Article QR

Title:	**Assessing the Impact of Public Behavior and Industrial Emissions on Ambient Air Quality in Pakistan**
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DOI:	https://doi.org/10.32350/gsr.21.01
History:	Received: January 10, 2023, Revised: April 28, 2023, Accepted: April 30, 2023, Published: June 29, 2023
Citation:	Ghaffar, W. (2023). Assessing the impact of public behavior and industrial emissions on ambient air quality in Pakistan. *Governance and Society Review*, *2*(1), 01–31. https://doi.org/10.32350/gsr.21.01
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Conflict of Interest:	Author(s) declared no conflict of interest

Assessing the Impact of Public Behavior and Industrial Emissions on Ambient Air Quality in Pakistan

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Abstract

Air pollution is a growing environmental concern worldwide, and Pakistan is no exception. The study investigates the impact of industrial emissions, as well as public behavior, on air pollution in Pakistan. For this purpose, a questionnaire-based survey was conducted among a sample size of 100 participants, including students, professors, and government employees. The goal was to assess their attitudes, practices, and understanding regarding air pollution, as well as their perception and contribution to the relevant issues and their role concerning industries and vehicles. The findings revealed significant insights into the prevailing situation. The respondents recognized the contributions of industrial emissions to pollution levels. However, a substantial portion of the participants exhibited limited knowledge regarding specific pollutants and their sources. These responses clarified certain facets regarding public behavior, including transportation choices, waste management practices, and energy-efficient technologies. It was evident that sustainable modes of transportation, such as cycling or public transportation, were underutilized, with personal vehicles being the primary choice. Furthermore, significant challenges were identified as a lack of proper waste management practices and the low adoption of energy-efficient technologies. Based on these findings, it is crucial to implement targeted interventions and raise awareness to address air pollution in Pakistan effectively. The study highlighted that there is a dire need for increased education and public outreach initiatives to improve knowledge regarding air pollutants and their sources. Policies that support environmentally friendly transportation choices and encourage industry adoption of cleaner technologies should also be developed.

Keywords: air pollution, behavior problems, environmental issue, industrial pollution, waste matter

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Introduction

Presently, the huge amount of gases produced by automobiles has drastically affected the atmosphere of big cities around the globe. In urban areas, the fatality rate from car pollution is rising rapidly. However, with time, people eventually came to know that air pollution had a negative impact on their health, the environment, and the economy. Weather and climate have an integrated effect on human activity, which leads to a global concentration of environmental pollutant particulates such as lead, carbon dioxide, methane, nitrogen oxide, chlorofluorocarbons (CFCs), and several other dust and gaseous particles. In Pakistan and other developing nations that are rapidly industrializing, motor vehicle use is quite prevalent, which has negative socioeconomic, environmental, health, and welfare impacts in addition to contributing to high levels of urban air pollution (Ilyas, 2007).

Since 2014, Pakistan has been ranked in the top five most air-polluted countries in the world. The Census and Economic Information Center (CEIC) reported that Pakistan consumes nearly five hundred barrel/Day, with an average of 269 barrel/Day between 1965 to 2021 was. Over the last decades, air pollution has become a global problem. The causes of air pollution in Pakistan is well known but least concerned. Due to rapid industrial development, population growth, resource depletion, changes in the chemical composition of the atmosphere, and the cycling of carbon, nitrogen, and phosphorous, many urban centers in developing nations are plagued with environmental problems, particularly air pollution. These factors are largely to blame for altering the earth's basic physiology (Omer, 2008).

In 1982, there were 0.85 million cars in Pakistan between 1991-2021, however, this number of motorcycles and scooters increased by 550%, and the number of motor vehicles increased by almost 750%, with an average annual growth rate of more than 8.5%. According to a World Bank assessment, urban air pollution costs Pakistan's economy an estimated US$369 million annually. The Pakistani economic study attributed that industrial and vehicular emissions are the biggest contributors to the country's poor air quality. Due to the rising health and socioeconomic hazards, both air pollution and particle matter have been termed as global issues in recent years (Anjum et al., 2021).

Thus, the study indicated that by considering every relevant aspect, such as the nation's economic situation, local weather conditions, industrial interests, public lifestyle, and national literacy rate, policymakers at the local, national, and regional levels should develop tailored policies. This study also highlighted that industrial emissions and public behavior have caused serious environmental issues, especially air pollution, which has caused severe damage to health. This strategy will also help in establishing and carrying out more effective policies that are less likely to be unsuccessful when put into practice (Anwar et al., 2021).

Problem Statement

Air pollution is a critical environmental issue that refers to the presence of harmful substances in the Earth's atmosphere. It is primarily caused by human activities, including industrial processes, transportation, energy production, and the burning of fossil fuels. Natural sources, such as volcanic eruptions and wildfires, can also contribute to air pollution, although to a lesser extent. Air pollution has a wide-ranging impact on human health, the environment, and the economy. The current study highlighted that industrial emissions and public behavior have caused serious environmental issues, especially air pollution, which has caused severe damage to health. Considering the increase in greenhouse gases has caused the world to become an unsuitable place to live due to excessive global warming and the dangerous deteriorating quality of air worldwide. The ever-increasing surge in toxic substances has caused irreparable climate change as the most prevailing impact of bad air quality. In Pakistan, air pollution poses a critical environmental challenge driven by industrial processes, urbanization, energy production, and fossil fuel combustion, leading to the release of pollutants like PM2.5, NOx, SO2, and CO. The country's vulnerability to climate change is exacerbated by the emission of greenhouse gases, thus contributing to global warming, erratic weather patterns, and melting glaciers.

Research Questions

RQ1: Does industrial emission affect the air quality in Pakistan?

RQ2: Is public behavior contributing to air pollution in Pakistan?

Research objectives

RO1: To evaluate the emerging air pollution in Pakistan and to investigate the impact of people's behaviors or actions on the environment.

RO2: To evaluate the industrial emission impact on the air quality in Pakistan. The increasing approach of industrialization in developing countries is affecting the environment by releasing greenhouse gases and chemical emissions.

Conceptual Framework

The framework illustrates the relationship between independent and dependent variables.

