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From grey skies to green spaces: Smog-smart architecture for building healthier workplaces

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ABSTRACT

This study proposes environmental sustainability and human-oriented design to be incorporated in the design of a smog-resilient corporate campus of an IT company in Lahore. This research exploration suggests an architectural regime that may counter this environmental degradation issue besides improving the well-being of the occupants ecologically using sensitive design intercession. Research methodologically is a case-based study that examines international precedents where successful applications of sustainable and biophilic design strategies have been applied in polluted urban environments. The principles of biophilic design are integrated into the built environment at large to facilitate psychological well-being, enhance work place satisfaction and as a way of facilitating a closer human-nature relationship in the workplace. Other innovations include green roofs, vegetative layers and water efficient systems that aid in air purification, biodiversity in the city and conservation of resources. The findings may add to conceptual and technical formulation of the proposed design which is placed as an example of an environmentally-responsible corporate architecture. The proposed design may act as a model of sustainable urban development, since it combines the environmental performance with the well-being of the people who would use the buildings.

Keywords: *Smog-resilient Architecture, Photocatalytic Façades, Biophilic Design Principles, Environmental Sustainability, Healthcare Design, Lahore City.*

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Introduction

Air Quality Index plays a very important role in defining the health quotient of a person and along with the combined carbon emission, the AQI is rising to an alarming scale and consequently, has brought about the air borne diseases in the plains of the subcontinent in general, and Lahore in particular. Poor air quality have become a significant issue in the world (Raza et al., 2021). The air pollutants pathogenicity is dependent on their size, concentration and origin. Despite the fact that the biogenic and anthropogenic sources cause the enormous emission of contaminants in the ambient air (Bhatti et al., 2024). But, empirical evidence concerning the air was that industrial the revolution has exposed the world to different forms of toxic pollutants since 18 century (Zhang, 2019). It is identified that the excessive use of poor quality fossil fuel in the combustion processes is releasing green house gases in excess quantity. Fossil fuel is now a big requirement neither at micro level in domestic stove nor at macro level in power plant to provide energy that causes greenhouse gasses (Ashraf et al., 2022).

All contribute, at global level, in emission of GHG, according to energy sector (25%), agriculture (24%), industry (21'), transport (14%), energy related activities (10%) and buildings (6%). The rise in the amount of greenhouse gases in ambient air has been causing the rise of the negative environmental effects in the form of global warming, climate change and ozone depletion. The global temperature has already warmed up to 0.74^{o} C since 1961 and the temperature is bound to increase to 1.5^{o} C to 1.8^{o} C in 21" century. Such climatic variations have aggravated the destiny of air pollutant in the photochemical transformation reactions and formed extra-terrestrial danger in the form of Smog. These gaseous by-products blend with fog close to the ground surface when the atmosphere is in the temperature inversion mode and results in Smog by generating minute drops of acid aerosols. PM2.5 (Particulate Matter) is mostly regarded as the significant contributor to smog formation on the global scale (Baig et al., 2025).

Therefore, the episodes of smog have been occurring in Pakistan last five years as well. Air pollution index of Pakistan was mostly 77 but pollution index of Pakistan has reached to 300 points and become fourth polluted country (Fu & Lyu, 2021). The air quality of the country is also being degraded not by the internal sources of emission only but also by the trans-boundary air pollution. Since monsoons blow all the smog and haze of India and China into Pakistan and north-western states. The pattern of natural wind flow moves the pollutant into the downwind countries in the South Asia, the natural winds enter in south-west and flow over India turning west to get into Pakistan. Moreover, the natural air purification has become inadequate and generated the heat island effect in urban areas. Since in Pakistan, 60 percent of electricity is generated by gas and furnace oil. Of which coal give (37%), petroleum (39%), natural gas (24%). This combustion emission 158.10 MT (Metric Tons) of CO2 (Carbon dioxide) (54%), 111.60 MT of CH4 (Methane) (36%), 27.90 MT of N2O (Nitrous oxide) (9%),2.17 MT of CO (Carbon monoxide) (0.75) and 0.93 MT of Volatile organic compound in the air when these emissions get trapped in the parcel of stationary cold air due to the static cold air leading to smog formation (Riaz & Hamid, 2018).

This anthropogenic metrological hazard has been going on in Pakistan since past five years. In Punjab particularly, dense blankets of smog have led to the explosion in the number of cases of allergies, itchy skins, sore throat, chest burns, respiratory hitches, eyes and nose irritations (Ahmed et al., 2024). The amount of smog in the country has been going up in recent years due to a number of factors including climate changes, industrialization, and more vehicles emissions. Smog may cause negative outcomes among the crowds in the background of recent flooding, the Dengue outbreak, and the COVID pandemic (Bhatti et al., 2025). The consequences of climate change are an increase in heatwaves and droughts. In its turn, these severe weather conditions worsen the pollution problem. It gets hotter, and ozone, a major constituent of smog, forms at the ground level and this may lead to respiratory problems, cardiovascular disease and even death.

Hence there existed a dire need to explore how architectural design of the buildings could be revisited to respond to this crisis through managing and mitigating the smog in the urban context of Lahore. In order to proceed ahead, following two major research objectives were

setforth:

1. To explore the current conditions and challenges caused by the smog in the context of Lahore city.
2. To evaluate how architectural design interventions could help in mitigating the risks associated with eth smog phenomena.

The research adds new value and knowledge to current ground explorations focusing on how future of architectural design may contribute to managing these gaps and help transform these challenges into new endeavors of design and public health enhancement in general. As a hypothetical design interventions proposal development for the research endeavor, research aims to develop a Microsoft headquarters in Lahore that is resilient to the current post pandemic & ongoing anthropogenic induced smog and climate-responsive, without sacrificing the building's functionality.

Literature Review

Understanding the Concept of SMOG & its components

Smog will be formed when the pollution level in the air will increase and it contributes to health problems; the most notable ones are in the respiratory system. Smoke (smoke + fog = smog) is a number of substances, e.g. ozone gas, nitrogen dioxide, etc. The key source of smog components is burning fuels, e.g. vehicle exhaust, and industrial activities in facilities, factories, and plants (Bhatti et al., 2023). Smog nowadays is a huge issue in numerous worlds countries including China. In Beijing, a great number of individuals are compelled to use face masks when they go outside. The Chinese authorities are attempting to minimize the issue by creating laws that lower the emission of polluting substances like prohibiting the use of coal as fuel (Tariq et al., 2024).

The ozone gas is a molecule that has three oxygen atoms. With smog, its formation occurs in the lower segments of the atmosphere close to the earth surface due to a reaction of pollutants produced by cars and factories in presence of the sun. such ozone gas is called bad ozone by the US Environmental Protection Agency.

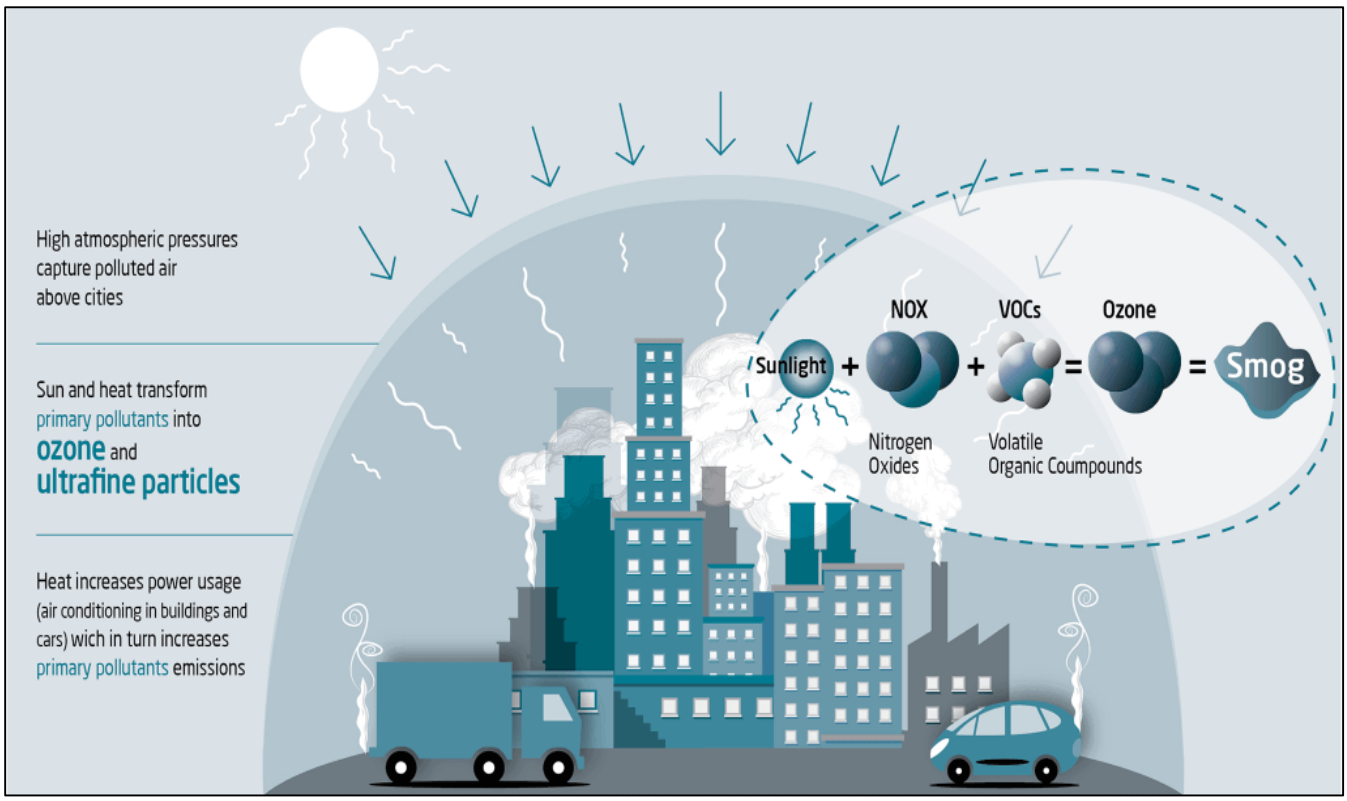

Figure 01: *Formation of SMOG*

This form of ozone gas is referred to as "harmful" to differentiate it with another form referred to as the good ozone and it exhibits the same molecular structure (O3). It is however formed in the upper atmosphere between 16 and 48 kilometers. Helpful ozone creates a covering that safeguards

