



**AIR POLLUTION**

# and its impact on **business**

**T H E   S I L E N T   P A N D E M I C**



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# Acknowledgements

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This is an independent report commissioned by the Clean Air Fund (CAF) and developed in partnership with Dalberg Advisors, Blue Sky Analytics and the Confederation of Indian Industry (CII) from November 2020 to March 2021.

A first of its kind study for India, this report seeks to quantify the impact of air pollution on Indian businesses using three primary methods. First, it synthesises existing research on the effects of pollution on economies and companies globally and extrapolates for the Indian context. Second, it leverages extensive data macro analysis that correlates movements in air pollution, captured by Blue Sky Analytics' BreeZo dataset, with top-level indicators that impact business; namely, deterioration in health and reduction in the movement of individuals to avoid air pollution. Third, it takes a bottom-up view of how individual sectors and cities experience air pollution, focusing on the IT and tourism sectors.

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This report was prepared by an independent advisory team from Dalberg Advisors. The team comprises Gaurav Gupta, Aditi Singh, Siddhant Damani, Rohit Bhatnagar, Sarthak Goyal, and Gauraang Biyani.

We welcome your feedback on this report and encourage you to reach out to the Dalberg team with your comments through [www.dalberg.com](http://www.dalberg.com)

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# Foreword

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**India faces a serious air pollution crisis.** Over the last decade, India has emerged as the world's fifth most polluted country and is home to 21 of the world's 30 most polluted cities. While the government has taken ambitious remedial steps, such as the launch of the National Clean Air Programme and its target of reducing PM2.5 pollution by 20-30% by 2024, the discourse on air pollution in India and around the globe has tended to focus on its public health implications.

**This study's primary purpose was to add another dimension to our understanding of air pollution: its impact on businesses and the economy.** This study undertakes a rigorous quantitative analysis of four pathways through which pollution decreases businesses' profitability; premature mortality, presenteeism, absenteeism and consumer footfall. It uses various data sources, including air pollution data, historical traffic data, pharmacy sales data and data premature mortality, to paint a holistic picture of pollution's business cost. While previous studies have looked at isolated pieces of this

puzzle at the level of individual firms or sectors in other geographies, this is the first report to estimate the business cost of pollution for India comprehensively.

**This study ultimately aims to motivate businesses and policymakers to become more active advocates for clean air by showing how much the economy and society stands to gain.** The report is premised on the principle that the private sector can and should join forces with government, researchers and civil society to improve air quality successfully. We hope this report's findings can augment collaborative efforts to move towards a less polluted and more prosperous India of the future.

# Executive Summary

## India is in the midst of a pollution pandemic.

According to the World Air Quality Report of 2019<sup>1</sup>, India ranked 5 out of 98 countries in 2019 based on weighted average PM2.5 concentration levels, behind Bangladesh, Pakistan, Mongolia, and Afghanistan. Twenty-one of the world's 30 cities with the worst air pollution are in India. New Delhi has the poorest air quality among cities globally, with PM2.5 concentration levels nearly ten times the WHO target. PM2.5 levels have remained alarmingly high over the last five years.

## Conventional wisdom considers air-pollution an unavoidable by-product of economic growth, thus limiting the intensity of response to it.

In existing literature and publications, GDP per capita and growth rate are often linked to emissions levels, one predicting the other. This has framed an understanding, with many businesses, that growth and good air-quality are always in conflict, which has led to an entrenched perception of environmental regulations as being a cost that holds back companies.

## In reality, air pollution costs Indian businesses 7 lakh crore (USD 95 billion) every year, ~40% of the cost of tackling the COVID-19 pandemic.

This is equivalent to 3% of India's GDP. While this cost may have gone unnoticed thus far, it is high and persistent. The cost of air pollution manifests in 6 ways – lower labour productivity, lower consumer footfall, premature mortality, lower asset productivity, increased health expenses and welfare losses. Out of these, employee productivity, consumer footfall and premature mortality impact businesses directly.

### 1 Labor Productivity (Absenteeism)

Air pollution resulted in 1.3 billion working days lost, costing USD 6 bn. in India in 2019 due to absenteeism. As air pollution rises, employees fall sick themselves or stay at home to take care of dependents such as children

and the elderly, who are more vulnerable to air pollution. 98% of this cost is borne by India's northern and eastern part, where AQI levels cross 300+ frequently. The survey conducted as part of this study reveals the cost to be much lower than what it should be, as even sick employees come to work, given the need to earn and support their families.

### 2 Labor Productivity (Presenteeism)

Employees' physical and cognitive performance take a hit due to air pollution. Business heads estimate that employee productivity decreases by 8-10% on high pollution days, costing USD 24 bn. in 2019. Workers often make up for these by working long hours. This loss is equivalent to the production of the entire pharmaceutical industry in India. As employees work overtime to cover up for lost productivity, the cost continues to exist but in the forms of burnout, attrition, and increased difficulty on HR managers to attract talent. The decreased cognitive functioning of pollution means a 7x higher impact for cognition-intensive sectors such as investment banking, software development, sectors where the dependency on complex mental tasks for output is highest.

### 3 Consumer Footfall

Air pollution diminishes India's strength of being a large consumer economy by reducing consumer spending by 1.3%, costing USD 22 bn. in 2019. As air pollution rises, consumers avoid exposure to pollutants, akin to what was observed during the COVID-19 pandemic. Sectors that comprise more discretionary purchases have fewer online substitutes, and where time foregone is revenue foregone, they are most hit. Apparel and food (including restaurants) bear ~50% of the overall cost, reminiscent of consumer behaviour in COVID-19.

