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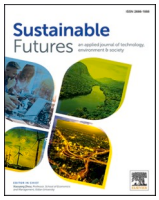

Air quality and travel behavior: analyzing the impact of smog on the intentions to choose clean air destinations in Lahore, Pakistan

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ABSTRACT

Smog has become an alarming issue in major urban areas suffering from climate change. The excessive amount of smog in the air affects urban tourism and makes people escape from smog-affected areas and intend to travel to clean air destinations. To explore this relationship well, this study explores factors such as daily life impact perceptions of smog, physical health impact perceptions, negative psychological feelings, and mass media influence affecting people's willingness to escape from the smog and behavioral intentions to seek clean air destinations. A questionnaire survey was conducted in Lahore city, Pakistan, which suffers from the worst air quality. A structural equation modeling technique was used to analyze the data. The results indicate that daily life impact perceptions of smog, negative psychological feelings, and mass media influence significantly influence travelers' behavioral intentions and willingness to seek clean air destinations. The study's findings suggest that smog plays a dual role in tourism-related travel demand. It can strengthen the individual's motivation to escape from areas with smog, whereas it makes clean air destinations attract visitors. Though the smog impacts on urban tourism might be negative, still, it can stimulate people to travel to green places, promoting tourism development in the neighborhood places with better air quality. Therefore, the authorities should consider enhancing the capacity of tourism management, providing alternative transportation, positive portrayal, and targeted marketing to promote tourism in areas with better air quality.

1. Introduction

Tourism and environment are related as a tourist destination exists in a certain physical environment, and this given social, physical, or natural environment plays an important role in stimulating or restraining the motivation to travel [1,2]. The climate of metropolitan cities is deteriorating with air pollution due to rapid urbanization and progressive industrialization, destroying the perceived image of these tourism destinations [3,4]. Air pollution has become one of the most serious problems in metropolitan cities deterring tourists from visiting these cities [5,6]. For example, Beijing, China, a tourist attraction place, suffered from haze-related air pollution, declining the number of tourists [7,8]. Likewise, the tourism industry in Brunei Darussalam has also suffered from the impacts of air pollution, causing a reduction in the number of visitors [9]. Other studies also found a similar trend, i.e., a reduction in the number of visitors visiting national parks in the United States was associated with air pollution [10], and tourists reduction in Taiwan due to rainfall and air pollution [11].

Smog, which occurs in many cities around the world, refers to a form of air pollution arising from chemical reactions occurring in the atmosphere due to the presence of nitrogen oxides and volatile organic compounds when exposed to sunlight [12]. Smog adversely affects people's health and daily lives [13]. By reducing the visibility in tourist attraction places, smog refrains tourists from visiting these places [11].

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This smog has a dual role in affecting domestic tourism. First, the smog in metropolitan cities pulls locals to travel to escape from smog. Second, it prevents travelers who plan to visit these cities [1]. Therefore, it is important to understand the role of smog regarding the escape of travelers from one tourist attraction place (affected by smog) to the other (not affected by smog).

Recent studies have highlighted the growing importance of air quality in travel decision-making. Rodrigues et al. [5]emphasize that while air quality may not significantly influence initial travel planning, episodes of air pollution during trips can drastically alter travel behavior, prompting adaptive strategies to mitigate negative effects. Similarly, Meena and Goswami [14] note that awareness of air quality indices and real-time pollution data plays a vital role in shaping travel choices, with commuters often altering routes or modes of transport to reduce exposure. These findings align with the broader discourse on the intersection of environmental quality and tourism, underscoring the need for destinations to prioritize air quality management to maintain their competitiveness.

The COVID-19 pandemic further complicated this relationship, as changes in travel behavior during the pandemic led to fluctuations in air pollutant levels. Cavallaro and Nocera [15] found that reduced travel demand during lockdowns decreased emissions of greenhouse gases and nitrogen oxides, but also highlighted the challenges of maintaining these gains as travel demand rebounds. Their study underscores the importance of integrating long-term decarbonization policies with post-pandemic recovery efforts to ensure sustainable travel behavior. This context is particularly relevant for smog-affected cities like Lahore, where air quality issues are exacerbated by high levels of vehicular emissions and industrial activity.

Despite the growing body of research on air pollution and tourism, there remains a paucity of studies examining the behavioral aspects of travelers seeking clean air destinations, particularly in smog-affected regions [3]. Eusébio et al. [3] claimed that air pollution reduces visibility and, therefore, can be perceived easily by people causing damaging effects on the tourism industry. Peng et al. [1] argued that there is a paucity of research on the behavioral aspects of travelers seeking clean air destinations from smog-affected cities. Previous studies have claimed that smog effects vary by region [16], pointing out the need to extend the current understanding of the smog impacts.

This study follows previous studies [1,17,18] to understand the role of smog in encouraging people to escape from their cities to travel to clean air destinations. While aligning with studies discussing behavioral intentions to travel to seek clean air destinations, the present work differs in terms of perspective, as it includes the role of social and traditional media perceptions affecting the perceived impacts of smog. Though some studies have discussed the influence of social and traditional media on behavioral intentions in the technology acceptance context [19,20], only a few have included mass media's influence on travel to escape from smog [18].

Therefore, this study aims to identify the factors affecting travelers' willingness to escape from smog-affected places and behavioral intentions to find clean air destinations. This study attempts to extend the current understanding of behavioral intentions to seek clean air destinations under smog conditions by considering the effects of social and traditional media perceptions, daily life impacts perceptions, physical health impacts perceptions, and negative psychological feelings of smog. This study derived and tested its hypothesis model quantifying the effects of the aforementioned factors to derive useful findings for tourism management.

