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Integrating Architectural Heritage with Environmental Concerns: A Case Study of Clock Tower, Faisalabad

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Abstract

Faisalabad is experiencing a surge in industrial development alongside its established agricultural base. This economic growth, however, presents a challenge of balancing progress with environmental protection. Industrial activity can often lead to environmental degradation, impacting the city's physical landscape and the health of its residents. To address this concern, the current research focused on the restoration of the Faisalabad Clock Tower, a historical structure from the British Era. The Clock Tower holds a significant importance due to its role in the city's early urban planning and its status as a prominent landmark. The research methodology employed a comprehensive literature review, examining local and international examples of heritage building projects. Air pollution levels were measured around the Clock Tower by using HORIBA APMA 360. According to the findings, NO_2 was found above the limit which confirmed that the presence of pollutants is the major deterioration factor. Furthermore, a detailed physical survey of the Clock Tower was conducted to identify the deteriorated areas within the building. The research culminates in a proposal outlining the necessary restoration work for the Clock Tower, informed by a thorough analysis that caters to architectural and environmental concerns to ensure a sustainable and historically sensitive restoration of this iconic structure.

***Keywords*:** built environment, clock tower, environmental analysis, old structures, restoration

Introduction

Faisalabad is experiencing rapid expansion and it can be deduced that its environment is increasingly impacting the city's infrastructure over time, primarily due to the large population and industrial growth (Arshad et al., 2024). Faisalabad Division has over 14,000 large and medium-sized

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industries, most of which are not registered (The Urban Unit, 2023a). Despite its significant contribution to the country's annual GDP through industrial development and agricultural production, these economic activities adversely affect the health and well-being of residents by deteriorating air quality and contributing to high pollution levels. Aggravating conditions have been observed in Faisalabad regarding pollution levels due to industrial growth, traffic congestion, and urbanization (The Urban Unit, 2023b). Generally, Faisalabad's grain mills, textile, and brick kilns industries are the primary sources of land, water, and air pollution along with the dyeing units from the textile industry, which chiefly pollute the city (Islam, 2017). Consequently, the built structures are getting the negative impact from polluted environment, particularly the older structures which have less strength to resist the negative environmental impact through pollution. The stability of historic structures depends on various factors, such as human activities, function of the building, impacts of natural loads like earthquakes, environmental impacts, and others (Hernandez, 2018).

The air quality in Faisalabad is very poor. According to the World Health Organization, the air is polluted with particulate matter 2.5 (PM 2.5) as the major pollutant. The PM 2.5 levels vary daily and can reach up to five times higher than the recommended standards (Manzoor & Gulzar, 2023). Accelerated commercial activities further concentrate higher levels of atmospheric pollutants that also cause the deterioration of historic buildings. The air in Faisalabad turned out to be more polluted than other industrial cities in Punjab and many industrial proponents are not following the standard for various activities (Faiz et al., 2015). Due to pollution, the structure and materials of historic buildings are being affected. The Clock Tower, (Ghanta Ghar) is one of the famous landmarks and oldest structure of Faisalabad. It is located at the center of the oldest market of the city Lyallpur currently Faisalabad with eight bazaars that were planned on the design of the Union Jack and the British Flag (The Urban Unit, 2023c).

Studies have been made to determine the factors that are responsible for the deterioration of built heritage. Different approaches have been made to inspect the causes of deterioration including a detailed analysis based on environmental concerns (Kuzmichev & Loboyko, 2016; Manzoor et al., 2024; Natarajan et al., 2022). The air pollution in Agra having carbon-containing particles due to the burning of biomass, fossil fuels, garbage, and

emissions from vehicles was responsible for turning the color of The Taj Mahal to a brownish-yellow form (Chandan & Kumar, 2019) as shown in Figure 1. The administration tried to preserve it through architectural preservation and by using rich lime-rich Fuller's earth (Multani Mitti) to give a clay pack treatment to save the original color of the monument (Bhattacharya, 2008). Shahdara Complex in Figure 2 is located near the Grand Trunk Road and the large industrial area of Shahdara, Lahore. Over three centuries, the environs of this complex had been transformed from lush green gardens to an area with large industrial areas and heavy vehicular traffic. The primary factors for deterioration are atmospheric pollution, the transmission of salinity to the main masonry through capillary action, and heavy rainfalls in monsoons in the absence of a rainwater management system at the complex (Abbasi & Jabeen, 2021).

Figure 1

Air Pollution Affecting the Taj (Rizwanurrehman89, 2011)

Figure 2

Three Magnificent Tombs of Shahdara Complex, Lahore (Gulzar et al., 2014)

However, several methodological approaches including identification, classification, documentation, and quantification of weathering products, weathering forms, and weathering profiles were applied to preserve the built heritage at Shahdara (Gulzar et al., 2014; Gulzar & Chaudry, 2009). The surface of the stone at the Tomb of Jahangir shown in Figure 3 is one of the most momentous historic buildings at Shahdara Complex, Lahore had been found roughened and pitted due to the atmospheric pollution caused by automobiles and industrial waste products (Majid et al., 2019). Unsuitable conservation techniques were applied to preserve the tomb. As a result, the tomb is losing its structure and material (Awan, 2008). The cities with valuable built heritage, Amritsar in India and Lahore in Pakistan exhibit similar ways of life in their street patterns, land use, and mohallas having small colonies. Governments of both cities are trying to preserve the heritage but no integrated conservation approach was adopted. Therefore, Singh (2012), suggested some integrated conservation techniques that should be followed to preserve the built heritage.