Figure 1

Conceptual Framework
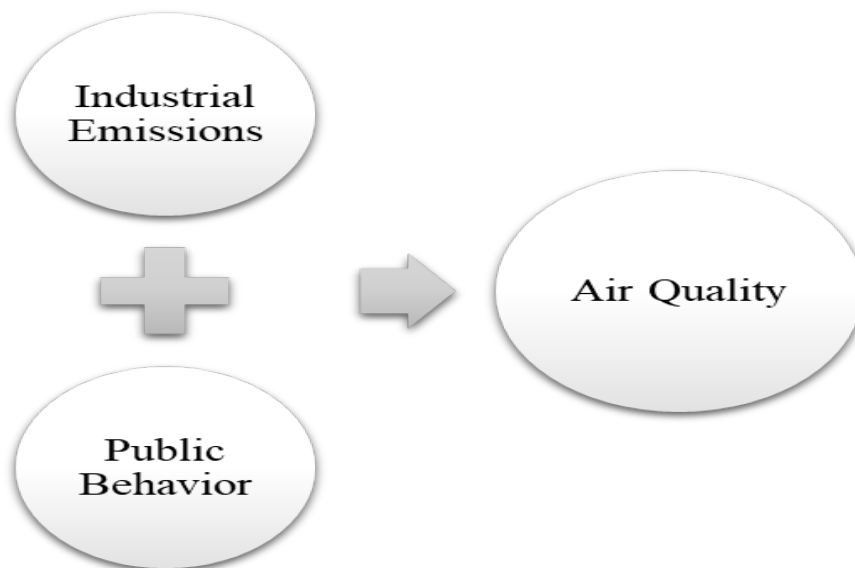
Note. Source: (Adeyanju & Manohar, 2017)

Theoretical Framework

Cumulative impact theory (CIT) is one of the most prevalent theories, which is subsequent to explain both the public behavior and industrial emission consumption rate and their impact in Pakistan. According to this theory, air pollution is not solely attributed to a single source but rather

results from the combined effects of various factors. Public behavior plays a significant role in air pollution. Practices, such as burning waste, using inefficient cooking stoves, and engaging in activities that release harmful pollutants (such as smoking in public places) contribute to the overall degradation of air quality. When multiplied across a large population, these individual actions can have a substantial impact on overall air pollution levels (Thatcher, 1990).

Vehicular emissions also contribute significantly to air pollution. The theory suggests that the cumulative effect of numerous vehicles on the road, each emitting pollutants, such as carbon monoxide, nitrogen oxides, and particulate matter, leads to increased air pollution. Factors such as outdated vehicle technology, inadequate emission control measures, and excessive traffic congestion further exacerbate the problem.

Furthermore, industrial emissions from factories and power plants are major contributor for contaminating the air. The cumulative impact theory posits that the combined emissions from multiple industrial sources, including the release of pollutants like sulfur dioxide, volatile organic compounds, and particulate matter, can have a severe impact on air quality. Additionally, factors such as outdated equipment, insufficient pollution control measures, and suboptimal waste management practices can amplify the overall pollution levels.

Overall, the cumulative impact theory also suggests that air pollution results from the additive effects of public behavior and industrial emissions. By recognizing the interconnectedness of these factors, it becomes clear that addressing air pollution requires a multi-faceted approach, including improving public awareness and behavior, implementing stricter vehicle emission standards, promoting sustainable transportation options, and enforcing stricter regulations on industrial emissions (Behles, 2010).

Research Hypotheses

The following hypotheses are constructed for this study:

H_1: Industrial emissions have a significant effect on the overall air quality.

H_2: Public behavior significantly affects the overall air quality.

Significance of Study

On a daily basis, part of the world news is devoted to air pollution and its adverse effects on the environment. When industrialization was expanding, people did not anticipate the adversity of the excessiveness of emissions on atmosphere. . This study tends to focus on problems caused by air pollution and examine the various causes of air pollution, such as factories, people's negligence, and lack of effective climate change policy in Pakistan. Despite the significant effects of human behavior on air pollution, this relationship has rarely been studied. Similarly, not much research has been done on the fact that air pollution affects are directly proportional to how people behave. The goal of this study is to assess the impacts of public behavior along with industrial emissions on air quality, which highlights knowledge gaps and establishes a preliminary conceptual framework for further investigation.

Scope of the Study

Air pollution stands as a critical modern challenge, aggravated by industrial progress and complex innovations. It negatively impacts the environment and the overall quality of life. This study investigates key factors behind air pollution, such as public attitudes, industrial emissions, and many more. The research focuses on two aspects: the influence of public behavior and the impact of industrial emissions on air quality. The study covers diverse regions in Pakistan, selected strategically to reflect urban and industrial variations. Thereby, utilizing mixed methods, including surveys, emissions analysis, and air quality monitoring, this research aims to comprehensively understand the interplay between behavior, emissions, and air quality. The findings aim to guide air quality management, enhance awareness, and foster sustainable practices to mitigate the impacts of air pollution on health and the overall environment.

Literature Review

Several researchers like Alexander von Humboldt and John Evelyn documented the impacts of industrialization on air quality in the 18th and 19th centuries, raising awareness regarding   health and environmental consequences of pollution. During the Industrial Revolution, early social scientists like Friedrich Engels and Karl Marx highlighted the adverse effects of industrial pollution on working-class communities, emphasizing the need for improved living conditions or standards. Pollution modifies the

natural characteristics of air by various chemical and biological agents in both indoor and outdoor environments (Grove, 1996).

"(Aristotle) believed that any resource used/shared by the enormous number of users is always least cared of. A global dilemma (the tragedy of commons) is at the center of this belief." All the resources that are easily accessible like air, water bodies, and others are suffering from exploitation. There is no one to take any action over the unmonitored use of these resources. Air pollution is linked to severe behavioral, physical, and psychological health risks. Unfortunately, the inhabitants of the earth are ignorant of the long-term destructive outcomes of the concerning problem. Undoubtedly, governments must be doing their best to control air pollution by taking prior actions, but the public should also contribute to cleaning the environment in the best feasible way.

D'amato et al. (2005) concluded that air pollution is badly affected due to the consumption of non-plant-derived food items by humans. The focus should be on avoiding the use of chemical factors that are used in the agriculture sector in the form of fertilizers and pesticides. This study examined three states for clean air programs, which are setting standards for ambient air quality, monitoring, and enforcement by empirical determinants. The ambient program will highlight the areas that still need to be focused on in order to control the hazardous situation.

