staff.

(2) Strengthen the centralized maintenance of the electronic interpreter, prevent the hardware and software failures in the use process, and ensure the interpretation quality.

(3) Conduct publicity for the rental of electronic interpreter. Judging from the present usage of the electronic interpreter, the device can better complete the task of interpretation and cultural transmission, and improve the cultural experience, but the popularity is not enough. It is possible to set up the trial, manual introduction points and advantages overview of the electronic interpreter at the entrance of the museum to enlarge the user group of the electronic interpreter.

(4) To improve the business requirements for cooperative tour guides, a feedback channel for tourists can be set up. According to the feedback information, optimize or retrain the service and attitude of the tour guides who have received many negative feedbacks to ensure the service level of the tour guides.

(5) During the period of epidemic prevention and control, if there is any update of the regulations on route restrictions, exhibition halls closing, etc., public notices should be made to tourists as soon as possible. Meanwhile, tour guides should be required to explain the route arrangement, to eliminate the possible information asymmetry between each other in the travel process and, avoid misunderstanding and influence of tourists' experience.

(6) As for the way to purchase tickets, due to the current restriction regulations during the epidemic, and online booking tickets are quite popular, all tickets are reserved by online booking. For tourists who do not want to book tickets online or collectors who are interested in paper tickets, it becomes a problem that they cannot get paper tickets. Therefore, this paper believes that it is possible to investigate tourists' demand for tickets and separate a few paper ticket channels, which are independent from online reservation and guarantee that paper ticket channels can be provided in the case of almost no impact on the daily ticket sales; And for those who like collecting, the Palace Museum can provide a service that can change the e-tickets booked online into paper tickets at the entrance to meet the needs of these visitors.

(7) During the period of epidemic prevention and control, the strict links of security inspection are necessary. Video explanations can also be arranged at the security check site to explain the historical allusions and culture of the Forbidden City, as well as the prevention and control regulations related to the epidemic to win the understanding of tourists. This can divert the attention of tourists while waiting, and the same time can supplement tourists' cultural knowledge and optimize the subsequent travel experience.

(8) The large number of tourists is the inevitable result of the tourism industry as the pursuit of profits. Hence, the managers can only try their best to adjust the density of tourists and keep it at an optimal level. In the context of epidemic, the flow restriction has buffered the total number of tourists to some extent. The Palace Museum can use a time-divided discount strategy through tickets, with the late entry being the more aggressive the discount. The second strategy is to recommend different tourist routes, which can play the role of route diversion and control the regional tourist density in the period. However, due to the nature of recommendation, the real effect may not be very significant.

(9) In view of the extra charge of Treasure Hall and Clock Hall, to attract tourists, this paper advises that free admission tickets can be provided for a limited time, so that the advantages of "Treasure Museum Collection" dimension can be spread to more tourists. This can help increase the attention of tourists and expand the potential group of tourists, so that many tourists are willing to pay for independent and high-quality exhibition halls. Another feasible plan is to provide a discount package ticket, by combining the tickets of independent exhibition halls with the tickets of the Palace Museum at a reasonable discount, which can fully show the advantages of high-quality exhibition halls to tourists.

(10) It is necessary to limit the scope of tourists' activities for the protection of the ancient buildings and exhibition buildings in the Palace Museum, which can be understood by most tourists. However, some tourists fail to understand and have negative emotions. For this, the explanation of the reasons for the restrictions should be strengthened, such as signage and manual service instructions, to gain the understanding of tourists and reduce the negative experience caused by restricted activities.

(11) Wearing masks in the context of epidemic prevention and control has a great sense of bondage to tourists, which seriously affects the tourist experience. It is suggested that flexible changes can be made according to the situation of the epidemic in China. In the period of a stable and relatively peaceful epidemic, the requirements for wearing masks can be relaxed, only requiring wearing masks before entrance, and strict security procedures can be carried out. In the period of relative fluctuation of the epidemic, tourists are required to wear masks during the whole journey to ensure safety. And, when the epidemic is more serious, the closure policy should be resolutely implemented, to give priority to domestic environmental safety.

The feasible management suggestions of the Palace Museum under the epidemic prevention and control environment are presented, hoping to facilitate its future development, provide some guidance for the future epidemic environment, and give some reference for other cultural tourist attractions.



## ACKNOWLEDGEMENT

This research was supported by the National Natural Science Foundation of China under Grant 716710111.

## REFERENCES

- [1] Afshardoost M, Eshaghi M S. (2020). Destination image and tourist behavioral intentions: A meta-analysis. *Tourism Manage*, 81: 104-154.
- [2] Breitsoh J, Garrod B. (2016). Assessing tourists' cognitive, emotional and behavioral reactions to an unethical destination incident. *Tourism Manage*, 54: 209-220.
- [3] Rana T A, Cheah Y-N. (2016). Aspect extraction in sentiment analysis: comparative analysis and survey. *Artif Intell Rev*, 46: 459-483.
- [4] Jang S, Moutinho L. (2019). Do price promotions drive consumer spending on luxury hotel services the moderating roles of room price and user-generated content. *Int J Hosp Manag*, 78: 27-35.
- [5] Pelsmacker D, Tilburg P, Holthof S, (2018). Digital marketing strategies, online reviews and hotel performance. *Int J Hosp Manag*, 72: 47-55.
- [6] Shrestha N, Nasoz F, (2019). Deep Learning Sentiment Analysis of Amazon.Com Reviews and Ratings. *Int J Soft Comp Artif Intell App*, 8: 1-15.
- [7] Bi J, Liu Y, Fan Z, Zhang J. (2019). Wisdom of crowds: Conducting im-portance-performance analysis (IPA) through online reviews. *Tourism Manage*, 70: 460-478.
- [8] Zhang K, Chen Y, Li C, (2019). Discovering the tourists' behaviors and perceptions in a tourism destination by analyzing photos' visual content with a computer deep learning model: The case of Beijing. *Tourism Manage*, 75: 595-608.
- [9] Taecharungroj V, Mathayomchan B. (2019). Analysing TripAdvisor reviews of tourist attractions in Phuket, Thailand. *Tourism Manage*, 75: 550-568.