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Impact of Air Quality Index on Foreign Tourist Arrivals in Delhi-NCR: A Quantitative Assessment

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Abstract: The rich cultural heritage of India has long been a magnet for tourism, with Delhi standing out as a premier destination on the global stage. However, rising air pollution is threatening the city's appeal to international visitors who priorities health and environmental conditions when choosing destinations. This study explores the correlation between the Air Quality Index (AQI) and foreign tourist arrivals (FTA) in Delhi-NCR using secondary data from the Central Pollution Control Board (CPCB) and other government sources from 2015 to 2023. The analysis reveals varying correlation values: periods of improved air quality, such as during the COVID-19 lockdowns, show positive correlations, while spikes in pollution from stubble burning, vehicular emissions, and industrial activity correspond with lower tourist inflows. These findings highlight the urgent need to improve air quality through innovative technologies and sustainable practices. Encouraging public-private partnerships can play a key role in mitigating pollution's impact on tourism, helping Delhi maintain its status as a leading global tourist destination.

Keywords: Air pollution • correlation • air quality index • Delhi-NCR • foreign tourists.

Introduction

The tourism industry serves as a cornerstone of economic development and cultural exchange, contributing significantly to global prosperity. However, amidst the allure of travel lies a growing concern – air pollution. Air pollution has emerged as a pressing environmental and public health issue in recent years, posing multifaceted challenges to various sectors, including tourism. With its burgeoning industrialisation and urbanisation, Delhi-NCR (National Capital Region) stands as a poignant case study reflecting the intricate relationship between air quality and tourism sustainability. Air pollution substantially threatens tourism, affecting destination competitiveness, visitor satisfaction, and overall destination attractiveness **(Smith et al, 2016).** The deteriorating air quality in tourist destinations like Delhi-NCR undermines visitor experiences and raises concerns about long-term destination sustainability.

Tourism, reliant on the environment, has the potential to rejuvenate urban areas and foster rural development, empowering locals economically. It serves as a catalyst for economic diversification and integration, though its connection with the environment is intricate yet vital. In regions like Delhi-NCR, air pollution poses severe threats, not only damaging the environment but also endangering the health of residents and deterring foreign tourists. Poor air quality diminishes visibility, directly impacting tourists' experiences. Also, air quality is integral to weather and climate and is an

external factor affecting tourism demand, participation, and overall experience. **(McKercher et al 2015; Xu and Reed 2017; Wang et al 2018).** Hence, maintaining good air quality is imperative for sustainable tourism.

According to the **World Health Organization (WHO)**, Delhi, the capital of India, ranks as the worst city globally for PM2.5 particles, with a recorded value of 153 µg/m³ among 1600 cities surveyed. On the other hand, tourism is widely acknowledged as a significant contributor to the economy worldwide, standing as the fourth-largest industry **(Ahmad 2014);** we can say that air pollution and the tourism industry are interrelated somewhere. If the air quality is good at a place, it can attract a larger number of tourists. Various governments have taken measures to combat air pollution, encompassing policy formulation, implementation, monitoring, technological advancements, and public awareness campaigns. While some cities have witnessed improvements in air quality due to these efforts, others, like India's National Capital Region (NCR), continue to grapple with severe pollution levels, adversely affecting public health and the environment and impeding regional progress.

Air Quality Index (AQI)

An Air Quality Index (AQI) is a numerical indicator utilised by government bodies to inform the public about the current or projected level of air pollution (Table 1). It is determined based on the measurements of eight pollutants: PM 10, PM 2.5, SO2, Nox, O3, CO, NH3, and Pb, expressed in micrograms (or milligrams for CO) per cubic meter. The AQI has been implemented in ten cities, including Delhi, Agra, Kanpur, Lucknow, Varanasi, Faridabad, Ahmedabad, Chennai, Bangalore, and Hyderabad. Poor air quality poses risks, particularly to the very young and elderly individuals. Young children are vulnerable due to their underdeveloped lungs and higher breathing rates relative to body weight. The elderly, who may have undiagnosed lung or heart ailments, are also at risk, as pollution can worsen these conditions. Additionally, even healthy individuals may experience adverse effects, especially during outdoor exercise or when pollutant concentrations are exceptionally high.