1.1. Theoretical framework

The smog has been deteriorating the urban environment causing damaging impacts on people's lives [21,22]. In such an environment, escaping from smog and seeking clean air destinations can be the most important motives for most people, consistent with the escape theory [23] and the psychological theory of tourism motivation [24]. Escape theory assumes that people sometimes travel to escape from a given place, and this escape can be due to the number of possible factors associated with that place, i.e., up in smog. On the other hand, the psychological theory of tourism motivation claims that both escaping and seeking a new place are the motivations for travel decision-making. One can escape from a given place by traveling away and seeking a psychological award at another place. In recent years, smog has affected tourism severely, and people have shown a strong perception of potential risks from smog resulting in an avoidance of visiting urban areas with smog [17]. Whereas, there is an encouragement to travel to places with a green environment and good air quality [25]. Wang et al. [26] highlighted that worsened air quality creates a pushing effect and encourages outbound travel to escape from the origin place. Therefore, the travel demand exists from both aspects, to avoid or escape from the smog and to seek clean air destinations.

As smog is harmful to the public and can be immediately visualized, it causes three apparent effects on travel behavior [17]. One is the physical health impact, the chance that smog may harm one's health. Second is the daily life impact due to poor visibility and smell. Third is the negative psychological feelings due to the discomfort caused by smog.

In this study, daily life impact perceptions refer to the extent to which individuals feel that their daily lives are affected by smog. Previous studies have found that smog adversely affects the daily lives of people [13,22,27,28]. A Canadian study suggested reducing outdoor activities during smog alert days [29]. The cancellation and rescheduling of flights have been observed in Delhi, India, due to the low visibility caused by smog [30]. Smog also affects people's travel behavior and travel mode choice. For example, people avoid walking and cycling during smog alert season due to the low visibility and odor in the air [16,31]. Thus, smog alters the daily life routines of the people, which might motivate them to escape from the place with smog and seek destinations with clean air. The hypothesis can be drawn as follows:

H1. Daily life impact perception affects behavioral intentions to seek clean air destinations

H2. Daily life impact perception affects willingness to travel to escape from the smog

The adverse health impacts of smog have been widely discussed in the literature [3,28,30]. In a review study of the deteriorating situation of smog in Pakistan, adverse health impacts such as pulmonary, respiratory, and skin diseases caused by smog were discussed [28]. Such health risks affect people's psychological state of mind and increase perceived health risks. A study from China found that people who perceive higher health risks from smog were more likely to use face masks or air purifiers to protect them from smog's adverse effects [13]. Likewise, another study stated that individuals reported changes in their daily routines, additional protective behavior, and travel behavior due to smog pollution [32]. For tourists, the risk perceptions and smog concerns negatively affect their satisfaction with the destination place and discourage revisits [33]. Additionally, physical health impact perceptions were related to the willingness to travel to escape from the smog and seek a clean-air destination [1]. Thus, the hypothesis, as shown in Fig. 1, can be drawn as follows:

H3. Physical health impact perception affects behavioral intentions to seek clean air destinations

H4. Physical health impact perception affects willingness to travel to escape from the smog

Seeing smog as visual pollution adversely affecting daily routines and health, it is inevitable for people to have negative psychological feelings. Li et al. [34] argued that smog affects people's psychological health and behavior. A study of tourists' protective behavioral

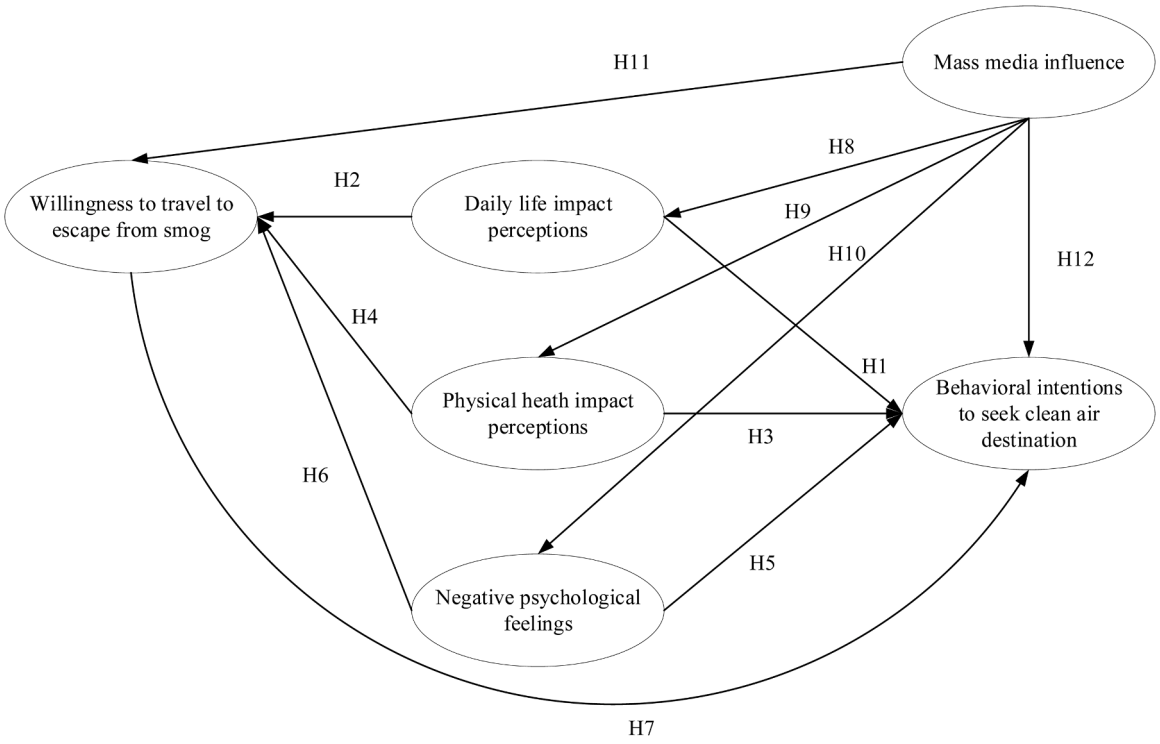

Fig. 1. Hypothesis model.

