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Workplace Adaptations and Employee Productivity in Smog-Affected Areas: Addressing the Effects of Environmental Pollution

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Abstract

Smog is a growing concern worldwide, affecting both public health and workplace productivity. Yet, its impact on employee performance has received little attention, particularly in developing countries. This study explores how smog influences the health and job performance of public-sector workers in Lahore, Pakistan, using Lawton's Personal Environment Fit Theory (1973) as a foundation. A survey of 200 employees from the Environmental Protection Agency (EPA) and Environmental Protection Department (EPD) examined the links between smog awareness, workplace conditions, health, and performance. Results from structural equation modelling showed that higher awareness of smog was linked to reduced performance ($\beta = 0.368$, $p < 0.05$), with employee health playing a central role in this effect ($\beta = -0.406$, $p < 0.05$). However, workplace measures such as adjustments to the environment had little influence ($\beta = -0.075$, $p > 0.05$), indicating that current strategies are not effective in protecting workers. The study highlights that smog undermines employee performance primarily through its negative impact on health. It stresses the need for stronger workplace responses, including air purification systems, flexible working hours, and protective equipment. These findings provide useful guidance for policymakers and employers operating in heavily polluted regions.

Key words: smog, employee performance, workplace well-being, environmental pollution, Personal Environment Fit Theory, Lahore, Pakistan

Introduction

The performance of employees is essential to an organisation's long-term viability. The accomplishment of their organisations' strategic goals and objectives is directly impacted by high-performing workers. Good performers do jobs faster, waste less, and use resources more effectively, which raises overall productivity (Koopmans et al., 2014).

High-performing individuals frequently give unique solutions and ideas, which promotes organisational innovation. Strong individual performance improves team collaboration and morale. High performers frequently motivate and inspire their peers, fostering an environment of excellence; in contrast, poor performance can result in errors, missed deadlines, and inefficiencies, raising operating expenses. Conversely, excellent performance reduces these dangers.

Both external environmental elements and internal organisational factors have an impact on employee performance. Focusing on strengthening employee skills, providing feedback, and maintaining a happy work environment can amplify their performance, leading to overall organisational success.

Environmental pollution includes a wide range of issues in addition to smog, such as air, noise, and water pollution, all of which have a negative impact on employee performance and workplace well-being. While smog predominantly affects respiratory and cognitive health, noise pollution adds to

increased stress, decreased focus, and worse productivity, especially in urban areas. Similarly, exposure to water contamination can cause health problems, leading to absenteeism and lower productivity. Globally, cities confronted with similar environmental concerns have introduced beneficial measures such as green building designs, tougher emissions restrictions, and technology-driven pollution monitoring. Incorporating a holistic picture of environmental pollutants allows for a more complete understanding of their cumulative impact on employee health and productivity, emphasising the importance of multifaceted workplace modifications and policies.

External factors affecting performances of employees i.e. transportation, family issues climate, smog season severely impacts employees' health, productivity, and overall well-being. Personal environment fit Theory (Lawton, 1973) suggests that the compatibility between an individual and their work environment significantly impacts their well-being, satisfaction, and performance. A poor fit, such as exposure to smog in the work environment, can lead to stress, reduced productivity, and negative health outcomes.

Personal Environment Fit Theory (Lawton, 1973) emphasizes the alignment between an individual and their environment, suggesting that compatibility in this dynamic significantly affects well-being, satisfaction, and performance. When there is a mismatch between an individual's needs and their work environment (misfit) then negative outcomes such as stress, reduced productivity, and health complications can arise. This theory provides a valuable lens to analyse how smog impacts employee performance.

Smog, characterized by its adverse health and environmental effects (Naureen et al., 2022) creates an external environment that disrupts the balance required for optimal employee performance. Employees exposed to smog face respiratory issues, cognitive fatigue, stress, and discomfort, all of which negatively influence their ability to function effectively. From the perspective of Personal Environment Fit Theory, smog represents a poor environmental fit for employees, as the polluted conditions fail to meet their physiological and psychological needs for a safe and conducive work environment.

This environmental misfit leads to reduced productivity, absenteeism, and presenteeism (where employees are present but underperforming). Furthermore, prolonged exposure to such harmful conditions may deteriorate employee health, creating a cycle of declining performance and satisfaction. The employees who are working outdoors in smog affected areas show extreme variation between the demands of their work environment and their capacity to adapt, leading to performance issues and job dissatisfaction.