Table 1. Air Quality Standards and Potential Health Risks

AQI (Range)	AQI (Category)	Colour Code	Potential health effects
0-50	Good		Negligible influence
51-100	Satisfactory		Slight respiratory discomfort for individuals with sensitivity.
101-200	Moderate		Individuals with lung, asthma, and heart conditions experience respiratory discomfort.
201-300	Poor		Most individuals experience respiratory discomfort with prolonged exposure.
301-400	Very poor		Respiratory sickness with extended exposure.
401-500	Severe		Affects healthy people and significantly impacts those with pre-existing conditions.

Source: Compiled from Central Pollution Control Board (CPCB) and Ministry of Environment, Forest and Climate Change (MoEFCC)

Study Area

The National Capital Region (NCR) in India, established in 1985 along with the National Capital Region Planning Board, is centred on the National Capital Territory of Delhi and includes adjoining districts from Haryana, Uttar Pradesh, and Rajasthan. It is designated for coordinated development and infrastructure planning. Key cities within the NCR include Delhi, Ghaziabad, Faridabad, Gurugram, Noida, Meerut, and others. With a population exceeding 46 million and an urbanisation rate of 62.6%, it comprises both urban and rural areas, encompassing ecologically significant zones such as the Aravalli Ridge and wildlife sanctuaries. Delhi, a major tourist destination in India, attracts both domestic and international visitors, with

the majority of domestic tourists choosing it as their destination, according to a **2014-15 survey by the NSSO**.

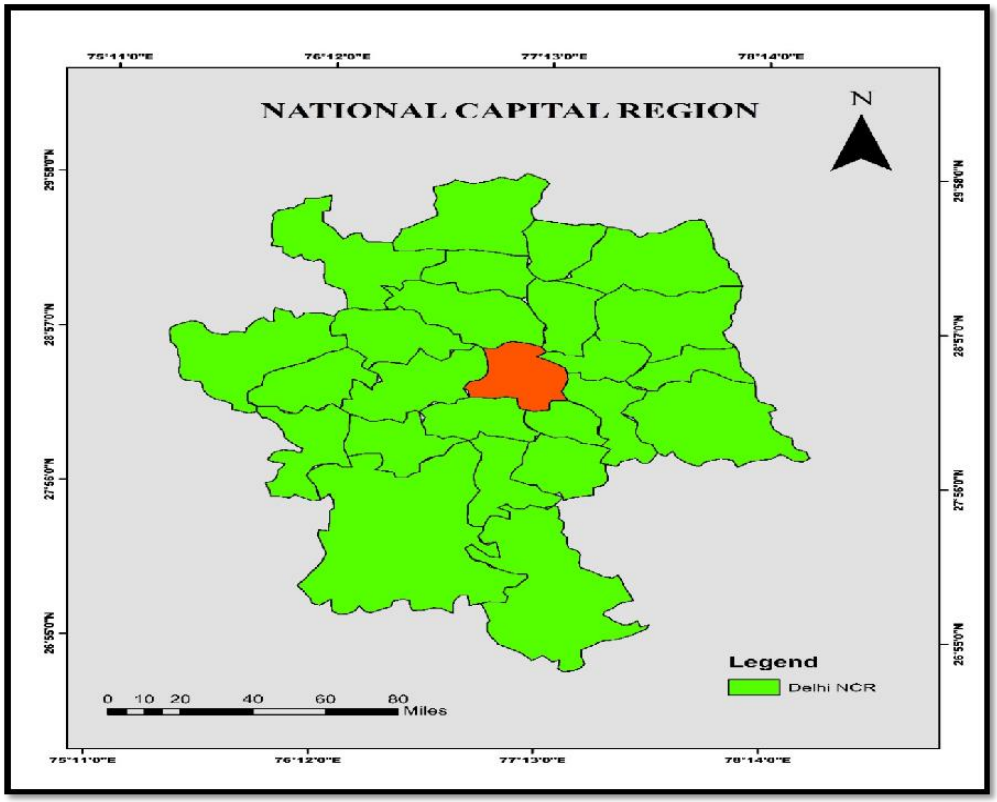

Fig. 1 Map of Study Area

Aims and Objectives

1. To evaluate the fluctuations in AQI levels from 2015 to 2023.
2. Examine the correlation between AQI and foreign tourist arrivals in Delhi NCR for the years 2015- 2023.
3. This study will provide recommendations and strategies to enhance the overall influx of foreign tourists to India.