Industrial Emissions

Human civilization has evolved along with industrialization during the 21st century. With the rapid progression in the field of science and technology, the Industrial Age paved the way for technological advancement, which has also been a progressive and emerging trend. In the past industries were small operations that mostly produced smoke as a pollutant. That is why the pollution levels did not considerably increase because the number of manufacturers was restricted and they only operated for a set number of hours each day, which controlled the air pollution level significantly. However, when these companies expanded into full-fledged businesses and manufacturing facilities, the problem of industrial pollution began to gain more significance. Additionally, the trash from these enterprises is dumped on the land and in the water, which clearly imposes a negative impact on both the health of animals and plants. Jain (2023) predicted that some plant and animal species may eventually extinct as a

result of the toxic compounds that these industrial pollutants leak into the land and water, which may also contaminate the water and have a detrimental effect.

As a matter of fact, organizations working to combat environmental deterioration now place a high priority on the issue of industrial pollution. Therefore, countries that are experiencing the sudden and quick rise of these industries perceive it as a severe issue that has to be swiftly brought under control. Industrial pollution has various guises; it degrades the quality of soil all across the world, contaminates several sources of drinking water, and releases undesired pollutants into the atmosphere causing it exhausting for the overall climate.

On Earth, industrial pollution is causing devastation on a large scale. Every country is nearly impacted, and individuals are making unremitting efforts to raise awareness and promote change. Pollution-causing activities include:

- Coal Burning.

- Fossil fuels burning like oil, natural gas, and petroleum.

- Chemical solvents usage in the dyeing and tanning industries.

- The emission of untreated gas and liquid waste into the environment.

- Improper radioactive material disposal.

The lack of effective policies and poor enforcement drive allowed many industries to bypass laws made by the pollution control board, which eventually resulted in mass-scale pollution that affected the lives of masses. In most industrial townships, unplanned growth took place wherein those companies flouted rules and norms and unapologetically polluted the environment with both air and water toxic waste. Most industries still rely on old-fashioned methods and technologies to produce products that generate a large amount of waste. To avoid high costs and expenditures, many companies still make use of traditional technologies to produce high-end products. Many small-scale industries and factories that don't have enough capital and rely on government grants to run their day-to-day businesses often escape environmental regulations and release many toxic gases into the atmosphere. We misuse land because we see it as a resource

that belongs to us. We may start treating the land with love and respect only when we perceive it as a community to which we belong (Leopold, 1949).

The extensive increase in air pollution in Pakistan is caused by various problems, which are common but ignored at both domestic and regional levels. The only thing, which can help us control this problem is the need for collective action. This paper further discusses the emerging problems caused by industrial waste matter.

Fossil Fuels Industrial Emission

Fossil fuels are one of the hazardous sources of air pollution in Pakistan. When fossil fuels are burned at large scale in power plants the atmosphere of surrounding areas is affected badly. The burning process releases sulfur oxide, which directly affects the atmosphere. China's substantial reliance on fossil fuels prompts a proactive shift towards cleaner alternatives like nuclear, solar, and wind technologies for a more sustainable future. Thus, by investing in renewable energy infrastructure, China aims to bolster its capacity in nuclear, solar, and wind power generation, thus mitigating environmental impact and fostering economic growth. This transition signifies a crucial step in addressing global energy challenges and reducing carbon emissions (Lu et al., 2020).

Industrial Exhaust

Carbon released from vehicles, heavy machinery in enormous number of huge industries is also exhausting gas power which is likely to be carbon emission. Inconsistent electricity also forces large industries to use fossil fuels, which is also a cost-effective approach. Subsequently, the current Green Energy solution failed to evaluate the policy. There is no proper plan to control this industrial exhaust, which is affecting the environment adversely.

Vehicular Emission

One of the major sources of air pollution in urban areas or city environments is vehicle exhaust, which contains carbon monoxide, hydrocarbons, nitrogen oxide, and PM 2.5. Carbon monoxide is the largest air pollutant in the world. Every vehicle leaves its carbon footprint on the environment. The emissions related to traffic represent a major component of airborne pollution. In recent years, the measurement and analysis of real-

world vehicle emissions have been focused on by significant scientific efforts (Ropkins et al., 2007)

The primary source of vehicular emissions is the burning of gasoline or diesel fuel in internal combustion engines. As the number of vehicles on the road increases, the overall pollution level also increases, which has an increased number of pollutants. Additionally, older vehicles and poorly maintained vehicles tend to emit higher levels of pollutants due to outdated or malfunctioning emission control systems.

The impact of vehicular emissions on air pollution is particularly pronounced in congested areas with heavy traffic. In these areas, the emissions from numerous vehicles can accumulate and lead to elevated pollutant levels. High levels of air pollution can cause respiratory problems, cardiovascular diseases, and other health issues, especially among vulnerable populations, such as children, the elderly, and individuals with pre-existing respiratory conditions. It's important to tackle vehicular emissions to improve air quality and mitigate the harmful effects of air pollution on both human health and the environment.

Public Behavior

There are various conceptual frameworks that can be used to group behavioral reactions to air pollution. According to Loveridge (1971), there are four different forms of personal reactions to air pollution: psychological, social, economic, and political. Psychological reactions are beliefs about how air pollution affects an individual and the state of humanity. Social reactions cover the impact of air pollution on a person's way of life. Some significant conclusions may be drawn from research on public reactions to air pollution in this context. For example, significant research has revealed a tenuous link between cognitive knowledge of air pollution and affective anxiety over it. Similarly, numerous studies concerning air pollution have shown a poor link between concern and specific criteria behaviors (such as willingness to complain). The study of people's knowledge and perceptions regarding air pollution has received somewhat less attention. It is considered knowledge to know something about air pollution, and it is called beliefs to have anything about it, regardless of the veracity of those beliefs. Dillman and Christenson further contended that the value placed on pollution control activities in comparison to other key government expenditures is a stronger indicator of public approval of pollution control

initiatives. They discovered that though public support for pollution mitigation declined, public concern for pollution increased along with the increased pollution levels. There are numerous human actions that contribute to pollution some of them are discussed below.

Waste Management

Improper waste disposal practices, including the burning of waste, contribute to air pollution. In a likewise manner, air pollution caused by waste burning can be controlled through public awareness and responsible behavior regarding waste management, such as recycling, composting, and proper disposal of waste material. However, nothing is waste in general; there are many different types of waste (Reno, 2015).