Smog, a hazardous combination of smoke, fog, and chemical pollutants, forms a thick, greyish haze in the atmosphere. Predominantly occurring in urban areas with significant vehicle emissions and industrial activities, smog poses serious health and environmental challenges. It becomes particularly severe during warm and sunny weather conditions.

Pakistan, an underdeveloped South Asian nation, faces substantial environmental issues despite contributing minimally to global greenhouse gas (GHG) emissions. Rapid urbanization, flawed policies, and a growing population have led to a stark reduction in green spaces, aggravating environmental degradation. Cities like Lahore, the second-largest city in Pakistan, have become particularly vulnerable

Lahore, covering 3,587 square kilometres and accommodating over 13 million residents (Census 2023), faces severe environmental challenges driven by rapid urbanisation and the steady decline of green spaces. These developments intensify urban heat and deteriorating air quality, with smog emerging as a seasonal crisis. Between November and March, Lahore consistently ranks among the world's most polluted cities, recording hazardous Air Quality Index (AQI) levels that directly affect public health and workplace environments.

Employees of key environmental institutions, such as the Environmental Protection Authority (EPA), responsible for maintaining urban greenery, and the Environmental Protection Department (EPD),

tasked with controlling pollution sources, are highly exposed to these conditions. Understanding how smog affects their performance is crucial for designing protective workplace strategies.

Although the physical health consequences of smog—such as respiratory disorders, cardiovascular strain, and weakened immunity—are well documented, far less is known about its impact on employee productivity. In South Asian countries such as Pakistan and India, where smog has intensified over the last decade, this gap in research is particularly concerning. Smog exposure not only undermines physical health but also influences psychological well-being, leading to fatigue, cognitive decline, and stress. These effects reduce focus, energy, and efficiency, resulting in absenteeism, presenteeism, and diminished job performance.

Despite growing recognition of these risks, the mechanisms linking smog exposure to workplace performance remain underexplored. This study aims to address this gap by examining the relationship between smog exposure and employee productivity, focusing on both physical and psychological health pathways. Insights from this research are expected to inform organisational practices and policy interventions aimed at safeguarding employees working in pollution-prone regions such as Lahore.

Significance of study

Air pollution, more specifically in the form of smog, is a major although frequently under researched determinant of worker performance. Made up of ground-level ozone, fine particulate matter (PM2.5), and other noxious pollutants, smog has been found to negatively influence both physical health and mental functioning of mankind. Acute exposure can cause respiratory and cardiovascular diseases, trigger asthma, and produce symptoms like fatigue, headaches, and eye irritation. These health problems lead to higher absenteeism, and general individual productivity losses. Aside from these physical impacts, there is also emerging empirical evidence that air pollution has a negative impact on cognitive function through its effects in undermining memory, decreasing attention span, and lessening problem-solving abilities necessary to maintain workplace productivity. Therefore, workers subjected to poor air quality conditions are more likely to make mistakes, take longer to accomplish their tasks, and struggle with decision-making. In addition, substandard air quality can impact psychological health, as seen in heightened stress, anxiety, and decreased job satisfaction, thus exacerbating its harmful effects on organizational performance.

This research seeks to scientifically investigate the connection between air pollution—more particularly, smog—and the performance of employees. It opens with a thorough review of the literature to assess current empirical evidence and theoretical viewpoints connecting environmental contamination with worker health and productivity. The next subsections detail the research problem and set out essential research questions geared towards filling some of the current gaps in the literature. The chapter on methodology describes the study design, sampling plan, data collection instruments, and analysis methods. Subsequently, the results are described and examined critically, with a discussion placing the findings in context within the wider literature. Lastly, the article concludes by recapitulating the main takeaways, pointing out pragmatic implications for management and policy, and proposing directions for future research to more elaborately investigate this important juncture between workplace performance and environmental conditions.

