

# Shanxi Temple Soundscape Satisfaction Evaluation and Analysis

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**Abstract.** This paper studies the soundscape characteristics of three Buddhist temples in Shanxi Province, China. Through questionnaire survey and laboratory research, it analyzes the satisfaction evaluation of monks and tourists on the soundscape of temples in the off-season and peak season and compares the satisfaction differences of different periods and sound sources. The results show that the satisfaction evaluation of temple soundscape is negatively affected by manufactured noise, and Buddhist sound is the only sound source that has been positively evaluated. Laboratory experiments show that sound is the key factor leading to the preference for soundscape evaluation, and the influence of visual pictures is insignificant.

**Keywords:** Buddhist temples; soundscape; satisfaction evaluation; satisfaction analysis.

## 1. Introduction

The Wutai Mountain Buddhist Temple Group is one of China's oldest and most famous Buddhist shrines. The research on these temples mainly focuses on analyzing the present situation and development of the temples, as well as the visual environment inside and outside the temples from the perspective of history and culture [1-4]. However, the acoustic environment of Buddhist temples is also an important environmental component that constitutes the religious atmosphere of temples [5-8]. Unfortunately, there is still little research on the acoustic environment of Buddhist temples, especially the lack of consideration of the acoustic environment of temples from the soundscape perspective. Soundscape is a new field of acoustics and one of the important research directions of architectural environment acoustics. The term "soundscape" is defined as "the acoustic environment as perceived or experienced and/or understood by a person or people, in context" [9-10]. It differs from traditional acoustics research in that it emphasizes the perception and understanding of an individual or society to the sound environment [11-12]. It studies the relationship between people, sound, and environment [13-14]. Previous research on the soundscape of Buddhist Temple mainly focused on investigating the sound parameters of Buddhist temples and the influence of the traditional temple sound environment on tourists' satisfaction and comfort through subjective questionnaires. Rui takes the Daci Temple block as the research object and counts the existing historical soundscape from the historical record of sound [15]. Jeon compares the soundscape evaluation of a Catholic cathedral and a Buddhist temple in Seoul, South Korea, finding that the visitors prefer natural sounds and religious sounds and that the soundscape evaluation is influenced by the listeners' cultural background and personal preferences [16]. By reappearing the historical soundscape, it can provide a good reference for constructing the soundscape of temple buildings in the later period. Zhang studied the influence of traditional temple space elements on the sound field in courtyards and Buddhist temples [17]. Liu and Yan used soundscape to evaluate the comfort of Qingcheng Mountain [18]. Li made a subjective and objective correlation analysis on the preference and sound level of the soundscape elements in Hanshan Temple [19]. Zhang discusses the influence of the soundscape of the Han Buddhist

Temple (including sound environment and sound) on the mental health of believers and tourists and the role of religious belief-related factors in this relationship [20].

In summary, the relationship between tourists' satisfaction and temple soundscape has attracted attention, but there is a lack of research on monks' satisfaction evaluation of temple soundscape. Therefore, it is necessary to study this topic. Taking three famous Buddhist temples in Shanxi, China, as the research objectives, this paper discusses the influence of tourists on the satisfaction evaluation of monks from different periods of off-season and peak season. Also, it analyzes that manufactured noise is the key factor affecting the preference for satisfaction evaluation. Firstly, questionnaires were distributed to monks and tourists in peak season and off season respectively, to analyze the influence of tourists on the overall soundscape satisfaction of the temple. Then, based on the questionnaire survey, the correlation analysis of people flow, loudness, and satisfaction is made. Finally, the satisfaction evaluation of a single sound source is carried out, and the subjective experiment proves that sound is the key factor leading to the preference for satisfaction evaluation.

## 2. Overall soundscape evaluation of temples

### 2.1 Questionnaire design

Unlike squares, parks, and other venues that are completely open to the public, temples are important places for monks to practice and live. Monks in temples live in temples all day for most of the year, which means that the soundscape of temples will have more influence on monks. Usually, we can divide the soundscape of temples into opening and closing times, peak season, and off-season, according to the number of tourists visiting in different seasons. This paper uses the research objects of three temples in Shanxi Province: Taiping Xingguo Temple, Tayuan Temple, and Nanshan Temple. The peak season for receiving tourists is generally between April and October, especially from May to September, with a pleasant climate, beautiful scenery, and many festivals. We selected May, July, and September as the investigation periods in the tourist peak season. Correspondingly, we chose March in the first half of the year and November and December in the second half of the year as the investigation periods in the off-season. It should be noted that although there are no Buddhist festivals in January and February, the traditional New Year festivals in China are usually located in these two months, and more tourists are praying for the New Year. Hence, the selection of off-season months avoids these two months. The total number of questionnaires is 1,252, including 255 in peak season and 150 in the off-season of Taiping Xingguo Temple, 244 in peak season and 171 in the off-season of Tayuan Temple, 272 in peak season and 160 in the off-season of Nanshan Temple.