intentions found that the perceived severity of smog, which refers to the degree of psychological threat to smog pollution during a trip, was significantly related to protective behavior [35]. It indicates that psychological threats from smog motivate individuals to act to protect themselves. Likewise, another study indicated that the perception of smog is negatively related to the desire to travel to a place [18]. Therefore, this study hypothesized negative psychological feelings as:

H5. Negative psychological feelings affect behavioral intentions to seek clean air destinations

H6. Negative psychological feelings affect willingness to travel to escape from the smog

Because of smog impacts, the willingness to travel to escape from smog may encourage people to seek places with clean air. Therefore, it can be assumed that willingness to travel to escape from smog may affect people's intentions to seek clean air destinations, consistent with past studies [1,17]:

H7. Willingness to travel to escape from the smog affect behavioral intentions to seek clean air destinations

Mass media, including newspapers, radio, television and the internet, provides factual information about the smog conditions of the cities [18]. Media exposure plays an important role in disseminating information about smog and developing positive or negative perceptions about a place based on risk perceptions [36]. In a study of individuals' emergency preparedness behaviors, media exposure positively affected public emergency preparedness behaviors and risk awareness [37]. Similarly, Ruan et al. [18] confirmed mass media's positive effects in developing smog perceptions and negatively affecting the behavioral intentions to visit a place with worsened air quality. Considering the mass media's role in developing public perceptions of smog, this study developed the following hypotheses:

H8. Mass media influence affects people's daily life impact perceptions

H9. Mass media influence affects people's physical health impact perceptions

H10. Mass media influence affects people's negative psychological feelings

H11. Mass media influence affects people's willingness to travel to escape from the smog

H12. Mass media influence affects people's behavioral intentions to seek clean air destination

In contrast to prior studies that mainly examine air quality as a contextual factor, this study provides a behavioral perspective by identifying how perceptions of smog's impacts and media influence interact to shape travel intentions. By focusing on Lahore, a highly polluted urban center, this research addresses a geographic and thematic gap in the literature. It further extends existing frameworks by integrating psychological, health-related, and informational (media) factors into a unified model of travel behavior.

2. Methodology

2.1. Questionnaire design

A well-structured questionnaire designed for this study was two-fold. The first section contains sociodemographic details, including gender, age, income, education level, employment status, time of residence in the study area (years), and the household. The second section covers the indicators based on the push-pull-mooring theory and media influence. All the statements in this section were adapted from previous studies [1, 17–19,35] to measure the daily life impact perceptions, physical health impact perceptions, negative psychological perceptions, travel willingness to escape from smog, behavioral intentions to seek a clean destination, and mass-media effect. These statements were measured on the Likert scale consisting of five points varying from strongly disagree to strongly agree, consistent with past studies, as mentioned in Table 1.

Table 1
Items to measure constructs.

No.	Items to measure constructs	References
Daily life impact perception		
DLI-1	Air visibility is low in smoggy days.	[1,18]
DLI-2	Severe smog influences my travel convenience.	
DLI-3	It is uncomfortable to put on mask in smoggy days.	
DLI-4	I prefer to stay at home in smoggy days.	
Physical health impact perception		
PHI-1	Air smells foul in smoggy days.	[1,17]
PHI-2	Severe smog can deteriorate cardio-cerebrovascular disease.	
PHI-3	Severe smog can harm human immunity.	
Negative psychological feeling		
NPF-1	Severe smog makes me feel depressive.	[1,18]
NPF-2	Severe smog makes me have a low passion.	
NPF-3	Severe smog makes me irritable.	
NPF-4	Severe smog makes me feel anxious	
Travel willingness to escape the smog		
Will-1	I want to escape from Lahore in smoggy days.	[1,17]
Will-2	I have stronger desire to travel out than usual.	
Will-3	I would like to go to suburban areas in smoggy days.	
Behavioral intentions to seek a clean destination		
BE-1	I would like to travel to those places with clean air in smoggy days.	[1,35]
BE-2	I don't like to travel to those places being devastated by smog.	
BE-3	I care about air quality in destination area before travelling out.	
BE-4	I will change my travel plan if there is severe smog in destination area.	
BE-5	I will delay returning home if Lahore is suffering from smog.	
Mass-media influence		
MME-1	The mass media (TV, news, internet) notifies of the risk of smog in Lahore.	[19,18]
MME-2	The mass media notifies of the negative impact of smog on modern society in Lahore.	
MME-3	The mass media notifies of the severity of smog in Lahore.	
MME-4	The mass media notifies of the negative impact of smog on human health in Lahore.	

2.2. Study area and data collection

This study was conducted in Lahore, Pakistan's second-largest metropolitan area [38]. Administratively, Lahore is divided into sub-districts, including Lahore Cantt, Aziz Bhatti Town, Data Ganj Bukhsh, Allama Iqbal Town, Nishtar Town, and Ravi Town. Shalamar Town, Wagha Town, Samanabad Town, and Gulberg Town, as shown in Fig. 2 [39,40]. Lahore is recognized as the "cultural heart of Pakistan" and exhibits various architectural buildings from Mughal Empire, recreational parks, playgrounds, tombs, mosques, and churches [38]. Besides, it has the second largest civil airport, named Allama Iqbal International Airport, which serves most international tourists, including those willing to visit Lahore or those eager to see the northern areas of Pakistan.

The city is central to Pakistan's domestic tourism industry. However, its potential has been increasingly affected by worsening air quality, particularly due to recurring smog events [28]. Since 2013, Lahore has been one of the most polluted cities in South Asia during the winter months, with AQI levels frequently exceeding hazardous thresholds, often comparable to pollution levels in Delhi (India), Dhaka (Bangladesh), and Kathmandu (Nepal) [41,42]. These conditions raise serious public health concerns and can significantly affect travel motivation, destination choice, and overall tourism activity—issues that remain underexplored in academic research related to air quality and travel behavior.