Conceptual Structure

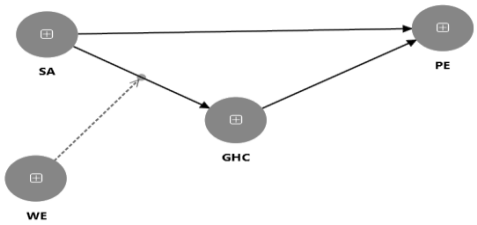
This study's foundation is the Personal Environment Fit Theory (Lawton, 1973), which provides a framework for understanding how employee effectiveness in contaminated workplaces might be hampered by discrepancies between personal capabilities and environmental expectations. An environmental misfit occurs when the workplace environment does not satisfy the physical and psychological needs of employees, leading to stress and a reduction in productivity. Smog is an unsuitable environmental fit that impairs work performance due to its harmful health impacts.

This concept provides a lens through which to view how workplace relations and employee well-being are impacted by pollution. For example, presenteeism and absenteeism among outdoor workers in smog-affected areas are caused by greater physical and mental strain. Additionally, this paradigm supports the mediating role of health and the moderating effect of workplace conditions (such as air filtration).

The impact of environmental stress on population genetics and adaptation was also examined by (Zhivotovsky, 1997). His theoretical research sheds light on how genetic and environmental factors interact to shape evolutionary dynamics and stress responses.

Using this approach, the study formulates hypotheses that investigate the connections among smog exposure, health, working conditions, and worker performance.

Research Model



SA: Smog Awareness
WE: Workplace Conditions
GHC: General Health Conditions
PE: Performance of Employees

Research Methodology

This idea offers a perspective for examining the ways in which pollution affects employee well-being and workplace interactions. Greater physical and mental strain, for instance, is the reason for presenteeism and absenteeism among outdoor workers in smog-affected locations. Furthermore, this paradigm endorses the moderating influence of workspace settings (such air filtration) and the mediating role of health.

Research Design

A cross-sectional quantitative design is used in the study to investigate how smog affects worker performance. Testing hypotheses and statistically analysing relationships are made possible by this design.

Population and Samples

This study's population is made up of employees from the Environmental Protection Authority (EPA) and the Environment Protection Department (EPD) in Lahore, Pakistan. These departments were chosen for their regular outdoor exposure and administrative importance to environmental and health-related policymaking.

To ensure thorough representation, the research used a stratified sample procedure. Employees were organized into two distinct groups: EPA and EPD. Respondents were also sorted into clusters within both strata based on their occupation and level of pollution exposure. Gpower software analysis was used to choose 200 personnel. So, questionnaires were distributed to EPA and EPD workers. The sample strategy ensured that both high- and low-exposure sections were well represented. Employees who had worked there for at least a year were specifically chosen to ensure that their experiences fit the study's goals. Although the Lahore focus provides a concentrated understanding of the

consequences of smog, future studies may widen the geographic clusters to include additional data for improved generalizability.

Data Collection Method

A standardized questionnaire with a Likert scale was used to conduct a survey based on selected variables to assess staff performance during the pollution season. The poll looked into concerns encountered when performing duties during smog, such as reduced visibility, respiratory issues experienced by outdoor workers, and the physical and emotional health repercussions of smog. The survey was completed by 200 personnel from the Environmental Protection Department (EPD) and the Environmental Protection Authority (PHA) via Google Forms.

Analysis Method

Demographic statistics were analysed using SPSS, whereas regression and correlation analyses were conducted using Smart PLS.

Results and Analysis

This section discusses and analyses the study's findings on the effects of environmental pollution, specifically smog, on employee performance and workplace well-being. The data were gathered from 200 respondents who worked for two government organisations in Lahore, Pakistan: the Environmental Protection Authority (EPA) and the Environment Protection Department (EPD). The investigation is separated into two parts: a demographic profile of respondents and an analysis of critical factors with statistical methods.

Table 1

Consolidated Demographic Statistics of Study Participants (N=200)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	108	54.4%
	Female	92	44.8%
Age	Under 18	5	2.1%
	25–34	30	20.7%
	35–44	145	68.9%
	45–54	13	5.4%
	54–60	6	2.5%
	Unspecified	1	0.4%
Employment Status	Contract	151	71.4%
	Regular	47	27.8%
	Regular	2	0.8%
Grade	Grade 1	36	19.1%
	Grade 6	86	39.8%
	Grade 13	22	13.3%
	Other grades (2, 4, 11, 14–21)	56	27.4%
Job Title	Field Assistant	78 (combined)	36.9%
	Mali	23	13.7%
	Inspector (various)	15	10.4%
	Others (titles with < 1% each)	84	39.0%
Tenure	Less than 1 year	135	62.7%
	1–3 years	25	12.4%

	4–6 years	15	10.0%
	7–10 years	05	6.2%
	More than 10 years	20	8.7%

The demographic information revealed important details about the individuals' backgrounds. 54.4% of the 200 respondents were male, 44.8% were female, with a minor percentage (0.8%) lacking gender data. The bulk of participants (68.9%) were between the ages of 35 and 44, indicating a mature workforce with extensive professional experience. Other age categories had lesser shares, with only 2.1% under the age of 18 and 2.5% aged 54 to 60.