Table 1. Number of questionnaires collected from monks and tourists in May.

Temple	Questionnaire object	Number of questionnaires on opening hours of	Number of questionnaires on closing time
Taiping Xingguo temple	Monks and priests	10	10
	visitor	73	None
Tayuansi	Monks and priests	10	10
	visitor	75	None
Nanshan Temple	Monks and priests	10	10
	Visitor	83	None

Among the 405 questionnaires in Taiping Xingguo temple, we designed 60 questionnaires separately and distributed them to 10 monks in this temple six times a month. These questionnaires added the soundscape evaluation of the temple during the closing time to compare the differences in the soundscape evaluation between the opening time and the closing time. Tayuan Temple and Nanshan Temple also distributed 60 questionnaires to the monks in this temple. Table 1 shows the distribution of questionnaires in May. Because tourists can't stay in the temple when it is closed,

there is no evaluation of the soundscape of the temple by tourists. The questionnaire collection in other months is similar.

Table 2. 5-level evaluation standard of overall soundscape.

Evaluating indicator	Evaluation Scale				
Visitor flow rate	Crowded	Dense	Moderate	Sparse	Empty
Loudness preference	Very noisy	Squabble	Neutral	Quiet	Very quiet
Degree of satisfaction	Very dissatisfied	Dissatisfied	Neutral	Satisfied	Very satisfied
Score	-2	-1	0	1	2

In the subjective evaluation of the overall soundscape, loudness, visitor flow, and satisfaction are taken as evaluation indicators. Visitor flow refers to the number of people visiting a specific place in the temple in a period. Loudness is a subjective judgment indicator, which means that the interviewee determines the total volume generated by the superposition of various sound sources in the current complex acoustic environment through the senses. Satisfaction is taken as the overall evaluation indicator. This paper uses the semantic subdivision method to evaluate soundscapes in different periods. The evaluation scale shown in Table 2 divides the respondents' observation results of soundscape into five levels, and the respondents choose the words that best represent their current soundscape feelings. It is important to note that the three indicators are all the measurements of the psychological feelings of the interviewees, although the number of tourists entering and leaving in a unit of time is objective data. For example, the number of tourists entering Taiping Xingguo temple in the peak season can reach more than 200 in five minutes, and the number of tourists in the off-season is less than 30 in five minutes. The difference is so obvious that monks and tourists can only judge the current number of people in the temple as crowded or sparse by their observation and on-site feelings without accurate statistics. In this paper, an integer score of -2 to 2 marks the respondents' observation results of the current soundscape, which is conducive to the numerical statistics of the respondents' opinions on the contemporary soundscape. Finally, the average score of each index is taken to represent the evaluation results of the present temple soundscape as a whole.

## 2.2 Evaluation results

To present the questionnaire results more clearly, we counted the average of the evaluation results of loudness, visitor flow, and satisfaction of the three temples during opening and closing hours. Because the questionnaire survey results of the three temples are similar, the questionnaire results are now merged. Table 3 presents the evaluation results of the monks of the three temples on the opening hours and closing times in the off-season and peak seasons. It can be seen that the score of soundscape evaluation in the open period is generally lower than that in the closed period, which shows that the monks think that the soundscape in the closed period of the temple is better than that in the open period, with more people flowing, noisier acoustic environment and lower satisfaction evaluation, and the average scores of the three indicators are all negative, which means that the noisy acoustic environment during the opening hours has caused more discomfort to monks. On the contrary, when the temple is closed, the soundscape evaluation of monks has been greatly improved. No matter whether in the peak season or off-season, all three indicators have been positively evaluated. The score of satisfaction evaluation is 0.63 (between [0,1] neutrality and satisfaction) during the closing hours because compared with the opening hours, the acoustic environment of the temple during the closing hours is mainly composed of natural sounds and Buddhist sounds such as bells. There is a lack of noise from tourists, mostly the voice of speech and the horns of vehicles. Monks have rejected the artificial noise made during opening hours and given a lower satisfaction evaluation. For the off-season opening hours, the average satisfaction score is still positive. However, it is lower than the closing time, which once again verifies the view that artificial noise during opening hours will cause a negative soundscape evaluation of temple

monks. When the tourist flow decreases in the off-season, it will get a more positive satisfaction evaluation.