From a global perspective, Pakistan shares many socioeconomic and infrastructural similarities with lower-middle-income countries in South and Southeast Asia, where rapid urbanization, limited environmental governance, and climate change pose shared challenges [43]. However, there is limited behavioral research exploring how environmental degradation affects travel and tourism in such contexts. This study aims to address that gap, using Lahore as a case study to understand how residents respond to urban smog by seeking cleaner-air destinations. Lahore has a population exceeding 13 million and encompasses a wide range of socioeconomic, educational, and occupational groups, making it suitable for understanding broader urban trends in Pakistan and similar regional contexts [40]. Moreover, the study covers 10 sub-districts across the city, ensuring variability in responses and spatial diversity

To collect data, the questionnaire survey was conducted in Lahore regarding people's willingness to escape from smog and behavioral intentions to seek clear air destinations. A team of twenty surveyors to collect paper-based responses was formed and sent to each subdistrict of Lahore. Respondents were randomly approached for voluntary participation in the survey. Researchers were also present to ensure the reliability of the data. Most of the responses were gathered from Gulberg, accounting for 21.43 % of the total responses. Iqbal town followed closely with 18.63 %, Data Gunj Bukhsh with 16.46 %, Samanabad town with 12.42 %, and Cantonment with 12.11 %. Ravi town contributed 11.18 %, while Shalamar town accounted for 6.21 %. The remaining towns had smaller percentages, with Aziz Bhatti town at 2 %, Nishtar town at 0.93 %, and Wagha town at 0.62 %. The questionnaire survey targeted residents of Lahore, and 395 responses were collected using a simple random sampling technique. Only 363 valid responses were retained for further analysis after removing the incomplete and invalid responses.

Table 2 indicates the respondents' details. Male respondents were slightly larger (59.8 %) than that of female counterparts (40.2 %). The majority of the respondents belonged to the age group above 18. Matric/College/Associate diploma or lower (≤13 years) was 30.9 %, followed by 52.9 % with 14 to 16 years of education and 16.3 % with 16 years of education or above. Most of the respondent's household income (35.8 %) in this survey was 40,000 PKR or less. Whereas some (16.3 %) were earning >200,001 PKR. Additionally, 41.9 % of respondents indicated that they had been living in Lahore for >20 years, and most of them (22.47 %). Among all the respondents, there were (30.6 %) people who had full-time jobs.

2.3. Analytical approach

This study involves psychological constructs of daily life impact perceptions, physical health impact perceptions, negative psychological perceptions, travel willingness to escape the smog, behavioral intentions to seek a clean air destination, and mass-media influence. As mentioned in the previous section, these factors were measured through various statements adapted from previous studies [1,17–19,35]. Given the complexity of these interrelated variables and the need to test hypothesized structural relationships, Structural Equation Modeling (SEM) was deemed the most suitable analytical approach, in line with existing literature [23,33,44–49]. Structural equation modeling [50] is mainly used for hypothesis testing when systematic theories about certain phenomena are presented. Within SEM, two primary estimation methods exist: covariance-based SEM and partial least squares SEM (PLS-SEM). The PLS method has some advantages when dealing with interdependent multivariate regression equations [51–53]. Additionally, PLS path modeling has the smallest measurement scale, sample size, and residual distribution requirements.

Using SmartPLS Software [54], the measurement model was first assessed for reliability and validity, followed by testing the structural model to evaluate the significance and strength of hypothesized relationships. Bootstrapping procedures were employed to estimate standard errors and p-values for path coefficients, providing a rigorous basis for hypothesis testing.

Recent behavioral studies from similar contexts—such as the effects of smog-related factors on Korean domestic tourists' decision-making [55], the factors affecting international tourists' intentions to visit