living organisms against ultraviolet radiations that accompany sun rays. It soaks them up and they do not have a chance to get to the surface of the earth. These are the ultra violet radiation rays which have significant contribution in causing skin cancer in human beings (Salahuddin et al., 2024). Industrial activities, the process of fossil fuel combustion, and power generation plants produce nitrogen oxides that include nitrogen monoxide and nitrogen dioxide. Industrial processes, as well as oil refineries, release sulfur dioxide.

Particulate matter is a conglomeration of tiny particles and liquid droplets that are generated due to forest fires, volcanoes and the process of burning fossil fuels including coal and oil. The diameter of the materials that can be a health hazard is 10 micrometer or less since they can be inhaled to get their way through the throat and nose into the lungs (Iftakhar et al., 2023).

Lahore & SMOG historical evolution

The history of smog in Pakistan is a tale of escalating environmental degradation paralleled by rapid urbanization and industrial growth. This literature review delineates the progression of smog in the country, segmented into distinct time periods, highlighting causative factors, impacts, and responses over time (Usman et al., 2018).

Pre-Industrial and Early Industrialization Era (Before 1950s)

Minimal Pollution Levels

Natural Environment: This era was characterized by minimal human impact on the natural environment. The air quality issues were mostly due to natural dust and occasional urban smoke from wood and coal use in homes. The sparse industrial activity was limited to small-scale factories, which had negligible emissions compared to modern standards (Igwe et al., 2022).

Initial Urbanization

Early Signs of Change: The initial urbanization phase saw cities like Lahore and Karachi begin to expand. The construction of railways and the introduction of motor vehicles started altering the urban landscape. Although air pollution was not a significant concern, these developments laid the groundwork for future environmental challenges.

Post-Independence Industrial Growth (1950s-1980s)

Rapid Industrialization

Industrial Boom: Post-1947, Pakistan embarked on an ambitious industrialization drive. The establishment of heavy industries, such as steel, textiles, and chemicals, particularly in the Punjab region, led to an increase in air pollutants. However, environmental regulations were virtually non-existent, allowing unchecked emissions to begin affecting air quality (Siemieniuk & Szatyłowicz, 2022).

Urban Expansion

Population and Vehicles Increase: As the population grew, so did the demand for housing, transportation, and services. Lahore and Karachi experienced significant increases in vehicular traffic, contributing to rising levels of air pollutants, including sulfur dioxide and particulate matter from exhaust emissions (Raza et al., 2021).

Recognition and Escalation (1990s-2000s)

Growing Awareness

Environmental Consciousness: The late 1990s marked a turning point in environmental awareness in Pakistan. Media reports and academic studies began highlighting the adverse effects of pollution on health and the environment. Smog started to be recognized as a distinct problem, especially in Lahore, where winter smog became a regular phenomenon (Khaled & Dewidar, 2010).

Increased Vehicular and Industrial Emissions

Economic Growth and Pollution: The economic boom led to a surge in both industrial output and vehicle ownership. Lahore saw its air quality deteriorate further due to emissions from aging vehicles, unregulated industrial growth, and an increase in construction activities. The situation was compounded by crop burning in adjoining agricultural lands, adding to the city's smog levels (Yousaf et al., 2024).

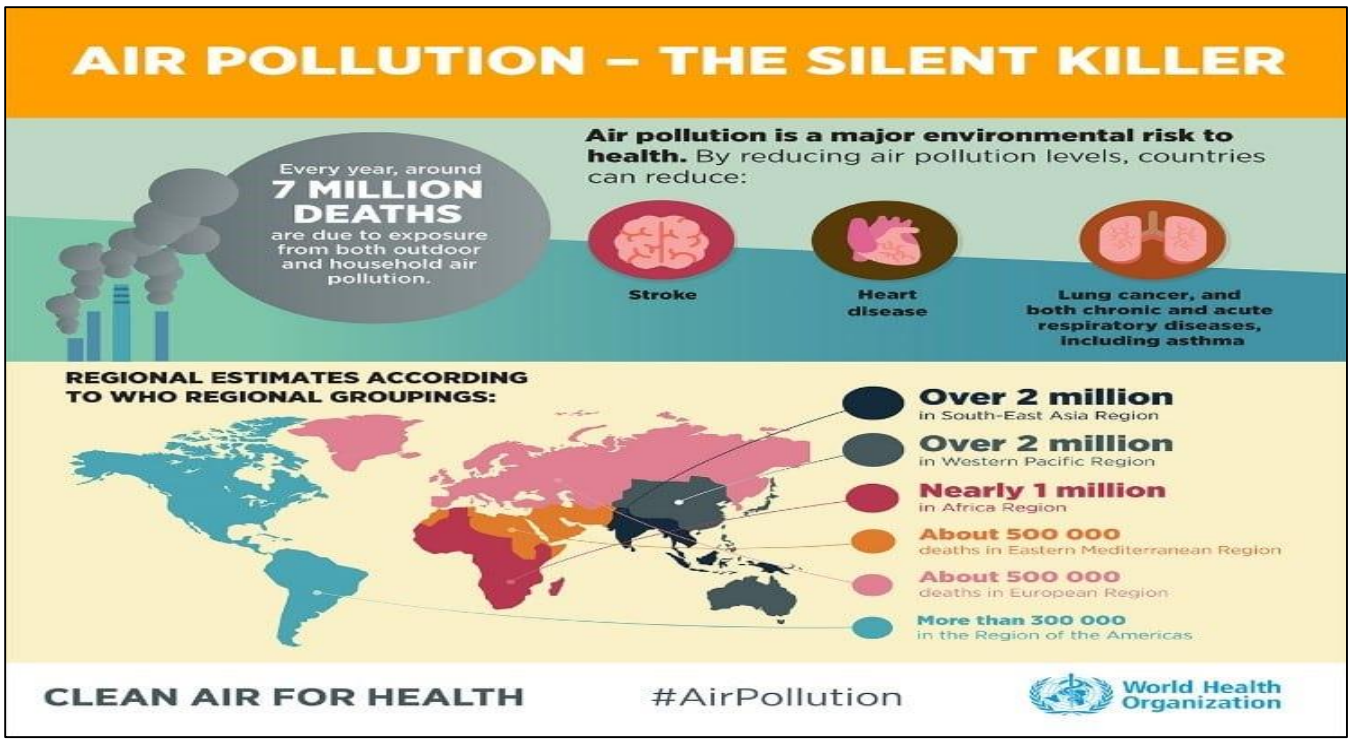

Figure 02: *Air Pollution*

The Modern Crisis (2010s-2024)

Severe Smog Episodes

Peak Pollution Levels: The last decade has witnessed unprecedented smog episodes in Lahore, with air quality indices frequently surpassing hazardous levels. The confluence of vehicular emissions, industrial pollution, crop residue burning, and construction dust has created a toxic cocktail, severely impacting the city's air quality each winter (Hussain et al., 2024).

Health Emergency

Dire Health Impacts: Recent research has illuminated the grim health impacts of smog, linking poor air quality to an array of serious health conditions. Hospitals in Lahore report surges in patients suffering from respiratory issues, heart diseases, and other smog-related ailments during peak periods, highlighting the crisis's scale (Siddqiue, 2023).

Smog primarily consists of tropospheric ozone (O3), primary particulate matter (PM) like pollen and dust, and secondary particulate matter (PM) including sulfur oxides, volatile organic compounds, nitrogen oxides (NOx), and ammonia gas. Key contributors to smog formation encompass regular pollution from fossil fuel combustion, exacerbated by the absence of pollution control technologies in vehicles, power generation, and the industrial sector. Additional pollution sources include the burning of municipal and industrial waste, operation of brick kilns using dirty fuels such as rubber tires, crop residue burning, and construction-related dust. In Pakistan, the Ministry of Climate Change (MOCC) addresses climate-related concerns at the federal level, while the "Environment Protection Department" in Punjab tackles regional environmental issues. To combat the health risks associated with smog in Punjab, particularly in Lahore, the MOCC has established a "Smog Control Room." This initiative aims to monitor AQI levels across Punjab and enforce regulations to mitigate air pollution (Pervaiz & Shirazi, 2023).