Employment status revealed that the majority (71.4%) were contract-based employees, while 27.8% had regular posts. This disparity reflects a substantial reliance on contract work in smog-affected areas.

Participants were divided into employment classes, with the most prevalent being Grade 6 (39.8%), followed by Grade 1 (19.1%) and Grade 13 (13.3%). A wide range of job titles were recorded, with the most common being "Field Assistant" (36.9%), "Mali" (13.7%), and "Inspector" (10.4%). These occupations are expected to have extensive contact to outdoor conditions, making their replies more pertinent to our study.

Tenure data revealed that the majority of respondents (62.7%) had less than a year of experience, most likely owing to seasonal or project-based hiring. A smaller fraction of employees (8.7%) had more than ten years of experience, which could influence how long-term smog exposure corresponds with performance or health difficulties.

Table 2: Measurement Model Assessment

(*Reliability and Validity of Constructs*)

Construct	**Cronbach's Alpha**	**Composite Reliability (CR)**	**Average Variance Extracted (AVE)**	**Conclusion**
Smog Awareness (SA)	0.894	0.911	0.389	Acceptable reliability, AVE slightly low
Workplace Environment (WE)	0.951	0.953	0.454	Excellent reliability, AVE borderline
General Health Condition (GHC)	0.648	0.846	0.361	Low reliability, needs improvement
Performance of Employees (PE)	0.865	0.892	0.269	AVE and convergent validity inadequate

The measurement model was assessed using Cronbach's Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE). Most constructs demonstrated adequate reliability (e.g., SA: $\alpha = 0.894$, CR = 0.911), demonstrating internal consistency. However, the AVE values for all constructs fell below the suggested threshold of 0.50, particularly for Employee Performance (AVE = 0.269) and General Health Condition (AVE = 0.361), indicating limited convergent validity. Although AVE values for some items were slightly lower than the threshold, composite reliability remained within acceptable bounds, indicating scale validity.

These results suggest a possible measurement problem, that is, the items may not be capturing the full nature of such constructs as health or performance in environmental pollution context. Refinement or extension of these scales in subsequent versions is suggested by the authors, perhaps with the use of qualitative input or context-specific items to enhance construct validity.

Table 3: Structural Model Assessment

(*Direct Path Coefficients and Hypothesis Testing*)

Hypothesis	Path	β (Path Coefficient)	Result
H1	SA → PE	0.368	Supported
H2	SA → GHC	–0.204	Supported
H2	GHC → PE	–0.406	Supported
H3	SA × WE → PE	–0.075	Weakly Supported
–	WE → PE	–0.255	Not strongly significant

The structural model results affirm the hypothesized relationships:

H1 (SA → PE) was supported (β = 0.368), indicating that increased awareness of smog correlates with perceived declines in performance. This reflects the psychological toll of environmental risk perception on employee behavior.

H2 (SA → GHC; GHC → PE) demonstrated that health condition mediates the relationship between smog awareness and performance. A negative impact of smog on health (β = –0.204), and of health on performance (β = –0.406), underscores health as a critical channel through which environmental stress manifests in the workplace.

H3 (SA × WE → PE) was weakly supported (β = –0.075), and the direct effect of workplace environment on performance was not statistically strong (β = –0.255), suggesting that current workplace adaptations do not adequately buffer against the adverse effects of pollution. The insignificant moderating role of adaptation suggests that current environmental adjustments in these departments are either insufficient or poorly implemented

This reinforces the theoretical lens of Person-Environment Fit: where environmental conditions (e.g., smog) mismatch the physiological and psychological needs of employees, performance is adversely affected unless effective interventions are in place.

