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Implications of Pollution and Weather Fluctuations on the Economic Health of India's Labour Workforce

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ABSTRACT

India's quest for globalisation and increased economic growth has been long and arduous, more so for some than others. In the past 4 years, India has seen a massive boom in the number of infrastructural projects aimed mainly at creating job opportunities to become a global superpower, but the weakening of environmental protection has marred this progress. Most daily wage workers in India earn 30-60% of the government's prescribed minimum wage (Labour Availability on Construction Projects, 2020) and aren't aware of their rights. The main objective of this paper is to ascertain the different causes of ill health in India's unskilled labour, determine the relationship between poor health and labour productivity and harness computational economics to alleviate the harmful impacts the workforce faces owing to pollution.

Keywords: economy, pollution, health, environment, labour

Introduction

The implications of pollution on a country's economy and matters of health are dire, especially on those of downtrodden communities such as daily wage labourers. For instance, in 2019, over 1.6 million deaths were attributed to air pollution, a lethal combination of ambient particulate matter pollution and household air pollution. (Dandona, 2021)

Looking at India through a microscope, New Delhi has been the hotbed for pollution- related health issues and deaths. A WHO report from 2014 found that New Delhi's levels of particulate air pollution were the highest among 1600 large cities globally, the highest contributing factors being industrial and vehicular pollution. No matter how many schemes and policies were rolled out by the government, New Delhi remains as polluted as ever. While urban and rural areas both dealt with the effects of pollution, there was extreme inequity between the areas. Poor living

ISSN: 2455-8834

Volume:09, Issue:10 "October 2024"

conditions, deprivation of necessary resources to combat pollution, and existing meagre health were the primary causes. (Gupta et al., 2019, 94-95)

When it comes to India's labour workforce, they are forced to deal with the dire circumstances of the impacts of pollution and the weather. India suffers from the most pronounced heat-related labour losses with reduced productivity due to most labourers working outdoors without proper protection.

Better exploring the effects of pollution is possible through machine learning and data analysis. Recent technological advances prove that the combination of satellites and ground monitoring aids in reanalysing data that might have been impacted by collector bias (Aguilar-Gomez et al., 2022) Machine learning and other AI tools deliver a higher level of accuracy while analysing large data sets and making predictions (Li et al., 2023) making it an ideal choice to examine the relation between economics and pollution and mitigate the effects to the fullest.

Background

Mitigating the effects of pollution on public health and the economy is of utmost priority, but where to begin? Throughout history, the economy and external factors like air pollution were looked at separately, but now, with pollution directly affecting economic growth, policies regarding the economy can no longer be drafted in isolation. Air pollution has significant implications for individual health, companies, and the government. Alarming statistics have come to light— nine out of ten people globally breathe in highly polluted air, leading to long-lasting health consequences, and over four million people die every year from exposure to pollution, both outdoor and indoor. (Oliva et al., 2019)

The relationship between pollution levels and economic indicators has been studied for decades. According to the World Air Quality Report in 2019, 21 out of the world's 30 worst-polluted cities are in India. Air pollution, by some, is considered a natural by- product of economic growth, which limits the response towards it. From a macro perspective, the health-related costs of air pollution are constantly rising, as pollution levels never decrease. In the USA, respiratory diseases caused by pollution cost over $820 billion annually. Burning fossil fuels and the smoke from wildfires are two of the biggest contributors to the hazardous pollution levels in the USA. (Bishop, 2023) A study conducted using data from 8 OECD countries showed that a seemingly meagre 1% increase in emissions increased healthcare expenditure by 2.5%, directly linked to the per capita expenditure. (Li et al., 2020) Premature deaths caused by air pollution cost the economy an estimated $95 billion, a whopping 3% of India's GDP, in 2019. (Economy and Air Pollution) A study central to the US and Europe found that premature deaths could be avoided by a 20% reduction in global anthropogenic emissions. (Im et al., 2018) The fact of the matter is

ISSN: 2455-8834

Volume:09, Issue:10 "October 2024"

clear, tackling pollution and taking effective, preventive measures will benefit a country's quality of life and the economy. New Delhi, in 2019, lost 6% of its GDP to air pollution, equivalent to 3 major cities combined. (Air Pollution and Its Impact on Business: The Silent Pandemic). Air pollution costs the economy dearly, leading to lower labour productivity, premature mortality, increased health expenses and welfare losses, to name a few. (Air Pollution and Its Impact on Business: The Silent Pandemic) The modern ecological movement during the 1960s cited economic development and growth as the main explanation for pollution. Indira Gandhi, the then Indian Prime Minister, on the other hand, argued that poverty and the lack of economic development were also detrimental to pollution, mostly in terms of sanitation. (Ali & de Oliveira, 2018)