Table 3. Monks' evaluation results of the overall soundscape of the temple during opening and closing hours ( $\bar{x} \pm s$ ).

Index	Opening hours		Turn-off time	
	Peak season	Off-season	Peak season	Off-season
Visitor flow rate	-1.87±0.34	0.70±0.79	1.63±0.56	1.73±0.52
Loudness	-1.80±0.40	0.57±0.68	1.67±0.55	1.70±0.47
Degree of satisfaction	-1.77±0.50	0.63±0.67	1.50±0.73	1.47±0.78

The above analysis shows that the satisfaction evaluation results are closely related to the amount of human noise. Table 4 gives Pearson correlation analysis between visitor flow, loudness, and satisfaction using SPSS. It can be seen from Table 5 that satisfaction is positively correlated with the flow of people and loudness in the four time periods, especially during the opening hours of the peak season. The correlation between satisfaction and loudness is  $R = 0.942, P < 0.01$ , indicating that more manufactured noise in the peak season brings Worse satisfaction ratings. For the off-season closing period, the flow of visitors is no longer a relevant factor affecting satisfaction evaluation. However, temple monks are still sensitive to the loud environment in the temple.

Table 4. Correlation of monks' evaluation results of the overall soundscape.

Index	Satisfaction degree			
	Opening hours in peak season	Opening hours in off-season	Closing hours in peak season	Closing hours in off-season
Visitors flow rate	0.805**	0.370**	0.467**	0.008
Loudness	0.942**	0.549**	0.518**	0.560**

\*\* : ; \* :  $p < 0.01$ ; \* :  $p < 0.05$

### 2.3 The impact of loudness on satisfaction

It is worth noting that although the increase in visitor flow will produce more manufactured noise, it will be relatively reduced in some important places in the temple, such as the chanting hall and the main hall for worshipping Buddha. However, visually, the smaller space in the temple will cause more crowded people, contrasting with the quiet scene. Table 5 describes the evaluation results of three indicators under overcrowded people and quiet scenes in peak season. Although the visitor is still heavily crowded (the average score is -1.87), when the average score of loudness index is 0.3 (between [0,1] neutral and quiet), the average score of satisfaction is 0.4 (between [0,1] neutral and satisfied), which shows that crowded visitor does not necessarily lead to the evaluation of dissatisfaction tendency. Similarly, Pearson's rank correlation analysis indicates no significant correlation between visitor flow and satisfaction under the premise of asking tourists to be quiet. In contrast, the correlation between satisfaction and loudness is substantial ( $R = 0.696, P < 0.01$ ), which shows that the acoustic environment in the temple affects the monks' satisfaction evaluation of the current soundscape. The less noise, the higher the satisfaction evaluation.

Table 5. Correlation analysis between soundscape evaluation results and Pearson in quiet places in peak season ( $\bar{x} \pm s$ ).

Index	Evaluation results	Correlation with satisfaction
Visitors flow rate	-1.87±0.34	0.049
Loudness	0.30±0.87	0.696**
Satisfaction degree	0.40±0.80	

\*\* : ; \* :  $p < 0.01$ ; \* :  $p < 0.05$

## 2.4 Visitors' evaluation of the overall soundscape

Since most tourists don't stay in the temple after it is closed, this paper only investigates their evaluation of the soundscape during the opening period. It can be found in Table 6 that the off-season score is generally positive, with an average satisfaction score of 0.61 (between [0,1] neutrality and satisfaction). In contrast, the peak season satisfaction evaluation is typically negative, with an average satisfaction score of -0.35([-1,0] dissatisfaction and neutrality). Compared with the evaluation results of monks' satisfaction with the opening period in peak season in Table 3, it can be found that monks are more sensitive to noisy sound environments, which are lower scores, while the standard deviation of tourists' soundscape evaluation in three indicators is greater than 1, which shows that tourists in peak season have greater differences in the current soundscape evaluation results of temples. This is because although they feel that the scene is crowded, many tourists like to be lively and favor noisy soundscapes.

Table 6. Evaluation results of loudness by tourists from three temples ( $\bar{x} \pm s$ ).