Addressing the smog crisis in Lahore requires a concerted effort involving policy reform, public awareness, and technological innovation. Strategies such as enhancing public transportation, implementing stricter emissions standards, promoting green energy sources, and improving waste management practices are essential steps toward mitigating the city's air pollution (Baig et al., 2025).

Figure 03: *Air Quality in Pakistan*

The challenge of smog in Lahore underscores the urgent need for sustainable urban planning and environmental management to safeguard public health and ensure the city's resilience against "The Invisible Killer." The causative factors of smog in Lahore are multifaceted, involving both natural and human-made elements. Rapid urbanization and the growth of the industrial sector without adequate environmental safeguards have led to increased airborne pollutants. Smog has established itself as a major public health adversary in Lahore, earning the moniker "The Invisible Killer" due to its pervasive and stealthy impact on the city's air quality. This environmental hazard comprises a complex mix of particulate matter, nitrogen dioxide, sulfur dioxide, and ozone, arising from a variety of sources such as vehicle emissions, industrial activities, agricultural practices, and construction work (Fu & Lyu, 2021).

Figure 04: *Air Quality Index in Lahore During Smog Season*

Lahore's geographical setting, nestled in a valley, exacerbates the issue by trapping pollutants, a situation worsened during the colder months through temperature inversions. The origins of smog in Lahore are complex, blending natural and anthropogenic factors. The city's rapid urbanization, paralleled by industrial expansion without sufficient environmental checks, has significantly elevated airborne pollutant levels. Additionally, the proliferation of vehicles, many lacking in maintenance and thereby more polluting, alongside agricultural burning in nearby areas, significantly contributes to Lahore's air quality dilemma (Raza et al., 2021).

The health ramifications of Lahore's smog are

profound, impacting millions. Exposure to smog's fine particulate matter is directly linked to an array of respiratory and cardiovascular conditions, escalating the public health burden and exerting economic strain through lost productivity and elevated healthcare costs. Air pollution is currently deemed the most severe pollution impacting Lahore's residents. The Air Quality Life Index Fact Sheet for Pakistan suggests that adhering to WHO's PM2.5 annual average concentration guideline of 5µg/m3 could potentially extend Lahore residents' life expectancy by 6.8 years (Ashraf et al., 2022).

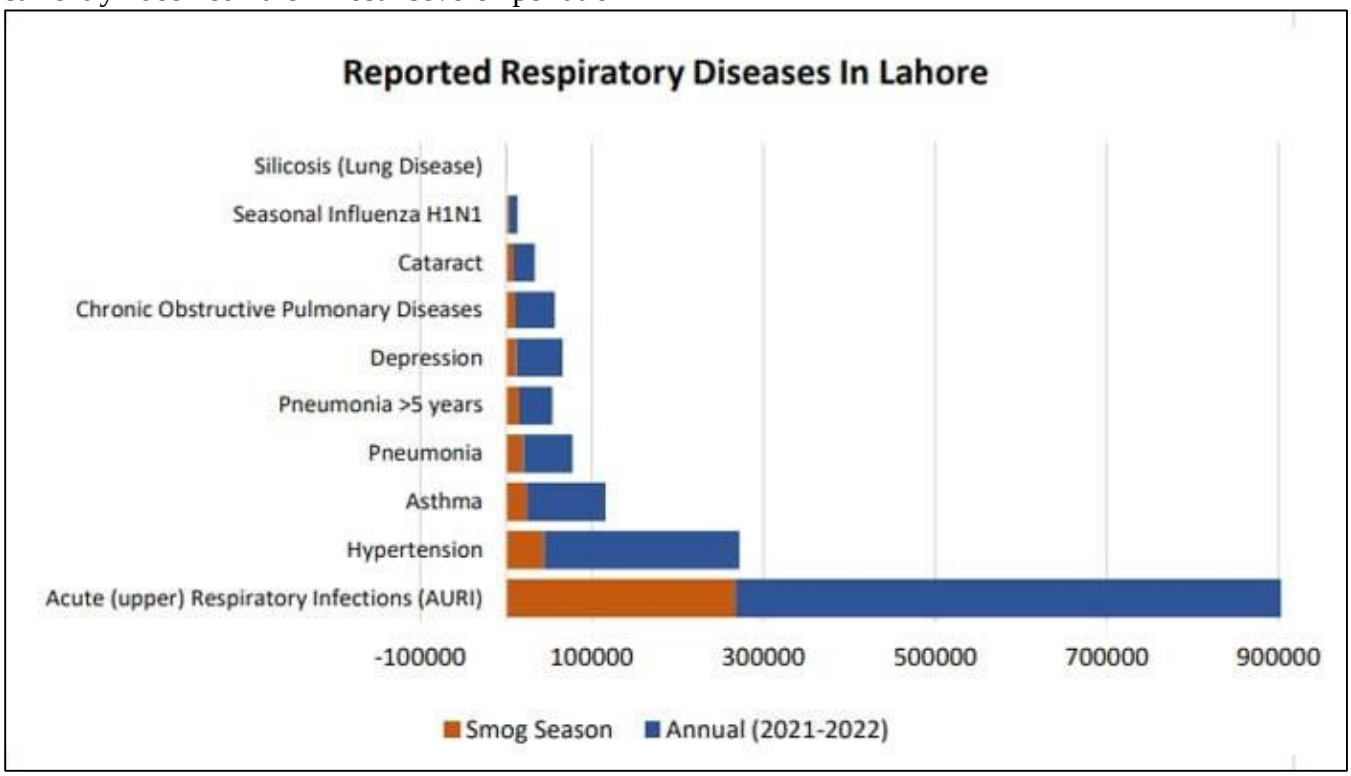

Figure 05: *Reported Respiratory Diseases in Lahore During 2021-22*

Incidences of seasonal influenza, pneumonia (>5 years old), pneumonia (<5 years old), Acute Upper Respiratory Infections (AURI), and cataract reported during smog season was 40%, 37%, 35%, 33%, and 32% of the whole year (October 2021 – October 2022). Data indicates a notable rise in respiratory illnesses within the city, correlating with increased pollution levels. The District Health Information System (DHIS) reported that during the smog season (October 2022 – October 2023), incidences of seasonal influenza, pneumonia, Acute Upper Respiratory Infections (AURI), and cataract surged, constituting 40%, 37%, 35%, 33%, and 32% of annual cases, respectively (Igwe et al., 2022).

Tackling Lahore's smog crisis demands a unified strategy encompassing policy reform, heightened public awareness, and innovation. Key measures include boosting public transportation, enacting stricter emission regulations, promoting green energy, and enhancing waste management to alleviate air pollution. The persistent smog challenge in Lahore calls for urgent action in sustainable urban planning and environmental stewardship to protect public health and fortify the city's defenses against "The Invisible Killer. (Igwe et al., 2022)"

Photocatalytic Facades

Depollution, which is the process of removing contaminants and impurities from the environment, plays a critical role in combating the pervasive problem of smog. The latest innovation in achieving depollution is the use of photo catalysts, materials that utilize solar energy to hasten chemical reactions without themselves being used up or diminished in the process. These photo catalysts accelerate the oxidation of pollutants in the atmosphere, effectively breaking down air-borne toxic organic materials that contribute to smog formation (Iqbal et al., 2025).

Titanium dioxide (TiO2), also known as titania, is one such potent photo catalyst, illustrated in figure 06 below. It is a naturally occurring oxide of

titanium and is deemed a benign substance that poses no harm to humans. With the aid of light, titanium dioxide generates two powerful oxidation agents: hydroxyl radicals and superoxide. These agents actively oxidize and decompose toxic substances, including those found in smog, transforming them into less harmful end-products. This not only leads to cleaner air but also contributes to improved public health and environmental quality (M et al., 2018).