Figure 3

The Tomb of Jahangir (Soudip, 2014)

Similarly, the Victoria Memorial is a monument from the British Era in Calcutta (Figure 4), constructed in 1921. Unfortunately, its magnificent exterior has deteriorated with time. A microstructural investigation on the cause of deterioration indicated that the expanded absorption of pollutants and hydratable salts has given rise to crystallization damage to sandstone (Roy & Kalidindi, 2017). The mortar joints of the building had been split up and it is undergoing a substantial loss of artistic magnificence. The Gateway of India was built in Mumbai by the British Government near the Arabian Seashore. It was planned to be built in 1911 to celebrate the arrival of Queen Mary and King George at the Arabian Seashore in Mumbai but was built in 1924. This magnificent monument was designed by Mr. George

Wittet during 1912-1913 (Figure 5). Researchers have used color measurement techniques to quantify the color change in stones. It was observed that the color of the stone changed due to environmental effects (Tiwari, 2005).

Figure 4

The Victoria Memorial

Figure 5

Gateway of India (Tiwari, 2005)

Different appropriate techniques have been used in the above buildings that are required for preservation and restoration including clay pack treatment and analysis of marble pieces from the Taj Mahal, from documentation to quantification of weathering products, weathering forms, and weathering profiles for historic structures of Shahdara Complex. Face uplifting of the Tomb of Jahangir did not consider the environmental aspect which was a weakness in the preservation and restoration plan. An instrumental micro-analytical approach was followed for the Victoria Memorial and a color measurement technique was applied on Gateway of India to study the environmental impacts. Therefore, research is required to analyze the structures for their proper restoration and preservation, which

may include architectural analysis also with environmental concerns. The objective of the current research is to study the building of Clock Tower in detail and identify the damages and their factors. Further, recommendations were suggested that would contribute in the restoration of the Clock Tower and maintain its historical significance and structural integrity.

The Clock Tower

Being the third largest city in the country, Faisalabad is also known as the Manchester of Pakistan as it is the center of the textile industry. The city of Faisalabad was founded by Sir Charles James Lyall in 1892 to make the area an agricultural market and was named "Lyallpur" after the name of its founder. Before 1892, the city comprised various villages and was named Chenab Canal Colony. At that time, this area was used by the travelers to stay and rest while traveling from Jhang to Lahore. The Chenab Canal Colony was located in the area across the river Chenab which was known as Sandal Bar. Later on, when the area was developed into a city, the space was designed like the Union Jack, that is the British flag. This idea was accepted by the British Government and Captain Pophan Young prepared its design (Manzoor et al., 2024; Manzoor & Gulzar, 2023).

The central point of the designed Union Jack Plan is the Clock Tower, which is one of the famous landmarks and oldest structures of Faisalabad (Figure 6). The erection of this structure was started in November 1903 by the British Lieutenant Governor of Punjab, Sir Charles Rivaz and the known local landlord of the Mian Family of Abdullahpur (Dost Pakistan). The Clock Tower is located at the center of Faisalabad with converging eight bazaars according to the design of Union Jack, approved by Sir James Broadwood Lyall in 1880, the Governor of Punjab at that time (Dost Pakistan) ("From Lyallpur to Faisalabad", 2022). Figure 7 shows the design of eight bazaars of Lyallpur along with the Clock Tower (Ghanta Ghar). The Clock Tower was opened for the public by Sir Lewis Tupper, Financial Commissioner of the city in December 1905. All the materials for the erection of this majestic Clock Tower were brought from India. The skilled labor of India shaped the stones of the Clock Tower in their homeland. The shaped pieces were brought to the site and were installed according to the design by the local labor and masons (Islam, 2014).

In the construction of the Clock Tower, three main materials have been used including Sandstone (Red and Bhoora) and White Makrana. Red

Sandstone has been used in both the structural and ornamental features of the Clock Tower, that is, stairs, exterior finishing, and interior finishing whereas the Bhoora sandstone has been used in the external pillars of the Clock Tower (Manzoor et al., 2024). The sandstone is made up of sand or quartz grains, which are tightly pressed together. It is available in several colors. White Makrana is the calcite stone which is also known as Sang-e-Marmar. This stone is well-known for its shine. It is one of the oldest stones in the world, which needs low maintenance and has a long life. Grade 1 white Makrana stone was used in the ornamental features of the Clock Tower, that is, cupolas, dome, lattice framing, crown, and ornamentation on the exterior side, because of its whiteness and strength. The Clock Tower and its surroundings were originally built to be an enormous public park for the people (Islam, 2016). It also didn't have gates and security bars around it and just had a chain that defined the monument's territorial boundaries. It was in the 1960's that security bars and gates were installed around the tower. Due to these boundaries, the tower has just become a monument and not a space for people to gather around. The graphical representation of the old and current boundary proportions is shown in Figure 8. However, the area of the surroundings of the clock tower was cut down to widen the road.