Index	High Season		Slack Season	
	Evaluation results	Correlation with satisfaction	Evaluation results	Correlation with satisfaction
Visitors flow rate	-1.23±1.41	0.371**	0.70±0.80	0.383**
Loudness	-0.40±1.29	0.930**	0.57±0.68	0.560**
Satisfaction degree	-0.35±1.31		0.61±0.66	
** : ; * : $p < 0.01$ ; * : $p < 0.05$				

## 3. Single sound source preference evaluation

### 3.1 Satisfaction evaluation of a single sound source

Determining which sound sources in the temple have influenced the satisfaction evaluation of monks and tourists is necessary. Table 7 divides the common sound sources in the three temples into four categories: natural sound, human voice, mechanical sound, and Buddhist sound. Natural sounds include cicada singing, bird singing, running water, wind blowing in the Woods, rain, and whistling. Natural sounds are related to seasons. For example, cicada singing is dense and sharp in summer, and bird singing is less in winter. The human voice consists of selling sounds, tour guides' explanations, children's playing sounds, tourists' communication sounds, shouts, and footsteps, which are mainly made by tourists and increase and decrease with the peak season and off-season of tourism. Mechanical sounds include background music of scenic spots, hawking sounds, engine and horn sounds of cars, and construction sounds. In peak season, cars' engine and horn sounds are numerous and loud. Buddhist sounds include chanting, bells, wind chimes, and Buddhist music. In the 100 questionnaires, tourists and monks first need to pick out the voices that are most noticed by them and give satisfaction evaluation from five scales: very dissatisfied, dissatisfied, neutral, satisfied, and very satisfied according to the five-level evaluation standard in Table 2, and do not need to give satisfaction evaluation for the voices that have not been noticed. It should be emphasized that to avoid the immediate impact of the environment, such as asking tourists whether they saw the sound of construction at the construction site, we chose a quiet environment not far from the three temples, which required respondents to recall their feelings about the sound and scenery in the temples.

As can be seen from Table 7, only cicadas are noticed in natural sounds. This is because there are many sharp cicadas in summer, which will make tourists and monks fidgety, so they get a low satisfaction rating of -1.72 (between [-2,-1] very dissatisfied and satisfied). At the same time, other natural sounds are not obvious relative to human voices, mechanical sounds, and Buddhist sounds and are easily ignored. Except for the sound of footsteps being ignored, all other human sounds received negative evaluations. Among them, the lowest satisfaction evaluation of the sounds of children's play is -1.93 ([-2, -1] between very dissatisfied and satisfied), and The satisfaction

evaluation of the tour guide's explanation is relatively good at -0.36 ([-1,0] between dissatisfaction and neutral), which is because, for some tourists, the tour guide's explanation is necessary for them to understand the Buddhist landscape. Most of them will focus on the content explained by the tour guide, while the other group of tourists who are free to tour will not care about what the tour guide explains and regard it as background noise. The differences between tourists can also be seen from the maximum standard deviation of 1.57. Generally speaking, the three mechanical sounds that received attention received low satisfaction ratings, especially the sound of construction, which received the lowest satisfaction rating of -1.95 ([-2,-1] between very dissatisfied and satisfied), and the standard deviation is 0.22, indicating that tourists and monks have relatively consistent low satisfaction evaluations of building construction noise. Buddha's sound is the only sound source with a positive evaluation among the four kinds of sounds, which also shows that Buddha's sound is an important part of the temple landscape. Further interviews show that tourists regard Buddha's sound as an important part of the temple's history and culture, which is one of the important purposes of their visit, so it is natural to give a positive evaluation. Among the 20 kinds of sounds in the temple, only 11 sound sources were noticed, accounting for 55.0%. Among the noted sound sources, except for 3 Buddhist types of sounds, the other eight were evaluated with low satisfaction, accounting for 72.7%, which shows that it is necessary to optimize the temple soundscape to improve the satisfaction of tourists and the comfort of monks living there.

### 3.2 Subjective evaluation experiment

We conducted indoor laboratory research to test further the influence of a single sound source on soundscape satisfaction. In this paper, sound samples were taken from the areas that can represent the soundscape characteristics of the three temples, including 21 sound samples in seven regions: the gate, bell tower, drum tower, hall, dining room, lecture hall, and courtyard of the three temples, which covered all sound sources in Table 7. The sound pressure level of the final sampled sound signal samples ranged from 45 to 63 dB (A). According to Chouard's experimental conclusion, this paper recruited 24 voice evaluators, 12 males and 12 females, with an average age of 32 [21]. The evaluators were randomly and equally divided into three groups. To avoid evaluators being disturbed by external noise during the evaluation process, this experiment was conducted in a subjective evaluation laboratory that was isolated from external noise to ensure the reliability of the evaluation results. Five identical videos were played to three groups, but the sound environment of each group was different. The first group could only hear the sound and not see the video. After the sound is played, the group members are asked to write down the three most impressive sounds and give a satisfaction evaluation of these sounds according to the five-level evaluation standard in Table 2. Members of the second group could see the video and hear the sounds simultaneously. After all the videos were over, they were also asked to write down the three most impressive sounds and give a satisfaction rating. For the third group, the group members can see the video and hear the sound simultaneously but are not told that this experiment is related to sound satisfaction. After all the videos are finished, they need to give a satisfaction evaluation for each video according to the comprehensive feeling of vision and hearing. It should be noted that the sound of each video recorded is composed of some main sound sources. For example, the sound in the construction site video is mainly composed of construction sound and car horn sound, which is beneficial to divide the video categories according to the sound composition.