Agriculture Activities

Focusing the agriculture activities, ammonia is the byproduct that is affecting the environment badly. It easily turns into water from ammonium hydroxide which causes irritation and burns. Around 80% of the ammonia produced by industries is used as a fertilizer in the agriculture sector. There are also other chemicals that are used in the agriculture sector as fertilizers and Pesticides which are major air pollutants.

Indoor Air Pollution

The general quality of air can also be impacted by public behavior, especially people working inside homes and buildings. Thus, improper ventilation, the use of solid fuels for cooking and heating, and smoking indoors release pollutants, which may affect the indoor and outdoor air quality. Hence, adopting cleaner cooking methods, promoting proper ventilation, and discouraging indoor smoking will help in reducing indoor and outdoor air pollution. As pollution, cannot physically be prevented, so active abatement devices must be installed (Samet, 2021).

Chemical Synthetic Products

Although indoor pollution has received less attention, it affects human life badly. Since households are where people spend the most of their time, household pollution is more hazardous. /Since households are where people spend most of their time, household pollution is more dangerous there. The use of various chemical products is also a source of carbon emissions. Perfumes, detergents, and cooking fumes are the sources of indoor air pollution. Additionally, smoking tobacco also releases harmful pollutants

that can cause various diseases, like cancer, liver issues, and immune system issues.

Ecological Impacts

Endangerment of Wildfire

Several diseases are adversely affecting both humans and animals. The toxic atmosphere is another factor contributing to the decreased reproductivity rates. There are a few special habitats that are being unseen and abandoned day by day. The overall endangerment of wildfire has also affected the overall ecosystem. A small number of hazardous chemicals also wash up on the water's surface, endangering fish and marine life.

Acid Rain

Sulfur and nitrogen oxide are released when fossil fuels are burned in industries; these emissions mix into the air and affect the environment. When these dangerous elements react with the air and water, it creates acid rain. It looks like regular rain, but it is much more hazardous than pure rain. It changes the pH levels in the soil. It removes the nutrients that trees need for their growth.

Global Warming

Climate change is a covert problem these days, which is dangerous for human existence. Probably the earth's global warming is one of the most concerning and harmful repercussions for scientists and environmentalists. High emissions of CO_2 and methane result in greenhouse gases, which are directly responsible for global warming. Most of this radiation is the result of industrial activities. Of course, solving this problem can be compensated by carrying out social responsibility and the actions of companies and factories.

Industrial processes cause enormous amounts of chemicals, hydrocarbons, and organic molecules to be emitted into the atmosphere. There is a lot of carbon dioxide in the atmosphere, which has a greenhouse effect. Greenhouse gases are beneficial to the environment as they absorb infrared light from the planet's surface. These gases are present in the atmosphere in excess, which has led to a recent shift in the climate.

Health Problems

Air pollution has become a prevalent reason for the cause of irritation in the eyes, nose, and throat. These symptoms do not cause severe issues among people; however, they do suffer from these infections very badly. It creates respiratory and immune problems, such as asthma. Heart disease is more common in people who are exposed to air pollution on a regular basis. Human life is affected by both outdoor and indoor air pollution. Similarly, cancer and liver problems are increasing day by day. Therefore, government should spread awareness among citizens regarding the impact of air pollution by using media or social media for their campaigns.

## Environment Protection Regulations in Pakistan

The beginning was in 1975 when the Environmental Pollution Control Organization (EPCO) was established in the public health engineering department of Punjab to ensure the control, reduction, and elimination of air pollution. EPCO has focused few environmental attributes, but unfortunately, there was no detailed work due to limited resources and scope. Afterward, in December 1983, under the Pakistan environment protection ordinance a provision was made to establish the Provincial Environment Protection Agency. In 1985, a request was made to the federal government to delegate powers to Environment Planning and Housing Physical Department on priority.

In 1987, Punjab was the first province where an environment protection agency was created for the best interest of their citizens. In 1980's the oil/petroleum consumption rose by 287% in Pakistan, which was one of the biggest causes of air pollution. The industries were also using fossil fuels and releasing harmful gases which were affecting the environment badly. A separate administrative unit, the Environment Protection Department formed in 1996. After that, EPA detached from HP and the EP department and started working under EPD Punjab (Opitz-Stapleton et al., 2021).

In 1997, the country's Environmental Protection Act (PEPA) was the most serious legislation piece in the country's history. Under this act, Federal and Provincial Environmental Protection agencies were formed to supervise and implement the rules and regulations. Along with this, National Environmental Quality Standards (NEQS) were introduced, which mandate ambient air quality and carbon emissions. The Pakistan Environment protection agency was a federal regulator, which was under

the federal ministry of climate change. An Independent body Pakistan Environment protection council (PEPC) established under PEPA to monitor EPAs and act enforcement. PEPC includes members from the wider society, which includes people from civil society, NGOs, and associations. Let us have a look at the administrative hierarchy under PEPA (Naureen, 2009).

Figure 2

Administrative Hierarchy under PEPA
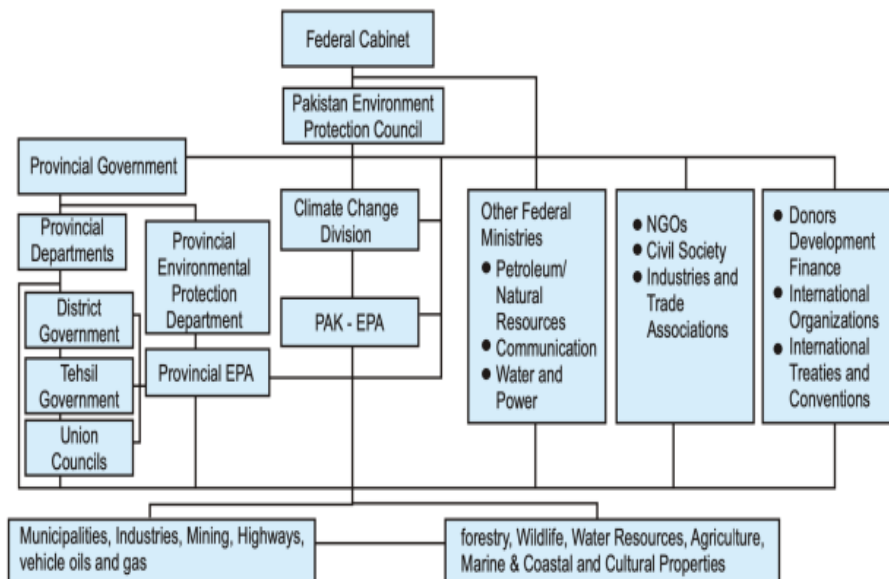
Pakistan enacted the Climate Change Act in 2017, which provides a legal framework for addressing climate change and its impact on various sectors. The act aims to reduce greenhouse gas emissions, promote climate-resilient development, and enhance adaptive capacity.