Figure 6

The Clock Tower, Faisalabad

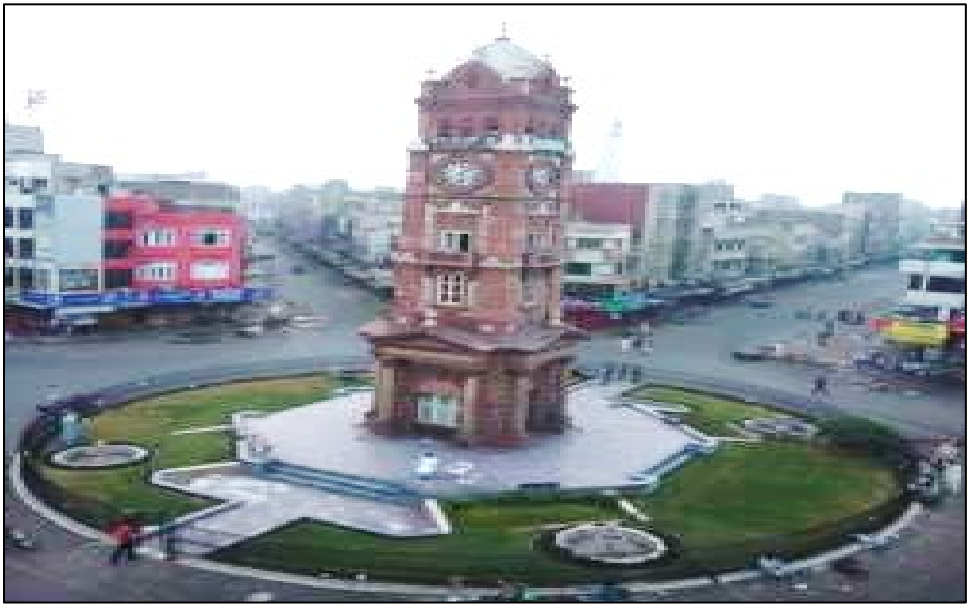
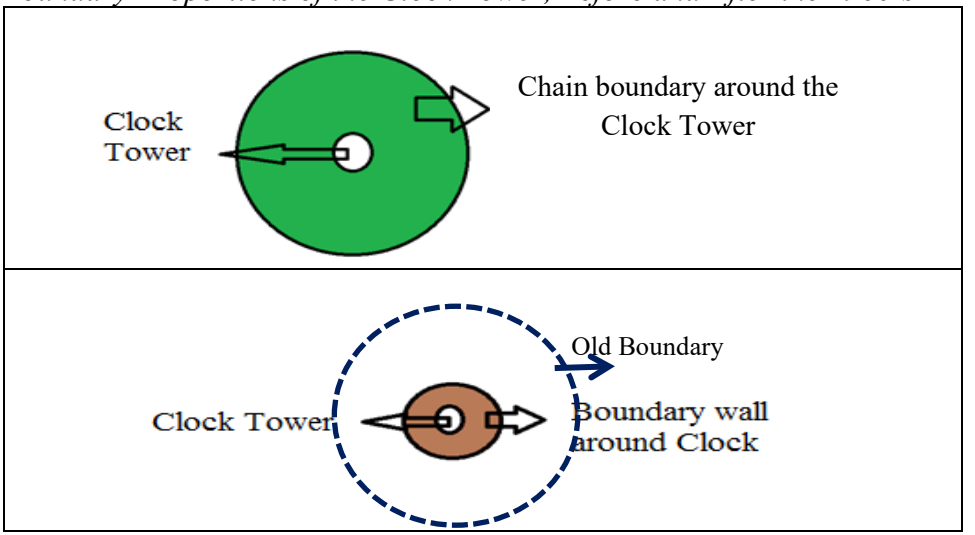


Figure 7

Clock Tower and Eight Bazaars of Lyallpur (Google Maps)

Figure 8

Boundary Proportions of the Clock Tower, Before and After the 1960's



The plan and elevation of the Clock Tower, as illustrated in Figure 9, were developed to facilitate the analysis of external elements and provide a clearer view of the tower's facade. The clock of the Clock Tower is still intact in its original position. As of now, the clock's machinery has not experienced any deterioration. The clock's mechanism includes a key, weighing approximately 8 kg. Additionally, the Clock Tower's machinery incorporates two pendulums, each weighing around 40 kg, as depicted in

Figure 10. These pendulums are interconnected with the external clock and its machinery, as illustrated in Figure 11. However, the maintenance of the clock's machinery falls under the responsibility of the residents' families who have been caring for it since the Clock Tower's construction.