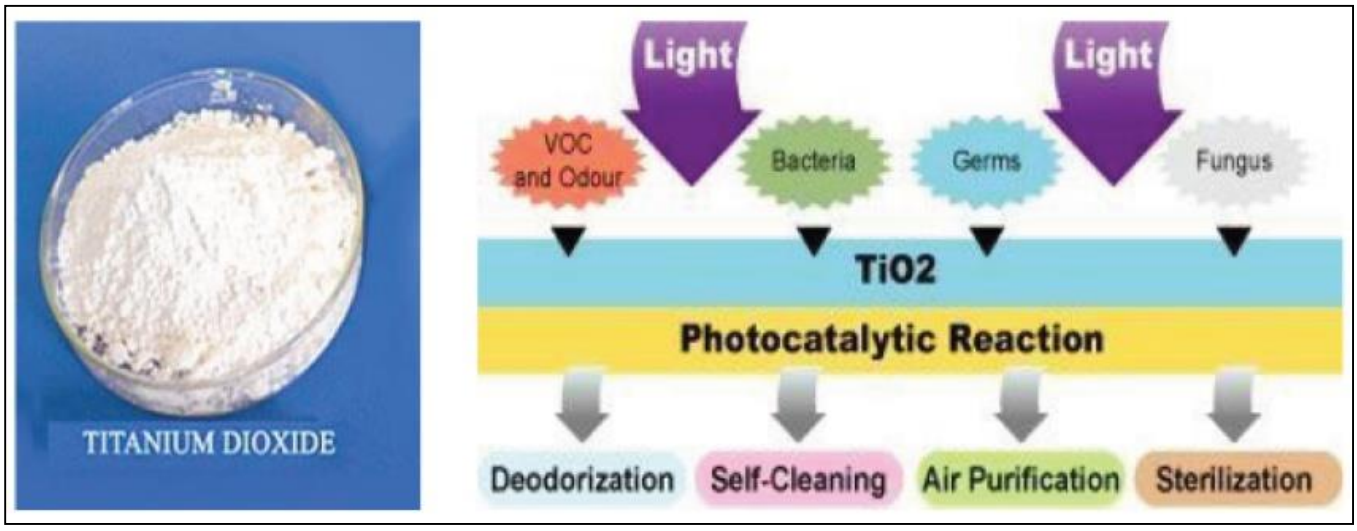

Figure 06: *Photocatalytic Reaction*

The application of a photo catalyst treatment to façade maintenance is both an economical and enduring approach, augmenting the durability of surfaces. This treatment ensures the edifice retains a pristine condition through a self-sustaining cleaning process, as illustrated in figure 07. It provides a defense against common blemishes like mildew, grime, oily substances, and various pollutants. Architectural facades treated with photo catalysts boast several key characteristics:

1. Antistatic properties prevent dust particles from adhering to the façade.
2. Oxidative decomposition effectively breaks down hydrocarbons and organic materials.
3. The hydrophilic nature of the surface allows rain to easily cleanse away any residual dirt or contaminants.

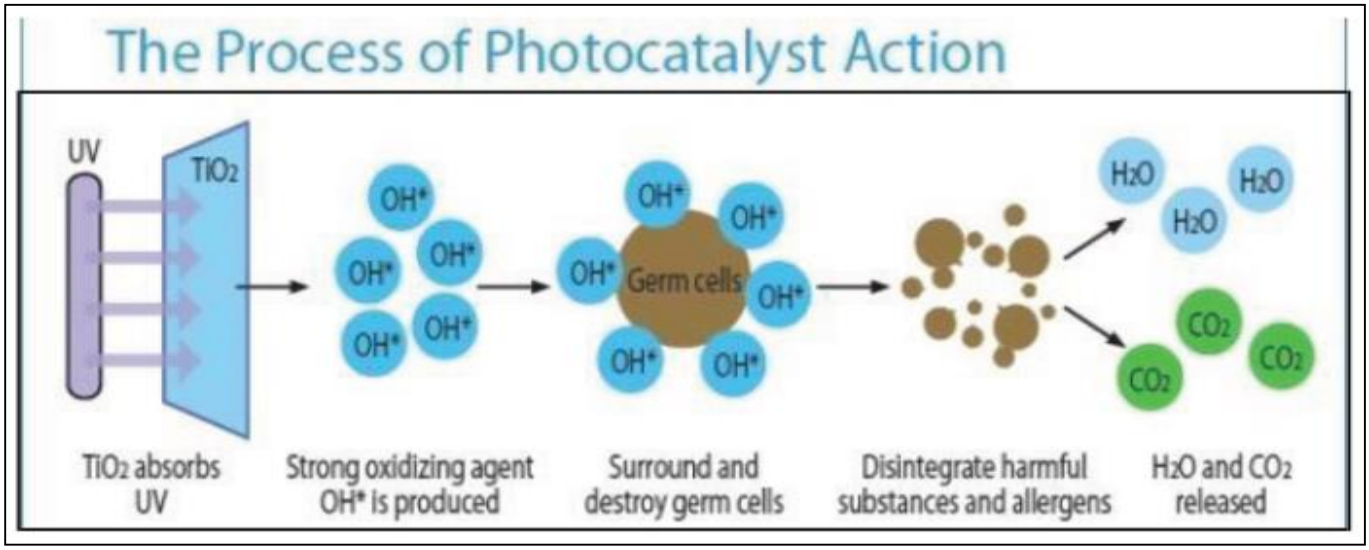

Figure 07: *Photocatalytic Reaction Process*

The self-cleaning mechanism of facades using photocatalysis unfolds as follows: Upon the facade's titanium dioxide (TiO2) enriched surface encountering an organic or inorganic compound, the TiO2 is activated under UV light, triggering redox reactions with highly reactive species that

degrade the compounds. The byproducts of this degradation are either absorbed by the covering or rinsed away by rainwater (Zhang, 2019). This process is particularly advantageous because, after the redox reactions, organic materials are converted into carbon dioxide, nitrogen oxides are transformed into harmless nitrate ions, and ozone breaks down into oxygen. Concurrently, any visible marks from soiling gradually lose opacity due to these photocatalytic reactions. Therefore, these advanced coatings not only maintain the cleanliness of urban structures but also play a role in diminishing the environmental pollutants commonly emitted by vehicular traffic and industrial operations. Some of the key technologies used with highlighted examples are shared below in table 01.

Table 01: *Key Technologies Used*

Building Example	**Location**	**Technology Used**	**Key Benefits**	**Key Disadvantages**
Infoscore Office Building	Baden-Baden, Germany	SGG BIOCLEAN Glass	- Less frequent cleaning required due to self-cleaning effect - Maintains aesthetic appeal with clarity and transparency.	- Higher initial costs compared to standard glass. - Self-cleaning effectiveness may vary with environmental conditions.
Brive-la-Gaillarde Hospital Extension	France	SGG BIOCLEAN Cool-Lite Glass	- Enhances patient and staff comfort. - Facilitates maintenance without hospital operation disruption.	- Design and renovation costs can be high. - Specific environmental conditions needed for maximum effectiveness.
Saphire Residential Project	Berlin, Germany	Self-cleaning Ceramic Tiles	- Unique aesthetic appeal. - Improved air quality through purification properties.	- Increased project costs due to customization. Maintenance, though less frequent, still required.
Vanke Pavilion	Italy	Red Metalized Tiles	- Cultural and aesthetic value. - Environmental benefits with self-cleaning and air purification properties.	- Increased costs due to design and material complexity. - Dependent on rain and UV for cleaning efficiency.
Hospital Building,	Mexico City, Mexico	proSolve370e Tiles	- Mitigates pollution in high-traffic areas.	- Performance varies with precipitation

Mexico City			- Innovative design reduces air conditioning needs. - Sustainable material use.	and pollution levels.- Higher initial investment for specialized tiles. - Complexity in facade design increases costs.
Palazzo Italia, Expo 2015	Milan, Italy	Photocatalytic Concrete	- Lowers maintenance costs and environmental impact with self-cleaning facade.	- Specific conditions required for photocatalytic process effectiveness.

As evident from the table 01 above, multiple technologies have their critical positive impacts and challenges to be looked into prior to decision for a specific technology adoption.

Research Methodology

To underpin the research on photocatalytic facades for IT company headquarter in Lahore, a diverse set of data collection methods was employed, focusing on articles that explore various facade systems. These articles provide essential insights into how different design approaches can be integrated into architectural projects to address specific environmental challenges in urban settings like Lahore. Key aspects covered included are shared below:

Table 02: *Key Selection Aspects*

Solution / Technology	Applicability in Lahore	Cost	Effectiveness in Air Pollution Reduction	Cultural Acceptability	Implementation Complexity	Maintenance Requirements	Potential for Local Adaptation	Legal and Regulatory Hurdles
Watery Facades	High	Medium	High	Medium	Low	Medium	High	Low
Green Facades	High	Medium	High	High	Medium	Low	High	Low
Algae Facades	Medium	High	Medium	Medium	High	Medium	High	Medium
Photocatalytic Facades	**High**	**High**	**High**	**High**	**High**	**Medium**	**Medium**	**Medium**
Living Walls	High	Medium	High	High	Medium	Low	High	Medium
Self-cleaning Glass	High	High	High	High	Medium	Low	High	Medium
Self-cleaning Concrete	High	High	High	High	Medium	Low	High	Medium
Green Roofs	High	High	High	High	Medium	Medium	High	Medium
Solar Panels	High	High	High	High	High	Low	High	Medium
Rainwater Harvesting	High	Medium	High	medium	Medium	Medium	High	Medium

Photo catalysis - prefix Photo – defined simply as light, Catalyst – a substance that accelerates a process, increases the rate of a reaction, without being consumed in that process. Photocatalytic reactions constitute one of the Advanced Oxidation Technologies(AOT) applied to water and air purification. This process involves a solid semiconductor catalyst, typically titanium dioxide

(TiO_2), which is activated with ultra violet light (UV) of certain wavelength. TiO_2 is a metal based compound, which is multiply present in nature (Khaled & Dewidar, 2010).

To use an ataseinheterogenic photo catalysis, UV-light with a wave length lower than 387 mm has to be present. Also the intensity of the light is important to optimize the photocatalytic activity. Normal daylight can be used for the photocatalytic reaction. Research is focusing now on the application of nano-particles of TiO_2, active in the visible light range. Existing applications may be found in water purification, air conditioning (air purification), self-cleaning glazing, ceramic tiles (self-cleaning, antibacterial, textile (anti-odour), mirrors (anti-condensation), tunnel lightning, white tents, etc. Besides the air The use of TiO_2 photo catalyst in combination with cementitious and other construction materials has shown a favorable effect in the removal of nitrogen oxides (Siddqiue, 2023).