The Government of Pakistan launched the Clean and Green Pakistan Initiative, aiming to address environmental challenges across the country. This initiative focuses on improving solid waste management, promoting tree plantation campaigns, and creating awareness about environmental issues.

In an effort to tackle plastic pollution, the Government of Pakistan banned the use, manufacturing, and sale of non-biodegradable plastic bags

in the capital city, Islamabad, in 2019. Similar bans have been implemented in other provinces and cities as well.

The ABCD project's Vehicle Pollution Control programme, failed to meet its objectives since no campaigns were run to encourage the use of catalytic converters for emissions reductions in gasoline-powered vehicles. ABCD project, which was started in 2009 by the Pakistan Environmental Protection Agency (Pak-EPA), includes the Industrial Environmental Improvement Plan, Industrial Survey Programme, Pakistan Green Seal Programme, Environmentally Friendly Brick Manufacturing Programme, and Vehicular Pollution Control Programme. Jahan claimed that the Industrial Survey Programme also collapsed because the Ministry of the Environment only carried just one of the 16 scheduled nationwide surveys.

In order to advance toward the global goal of stabilizing GHG concentrations in the atmosphere, the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement call upon parties with more financial resources to help those who are less endowed and more vulnerable. Additionally, it is anticipated that rich nations will take the initiative in mobilizing climate funding. Pakistan has had relatively little access to global climate flows up to this point. Although it will need to meet strict eligibility requirements, its characteristics of comparatively high climate sensitivity and low wealth per capita might enable it to access concessional climate money.

According to a report from the World Bank, the annual damage to the environment in Pakistan is approximately Rs.365 billion. In which 1% of this damage is due to indoor air pollution, which is mainly caused by public behavior, vehicle consumption, and industrial emissions. the comparative data of Pakistan AAQS with South Asian countries (Khwaja & Shams, 2020) is stated below in Table 1.

Table 1

Comparative Data of Pakistan AAQS with south Asian countries.

Parameters (Time Average)	Pakistan	AAQS for South Asian Countries (µg/m3)					WHO
		India	Bhutan	Sri Lanka	Bangladesh	Nepal	
Carbon Monoxide	5	2	2000	10000	10	10000	N/G*

Parameters (Time Average)	Pakistan	AAQS for South Asian Countries (µg/m3)					WHO
		India	Bhutan	Sri Lanka	Bangladesh	Nepal	
(CO) (8 Hours) Nitrogen Dioxide (NO2) (24 Hours)	80	80	N/G*	100	N/G*	80	N/G*
Sulphur Dioxide (SO2) (24 Hours)	120	80	80	80	365	70	125
Ozone (O3) (1 Hour)	130	180	N/G*	200	235	N/G*	150-200
Lead (Pb) (Annual)	1	0.50	N/G*	N/G*	0.5	0.5	0.5-1
0PM (PM10) (24 Hours)	150	100	100	100	150	120	50
PM (PM2.5) (24 Hours)	35	60	N/G*	50	65	N/G*	25

Methodology

In today's era, air pollution is a very big problem, and a lot of research has been done in this area. However, the current study adds to the existing knowledge of research by selecting air pollution as independent variables for that have a role in air pollution, such as general causes of air pollution, attitude towards air pollution, and the effect of industrial factories on air pollution. For this purpose, a questionnaire was prepared and responses were collected from more than hundred people. For each question special values such as agree, strongly agree, neutral, disagree, and strongly disagree were given for each question. The questionnaire was conducted in an adaptive form. Asking these questions was a bit difficult because collecting individual opinions from the general public was a bit hard and difficult task.

A research project's methodology is its lifeblood, and its analytical process serves as its foundation. The questionnaires were physically gathered by the researcher, who also examined them to ensure that they had been correctly completed and returned. Furthermore, SPSS software was used for accurate and quick data processing to create, arrange, and analyze the data. Measures of Central Tendency (Mean, Median, Mode) and

Measures of Dispersion (Range, Standard Deviation, Variance) of control variables are calculated.

Research Design

The study employed a quantitative survey approach, which resulted in the establishment of fundamental knowledge principles. A survey is a way of gathering information that involves a questionnaire to a group of people. This design has been shown to be an effective research strategy (Orodho, 2003). For this study, a quantitative survey approach was utilized to examine the link between factors impacting Air Pollution. Quantitative data will be collected through structured surveys distributed to the selected sample. The survey will include questions about knowledge, attitudes, and behaviors related to air pollution and environmental protection.

Target Population

A target population comprises a group of people who share one or more traits and are all interested in the same thing. The target population is the general public.

Sampling Procedure and Sample Size

Convenience sampling, a non-probability sample method, was utilized in this study. Under this study, a total population of 30,000 people were observed and the sample size was 379, respectively. However, convenience Non-probability sampling tactics are less objective than probability processes since they rely on sampling when participants are selected for the study voluntarily, at the researcher's recommendation, or through other means. Convenience sampling works well because it is for a quantitative study as it is less expensive, takes less time, and is simpler than other sampling techniques.

Questionnaire

Air Pollution

Sr. No	Questions	Source
AP1	Air pollution is affecting the environment in a hazardous manner.	Stern (1977)
AP2.	Air pollution is being raised due to the collective action of humans.	Stern (1977)

Sr. No	Questions	Source
AP3.	Nature-released substances are more harmful than ones synthetic (released from Industries).	Stern (1977)
AP4.	The government has no such authentic policies on controlling air pollution.	Stern (1977)
AP5.	Air pollution is affecting human lives badly.	Stern (1977)
AP6.	Recycling programs should be put in place and promoted across the country.	Stern (1977)

Public Behavior

PB1	In this modern era, the public really doesn't care about the environment.	Evans and Jacobs (1981)
PB2.	The public plays a key role in raising air pollution.	Evans and Jacobs (1981)
PB3.	Public Pollutes by throwing garbage in canals.	Evans and Jacobs (1981)
PB4.	Garbage or waste material should be disposed of.	Evans and Jacobs (1981)
PB5.	Plantation should be increased in the environment.	Evans and Jacobs (1981)
PB6.	People should follow strict rules on violating the environmental conditions.	Evans and Jacobs (1981)
PB7.	Improving the environment is the responsibility of every citizen.	Evans and Jacobs (1981)