Figure 9

Plan and Elevation of the Clock Tower

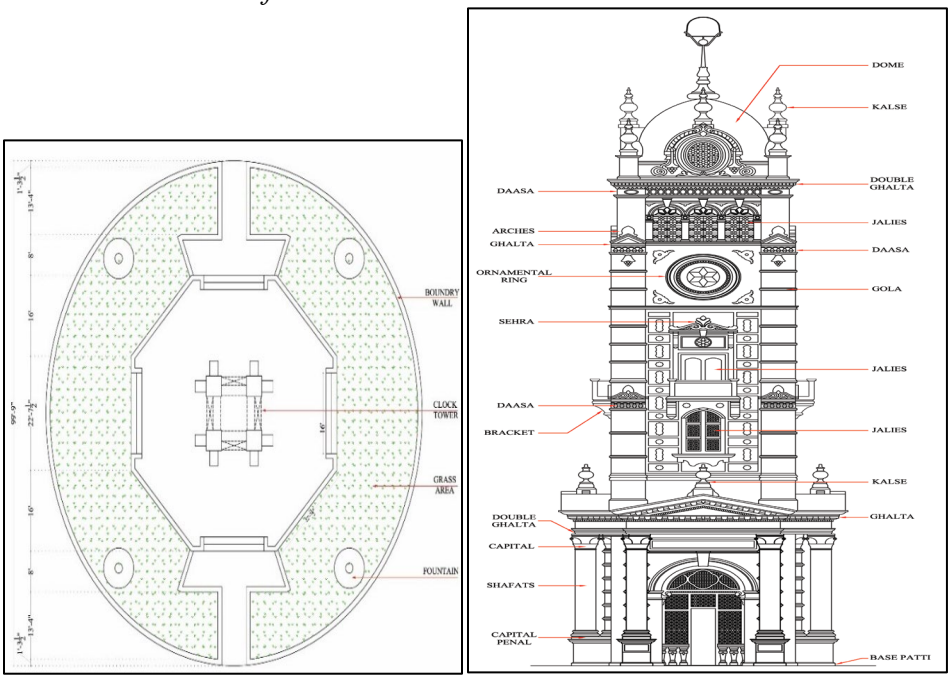


Figure 10

Key and Pendulum of the Clock Tower

Figure 11

External and Internal View of the Clock Tower

Since its establishment, the Clock Tower has not undergone any repair work. The original bells remain functional, however, due to the city's dense population and noise pollution, their sounds are no longer audible. In response, electronic bells were installed by the authorities, but these have been non-operational for some time due to negligence in maintenance. The installation of these electronic bell speakers in 1971 destroyed the original *Jali* work, as depicted in Figure 12, showing the current state of the distorted *Jali* and non-functional speakers.

Approximately 30 to 40 years ago, the Clock Tower was washed for the first time in its history using fire brigades and double-decker buses. A second manual washing took place on 14th August 2015. In 2003, under orders from the town's Municipal Officer, the stairs leading to the Clock Tower from the ground floor were demolished to create an office space for police officials. The current state of the area where the stone stairs once stood is depicted in Figure 13. Currently, an aluminum ladder is used to access the first floor.

The white Kalse of the Clock Tower has also suffered deterioration, as shown in Figure 14. Eight "Kalse" can be viewed at each elevation of the Clock Tower, such as three above the entrance and five with the dome. The total number of Kalse installed on the tower is twelve. Observations indicate that none of the Kalse remained in their original state as each of them is partially broken (Figure 14). In 2014, landscaping work was carried out around the monument to enhance the beauty of this historic structure. Additionally, measures were taken to remove visual pollution from the

vicinity, such as banners and hoardings. In 2015, lighting was installed on the exterior and surrounding areas of the Clock Tower to give it a majestic appearance.

Figure 12

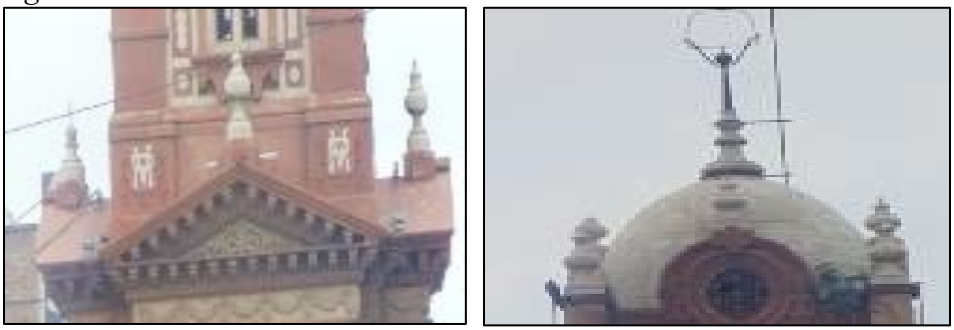
Jali of The Clock Tower

Figure 13

Aluminum Ladder in Place of Broken Sandstone Stairs

Figure 14

White Kale, Above the Entrance on The Left and With the Dome on The Right



Material and Methods

A detailed physical survey was conducted for a comprehensive study of the Clock Tower. By observing the architectural elements of the selected building, the research focused on identifying the environmental concerns that are responsible for its deterioration. The qualitative research involved observations made by the researchers during various site visits. Moreover, interviews were conducted with experts from four major fields of interest who recognized the indicators and factors responsible for the damage. After the expert consultation, the identified damaging factors were further analyzed through a detailed study of the selected architecture (Table 1).

According to the expert consultation and literature review, the major factor that is impacting the environment and built heritage of Faisalabad is air pollution.

Table 1

The Expert Consultation regarding Clock Tower

Sr. No.	Designation	Indicators	Comments	Factors Identified
1.	District Officer, Environment (Deputy Commissioner Office), Faisalabad.	Discoloration	Air in the surroundings of the clock tower is polluted due to vehicular traffic and coal consumption.	Air pollution
		Chipping		
		Flaking	The rise of pollutants in the air and improper drainage of rainwater is harming the stone of the Clock Tower, especially at the base area.	Air pollution and accumulation of rainwater at the base of the tower
		Joint Widening	A rise in temperature is observed in the city due to which joints of stones widened.	Thermal movement
2.	Environmental Engineer, (Pak Green Laboratories), Lahore	Discoloration	Particulate matter and other harmful gases in the air expedite the weakening process of building materials. They are being observed with less age. Discoloration is also being seen due to pollutants in the air. Lack of proper cleaning allows pollutants to react with the material layer. The structural integrity of the stone keeps decreasing due to improper maintenance and pollutants	Air Pollution and poor maintenance
		Chipping		
		Flaking		
		Joint Widening		