Table:4 Indirect and Total Effects

Path	Indirect Effect	Total Effect
SA → GHC → PE (Mediation)	0.083	0.451
SA × WE → PE (Moderation)	0.030	0.030
WE → PE (Total)	0.104	0.104

The indirect effect of smog awareness on performance via health (0.083) and the cumulative total effect (0.451) show that health serves as a partial but substantial mediator. This emphasizes the indirect channels through which pollution affects workplace performance, even when direct contacts are minimal.

The interaction effect of the office environment on the smog-performance relationship is negligible (0.030), highlighting the importance of reevaluating the effectiveness and implementation of current mitigation techniques such as ventilation, PPE provision, and flexible scheduling. Without resilient, flexible workplace settings, even knowledge and prudence do not convert into improved outcomes.

Table:5 Model Fit & Predictive Power

Construct	R^2	Adjusted R^2	Interpretation
GHC	0.129	0.118	Weak explanatory power
PE	0.363	0.358	Moderate explanatory power

The model accounted for 12.9% of the variance in general health condition (GHC) and 36.3% in employee performance. While the performance model has moderate predictive value, the health model's explanatory power remains low, implying that future models should include additional factors such as stress, job demands, diet, or coping mechanisms.

These findings imply that performance is more easily explained by smog awareness and health

interactions, whereas health outcomes are influenced by a broader set of external and personal variables not addressed in this study.

Table: 6 Discriminant Validity

	GHC	PE	SA	WE	WE × SA
GHC	0.601				
PE	0.534	0.519			
SA	0.255	0.491	0.624		
WE	0.303	0.361	0.264	0.673	
WE × SA	0.132	0.186	0.380	0.177	1.000

Discriminant validity was assessed using Fornell-Larcker criteria. The square roots of AVEs were generally higher than inter-construct correlations, indicating acceptable discriminant validity. However, slight overlaps between constructs such as Smog Awareness (SA) and the interaction term (SA × WE) suggest potential multicollinearity or item redundancy.

This issue could be resolved in future studies by ensuring greater conceptual distinction in scale development and using confirmatory factor analysis to further validate construct boundaries.

Conclusion and Implications

The findings demonstrate that smog awareness considerably decreases performance and well-being, supporting the person-environment mismatch in polluted workplaces. The goal of this study was to measure the influence of environmental pollution, notably smog, on employee performance and workplace well-being by using empirical data collected from government sector employees in Lahore, Pakistan, particularly those who were most affected by smog. Based on the Personal Environment Fit Theory, the study found that pollution has a direct and considerable negative influence on work performance, mostly through overall health conditions. Furthermore, the investigation revealed that existing workplace changes, as they pertain, have a limited moderating impact in counteracting the negative impacts of smog exposure. The findings have important theoretical and practical ramifications. Theoretically, the study applies the Person-Environment Fit concept to environmental pollution, illustrating how a disparity between employees' health needs and the physical environment has a negative impact on individual performance. It also contributes to the current literature on environmental stressors in developing countries, a field that is understudied.

From a practical standpoint, the findings underline the need for government institutions to improve workplace health and safety measures, particularly in smog-ridden urban areas. Measures such as improved indoor air quality systems, the provision of protective gear (N95 masks), flexible working hours during smog season, and periodic health screening can all be employed as important prevention strategies for assuring worker well-being and productivity. Furthermore, policy coordination between the environmental and labour departments is necessary to address structural concerns associated to pollution and occupational health.

Limitations and Future Research

Although this study makes important contributions, it is not without limits. To begin with, the cross-sectional research design limits the ability to draw causal inferences among variables. Longitudinal studies are required to provide a fuller understanding of how long-term pollution exposure affects employee health and performance over time. Second, this study is based on self-reported data, which is susceptible to frequent technique or response bias. While reliability and validity were established, future studies must include objective measures of performance or health history to triangulate the findings.

Third, the study was limited to Lahore and involved public sector organisations. Although this context

is relevant due to its high level of pollution, the conclusion may not apply to other cities, sectors, or countries with different environmental or institutional circumstances. External validity can be improved by doing a comparative analysis with private sector organizations or samples from multiple cities.

Finally, the model explained only a moderate percentage of the variation in employee performance and a small percentage in health conditions. Future research should include additional psychological and organizational characteristics such as perceived stress, coping, organizational support, job control, and workload in order to have a better understanding of how pollution affects employees. Future research could also consider mixed-method approaches to investigate employees' subjective experiences with environmental stressors.

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