Materials and Methods

This study investigates the relationship between air quality and foreign tourist arrivals (FTA) in Delhi-NCR from 2015 to 2023 using secondary data from credible government sources, including the Ministry of Tourism, Central Pollution Control Board (CPCB), Bureau of Immigration, and *Business Standard*. Monthly data were collected for two primary variables: the Air Quality Index (AQI), representing overall air pollution levels, and FTA, indicating the number of international tourists visiting India each month.

AQI values reflect concentrations of key pollutants such as PM2.5, PM10, SO_2, NO_2, CO, NH_3, and O_3. Data were compiled systematically to ensure accuracy and consistency across the nine-year period. Once the dataset was complete, Pearson's correlation analysis was employed to assess the relationship between AQI and FTA.

Correlation analysis measures the strength and direction of the association between two variables. In this context, it helps determine whether fluctuations in air quality have a statistically significant impact on foreign tourist arrivals. A negative correlation would suggest that poor air quality deters tourism, whereas a positive correlation may indicate the influence of other factors overshadowing environmental concerns.

This approach offers initial insights into how environmental conditions intersect with tourism trends in a major global city, providing a foundation for further research incorporating additional variables or advanced econometric methods.

Results and Discussion

Tables 1, 2, and 3 display the month-wise Air Quality Index (AQI) levels and Foreign Tourist Arrival (FTA) data for the years 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 and 2023.

Table 1. Month-wise AQI Levels and Foreign Tourist Arrival 2015 - 2017 (Source: Retrieved from CPCB, Ministry of Tourism and Bureau of Immigration)

	2015		2016		2017	
Month	**AQI**	**FTA**	**AQI**	**FTA**	**AQI**	**FTA**
Jan	208	790854	370	844533	304	964109
Feb	153	761007	293	848782	267	931025
March	79	729154	238	809107	213	885936
April	78	541551	271	592004	227	717899
May	242	509869	242	527466	273	622408
June	192	512341	192	546972	173	663470
July	138	628323	138	733834	98	779309
Aug	147	599478	147	652111	103	724000
Sep	194	542600	194	608177	139	719964
Oct	264	683286	264	741770	285	866976
Nov	360	815947	300	878280	361	997738
Dec	293	912723	293	1021375	316	1167840

The AQI values represent the air quality measurement for each month, while FTA denotes the number of foreign tourists arriving during that period. For example, in January 2015, the AQI was recorded at 208, with a corresponding FTA of 790,854. Similarly, in February 2016, the AQI decreased to 293, while the FTA increased to 848,782. This pattern continues for each month across nine years, providing a comparative analysis of air quality levels and foreign tourist arrivals over the specified time frame.

Table 2. Month-wise AQI Levels and Foreign Tourist Arrival 2018 – 2020.

	2018		2019		2020	
Month	**AQI**	**FTA**	**AQI**	**FTA**	**AQI**	**FTA**
Jan	328	1045027	328	1111040	286	1118150
Feb	243	1049259	242	1090516	241	1015632
March	203	1021539	184	978236	128	328462
April	222	745033	211	774651	110	2820
May	217	606513	221	615136	144	3764
June	202	683935	189	726446	123	8590
July	104	806493	134	818125	84	12655
Aug	111	785993	86	800837	64	19761
Sep	112	719894	98	751513	116	28167
Oct	269	890223	234	945017	266	41494
Nov	335	1012569	312	1092440	328	70977
Dec	360	1191498	337	1226398	332	90544

Source: Retrieved from CPCB, Ministry of Tourism and Bureau of Immigration

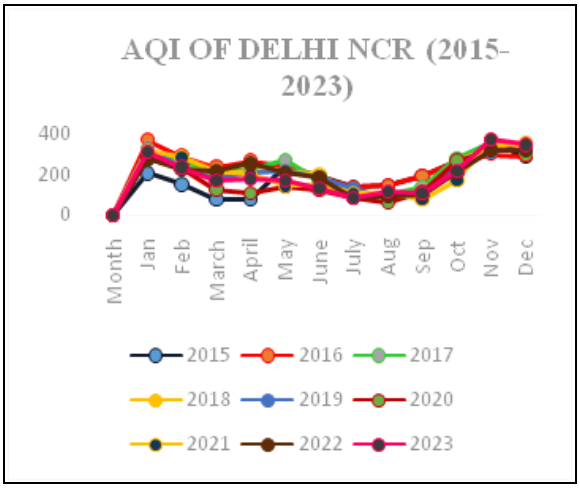

Fig 1.