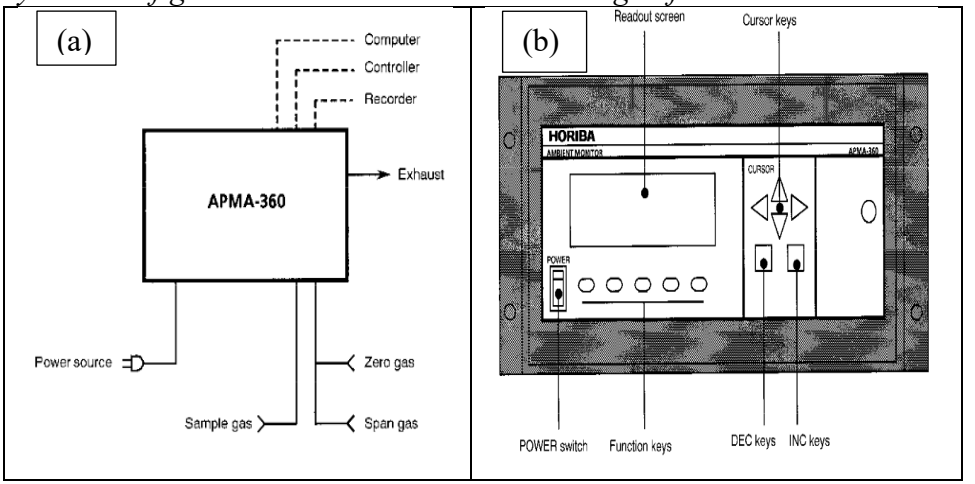
Sr. No.	Designation	Indicators	Comments	Factors Identified
3.	Environmentalist (Government College University), Faisalabad	Discoloration Chipping Flaking Joint Widening	Airborne particles and toxic gases accelerate the decaying of building material and cause discoloration. Inadequate cleaning allows pollutants more time to deteriorate the materials, leading to diminishing structural properties. Rising city temperature is expanding the materials at a faster rate.	Air pollution and rising temperature
4.	Archaeologist (Lyallpur Heritage Foundation), Faisalabad	Discoloration Chipping	Discoloration typically happens when pollutants such as sulfur dioxide and nitrogen oxides from vehicle emissions and industrial activities react with the surface of the building, forming compounds that change its color. For instance, sulfur dioxide can react with moisture in the air to form sulfuric acid, which can corrode surfaces and lead to discoloration. The chipping process is often observed in areas with high level of pollution or in buildings located near industrial zones or busy roads as is Clock Tower.	Air pollution

Sr. No.	Designation	Indicators	Comments	Factors Identified
		Flaking	Flaking of the tower due to air pollution and improper maintenance is a result of pollutants weakening the tower's surfaces and improper maintenance that exacerbates the deterioration process.	Improper cleaning and maintenance
		Joint Widening	Joint widening in the clock tower occurs when the pollutants interact with materials, leading to physical and chemical changes that result in the expansion of joints between the elements. This phenomenon can compromise the structural integrity and aesthetic appeal of the tower over the time.	Air Pollution

Air pollution is the major factor which adversely affected the built heritage. Consequently, it was vital to observe the actual air pollution level around the Clock Tower, therefore, required recommendations for its preservation and restoration can be drawn accordingly for the analysis. The method used to check the limits of air pollution is known as the Ultraviolet (UV) Fluorescence method in which UV light is radiated on SO_2 molecules, which in turn releases fluorescence. When this fluorescence is passed through a bandwidth filter and photomultiplier tube, it converts the signal into the voltage which can be measured directly through Gas-Phase Chemiluminescence, as NO is an unstable molecule, it reacts with O_3 and NO_2 is produced. This reaction produces a quantity of light that can be measured by using a photomultiplier tube (Signal USA). The instrument used is known as HORIBA APMA 360 (air pollution monitoring system) (HORIBA, 1998). The overall working of the equipment is illustrated in the Figure 15.

Figure 15

System Configuration and the Front Panel Design of HORIBA APMA 360



This equipment works in the open air and measures the concentration of carbon monoxide by using the non-dispersive infrared analysis procedure as its operation principle. NDIR or non-dispersive infrared analysis is done by analyzing the concentration of gases depending upon their characteristics of infrared absorption (Tan et al., 2020).

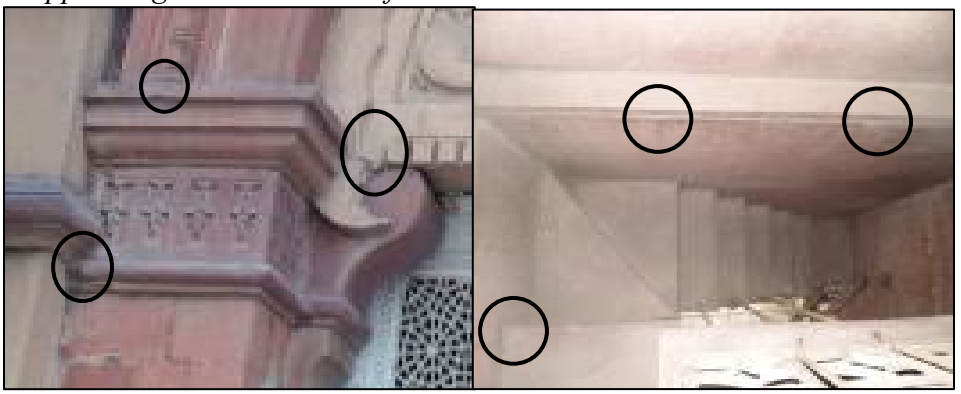
Damages Due to Pollution

Air pollution and acid rain are the primary causes of the deterioration of the Clock Tower (Manzoor & Gulzar, 2023). This deterioration manifests as discoloration, chipping, flaking, and joint widening, as shown in Figures 16, 17, and 18. These factors have been observed and analyzed in the Clock Tower using the methods explained below.