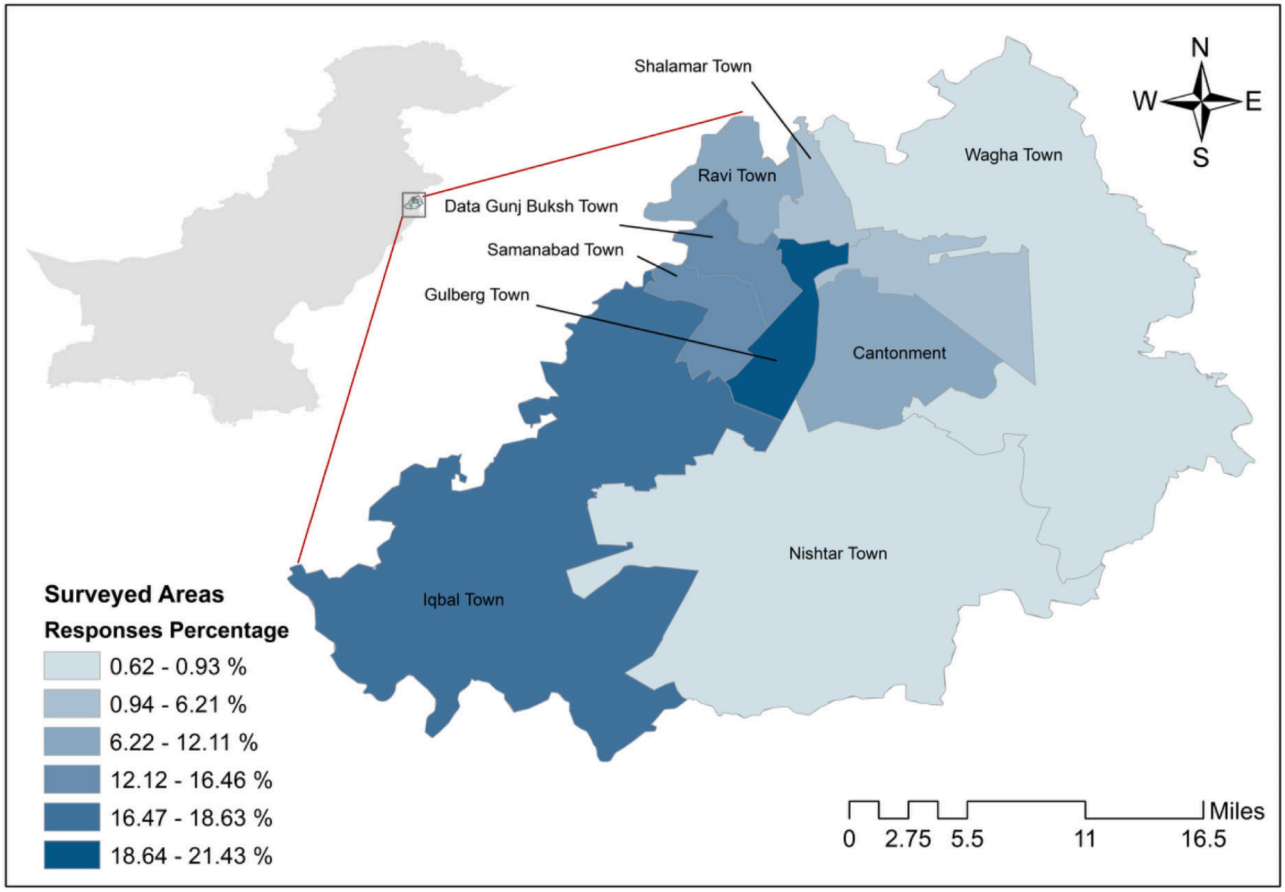

Fig. 2. Location of selected study area and distribution of responses.

Table 2
Respondent' details.

Details	Distribution	Frequency	Percentage
Gender	Female	146	40.2
	Male	217	59.8
Age	18–24	202	55.6
	25–35	83	22.9
	36–45	49	13.5
	46–55	19	5.2
	Above 55	10	2.8
Household income (PKR)	<40,000	130	35.8
	40,001–80,000	82	22.6
	80,001–120,000	44	12.1
	120,001–160,000	44	12.1
	160,001- 200,000	35	9.6
	>200,000	28	7.7
Education level	Matric/College/Associate diploma or lower (≤13 years)	112	30.9
	Bachelor's degree (14 to 16 years of education)	192	52.9
	Masters or above (17 years of education or above)	59	16.3
Employment status	Company employee	72	19.8
	Government worker	111	30.6
	Self-employed	145	39.9
	Retired	4	1.1
	Student	26	7.2
	Unemployed	5	1.4
Time of residence (years)	Less than 5	109	30.0
	5–10	51	14.0
	11–20	47	12.9
	>20	152	41.9

Beijing, China under the threat of air pollution [35], and exploration of local tourists' post-pandemic destination choices in Indonesia using [56] supports SEM's suitability for exploring complex psychological constructs in travel behavior research. Thus, this approach aligns with best practices in the literature for evaluating behavioral intentions and psychological perceptions using SEM.

3. Results

3.1. Measurement model

The measurement model was developed in line with the hypothesized model and validated through factor loadings of items, internal consistency reliability, composite reliability, convergent validity, and discriminant validity.

As shown in Table 3, the factor loadings of all items except DLI 3 and PHI 3 achieved the values above 0.5, which is acceptable in academic literature [44,53]. The acceptable range of factor loadings indicates that the items are associated with the constructs. However, the two items DLI 3 and PHI 3 were removed from the measurement model due to the low factor loading associate to their respective construct. Likewise, Cronbach alpha values for all constructs were calculated to test the internal consistency reliability for all constructs. The values above 0.5 of Cronbach alpha were recommended and achieved for all constructs as shown in Table 3. The values between 0.6 and 0.7 were recommended acceptable for composite reliability [57]. Whereas, the average variance extracted (AVE) of above 0.5 was considered satisfactory to achieve the constructs'' convergent validity. The values presented in the Table 3 for all constructs indicated that all the constructs achieved reliability and validity.

According to the Fornell-Larcker criterion, the values of the square

Table 3
The reliability and validity of measures.

Distribution	Measures	Factor loadings	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
Daily life impact perceptions	DLI-1	0.673	0.603	0.602	0.559
	DLI-2	0.812			
	DLI-4	0.851			
Physical health impact perceptions	PHI-1	0.768	0.73	0.765	0.785
	PHI-2	0.796			
Negative psychological feeling	NPF-1	0.785	0.832	0.834	0.665
	NPF-2	0.812			
	NPF-3	0.841			
	NPF-4	0.640			
Willingness to escape from smog	Will-1	0.834	0.672	0.712	0.604
	Will-2	0.644			
	Will-3	0.688			
Behavioral intentions to seek clean air destinations	BE-1	0.787	0.763	0.765	0.518
	BE-2	0.798			
	BE-3	0.666			
	BE-4	0.757			
	BE-5	0.830			
Mass media influence	MME-1	0.857	0.837	0.841	0.673
	MME-2	0.834			
	MME-3	0.854			
	MME-4	0.917			

root of AVE of constructs should be larger than the values of the correlations of the latent variables. The square root values of AVE of each construct were presented in diagonal, accompanied by the values of the correlation of latent constructs at off-diagonal in Table 4. The results arranged in Table 4 illustrate that the measurement model achieved satisfactory discriminant validity.

It is important to assess the discriminant validity of the measurement model. Discriminant validity is a measure to identify how much one construct is distinctive from the others. To achieve discriminant validity, Fornell and Larcker criterion and heterotrait–monotrait (HTMT) have been widely used [57–59]. According to Fornell and Larcker's criterion, discriminant validity can be achieved if the correlation values of the constructs presented in the off-diagonals of a matrix are lower than that of the square root values of AVE assigned in the diagonals of the matrix. The values in Table 4 indicates that all the measurement model of this study satisfies the acceptable conditions of the Fornell and Larcker Criterion. Likewise, HTMT can also be used to verify the discriminant validity of the model. HTMT refers to the mean value of the item correlations across constructs relative to mean of the average correlations for the items measuring the same construct. Literature recommends the values below 0.9 as acceptable for HTMT criterion to achieve discriminant validity. All the constructs presented in Table 5 indicated the HTMT values below 0.9 and satisfied the recommended criterion.