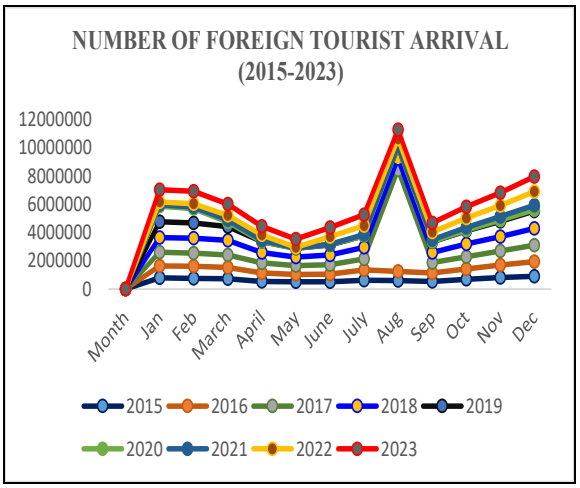

Fig 2.

Fig 1. Representing AQI of Delhi NCR from 2015-2023; Fig 2. Representing the number of FTA from 2015-23

Table 3. Month-wise AQI Levels and Foreign Tourist Arrival 2021 - 2023

	2021		2022		2023	
Month	**AQI**	**FTA**	**AQI**	**FTA**	**AQI**	**FTA**
Jan	324	94662	**279**	201546	311	868160
Feb	288	110312	**225**	240896	237	865779
March	223	133768	217	342308	170	795827
April	202	78718	255	392930	179	603985
May	146	19765	212	42370	171	598480
June	147	36070	190	522737	130	648008
July	110	72501	**87**	640858	84	760623
Aug	107	92728	93	498243	116	643194
Sep	78	115661	104	536340	108	648213
Oct	173	191415	**210**	656895	219	811411
Nov	377	263867	**320**	768675	373	922265
Dec	336	317647	**319**	966270	348	1070163

Source: Retrieved from CPCB, Ministry of Tourism and Bureau of Immigration

The table 4 provides a detailed overview of the correlation coefficients between the Air Quality Index (AQI) and Foreign Tourist Arrival (FTA) in Delhi NCR for the years spanning from 2015 to 2023. Each correlation coefficient represents the strength and direction of the relationship between AQI and FTA during a specific year. In 2015, the correlation coefficient (r = 0.60) suggests a moderately positive relationship between AQI and FTA. This may be attributed to, firstly, Tourism growth momentum, i.e. 2015 saw rising inbound tourism due to "Incredible India" campaigns and expanding international connectivity. Secondly, seasonal overlap, i.e. Tourist peak season (Oct–Feb), overlapped with worsening air quality due to stubble burning and winter smog. Tourists may have considered pollution manageable or secondary to the cultural attractions of Delhi. As a result, tourist arrivals increased during months with poor air quality, creating a statistically positive correlation.

Table 4. Correlation between AQI and Foreign Tourist Arrival in Delhi NCR

S.NO.	YEAR	Correlation coefficient (r)
1	2015	0.60
2	2016	0.40
3	2017	-0.41
4	2018	0.64
5	2019	0.72
6	2020	0.39
7	2021	0.64
8	2022	0.23
9	2023	0.79

Source: Computed by author

A weak positive correlation (r = 0.40) in 2016 is attributed to global events as India hosted international conferences and events that drew business and cultural tourists. Apart from that, pollution as a background factor was no major public health crisis related to air quality that year, so tourists likely didn't alter their plans. And also, Delhi's cooler winter weather remained attractive to European and North American tourists. In 2017, the negative correlation coefficient (r = -0.41) suggests a weak inverse relationship between AQI and FTA. The reason is that severe smog events witnessed in 2017 caused extreme pollution levels, including the November "gas chamber" episode, drawing global media attention. Therefore, health advisories issued by several countries warn about travel to Delhi. As a result, foreign tourists may have postponed or diverted their travel plans due to health risks. The correlation coefficient (r = 0.64) indicates a strong positive relationship between AQI and FTA in 2018. This could be attributed to various factors such as favorable weather conditions, improved air quality management initiatives, or significant events or festivals attracting tourists to Delhi NCR despite the prevailing pollution levels. The correlation coefficient (r = 0.72) suggests a strong positive relationship between AQI and FTA in 2019. This is due to visa liberalization as India expanded its e-visa policy to more countries, increasing tourist numbers. And along with that, currency advantage was the other reason, as a weaker rupee made travel to India more affordable. As a result, pollution was again overshadowed by strong economic and cultural drivers of tourism. In 2020, the correlation coefficient (r = 0.39) indicates a weak positive relationship between AQI and FTA. This is influenced by external factors such as the COVID-19 pandemic, which led to disruptions in travel patterns and fluctuations in air quality levels due to changes in human activity and reduced emissions (Singh, J., 2020). The correlation coefficient (r = 0.64) suggests a strong positive relationship between AQI and FTA in 2021. This could be attributed to factors such as recovery from the pandemic-induced downturn in tourism and ongoing efforts to address air pollution issues and attract visitors to Delhi NCR. The correlation coefficient (r = 0.23) indicates a weak positive relationship between AQI and FTA in 2022.