Chipping, the separation of small pieces from larger stone pieces, frequently occurs on edges, corners, and joints. The Clock Tower exhibits this chipping problem, as highlighted by the black circles in Figure 16. Chipping has been observed on nearly all parts of the Clock Tower, both interior and exterior. The primary causes of it include poor maintenance and the weakening of the stone's external layer due to air pollution, such as smoke from nearby shops and vehicles, as well as dust particles. This chipping not only spoils the appearance of the Clock Tower for local visitors and tourists but also leads to the progressive deterioration of the structure, particularly at its corners and edges.

Figure 16

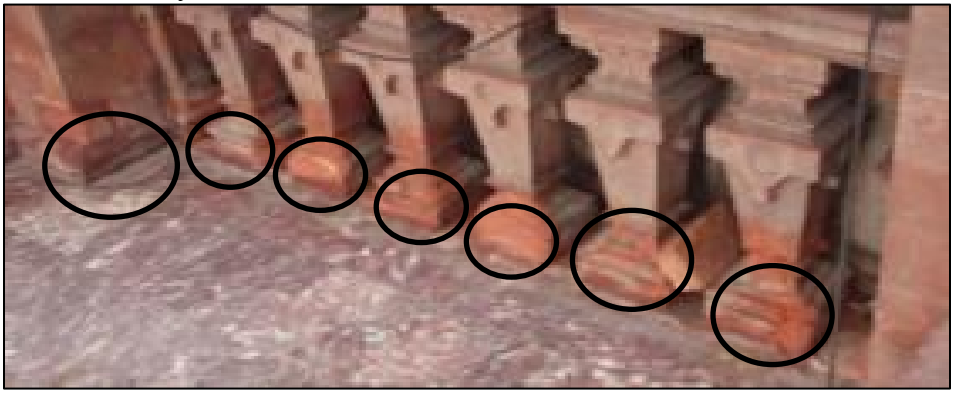
Chipped Edges and Corners of the ClockTower



Flaking, as depicted in Figure 17, is a problem where small flat pieces of stone get separated from a larger stone surface. Flaking has been observed at the base of the Clock Tower. This issue arises due to moisture that accumulates at the tower's base after rainfall and washing of the circular path around it. The presence of this moisture is largely due to inadequate maintenance practices, such as improper drying after rain and washing.

Figure 17

Flaked Base of the Clock Tower



Cracks have been observed on various parts of the Clock Tower, as shown in Figure 18. These cracks are attributed to thermal movement, resulting from the rising temperatures in the city. This observation was confirmed by the District Officer Environment, Faisalabad during a visit to the tower. Since these cracks are caused by thermal movement, they are not found in the interior of the building, as the exterior of the Clock Tower is

more directly exposed to heat. Additionally, the joints of the Clock Tower have widened, as depicted in Figure 20. This widening is due to rainwater and occasionally acid rain water that remains on the joints for extended periods. Another contributing factor to the widening of joints is temperature fluctuations or thermal movement.

Figure 18

Cracking on the Ground Floor

Discoloration and smoke deposits have been observed on various parts of the Clock Tower, as shown in Figure 19. The primary cause of this discoloration is air pollution resulting from smoke emissions from restaurant and vehicular traffic around the Clock Tower. Additionally, black deposits are visible on the stone surfaces engraved in the interior of the Clock Tower, as depicted in Figure 20.

Figure 19

Gaps in Joints of The Clock Tower

Figure 20

Black Deposits on the Exterior and Interior of the Clock Tower

Natural climate is another factor that contributes to the deterioration of the Clock Tower. However, considering the significant impact of human-induced environmental pollution, natural weathering can be managed with minor maintenance efforts. Issues, such as chipping, flaking, and joint widening are notably accelerated by air pollution.

Figure 21

The Techinician Sets and Arranges the Equipment of HORIBA APMA 360

Measurements for Air Pollution

Air pollution was identified as the primary cause of the deterioration of the Clock Tower, leading to issues such as discoloration, flaking, and joint widening, as discussed in the previous section. To validate these findings,

air pollution levels were measured in and around the Clock Tower. The equipment used for this measurement, the HORIBA APMA 360, was placed at the base of the Clock Tower, as shown in Figure 21. Figure 22 displays the readings from the machine used for the environmental analysis. These measurements were conducted by Pak Green Laboratories. The equipment was then installed to record readings during peak working hours in order to capture the maximum generation of pollutants.

Figure 22

Machine shows reading for air pollution measurement

Results and Discussion

The results of the readings taken by HORIBA APMA 360 are shown in the following Table 2.