Industrial Emissions

IVE1.	Industries are affecting the environment in a hazardous manner.	Hussain et al. (2018)
IVE2.	We don't have policies or strict rules over industries to use inappropriate tools or chemicals.	Hussain et al. (2018)
IVE3.	Recycling programs should be put in place and promoted across the whole city.	Hussain et al. (2018)
IVE4.	The waste material should not be released in canals by industries.	Hussain et al. (2018)

IVE5.	The combustion of fossil fuels like coal, petroleum, and other factory combustibles is a major cause of air pollution.		Hussain et al. (2018)
IVE6.	Industries do release harmful gases in the environment, which leads to multiple health diseases.		Hussain et al. (2018)
IVE7.	Industries should not be placed in urban areas.		Hussain et al. (2018)

Descriptive Statistics

It clearly shows the average age, qualification, and income along with a majority of the male gender. Low standard deviation values indicate that most of the data is clustered around the mean or average value.

Table 2

*Measures of Central Tendency and Measures of Dispersion of Control Variables*

		Gender of respondents	Age of respondents	Education of respondents	Income of respondents
N	Valid	103	103	103	103
	Missing	0	0	0	0
Mean		1.48	2.59	3.51	3.50
Median		1.00	3.00	3.00	4.00
Mode		1	3	3	4ᵃ
Std. Deviation		.540	.760	.575	1.413
Variance		.291	.577	.331	1.998
Range		2	4	2	4
Minimum		1	1	3	1
Maximum		3	5	5	5
Sum		152	267	362	360

a. Multiple modes exist. The smallest value is shown

Distribution by Gender

Gender is not a binary, but a spectrum of identities. By delving into data distribution by gender, the intricacies of diverse experiences were unraveled, shedding light on disparities, achievements, and the need for inclusive policies that empower all individuals. Therefore, the data was collected from male, female, and transgenders. There should be no disparity among societies.

Figure 3
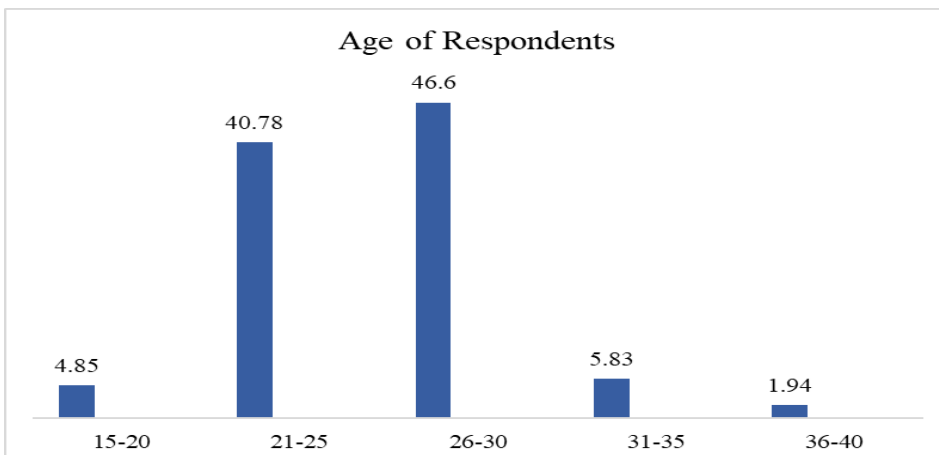*Distribution by Gender*

Gender of Respondents
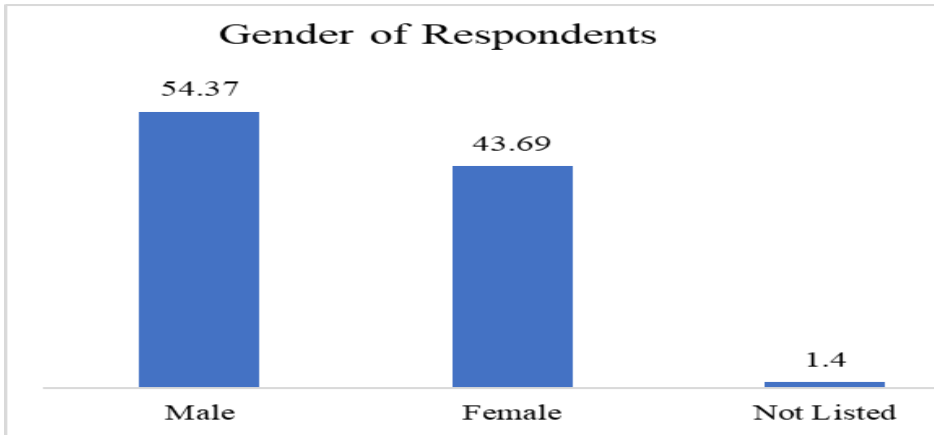
There was not much difference in number of males and females. The data was collected in an equivalent manner as shown in the pie chart above.

Distribution by Age

Age is not merely a number, but a powerful dimension that shapes our society. By exploring data distribution by age, a treasure trove of insights was unlocked, unraveling the unique preferences, behaviors, and challenges faced by different generations." The authenticity of data collected should be judged based on the age or education.

Figure 4
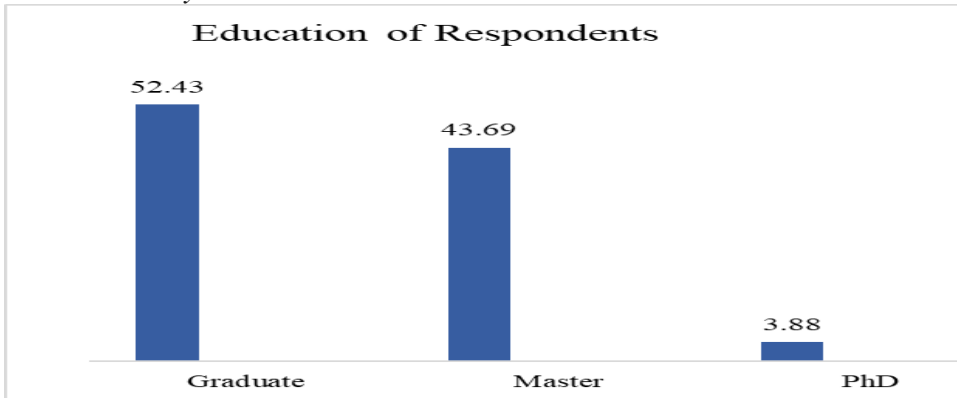*Distribution by Age*

Age of Respondents

Distribution by Education

"Educational attainment acts as a catalyst for societal progress. When data distribution dissected by education, a profound understanding of knowledge gaps are gained, which develop skill development, and the transformative impact of education on individuals and communities."