Titanium dioxide technology

Titanium dioxide technology filters the air polluted with smog through the building's façade. There are projects that prove their ability to filter air pollutants for (10,000) vehicles per day from the building's perimeter through a reactive material that stimulates with sunlight to purify the air from these pollutants. But how does that happen? Titanium dioxide (TiO_2) is a reactive material stirred by sunlight that transforms air pollutants as in nitrogen oxides (NOx), volatile organic compounds (VOCs), carbon monoxide (CO) and ozone into biologically tolerable products like carbon monoxide and calcium nitrate (Willmott, 2018). These materials can be treated either via:

- Mixing it with the concrete, so that the concrete mixture becomes pollution absorber.
- Mixing it with specific polymers to produce facades design.
- Mixing it with asphalt.
- Using it as a façade paint.
- Or a transparent layer for the surfaces.

This innovative technology was recently applied in Manuel Gea González Hospital in Mexico City.

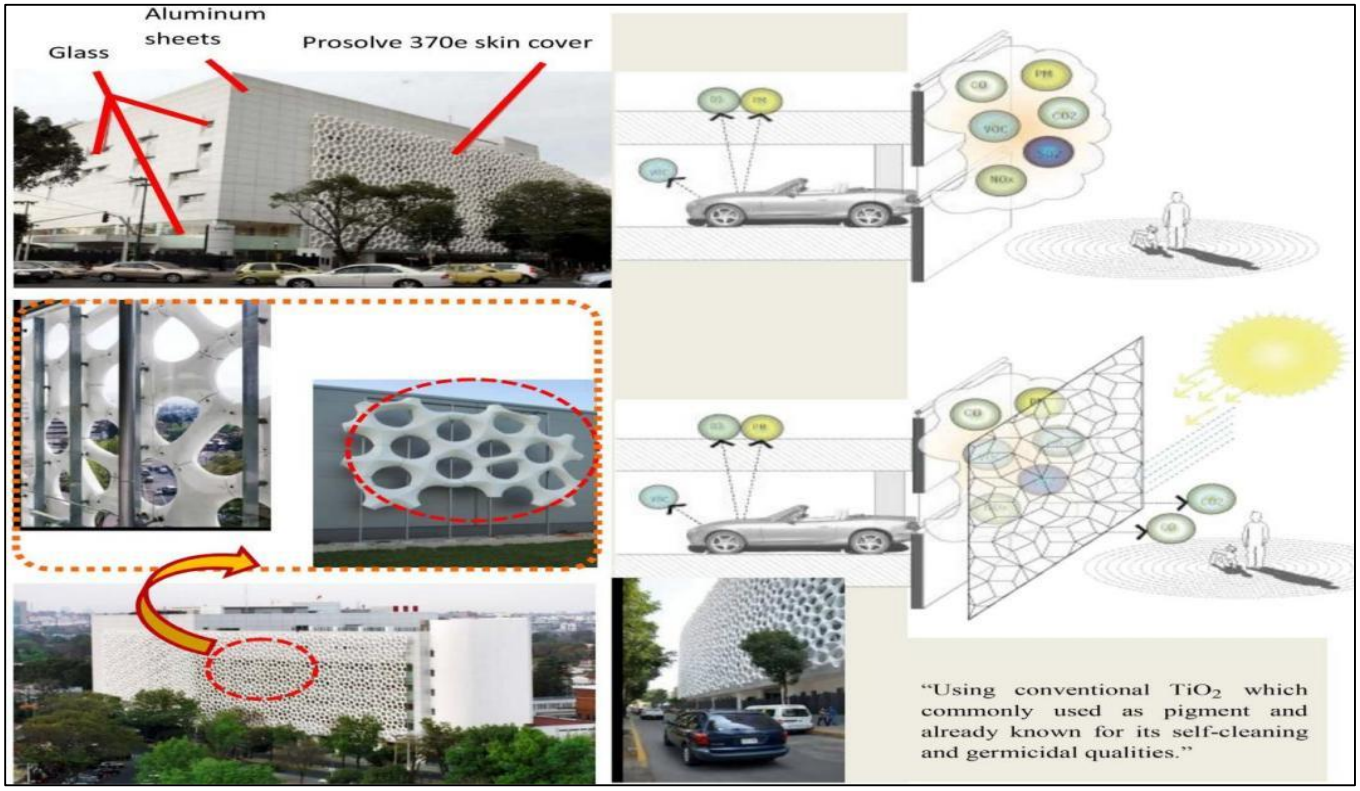

Figure 08: *Manuel Gea González Hospital in Mexico City*

Prosolve 370e units were used to cover the entire façade, which is a three-dimensional collectible decorative architectural unit that removes air pollutants by applications (Optical stimulation

technology by titanium dioxide TIO_2). The units are characterized by ease of installation, assembly, and flexibility of formation, and are also used in (Willmott, 2018):

- Combating air pollutants, the ability to eliminate the pollutants of 8750 vehicles per day
- Anti-fog spreading in the city
- Reducing wind speeds to treat the most air pollutants possible
- Take advantage of all aspects of the façade (skin)
- Shading the building to maintain low temperatures
- Reduce building thermal loads
- Distinguished mental image of the building

Research Methodology & Design Evolution

In order to proceed ahead with a design proposal development to review the design interventions as a strategy to mitigate the smog in the current context of exploration i.e. Lahore, a detailed site analysis and site selection was followed by development of a building program which lead to defining the requirements for the proposed building to deploy the proposed anti-smog architectural solution as a future design integration for sustainable cities and health of the people. Hence the detailed site analysis and its prospects are shared below:

Site Analysis

Location: The site is situated in a densely populated area near Phase 8, Lahore, within the Nawaz Sharif IT Park, which serves as a technology hub.

Connectivity: The site is connected with three major road networks of Lahore, ensuring easy accessibility and connectivity.

Economic Potential: The Nawaz Sharif IT Park is proposed as a key technology hub with a pre-financial feasibility of around 2700-3000 billion PKR. This development is expected to advance the economy and generate employment across various sectors, particularly in the IT and technology industries.

Sustainability and Certification: The IT Park aims to be Pakistan's first LEED Certified project, establishing a sustainable and pedestrian-friendly community with modern infrastructure.

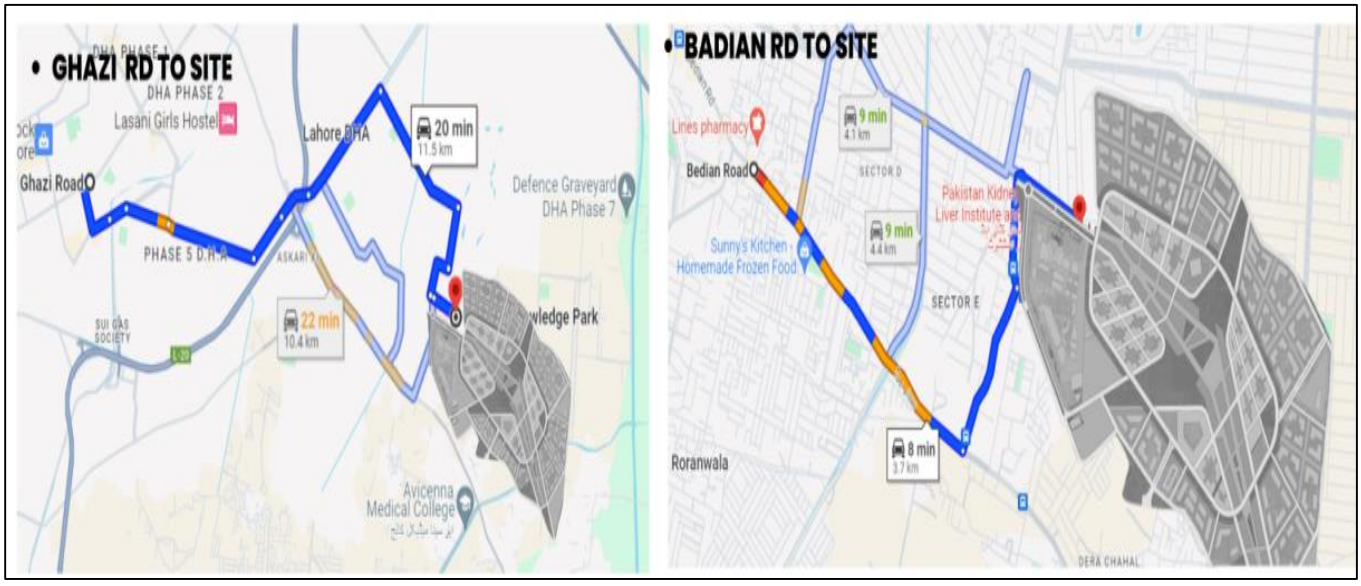

Figure 09: *Site Location in Context of Lahore*

Urban Design: The Nawaz Sharif IT Park not only provides exceptional opportunities for technology businesses but also offers efficient working, living, and recreational spaces, thanks to quality urban design. The IT Park will encompass the following five themes:

- **Inclusiveness:** The IT Park will welcome a diverse range of minds and respect all cultures.
- **Eco-friendly:** The natural environment will be protected through green spaces, tree cover, and innovative green initiatives.
- **Sustainable:** Key elements of sustainable

development include restoration, affordable access to public resources, and community empowerment.