Table 2

Level of Air Pollutants Measured by HORIBA APMA 360

Sr. No	Time (Hours)	CO Mg/m^3	NO $\mu g/m^3$	NO_2 $\mu g/m^3$	NOx $\mu g/m^3$	SO_2 $\mu g/m^3$	H_2S $\mu g/m^3$
1.	12:25 Hours	0.369	10.56	290.29	300.85	3.384	3.00
2.	12:40 Hours	0.5535	14.52	505.47	519.99	1.974	2.60
3.	12:55 Hours	1.5375	23.76	907.41	931.17	4.794	3.00
4.	13:00 Hours	1.5252	22.44	986.58	1009.02	4.794	2.11

Sr. No	Time (Hours)	CO Mg/m^3	NO $\mu g/m^3$	NO_2 $\mu g/m^3$	NOx $\mu g/m^3$	SO_2 $\mu g/m^3$	H_2S $\mu g/m^3$
5.	13:10 Hours	0.492	9.24	229.39	238.63	4.23	3.00
6.	13:12 Hours	0.6765	10.56	602.91	613.47	5.076	2.55
7.	13:30 Hours	1.3161	5.28	357.28	362.56	4.23	2.55
Average		0.92	13.77	554.19	567.96	4.07	2.69
NEQS*		10 (1 hour)	40 (24 hour)	80 (24 hour)	NGVS	120 (24 hour)	NGVS

Note. *National Environmental Quality Standard

The readings taken by the HORIBA APMA 360 depicted in Table 2 demonstrate elevated levels of various air pollutants, including CO, NO, NO_2, NOx, SO_2, and H_2S. The average NO_2 level recorded (554.19 $\mu g/m^3$) is significantly higher than the National Environmental Quality Standards (NEQS) limit of 80 $\mu g/m^3$ for 24 hours, indicating severe air pollution. The high levels of air pollutants, especially NO_2, contribute to acid rain formation, which accelerates the deterioration of historic structures. The primary cause of the aforementioned results is that Faisalabad serves as an industrial hub, due to which it significantly contributes to the emission of sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) into the atmosphere. These emissions lead to acid rain, which occurs when sulfur dioxide and nitrogen dioxide react with water molecules in the atmosphere to produce acids. Consequently, these factors negatively impact the historic structures. According to the report (The Urban Unit, 2023a), NO_2 levels are particularly high. It has been observed by chemical/environmental engineers that the main sources of NO_2 are not solely industrial, but traffic, diesel generators, and domestic and commercial cooking activities near the Clock Tower also significantly contribute to the elevated NO_2 levels.

The report indicates that SO_2 levels near the Clock Tower do not exceed the permissible limits. However, it is generally observed that SO_2 levels often surpass acceptable limits, leading to acid rain, as noted by a chemical/environmental engineer from Pak Green Laboratories. Therefore, environmental pollution has severely damaged the Clock Tower's structure, necessitating its restoration to preserve this heritage landmark. Faisalabad is one of the fastest-growing cities, primarily driven by its industrial sector. The city's industry is highly developed and continues to expand, attracting

numerous workers and contributing to the city's population growth. This growing population, including residents and daily visitors, results in increased vehicular traffic, especially in the central area around the Clock Tower, which in turn produces substantial air pollution. Additionally, the industrial sector and garbage stands are major sources of air and wastewater pollution.

Such environmental pollution affects both living beings and the built environment. Humans and other living beings face health issues, while the built environment, particularly older buildings, undergoes rapid deterioration. The other historic buildings of Faisalabad, representing the city's heritage, have deteriorated due to environmental impacts and poor maintenance. These structures require restoration to their original state to preserve Faisalabad's cultural heritage.

Conclusion

Faisalabad's rapid industrial development has increased the economic growth and also resulted in increased pollution and population density. The growing population and industrial activities contribute significantly to environmental degradation, impacting both human health and the built environment. Various air pollutants, including CO, NO, NO_2, NOx, SO_2, and H_2S were found above limits including the average NO_2 recorded level (554.19 $\mu g/m^3$), which indicated serious air pollution. Also, the high levels of NO_2, contribute to acid rain formation, which accelerates the deterioration of historic structures. The Clock Tower is particularly affected in terms of discoloration, chipping, flaking, and joint widening. These problems are exacerbated by acid rain and air pollution. The structural integrity and aesthetic value of the Clock Tower have been compromised due to environmental pollution. In light of these deterioration issues and maintenance-related problems, such as broken architectural and structural elements, a restoration plan has been developed to return the tower to its original state. There is an urgent need for restoration to preserve this historical and cultural heritage of Faisalabad. Restoration efforts should address both pollution-induced damage and maintenance neglect.

Recommendations

The Clock Tower is surrounded by eight bazaars with extensive commercial activities that have been deteriorated by the adverse environmental impacts also endorsed by the District Officer Environment,

Faisalabad. As it is very important and essential to conserve this heritage, the following plan for conservation, while considering the adverse environmental impacts has been prepared. The following jobs have been suggested for the appropriate conservation of the Clock Tower.

1. Careful removal of the broken stonework including all elements of the Clock Tower.
2. Provision of red sandstone *Jali* according to the original design and pattern laid in lime mortar.
3. Provision of red sandstone *daab patti* as per existing design laid in lime mortar.
4. Provision of red sandstone base molding as per existing design laid in lime mortar
5. Provision of red sandstone muttacas as per existing design.
6. Reparation of makrana stone Kalse laid in lime mortar as per existing design.
7. Provision of scientific cleaning, with soft brushes, to avoid damage to the original features with lisabol (local name) chemical.
8. Provision of stone polish (as to preserve it from the negative impacts of air pollution).
9. Provision of joint filling of red sandstone with traditional mortar all over the Clock Tower, on both interior and exterior sides.
10. Fixation of red sandstone elements in position, all over the Clock Tower in lime mortar with copper or stone dowels wherever found necessary.
11. Rubbing and polishing of grit floor, including repairing the voids and uneven surfaces, complete in all respect.
12. Provision of red sandstone steps in lime mortar, complete in all respects.
13. Burning off or rubbing down of old paint from the woodwork.
14. Reparation of deodar wooden door and *jali* as per existing design.
15. Provision of paint on woodwork.
16. Reparation of electrification.