Table 7. Satisfaction Evaluation of Single Sound Source ( $\bar{x} \pm s$ ).

Classify	Sound source	Be noticed (marked by $\checkmark$ )	Satisfaction degree
Natural sound	Cicadas	$\checkmark$	-1.72±0.64
	The bird		
	Running water sound		
	The sound of the wind blowing in the Woods		

	sound of rain		
	Wind howling		
Human voice	Cries	√	-1.80±0.53
	Guide's explanation	√	-0.36±1.57
	Children's playfulness	√	-1.93±0.33
	Tourist communication	√	-1.48±1.02
	footfall		
Mechanical sound	background music		
	Advertising sound	√	-1.90±0.54
	Engine sound		
	The honking of cars	√	-1.89±0.37
	Construction sound	√	-1.95±0.22
Buddhist sound	Chanting sound	√	1.55±0.69
	Ring	√	1.79±0.52
	Wind bell		
	Buddhist music	√	1.85±0.54

Because not every sound will get a score, Table 8 only gives the total score of the satisfaction evaluation of the noticed sounds in the first group and the second group. From the first group, it can be seen that the negative sound is more likely to attract people's attention, and only the chanting sound gets a positive evaluation. In contrast, all first-group members noted the construction sounds and car horns and collectively gave the lowest score of -2 and an overall satisfaction score of -14. The cicada sound and the tourist communication sound get a negative satisfaction evaluation. Although the scores of the second group were affected by the visual images, the sound of construction, vehicle horns, and cicadas also received low negative satisfaction ratings, with the lowest total satisfaction score of construction sound being -14. The sound of bells appeared together with the sound of chanting in the video, so it received a high satisfaction rating like the sound of chanting. Simultaneously, influenced by the video, the sound of tourists' exchanges became acceptable. In the third group, the combination video of the sound of construction and car horns received the lowest score, the combination of the sound of cicadas and tourists communicating also received a low score, and the two videos containing the sound of chanting both received a good satisfaction evaluation.

Table 8. Subjective evaluation experiment scores.

First group		Second group		Third group	
Noticed sound	Score	Noticed sound	Score	The main sounds in the video	Score
Construction sound	-14	Construction sound	-14	Construction sound + horn sound	-12
Car whistle	-14	Car whistle	-12	Chanting + tourist voice	-10
Cicadas	-10	Cicadas	-12	Tour guide's explanation + tourist voice	-6
Tourist voice	-7	Tourist voice	3	Chant + bell	12
Chanting sound	10	Chanting sound	12	Chanting + tourist voice	8
		Ring	10		

Through the comparison between the first group and the second group, it was found that visual images did not affect the evaluators' evaluation preference for sound satisfaction, while the

experiments of the second and third groups showed that under the influence of the same visual images, even if Without emphasizing the impact of voice on satisfaction evaluation, voice is still a key factor that dominates satisfaction evaluation preferences.

#### 4. Conclusion

Through these questionnaire surveys, this paper analyzes the satisfaction evaluation of monks and tourists in three temples on the overall soundscape during the opening and closing hours. It is found that monks are more sensitive to soundscape, and the artificial noise during the opening hours will reduce their satisfaction, while the satisfaction evaluation of soundscape during the closing hours is higher. Tourists' evaluation of soundscape is also affected by manufactured noise, and the evaluation of soundscape in peak season is lower than in low season. The correlation study of the whole soundscape shows that the greater the loudness, the lower the satisfaction evaluation, and there is no significant correlation between the satisfaction results and the flow of people. In the satisfaction evaluation of a single sound source, Buddha sound is the only source with a positive evaluation. Through laboratory research, it is found that the visual picture will not affect the evaluator's evaluation preference for sound, and sound is the key factor that dominates the satisfaction evaluation preference. Finally, we suggest that effective measures should be taken to protect and improve the temple soundscape, such as reducing the interference of manufactured noise, increasing the proportion of Buddhist-related sounds, and improving the sound quality to enhance the satisfaction and attractiveness of the temple soundscape.

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