Furthermore, the multicollinearity of variables was also examined using the variance inflation factor. Variance inflation factor values for the items involved in this study ranged from 1.085 to 2.254, lower than the threshold of ten. Thus, the study's results can be considered free from the problem of multicollinearity as it satisfies the mentioned criterion.

Table 4
Fornell and Larcker criterion.

Constructs	DLI	MMI	NPF	PHI	Seeking clean air	Willingness
DLI	0.748					
MMI	0.262	0.82				
NPF	0.502	0.273	0.815			
PHI	0.489	0.333	0.333	0.886		
Seeking clean air	0.524	0.356	0.481	0.35	0.719	
Willingness	0.451	0.197	0.465	0.21	0.53	0.777

Table 5
Heterotrait–Monotrait criteria HTMT.

Constructs	DLI	MMI	NPF	PHI	Seeking clean air	Willingness
DLI						
MMI	0.365					
NPF	0.699	0.325				
PHI	0.733	0.415	0.416			
Seeking clean air	0.76	0.441	0.601	0.455		
Willingness	0.676	0.257	0.615	0.294	0.723	

3.2. Structural equation model

The hypotheses developed earlier in this study were tested using the PLS approach of SEM considering the significance of path relationship, as presented in Fig. 3. A bootstrapping test was conducted with 5000 subsamples to test the significance of each path presented in the structural model. Path coefficients with the p-values in small brackets depicting the path significance are presented in Fig. 3. In one path, the arrowhead explains the path effects generated from the construct at the arrow tail. The slid arrow lines indicate significant paths, whereas dotted arrow lines refer to insignificant ones.

Hypothesis (H1) refers to the relationship between daily life impact perception and behavioral intentions to seek clean air destinations. Fig. 3 indicates that respondents' daily life impact perceptions affect their behavioral intentions to seek clean air destinations ($\beta = 0.309$, $p < 0.001$). It was also found that daily life impact perception affects ($\beta = 0.233$, $p < 0.001$) willingness to travel to escape from the smog, which confirms the hypothesis (H2). These findings indicate that people who perceive higher daily life impacts of smog were more likely to seek clean air destinations as well as willing to escape from smog. Hypotheses H3 and H4 were about how physical health impact perception affects behavioral intentions to seek clean air destinations and willingness to travel to escape the smog. Both of the hypotheses were not supported in this study. One possible reason for these insignificant findings is that people might not feel the immediate health effects of smog, which is why this construct is effects are insignificant on their travel behavior. Also, when people travel, the exposure to smog is short, and diseases caused by such short term exposure might not be the reason for serious concerns for the respondents. The hypotheses H5 and H6 were confirmed, indicating the significant effects of negative psychological feelings on behavioral intentions to seek clean air destination ($\beta = 0.15$, $p < 0.001$)

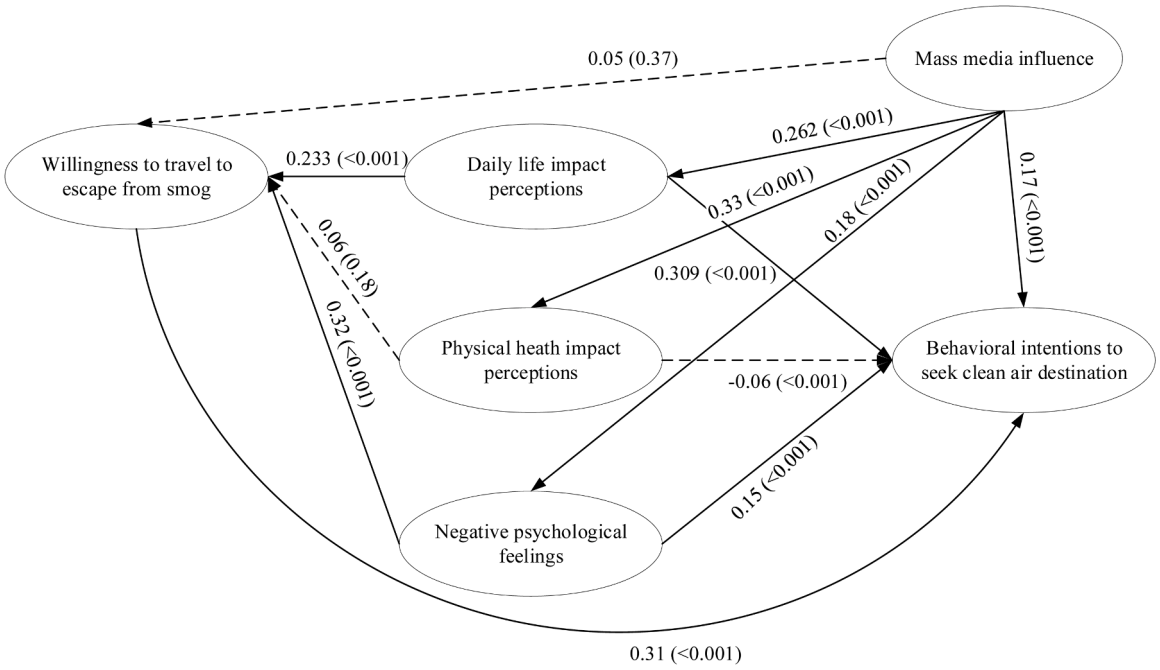

Fig. 3. Structural equation model.

and willingness to travel to escape from the smog (β= 0.32, $p < 0.001$), respectively. The structural model also highlights that willingness to travel to escape from the smog affects behavioral intentions to seek clean air destinations (β= 0.31, $p < 0.001$), in line with the hypothesis (H7). These findings uncover an important insight regarding the motivation to travel due to the escape from smog.