Economic indicators like productivity and healthcare costs have always been affected by pollution levels. Labour supply and worker productivity are adversely affected by air quality and pollution, leading to an increase in sick leaves, which in turn leads to a reduction in average hours worked and subsequent pay. (Hospido et al., 2023, 17) A study conducted in China showed that particulate exposure, which is the foremost cause of illness, causes a variety of symptoms in an individual, impeding their work performance. Another concern was traffic, a major contributor to pollution, which reduced productivity and raised employees' stress and timing. (Maas, 2016).

The global economic cost of air pollution is a never-ending spike. A 2018 report by Greenpeace Southeast Asia and the Centre for Research on Energy and Clean Air proved that air pollution impacts the economy in irreversible ways like higher rates of respiratory diseases, diabetes, and lowered ability to work among the labour force. India ranked second highest in bearing economic costs of air pollution. (McCarthy, 2020)

The disposition of India's working class acts as a microcosm of this large-scale issue. A study found that 57% of migrant workers preferred the living conditions of their hometowns compared to Delhi (Gunjan, 2019), possibly staying back for the opportunities.

Most workers are unable to read and write and haven't been made aware of social security schemes set in place for their benefit. To meet their family's consumption requirements, members are compelled to work even during their old age, and in the process, they face high risks of contracting TB, pneumonia and asthma. Their exposure to harmful dust, chemicals, and pollutants severely impacts their respiratory health. Elderly workers are already prone to more diseases due to weakened immune systems and declined physical resilience, putting them at risk of death, but unfortunately, most of them have no choice. (Alam & Mitra, 2012)

In a highly competitive field of unstable incomes and physically taxing jobs, compromised

ISSN: 2455-8834

Volume:09, Issue:10 "October 2024"

immune systems and physical weakness are a huge liability. There is an inverse relationship between ill-health of workers and number of hours worked and subsequent wages earned. As child workers grow into adults low on energy and in dire health, the young children and old members of the families have to make up for the lost hours they are unable to put in, leading to a constant cycle of poor health and lower productivity and income. (Reddy & James, 2024)

Discussion

For India's labour workforce, many working hours are lost to unbearable heat, decreasing the overall amount of money they make in a day. Most families don't have adequate resources like electricity and running water to mitigate the effects of high temperatures in summer, which in turn leads to the production of odour, flies, and microbes, causing diseases and skin issues in workers. (Sofi, 2023)

In winter, winds blow in from the northwest with fumes from burning fields as well as loose soil particles. This, combined with the celebrations of Diwali and Dussehra, increases the amount of dangerous particulate matter and air pollution tenfold. The demand for local products is extremely high during festivities and in the quest for opportunities for work in highly competitive fields, workers are forced to work disproportionately long hours in slovenly conditions. (Saxena et al., 2021)

There exists an economic theory of pollution which details how the two are inextricably linked. The Handbook of Environmental Economics states-

Physically, pollution occurs because it is virtually impossible to have a productive process that involves no waste; economically, pollution occurs because polluting is less expensive than operating cleanly.

There is a lot of research on the theory, which is highly complex and nuanced. Pollution, particularly air pollution, affects groups of people differently, generally according to their socio-economic status. Some of the interventions proposed as solutions are introducing a pollution tax and maximising social welfare by formulating ways to combat environmental damages. (Helfand et al., 2003)

"What is the level of pollution that society should accept?" is a pertinent question that Stephen Smith asks in his book Environmental Economics. He says a civilized society should be willing to eliminate pollution, but while reducing pollution is necessary, a clean environment comes at a cost. Can a price be put on the priceless act of using resources for pollution control? Costs rise sharply the more rigorously we try to control pollution, so how much are we, as a society, willing to pay for the results?

ISSN: 2455-8834

Volume:09, Issue:10 "October 2024"

The World Bank identified industrialization, crop residue, fertilizers and pesticides and urbanization as the primary causes of health risks in low and middle-income countries. The report laid out the negative link between the economy and health that mostly takes a toll on the underprivileged.