Figure 5
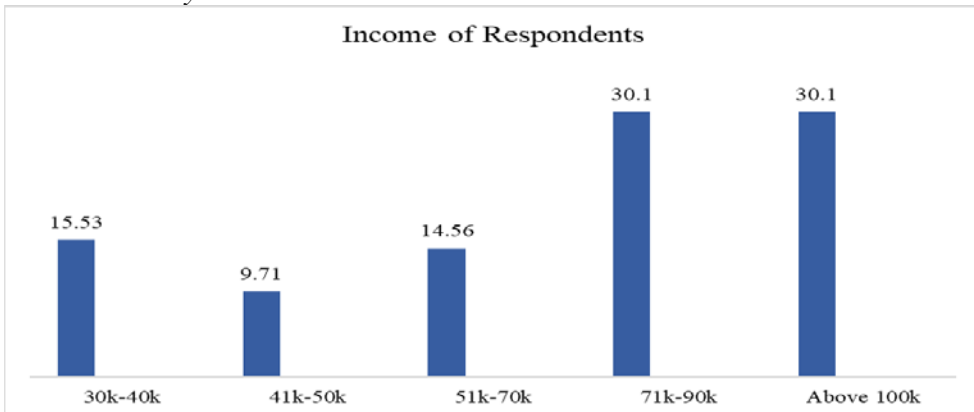*Distribution by Education*

Distribution by Income

"Income inequality is a stark reality that shapes our world. Through data distribution by income, we confront the disparities that exist within our societies, highlighting the impact of wealth, resources, and opportunities on various aspects of life."

Figure 6
Distribution by Income

Inferential Statistics

Multiple regression analysis was used for the hypothesis testing section to understand the relationship between the two independent variables along with the dependent variable.

Table 3
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error	R^2 Change	F Change	$df1$	$df2$	Sig. F Change
1	.620[a]	.385	.346	.476	.385	10.011	6	96	.000

Note. a. Predictors: (Constant), Income of respondents, industrial effects, Age of respondents, Gender of respondents, Public behaviors, Education of respondents

The above table states that approximately 34.6% of the variability in the air quality can be explained by the independent variables (public behavior, industrial effects) and control variables (gender, age, income, education).

Table 4
ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.610	6	2.268	10.011	.000[b]
	Residual	21.752	96	.227		
	Total	35.362	102			

Note. a. Dependent Variable: Air pollution
b. Predictors: (Constant), Income of respondents, industrial effects, Age of respondents, Gender of respondents, Public behaviors, Education of respondents

Table 5
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.212	.468		2.589	.011
	Public behaviors	.594	.108	.570	5.473	.000

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
industrial emissions	.082	.097	.088	.846	.400
Gender of respondents	-.079	.103	-.072	-.767	.445
Age of respondents	.032	.086	.041	.367	.715
Education of respondents	-.029	.109	-.029	-.268	.789
Income of respondents	.049	.037	.118	1.325	.188

Note. a. Dependent Variable: Air pollution

Figure 7

Statistical Model

$B = 0.594$ $t = 5.473$ $p = 0.400$

$B = 0.082$ $t = 0.846$ $p = 0.000$
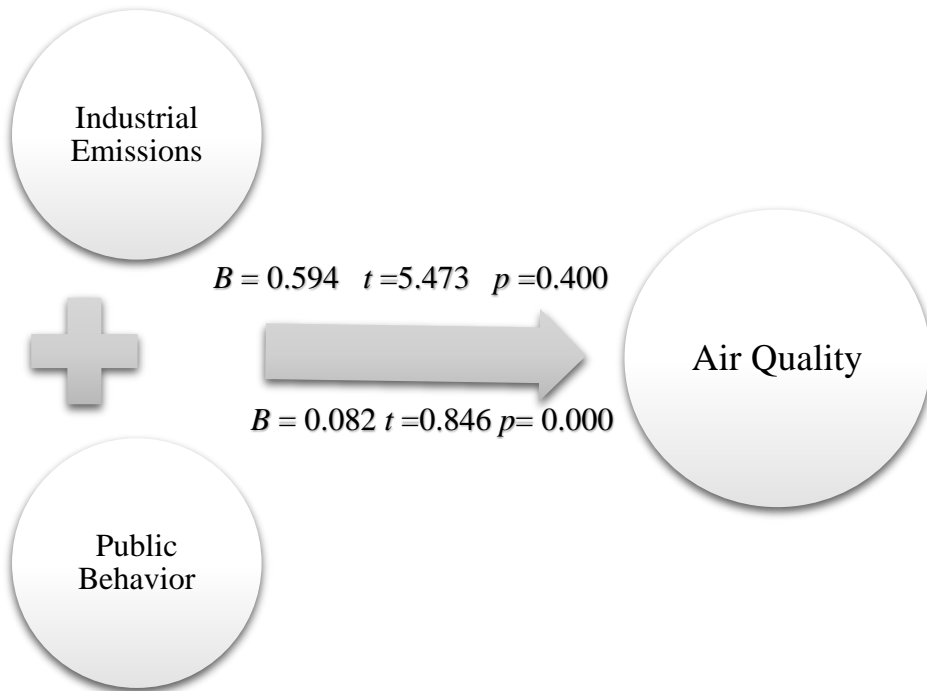
Hypothesis 1

The air quality is getting polluted day by day, which is a resultant cause of bad human activities and behavior. The above-presented results show that the relationship between air pollution and public behavior is significant. However, it indicates that industrial effects are positively associated with air pollution.

1-unit increase in public behavior leads to a 0.594 unit increase in air pollution, keeping all other variables constant.

Hypothesis 2

The above-presented results depicted that the relationship between the industrial effects and air pollution is not significant. However, it also indicates that industrial emissions are positively associated with air pollution.