This study also supports the notion that mass media, including television, radio and the internet, plays an important role in developing people's perception of smog impacts and affects their travel decisions. The hypotheses H8 to H9 indicate that mass media influence affects people's daily life impact perceptions (β= 0.26, $p < 0.001$), people's physical health impact perceptions (β= 0.33, $p < 0.001$), people's negative psychological feelings (β= 0.15, $p < 0.001$) were supported. This finding indicates that mass media influence affects individuals' perceptions about the severity of the impacts of smog. Meanwhile, this study did not support the Hypothesis (H11) regarding the mass media influence affecting people's willingness to travel to escape from smog. This finding might be because the mass media circulate more information about the impacts and severity of the smog, encouraging people to stay indoors. The instructions through the mass media to stay indoors may cause an insignificant relationship between the mass media influence and travel to escape from smog. In contrast, mass media influence was found to positively affect the behavioral intentions to seek clean air destinations (β= 0.15, $p < 0.001$). This finding highlights the mass media influence's role in promoting nature-based tourism.

The R square values were also calculated to understand the model's explanatory power. R square values represent how much variance can be explained by an endogenous variable, and the values of R square range from 0 to 1, with higher values explaining greater explanatory power. The R square values as low as 0.1 can also be considered satisfactory [57]. Past studies also considered R square values of ($0.20 < R$ square < 0.50) moderate, and the values above 0.50 were considered substantial to measure the quality of PLSPM based model.

The R square values of behavioral intentions to seek clean air destinations and willingness to travel to escape from smog were found to be 0.441 and 0.283, respectively. Furthermore, the R square values of daily life impact perceptions, physical health impact perceptions, and negative psychological feelings were 0.168, 0.111, and 0.141, respectively. These findings show that the model is acceptable.

4. Discussions

This study discusses the impact of smog on individuals' travel perceptions, their willingness to escape from smog, and their intentions to find clean air destinations. The results revealed that daily life impact perceptions of smog, negative psychological feelings, and mass media influence significantly influence travelers' willingness to seek clean air destinations and behavioral intentions to escape from smog-affected areas. These results align with and extend previous research on the interplay between air quality and travel behavior, while also offering new insights into the dual role of smog in shaping tourism demand

The study confirms that smog plays a dual role in tourism: it discourages urban tourism while simultaneously promoting nature-based tourism in clean air destinations. This finding is consistent with prior research, such as Wang et al. [55], who noted that air pollution reduces the appeal of urban destinations by diminishing visibility and creating health concerns. Similarly, in Delhi, air pollution episodes have contributed to travelers' avoidance of the city, prompting government advisories and shifts in domestic tourism patterns [60]. Eusébio et al. [3] further confirms that air pollution episodes during trips can drastically alter travel behavior, prompting tourists to seek cleaner alternatives. Likewise, these patterns were echoed in Bangkok, where city residents increasingly seek clean-air destinations during the smog-heavy months [61,62]. In the context of Lahore, Pakistan—the study area for this research—the findings reflect a clear trend of tourists having intentions to flee to the northern regions of the country, which are known for their pristine air quality and natural beauty [62]. This aligns with global patterns observed in cities like Beijing, where haze-related pollution has led to a decline in urban tourism [8,27].

Moreover, the study's findings resonate with Becken et al. [63], who highlighted that environmental quality is a critical factor in destination choice, particularly for nature-based tourism in China. Tourists are increasingly seeking destinations with clean air and natural beauty, a trend that is amplified in regions affected by severe air pollution. In line with this study, findings demonstrate how smog not only deters tourists but also stimulates demand for clean air destinations, thereby reinforcing the need for urban areas to address smog through stricter emissions controls, green transportation alternatives, and sustainable urban development practices.

A key contribution of this study is its exploration of the role of mass media influence in shaping perceptions of smog and travel intentions. The results indicate that individuals exposed to information about smog's impacts through mass media are more likely to perceive greater effects on their daily lives, experience negative psychological feelings, and develop stronger intentions to seek clean air destinations. This finding aligns with past studies, which found that air quality information and awareness campaigns significantly influence travel behavior [64]. Additionally, it supports the work of Ruan et al. [35] who emphasized that mass-media effect significantly influences both the perception of smog and international tourists' behavioral intentions towards traveling to Beijing, highlighting the importance of media in shaping tourists' decisions amid air quality concerns.

Findings suggest local authorities and governments in smog-affected urban areas, like Lahore, in this study, should prioritize and invest in measures to reduce smog levels. This includes the implementation of stricter emissions controls, promoting green transportation alternatives, and adopting sustainable urban development practices. By reducing smog, the decline in urban tourism can be mitigated, leading to improved air quality and a more pleasant experience for both residents and visitors. Besides, authorities should collaborate with manufacturers to develop and promote smog protective gear to enhance tourists' experience and safety in smog-affected areas. These could include masks or other innovative gadgets designed to shield individuals from harmful pollutants. Awareness campaigns should be conducted to educate tourists about the importance and availability of such protective gear.

Transportation authorities should collaborate with tourism stakeholders to provide sufficient public transportation services to clean air destinations. Enhanced connectivity to these areas will facilitate easier access for travelers, making clean air destinations more attractive and feasible choices for those seeking to escape from smog-affected regions. As the people who are willing to escape from smog are more likely to have intentions to find green places to seek clean air, therefore, targeted promotion of nature based tourism should be encouraged. As tourists increasingly seek clean air destinations, authorities must work on enhancing the capacity of these areas to accommodate larger numbers of visitors. This involves sustainable infrastructure development, waste management systems, and ecosystem preservation to ensure that these destinations can cater to tourists without compromising their natural beauty and resources.

Additionally, this study also discusses the role of mass media influence in disseminating smog impacts perceptions. The individuals who received information about the smog impacts might perceive larger impacts on their daily lives. Similarly, mass media influence positively affects negative psychological feelings and physical health impact perceptions. Also, mass media influence encourages individuals' behavioral intentions to seek clean air destinations. The tourism promotion industry should leverage mass media channels, such as television, radio, and social media, to disseminate information about clean air destinations. By highlighting the attractiveness and benefits of these destinations, particularly during peak smog seasons, more travelers may be encouraged to visit these areas, boosting tourism revenue and alleviating the pressure on smog-affected urban centers. Mass media should be utilized to provide accurate and up-to-date information about smog and its actual impacts on health and daily life. By countering misconceptions and overestimated negative perceptions, the media can significantly alleviate unnecessary fears and concerns among travelers, encouraging them to make informed decisions about their travel plans.