> Pollution stunts economic growth, exacerbates poverty and inequality in both urban and rural areas, and significantly contributes to climate change. Poor people, who cannot afford to protect themselves from the negative impacts of pollution, end up suffering the most. (*Pollution*, 2023)

Air pollution has long-term effects on virtually everything in its way, permanently impairing economic growth, development and public welfare. Adding to the list of problems already discussed, reduced tourism, low investment rates, increased energy costs, damage to livestock and crops, and high costs of cleaning up the environment are some others. (*The Economic Impact of Air Pollution on Communities: Negative Aspects*) With the rapid, impressive technological advances, harnessing computational economic methods to battle rising pollution levels can greatly help the current situation. Machine learning promises more effective urban planning, assisting in creating more human- centric cities with less air pollution. Using Artificial Intelligence to examine real-time data (WEF, 2018) on health risks that arise due to pollution can benefit the present and future generations.

Pollution has established itself as one of nature's destroyers, slowly but surely disturbing the equilibrium that has been set in place over the centuries. Forecasting pollution levels and their threat is of utmost importance to implement a warning system, allowing people to take precautions. AI has the unparalleled ability to analyse data and pinpoint areas of concern accurately. (Subramaniam et al., 2022)

The quantification of a problem that only presents itself through abstract and indirectly related symptoms now has the prospect of being gauged more efficiently.

Quantifying the economic effects of pollution is possible through analysis of reports and tools used in research studies. The BenMap-CE (Benefits Mapping and Analysis Program) tool is one of the most effective means to estimate the adverse effects of pollution on the economy and health. It takes published literature as its primary source of data and calculates health impacts. The results of the tool help formulate policies for reducing air pollution and gauging the realistic burden of air pollution on human health. (*How BenMAP-CE Estimates the Health and Economic Effects of Air Pollution | US EPA*, 2024)

There are some powerful statistical tools used to study factors like pollution and its relation to the economy and the labour force. One of the most used tools is the regression model, which is

ISSN: 2455-8834

Volume:09, Issue:10 "October 2024"

used to understand the relationship between a dependent variable and one or more independent variables. Linear regression is the most common form, establishing how a change in one variable impacts a change in another. (Beers & Rubin, 2024) Regression models can be used to define the relationship between parameters like weather and pollution fluctuation and labour productivity. In times of low rates of productivity, a market with an inelastic demand for products can be constructed in ways that enable raised prices to alleviate potential working hours for the workforce.

Polynomial regression is a linear model algorithm modified to increase the accuracy, (*Machine Learning Polynomial Regression*) for instance, it can be used to capture complex patterns to identify how much productivity would decrease in the context of various environmental fluctuations.

Time series analysis is a tool that examines data collected at regular intervals to discover underlying patterns and trends. It enables informed decision-making and highly accurate predictions based on historical data. (*Time Series Analysis*) It can be used to forecast the demand for medical treatment and resources can be stocked and allotted to meet the market demands efficiently.

Survival analysis is a branch of statistics that studies the amount of time it takes for an event to occur. (Liberto & Kvilhaug) Based on morbidity rates of workers, for example, survival analysis can be done to predict the amount of time before a health crisis is serious enough to render the worker incapable of working. This allows for timely intervention so that the families of the workers can be compensated appropriately for their loss.

The negative association between exposure to pollution and risk of mortality have serious implications for public health (Higbee et al., 2020) and in turn, the economy. The Cox Proportional Hazards Model is used to study how different factors affect the period before an event occurs. In the context of this paper, this model has the potential to test the survival time of groups of people while allowing for other factors, making the ‘hazard’ the dependent variable. (Bewick et al., 2004)

Daily activities, whether industrial, transport-related, or domestic, release perilous pollutants into the environment. Monitoring and predicting air quality levels using AI and machine learning techniques is essential today, especially in developing countries. While COVID-19 saw a drastic, yet temporary, drop in pollution levels (Kumar & Pande, 2023), it is now back to normal.

Conclusion

India’s drive for economic growth is relentless and comes at the cost of the very people

ISSN: 2455-8834

Volume:09, Issue:10 "October 2024"

facilitating it. The confluence of unprecedented industrialization and weak environmental regulations combined with generational poverty has created a cycle of never-ending challenges for the most vulnerable sections of the country. The findings of this paper underscore the subtle but insidious cause-and-effect relationship between poor environmental and working conditions and increased poverty, definitively linking poor health and labour productivity.

By leveraging computational methods, we can not only determine practical solutions to mitigate the economic effects of pollution but also gain a deeper sense of the gravity of the issue through the predictions drawn up.

However, these solutions are only a short-term fix for a problem that is rapidly mushrooming as India reaches new heights of technology and civilization. To address and jettison the root causes of labour exploitation and environmental degradation must become a government priority. This paper presents a series of alleviation techniques that act as placeholders till the real issue is taken up.

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Volume:09, Issue:10 "October 2024"

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