- **Advancement:** The IT Park will serve as a central point for technology businesses and communities, balancing prosperity and progression for overall well-being.
- **Connected:** The IT Park will be connected to surrounding neighborhoods through sustainable transport modes and extensive road infrastructure.

Located in Lahore, the capital city of Punjab, Pakistan, serving as a major educational, cultural, and economic hub. Situated in the NSIT, located in the IT HUB zone near the main road educational block. Positioned near key local areas including Gulberg (15 km) and DHA Lahore (25 km), providing access to commercial, educational, residential, and business hubs.

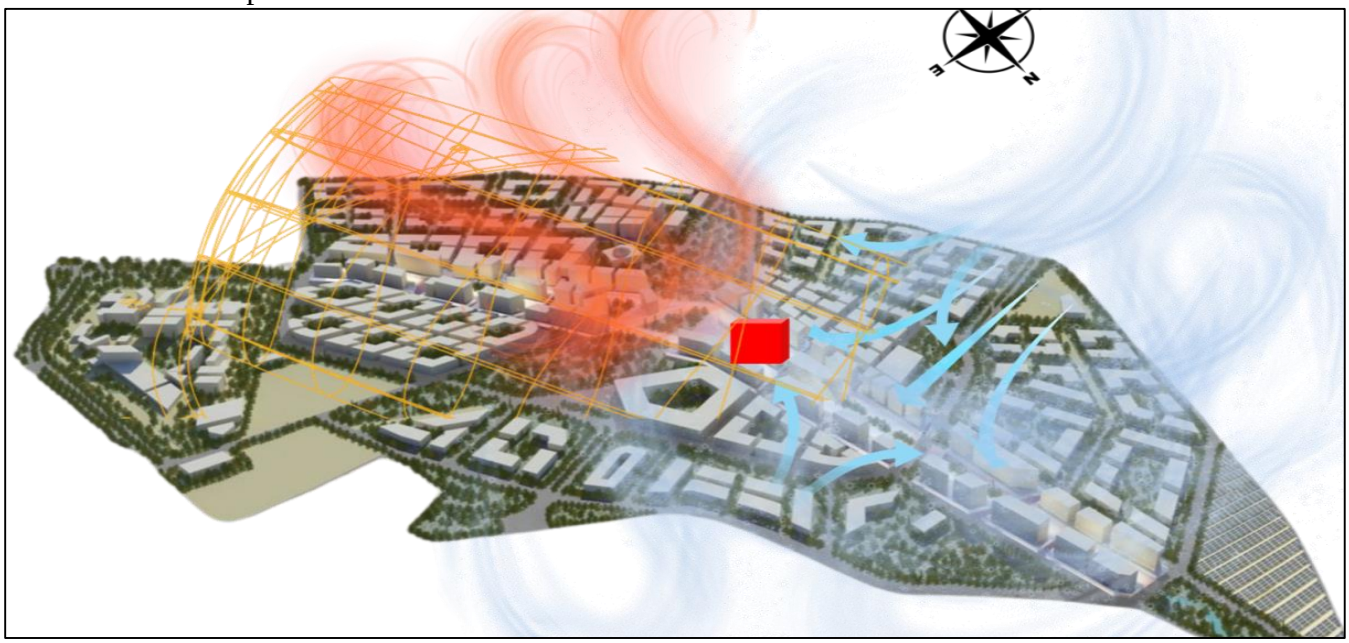

Figure 10: *Wind Influence on Site*

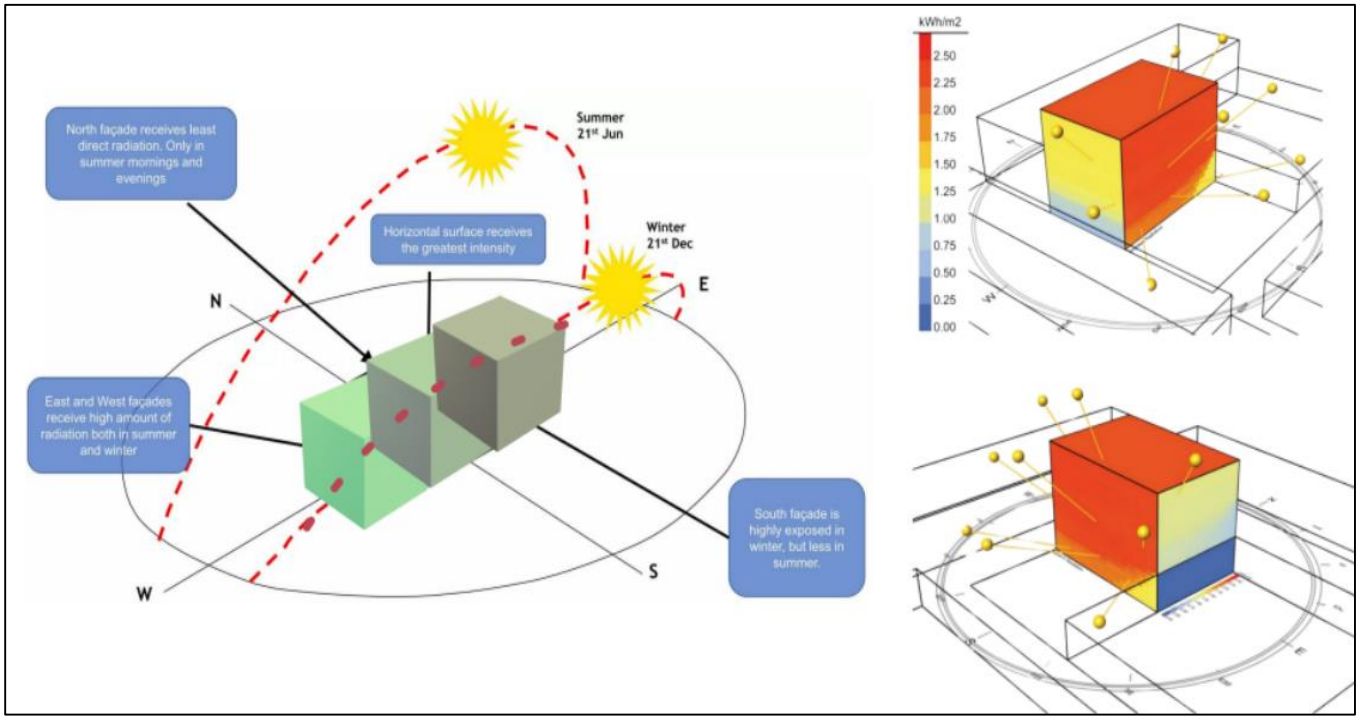

Figure 11: Solar Study Analysis of Site

Summer Climate Analysis: Temperature and Humidity: Summers in Lahore are typically hot and humid, with temperatures frequently exceeding 40°C (104°F). Humidity can make these temperatures feel even more oppressive. Wind Influence: West and south winds prevail, offering opportunities for natural cooling. Effective building design should incorporate elements that enhance cross-ventilation to exploit these winds for cooling purposes and to mitigate the urban heat island effect. Winter Climate Analysis: Temperature and Wind: Winters are relatively mild but can feel colder due to the prevalent east winds. Temperatures usually range from 5°C to 20°C (41°F to 68°F), with occasional cold spells.

Figure 12: *Contextual Site Pictures on Selected Site Multiple Sides*

Site has the following key features applicable with respect to site design:

Site has a regular rectangular shape. CBD BYLAWS are applicable to this site. 1Marla=225sqft 1kanal=20Marla's. Building setback from front is 30’, from back is 20’, from sides are 20’ and maximum ground coverage allowed is 35% with maximum floor area ratio of 1:8.