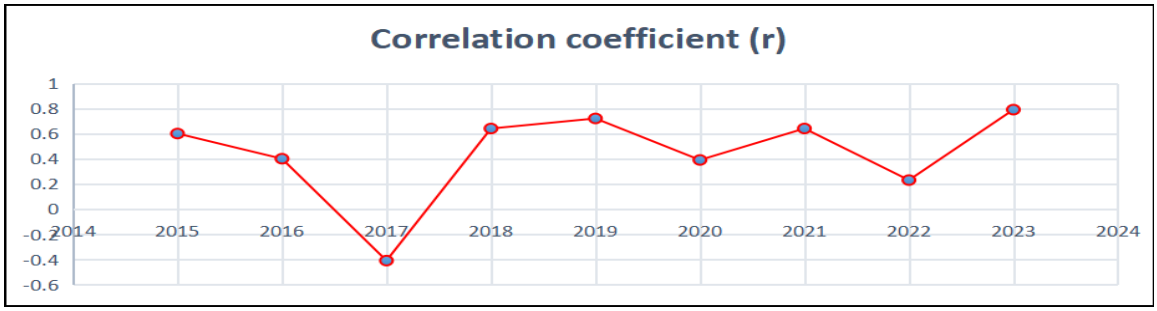

Fig. 4. AQI and FTA Correlation coefficient value

This could be influenced by various factors, such as continued efforts to improve air quality, but other factors may significantly impact tourist arrivals during this period. The correlation coefficient (r = 0.79) suggests a strong positive relationship between AQI and FTA in 2023. In 2021 and especially 2023, the pent-up demand for travel post-pandemic led to a surge in tourist numbers. Tourists may have been more willing to overlook pollution in favour of finally travelling again. This caused FTA to rise even during high AQI months.

Conclusion

The findings indicate a concerning trend of worsening air quality over the years, indirectly impacting the influx of foreign tourists in Delhi-NCR. To address this issue, individuals must take responsibility by adopting eco-friendly practices and reducing activities that contribute to air pollution. Merely relying on governmental policies won't suffice; active participation from the public is crucial to achieving the goals outlined in these policies.

Furthermore, tourism plays a significant role in India's economy, providing employment to a substantial portion of the population and contributing to the GDP. However, negligence on the part of individuals poses a threat to this sector, potentially jeopardising the livelihoods of millions who rely on it for sustenance. As air quality deteriorates, there is a noticeable decline in the number of foreign tourists, highlighting the urgent need for collective action to mitigate these adverse effects.

Recommendations and Strategies

Enhancing the influx of foreign tourists to India requires a multifaceted and strategic approach focused on infrastructure, cultural promotion, and safety. Investing in the development of robust transportation networks, quality accommodation, and upgraded tourist attractions can greatly improve the overall travel experience. Enhanced connectivity through modern airports, railways, and roadways, along with world-class hotels and resorts, can cater to the diverse needs of international travelers. Simultaneously, leveraging India's rich cultural heritage, historical monuments, and varied natural landscapes through targeted global marketing campaigns and cultural exchange initiatives can expand its appeal. Equally vital is ensuring the safety and well-being of visitors by strengthening law enforcement, implementing tourist-friendly services, and enhancing crisis response mechanisms. Partnering with international travel advisories and adopting transparent safety protocols can build trust and mitigate concerns. By holistically addressing infrastructure, culture, and safety, India can cultivate a welcoming environment, attract a larger volume of foreign tourists, and position itself as a leading global travel destination, ultimately boosting the economy and fostering international goodwill.

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