Discussion

The data presented in the hypotheses suggests an association between air quality and public behavior, as well as the impact of industrial effects on air pollution. It also highlights the percentage of air quality explained by variables, such as public behavior, industrial effects, and control variables.

In the context of emerging air pollution in Pakistan, these findings can provide valuable insights into the factors contributing to the problem.

Hypothesis 1 suggests that air quality is getting worse due to adverse public behaviors or actions. This implies that individual behaviors, such as excessive vehicle emissions, improper waste disposal, or inefficient energy usage by the public, could be contributing to the increasing air pollution. It is important to understand that these behaviors through awareness campaigns, education, and policy interventions aimed at promoting environmentally friendly practices. Encouraging the public to adopt sustainable transportation methods, practice waste management, and reduce energy consumption can help mitigate air pollution (Berry et al., 2017).

Furthermore, Hypothesis 2 indicates that industrial effects have a positive association with air pollution. This finding suggests that industrial activities, such as manufacturing processes, emissions from power plants, and other industrial sources, contribute to air pollution in Pakistan. This highlights the need for stricter regulations, monitoring, and enforcement of

pollution control measures within the industrial sector. Implementing emission standards, promoting cleaner technologies, and encouraging industries to adopt sustainable practices can help reduce the negative impact on air quality (Cole et al., 2005).

To tackle Pakistan's emerging air pollution issue, policymakers, environmental agencies, and the public must collaborate to implement effective strategies. These strategies should focus on reducing emissions from industrial sources, promoting sustainable practices among the public, and investing in cleaner technologies. Additionally, enhancing monitoring systems, conducting regular air quality assessments, and raising awareness about the health risks associated with air pollution are crucial steps in combating the problem.

The data supports the hypothesis that public behavior and industrial effects are associated with air pollution. Understanding these relationships can guide policymakers and stakeholders in formulating targeted interventions to improve air quality in Pakistan. By addressing individual behaviors, regulating industrial emissions, and implementing sustainable practices, it is possible to mitigate emerging air pollution challenges and create a healthier environment for the population.

Theoretical Contribution

The Cumulative Impact Theory is a conceptual framework used to understand the combined effects of multiple sources of pollution on a particular environment or population. When applied to air pollution, the theory suggests that the impacts of multiple pollution sources are not simply additive but can interact and accumulate, leading to more severe and complex consequences than the individual sources alone would cause. The theoretical contribution of the Cumulative Impact Theory to air pollution lies in its ability to address the limitations of traditional approaches that often focus on individual sources or pollutants in isolation. By considering the cumulative effects of multiple pollution sources, the theory provides a more comprehensive understanding of the overall pollution burden on a particular area or population.

Here are some key theoretical contributions of the Cumulative Impact Theory in relation to air pollution:

Synergistic Effects: The theory acknowledges that several pollution sources can interact synergistically, which means that the aggregate of their

individual effects can be larger than the total of their combined effects. For instance, the interaction of emissions from industrial facilities, traffic, and home heating systems may result in higher pollution levels and more serious health effects than one source could produce alone.

Conclusion

The current study demonstrated a clear link between air quality and public behavior in Pakistan as a clear indication of the increased air pollution issue. The results indicate that individual actions, such as inefficient energy use and improper waste disposal, contribute to worsening air quality. The data also highlighted that while the relationship between industrial effects and air pollution might not be significant, there is a positive association between industrial emissions and air pollution levels. These findings underscore the need for multifaceted strategies to address air pollution.

Unfortunately, there are very fewer efforts made at the international, industrial, and governmental levels to lessen the severity of air pollution, and much of the burden for doing so rests with the general public. The world is currently focusing its efforts on preventing global warming and as a result, a number of ideas and experiences are being used to develop novel and unconventional ways to minimize pollution. Air pollution is one of the indicators of a bad lifestyle, which must overcome in order to create a better future. Long-term solutions to this issue, such as institutionalizing the use of public transportation, permanently removing manufacturing from urban areas, fostering the culture of planting saplings, and embracing a healthy lifestyle will go a long way towards solving it. Short-term fixes may include using an air purifier, building a greenhouse in enclosed spaces, and conserving electricity. Thus, saving future generations from bad air quality.

Policy Implications

The Cumulative Impact Theory suggests that regulatory and policy frameworks need to shift from a single-source or pollutant-centric approach to a cumulative impact approach. It calls for integrated and coordinated efforts to assess and manage the cumulative effects of air pollution, including the implementation of emission controls, land-use planning, and public health interventions.

Overall, the Cumulative Impact Theory offers a theoretical framework that enhances our understanding of the complex and interconnected nature

of air pollution. By considering the cumulative effects of multiple pollution sources, this theory provides insights that can inform more effective strategies for pollution management, public health protection, and environmental decision-making.

Recommendations

To reduce pollution, public transit must be used more frequentlyAdvice that we hear again and again might not be taken seriously. But you might start with easier tasks. For instance, you can take this route with just one car and save energy and money if you and your coworkers share a location and commute at the same time.

There should be some efforts made by people to control air pollution at individual levels and societies. There must be awareness activities and parents should realize that their children may get sick due to hazardous air quality so that they can have a better look at the issue. Try to have a garden or even a small green space in your yard or balcony, avoid burning garbage, dry leaves, or other materials in your yard, and light a fire outdoors. If you can, use compost in the garden and clean the yard or parking lot with environmentally friendly cleaning products.

- Establish stringent emission standards for both vehicular and industrial sources to effectively curb pollution levels.

- Strengthen monitoring systems and ensure strict adherence to emission regulations through regular inspections.

- Implement consistent regulations for all industries regardless of affiliations, preventing biased treatment.

- Engage the Pakistan Business Council to disseminate preliminary strategies for addressing gas-related air quality challenges.

- Create dedicated Environmental Squads in major cities under provincial administrations to oversee pollution control measures.

- Revise existing air quality policies, legislation, and standards to align with contemporary environmental demands.

- Encourage the adoption of renewable energy sources like solar, wind, and hydroelectric power to reduce fossil fuel dependence.

- Foster electric vehicle adoption by offering incentives and establishing proper charging infrastructure. Promote efficient waste disposal methods to minimize air pollutant release.

Addressing air pollution requires a multi-faceted approach, which involves government policies, public participation, and industrial responsibility. By implementing these recommendations, Pakistan can make significant progress in reducing air pollution and improving the quality of life for its citizens.

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