Building Program:

Working Spaces

SPACES	**SQ. FT PER PERSON / (Persons) SIZES**	**QUANTITY**	**TOTAL AREA(SQ.FT)**
BOARDROOM	525sqft for 21 person	4	2100SFT.
CONFERENCEROOMS	150sqftfor6person	4	600SFT.
INFORMALSHARED WORKINGSPACES	1000sqftfor 40 person	4	4000SFT.
HUDDLEROOM	225sqft for 4 person	6	1350SFT.
MULTIPURPOSE HALL	(25-30users)(40 x50)	2	4000SFT.
INDOOR RECREATIONAL AREAS			
TABLETENNIS	22x40playingarea	1	880SFT.
DISCUSSIONSPOTS	49sqft/2person	8	392SFT.
BOARDGAMES	(10 x10)	1	100SFT.
GAMINGROOM	(15 x30)	1	450SFT.
MUSIC/PIANOROOMS	30sqft for one piano	1	94SFT.
NAPPODS	(20 x20)	1	400SFT.
YOGA/MASSAGE ROOM	100sqft for 1 person	1	400SFT.
LIBRARY	36sqft for 1 person	1	72SFT.
THINKING PODS	99sqft for 1 person	7	693SFT.
PRAYERROOM	8sqftfor1prayermat	1	118SFT.
SMOKERROOM	108sqft for2person	1	108SFT.
FIRSTAIDROOM	180sqft for 2 person	1	180SFT.
SUB TOTAL			**21,297SFT.**

Administration Department

RECEPTION	10sqft/person(4person)	1	40SFT.
WAITING LOUNGE	10sqft/person (50person)	1	500SFT
CEO ROOM	2users (20x15)	1	300SFT.
CFO ROOM	2users (20x15)	1	300SFT.
HR MANAGER	3users	1	645SFT.
ACCOUNTS AND FINANCE TEAM	60sqft/person (27users)	1	1620SFT.
ADMISSION OFFICE	60sqft/person (23users)	1	1380SFT.
SALES AND ADVERTIZING TEAM	60sqft/person (26users)	1	1560SFT. .
RESEARCH AND DEVELOPMENT TEAM	60sqft/person (25users)	1	1500SFT.
SYSTEM AND NETWORKS TEAM	1000sqftfor40person	1	1000SFT.
CALL CENTER	60sqft/person 9users	1	540SFT.
STAFF ROOM	(20 x15)	2	600SFT.
TOILETS	1for 50workstation	10	785SFT.
CONFERENCE ROOM	200 sqft for 10 person 250 sqft for 20 person	2	450SFT.
	SUB TOTAL		**11,2220SFT.**

Working Spaces Semi- Private

OPEN, SHIELDEDANDENCLOSEDOFFICES			
ENTRANCEAND RECEPTION			
RECEPTIONCOUNTER	10sqft/person (4person)	1	40SFT.
WAITINGLOUNGE	10sqft/person (100person)	1	1000SFT.
WORKINGSPACES			
OPENWORKING LOUNGE	60sqft/person (120users)	1	7,200SFT.
ENCLOSED WORKING SPACE	60sqft/person (60users)	5	3600SFT.
SHIELDEDWORKING SPACES	60sqft/person (60users)	5	3600SFT.
LIBRARY	36sqft for 1 person (for8-9person)	1	320SFT.
CONFERENCE ROOM	200sqftfor 10person 250sqftfor 20person	2	450SFT.

Private Offices Space

PRIVATEOFFICES			
ENTRANCEANDRECEPTION			
RECEPTION COUNTER	10sqft/person (4person)	1	40SFT.
WAITING LOUNGE	10sqft/person (100person)	1	1000SFT.
WORKINGSPACES			
EXECUTIVE DESKS	100sqft/person	6	600SFT.
EXECUTIVE LOUNGE WITH BATH	400sqft /person	4	1600SFT
EXECUTIVE CONFERENCE ROOM	200sqft for 10 person250sqftfor20person	4	850SFT
LARGE PRIVATE OFFICES	60sqft/person (11users)	2	660SFT
MEDIUM PRIVATE OFFICES	60sqft/person (5users)	2	300SFT
SMALL PRIVATE OFFICES	60sqft/person (4users)	2	240SFT
TOILETS	1for50workstation	10	785SFT.
SUBTOTAL			**6,075SFT.**
SUB TOTAL FOR CHROME AND APPS DEPARTMENT			**6,075 + 17245 23,320SFT.**

Architectural Design Development

The overall concept of the design evolved through a notion towards architectural integration into the environment as a solution. The evolving ides here conceived as a fight between Prey & Predator: A Sanctuary of Survival. The designer believed that in SMOG filled Lahore, the buildings embodies the battle between humanity and its environment. SMOG as the predator which overwhelms the city but advanced technology and adaptive systems crate a sanctuary of clean air and innovation. Over time, human resilience and technology reverse the predator's dominance, transforming survival in to progress of the people and the environment itself. The design concept evolution is shared below through multiple transformation and transition figures:

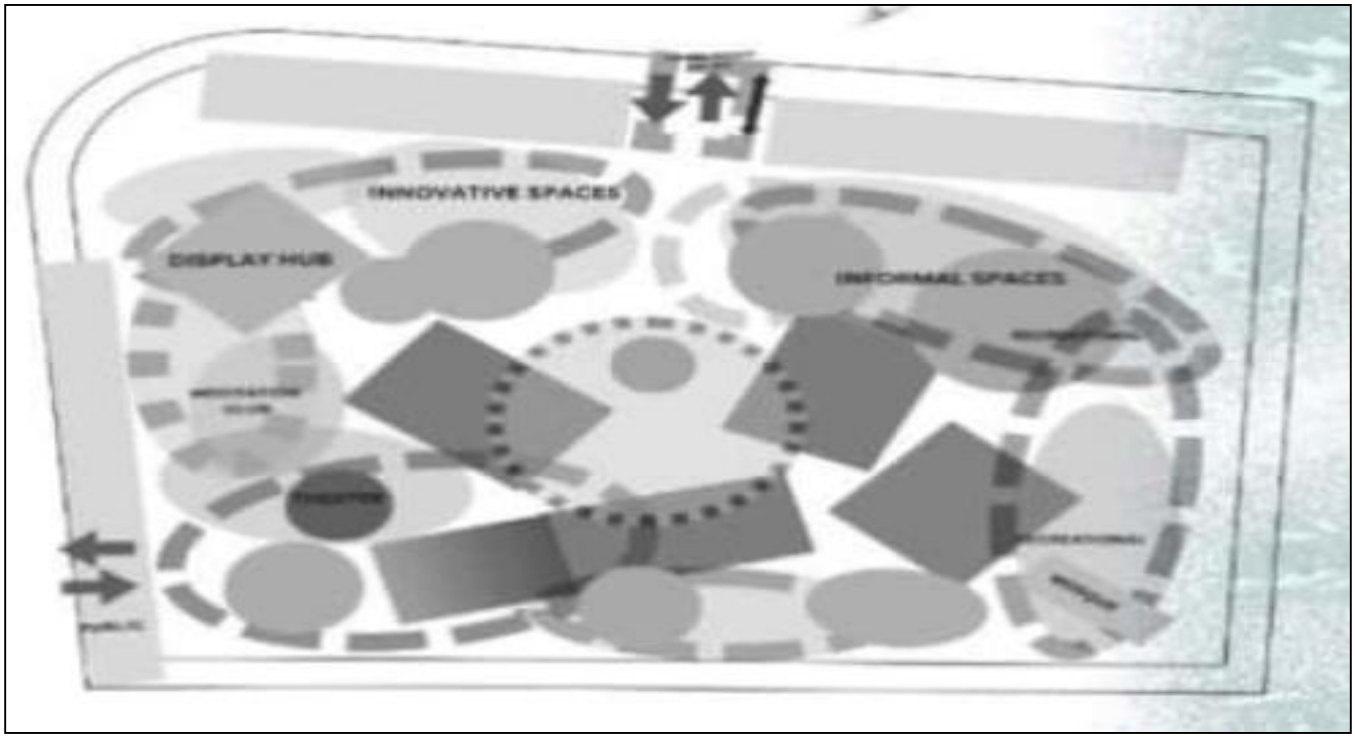

Figure 13: *Final Zoning of Functions and Blocks on Site*

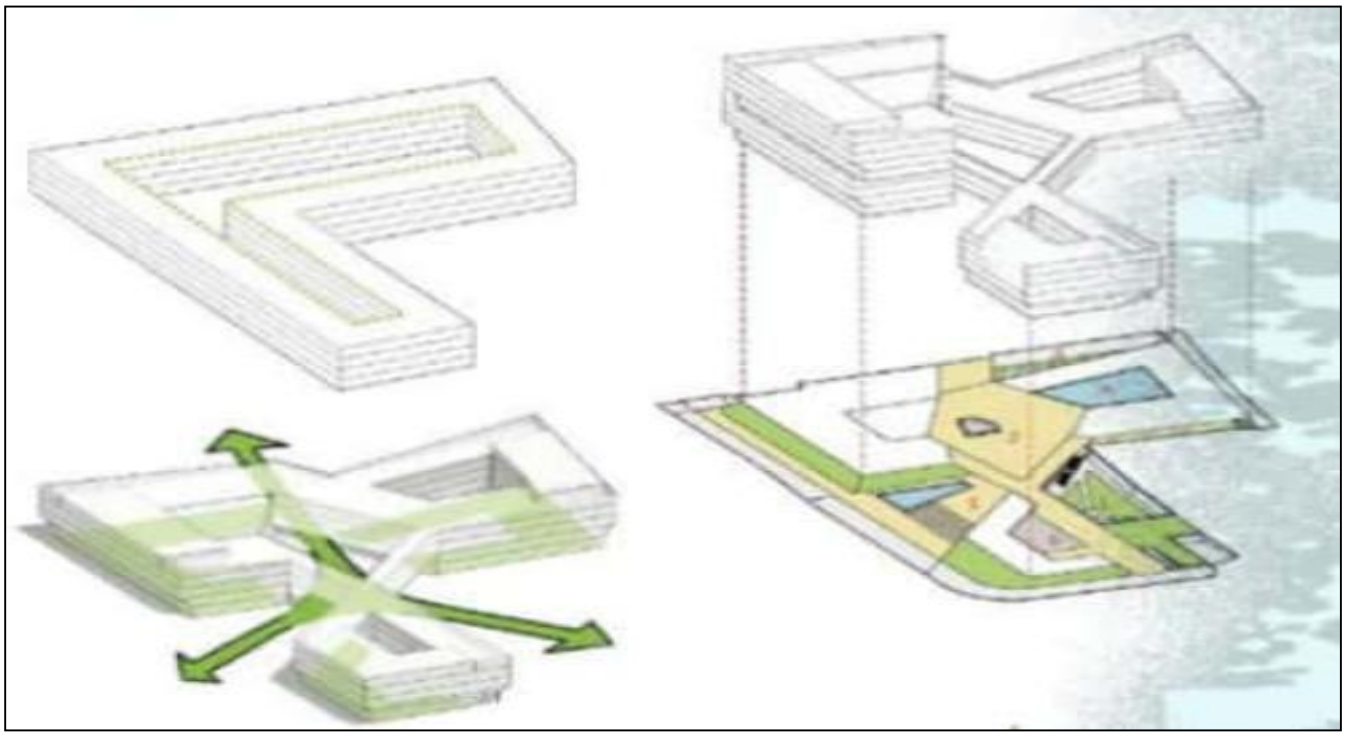

Figure 14: *Evolution of Design Form and Its Overall Zoning*

LEGENDS

1. ENTRANCE GATE
2. EXIT GATE
3. EXECUTIVE PARKING
4 DROP OFF
5. BLOCK ENTRANCES
6.OXYGEN OASIS
7. BREATHE PLAZA
8. AIR-PURIFYING ART INSTALLATIONS
9. INNOVATION CANOPY
10. PEDESTRIAN CROSSINGS
11. CLEAR SKIES LAB
12. O2 RETREAT
13.BIO SYNERGY PATH LAKE
14. COLLAB HUB
15. CYCLYING TRACK
16 AIR-PURIFYING ART INSTALLATIONS
17 COMMUNITY INNOVATION AMPHITHEATER
18 SMOG-RESILIENT GREEN CANOPIES
19 CREATIVE COMMONS
20 O2 OASIS WORK ZONE
21 INTERACTIVE HOLOGRAM GARDENS
22 LIGHTRESPONSIVE 02 PATHS AND PUBLIC JAMER
23INFORMAL MEET ZONES
25 MALINDA ORG. PAVILION
26 PUBLIC ENT/ EXT
27 PUCLIC BLOCK ENT /EXT
28 BASEMENT P.
29 BRIDGES

Figure 15: *Overall Proposed Master Plan of the Designed Facility & Its Legend*

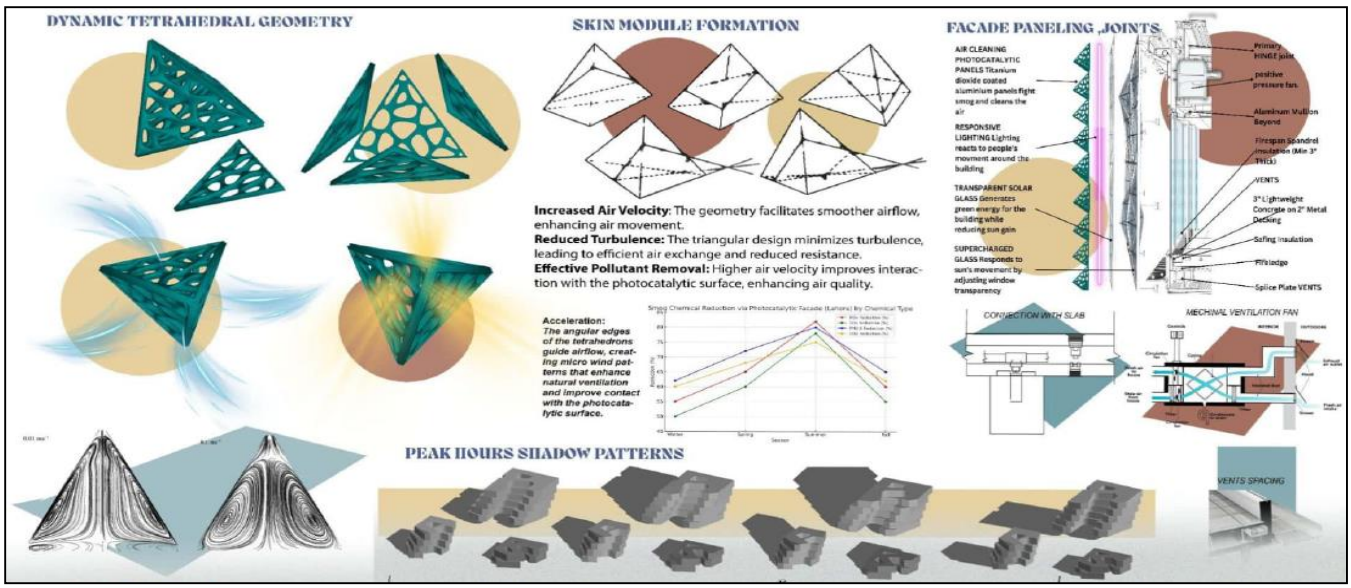

Figure 16: *Overall Design Evolution & Technical Details*

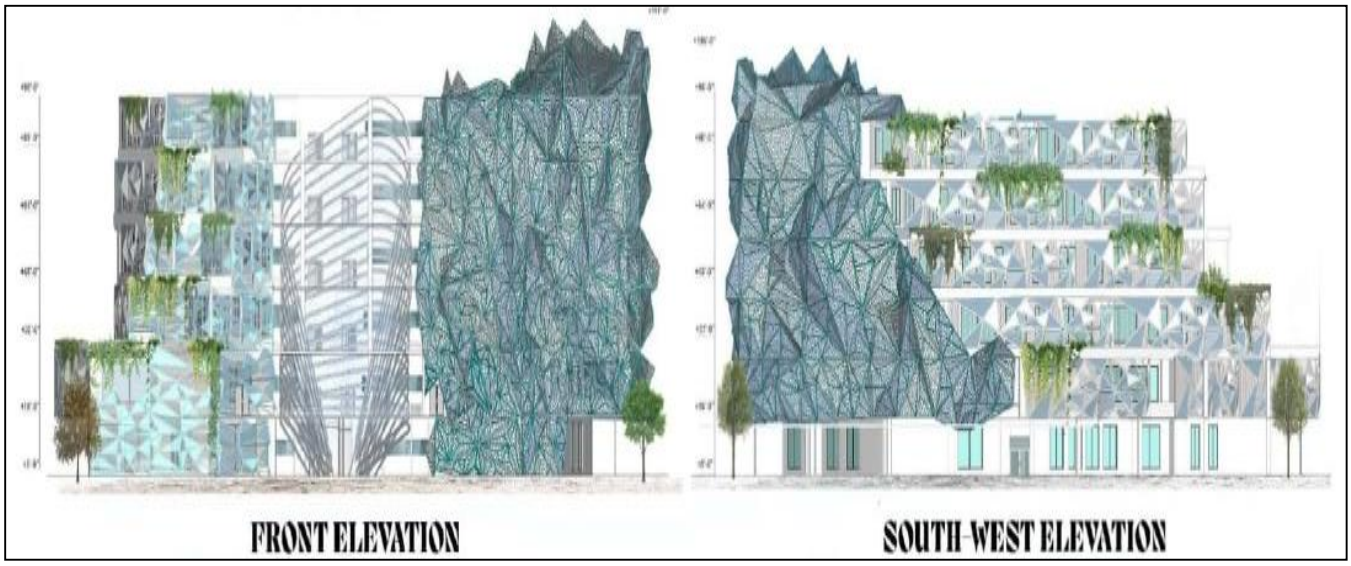

Figure 17: *Proposed Elevations of the Design*

Research Findings

Key research findings mainly included that design integration of technical solutions and advanced technologies may help fight back with the help of architecture to beat the environmental challenges like SMOG in the context of Pakistan specially the city of Lahore. Deployment of such solutions through integration of technology will require extensive exploration, analysis, simulation as well as financial support including public-private partnership with mediating role of governing bodies to transform these challenges into opportunities

Research Conclusions

Following were the major conclusions of the research exploration:

1. SMOG is one of the major climatic threat faced by the people of Pakistan across Punjab, KPK and Sindh province.
2. It has now been considered a season due to its prevailing long term time of 3-4 months.
3. Serious health threats are associated with it across the public and people across all genders, ages, sects and cultures.
4. It is need of the hour that architectural design be integrated with respect to the environmental needs so that climatic conditions including challenges like climate change, SMOG, urban heat island effects etc could be managed.
5. Existing design exploration aimed to resolve these challenges through architectural design interventions and how architecture can play its vital role in managing these challenges at large.

Research Recommendations

Following were the major recommendations based on the research exploration with respect to the objectives defined:

1. There is a need to explore the current architectural practices with respect to the current built forms and the overall urban planning and context of the city.
2. Transformation of existing buildings through interventions needs further exploration to ensure that existing built forms as well as buildings help manage this burden of climatic chaos and help build resilience.

There is also need to enhance the current body of knowledge as well as the skill set of the professionals engaged along with academia and industry to help, cope and transform these challenges into business, research and transformative opportunities in inter-industry and cross-disciplinary domains.

Conflict of Interest

The authors showed no conflict of interest.

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