Authorities and tourism industry stakeholders should promote sustainable tourism practices, encourage eco-friendly transportation options, promote responsible waste management, and support local communities in clean air destinations. Responsible tourism practices can help minimize the carbon footprint of travelers and contribute to sustainable tourism development.

While this study provides valuable insights, further research with larger sample sizes and longitudinal analysis is necessary to validate and extend these findings. Regular monitoring of smog levels, public perceptions, and travel patterns will help in implementing evidence-based policies and strategies to address the evolving impact of smog on tourism.

By implementing these practical implications, policymakers, tourism authorities, and relevant stakeholders can effectively tackle the challenges posed by smog and promote sustainable tourism practices, benefiting both the tourism industry and the well-being of travelers and local communities alike.

5. Conclusion

This study reveals how smog reshapes travel behavior in Lahore, Pakistan, demonstrating its dual role as both a deterrent to urban tourism and a catalyst for escapes to clean-air destinations. Three key factors emerge as significant drivers: the disruption of daily life routines, the psychological distress caused by smog exposure, and the amplifying role of mass media in shaping risk perceptions. The findings establish that when urban environments become psychologically oppressive due to smog, travelers don't merely seek escapes—they actively pursue clean-air destinations as restorative spaces. This behavioral shift creates a dual tourism economy where urban centers decline while nature-based destinations flourish, demanding innovative management approaches.

The research demonstrates that media narratives play a pivotal role in this transformation, not just by reporting pollution levels but by framing travelers' perceptions of both risks and alternatives. This insight suggests that destination marketers could strategically collaborate with environmental agencies to communicate solutions rather than just problems. For policymakers, the study highlights the need to integrate urban air quality initiatives with regional tourism development plans, particularly in preparing clean-air destinations for seasonal demand surges.

At a theoretical level, these findings advance our understanding of environmental push-pull factors in tourism by quantifying how immediate livability concerns outweigh potential health risks in travel decision-making. The validated measurement model provides researchers with a robust tool for investigating similar phenomena in other pollution-affected regions, particularly in developing nations undergoing rapid urbanization.

For Lahore specifically, the results call for coordinated action between transportation planners, environmental regulators, and tourism boards to transform smog-related challenges into opportunities for sustainable tourism redistribution. Future interventions should focus on mitigating the daily disruptions that most strongly trigger escape behaviors while developing the infrastructure and marketing systems to responsibly channel this demand toward alternative destinations. By addressing the concerns and preferences of travelers related to smog, destinations can better attract and retain visitors while promoting sustainable and environmentally friendly tourism practices.

5.1. Limitation

While this study provides valuable insights into how smog influences travel behavior in Lahore, several limitations should be acknowledged. The research focused exclusively on Lahore, which may limit the generalizability of findings to other smog-affected regions with different geographical, cultural or socioeconomic contexts. The cross-sectional nature of the data collection during peak smog season may have influenced responses, suggesting a need for longitudinal studies to capture seasonal variations in travel behavior. Additionally, the study did not account for several potentially influential factors, such as travel costs, destination accessibility, or pre-existing health conditions that could moderate the relationship between smog perceptions and travel decisions. The study used PLS-SEM which was appropriate for this study's predictive research objectives and complex model structure, however, its limitations include the absence of global goodness-of-fit measures

and the inability to establish definitive causality despite theoretically implied relationships. The reliance on self-reported measures rather than objective behavioral data may also introduce response biases that should be considered when interpreting the results.

5.2. Future research

Building on these findings, several promising directions emerge for future research. Expanding the geographical scope to include multiple smog-affected cities across different regions would help establish the generalizability of the current findings and identify location-specific patterns. Longitudinal studies incorporating real-time air quality data and actual travel behavior tracking could provide more robust evidence of causal relationships and seasonal variations. Comparative research between cities with different pollution control policies and green infrastructure development could yield valuable insights for urban planning and tourism management. Future studies should also explore why physical health impact perceptions showed insignificant effects, potentially examining cultural or contextual factors that may influence health risk assessments. There is particular need for research examining the effectiveness of different policy interventions and media campaigns in shaping travel behavior during smog episodes. Investigating the infrastructure requirements and carrying capacity of clean-air destinations that experience increased visitation during smog periods would help inform sustainable tourism development. Finally, incorporating more objective measures of both air quality exposure and actual travel behavior could strengthen the evidence base for policymaking in this important area of environmental health and tourism management.

Author contribution statement

The authors confirm contribution to the paper as follows: study conception and design: F. Baig, J. J. Lee; data collection: N. Shakeel, M. S. Shafin, K. Amar; analysis and interpretation of results: F. Baig, J. J. Lee; writing-original draft: F. Baig, N. Shakeel, M.S. Shafin, K. Amar; funding acquisition: J. J. Lee; validation: J. J. Lee, F. Kurniawan; writing-review & editing: F. Kurniawan. All authors reviewed the results and approved the final version of the manuscript.

CRediT authorship contribution statement

Farrukh Baig: Writing – review & editing, Writing – original draft, Visualization, Supervision, Software, Resources, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Nabeel Shakeel:** Writing – original draft, Software, Conceptualization. **Muhammad Shafin Saif:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Kainat Amar:** Writing – original draft, Software, Investigation, Formal analysis, Data curation, Conceptualization. **Jaeyoung Jay Lee:** Writing – review & editing, Supervision, Methodology, Funding acquisition. **Febri Kurniawan:** Validation, Writing – review & editing.

Declaration of competing interest

The authors have no competing interests to declare.

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Data availability

Data will be made available on request.

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