Figure 23

Current Parking Plan

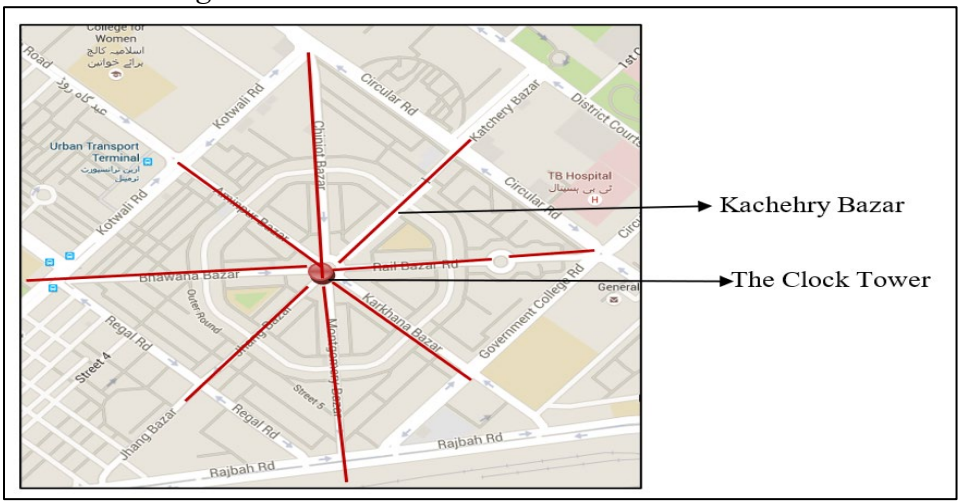
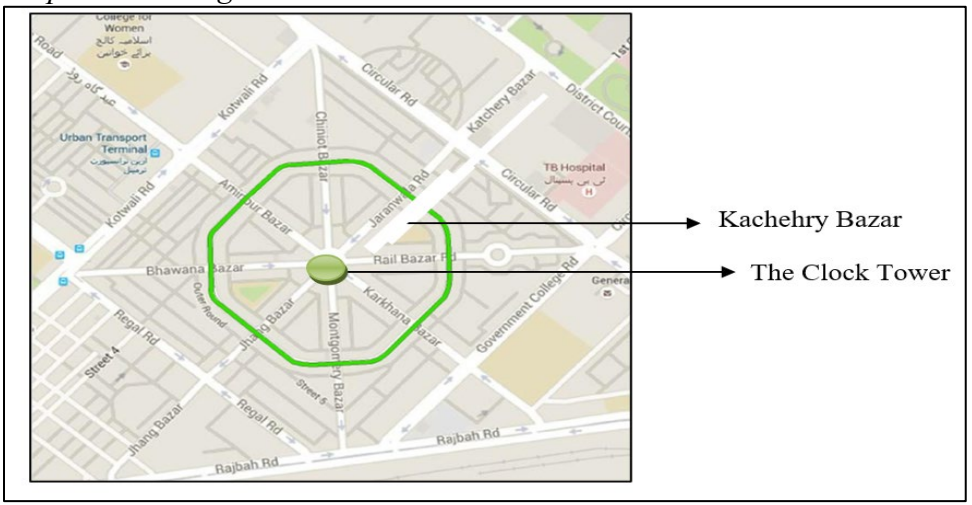


Figure 24

Proposed Parking Plan



Correspondingly, to make the surrounding area of the Clock Tower relatively green, it is suggested to make the area pedestrianized. According to the existing situation, vehicles are allowed to move in every bazaar up to the Clock Tower. The traffic flow can be controlled by restricting the entry of vehicles in Gol Bazar. In this way, the adjacent area can have less air pollution, thus the building structures can have less adverse environmental impacts. Old residents of Faisalabad claimed that Gol Bazar was designed

by the British Government as a parking area. As there were very less cars at that time, therefore, people constructed shops there with time. The parking around the Clock Tower is required to be re-planned in order to minimize the air pollution around the Clock Tower to some extent. The current and proposed parking plan is shown in the above Figures 23 and 24.

The proposed parking plan will not only help to minimize the air pollution around the tower but will also restore the original parking plan of the market on which it was designed by the British Government. The above-drawn red lines show the existing parking plan in the bazaars. It can be observed from the above figure that the vehicles are allowed to be parked in all the bazaars. The green line shows the parking area in Gol Bazaar only, the rest of the area between Gol Bazaar and the Clock Tower is proposed to be pedestrianized. All the above-stated suggestions and recommendations are proposed to create a better environment around the Clock Tower, which will minimize the environmental impact on the tower and the other buildings and structures. This line of research can be applied to other British Era Structures of the city for their proper restoration and minimization of the environmental impacts on them.

Conflict of Interest

The authors of the manuscript have no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

Data Availability

The data associated with this study will be provided by the corresponding author upon request.

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