### 4 Premature Mortality

Air pollution contributes to 18% of all deaths in India. India lost 3.8 billion working days in 2019, costing USD 44 bn. to air pollution caused by deaths. Not only premature mortality devastate our current workforce, but also the workforce of the future, with children under the age of 1 contributing to 34% of the total impact. As India's population's median age increases from 27 in 2019 to 32 in 2030<sup>2</sup>, its susceptibility to air pollution will increase, raising the question of a sub-optimal workforce.

**These effects, while devastating on their own, become even more so combined.** It changes across sectors as well as cities:

- a IT sector** USD 1.3 bn or 0.7% of its GDP to air pollution, saw a 10% decrease in attendance on bad air days, 3% reduced productivity and even faced 28% higher hiring challenges. These effects impact growth. An Indian IT company in Delhi loses 33% of its competitive advantage over a company in the Philippines due to air pollution.
- b Tourism** saw a 1% decline in GDP, costing USD 2 bn. International tourists increasingly re-consider travel plans to India, with pollution being a top concern. This translated to 820,000 jobs lost in tourism and ancillary industries.
- c Delhi** faces 275 days of unhealthy air with a 6x rise in respiratory medicines' sale during bad air quality days, with 40% of survey respondents preferring to leave Delhi. Migrant workers find it more challenging to adjust to the air quality and see a higher attrition rate. With CEOs' cognitive decision-making ability located in Delhi compromised by pollution, decision-makers value proposition comes into question.
- d Gurgaon**, the start-up hub of the North, has seen many of its start-ups opting to move or expand to other cities, citing air quality as a concern. Its IT companies are 6% lower productive than peers in the south of India. Gurgaon's unique value proposition for

"medical tourism" comes under question, with 64000+ cases of respiratory ailments being registered in a single hospital in 2015

- e Kolkata**, the gateway to the east, has seen air pollution suffocating its transport system. Air pollution-caused low visibility causes 13% of all flights to be delayed and shipping and cargo handling delays. Kolkata's MSME and manufacturing base sees its productivity hit due to the high exposure to outdoor air pollution required from workers.

## It is time to address the elephant in the room – air pollution.

India has already made strides in its commitment to the Paris Agreement on climate change and its commitment to the environment. With the USD 95 bn. of cost figure attached to pollution, the experience of the pains of a pandemic, and the short period during which we saw beautiful blue skies in our cities, we now know what's at stake. Business advocacy and support will be a must for India to tackle this head-on. It is time businesses start seeing air-pollution on the cost side of profit statements.

<sup>1</sup> IQAir, "World Air Quality Report," 2019

<sup>2</sup> Statista, 2021



**Air pollution costs Indian businesses USD 95 billion or 3% of India's GDP every year.**

**Air pollution impacts businesses along three direct impact pathways.** These are (a) the opportunity cost of lost worker productivity (e.g., due to higher absenteeism), (b) revenue lost due to reduced consumer footfall, and (c) the opportunity cost of premature mortality attributed to air pollution. These costs differ in both the intensity and their directness of impact on businesses. Costs such as labour productivity increase the cost of producing output for companies. It drives up work absenteeism and lower on-the-job productivity by impairing workers' cognitive and physical performance. For example, a Spain-based study found a 10 µg/m<sup>3</sup> increase in PM10 levels correlated with a ~2% increase in absenteeism due to sick days.<sup>3</sup> An analysis of call centre workers in China found that lost productivity incurred over USD2 billion<sup>4</sup>. Reduced consumer footfall impacts the revenue potential of businesses. Lower air quality is likely to reduce consumers' willingness to venture out of their homes, leading to lower footfall, impacting revenue for consumer-facing companies. For example, an analysis of credit card

transaction data in Spain found that for every 10% increase in particulate matter, consumers in Spain spent between EUR20-30 million less per day.<sup>5</sup>

**Premature mortality affects the size and potential of India's workforce.** For example, a study on income foregone due to air pollution-caused early deaths estimated that USD225 billion in global income was lost annually; these losses were highest in South Asia, where they amounted to 1% of regional GDP.<sup>6</sup> Asset productivity also takes a hit: air pollution has been shown to reduce physical assets' efficiency and lifespan. For example, solar panels generate lesser electricity<sup>7</sup>, and IT systems degrade faster<sup>8</sup>, flights and other transport vehicles are delayed more often.<sup>9</sup>

**This culminates in a USD 95 billion impacts amounting to ~3% of India's 2019 GDP.**

This impact figure is staggering in isolation, but even more so when held in context. The loss is comparable to ~2X of the country's annual public health expenditure (1.6-2.2% of GDP<sup>10</sup>), ~1.5X



3 Holub et al., "Air pollution and labor supply: Evidence from social security data", 2016  
4 Neidell et al., "The Effect of Pollution on Worker Productivity: Evidence from Call-Center Workers in China", 2012  
5 Brandt et al., "Air Pollution Induced micro-migrations: Impacts on Consumer Spending", 2018  
6 The World Bank, "The cost of air pollution - strengthening the economic case for action", 2016  
7 Yeeles, "Solar power reduced by haze", 2018  
8 Hardcastle, "Air Pollution Hurts Computers, Intel Says", 2013  
9 We have not considered this cost in our impact estimation, since the focus is largely limited to the impact of air pollution on agricultural yields  
10 Ministry of Finance, "Economic Survey 2019-20", 2020



of India's defence budget (~2% of GDP<sup>11</sup>), and approximately one-third of the country's tax revenue (~10% of GDP<sup>12</sup>). This impact's scale cannot be exaggerated: the value Indian businesses lose to air pollution every year is equivalent to ~40% of the country's outlay on managing the COVID-19 pandemic.

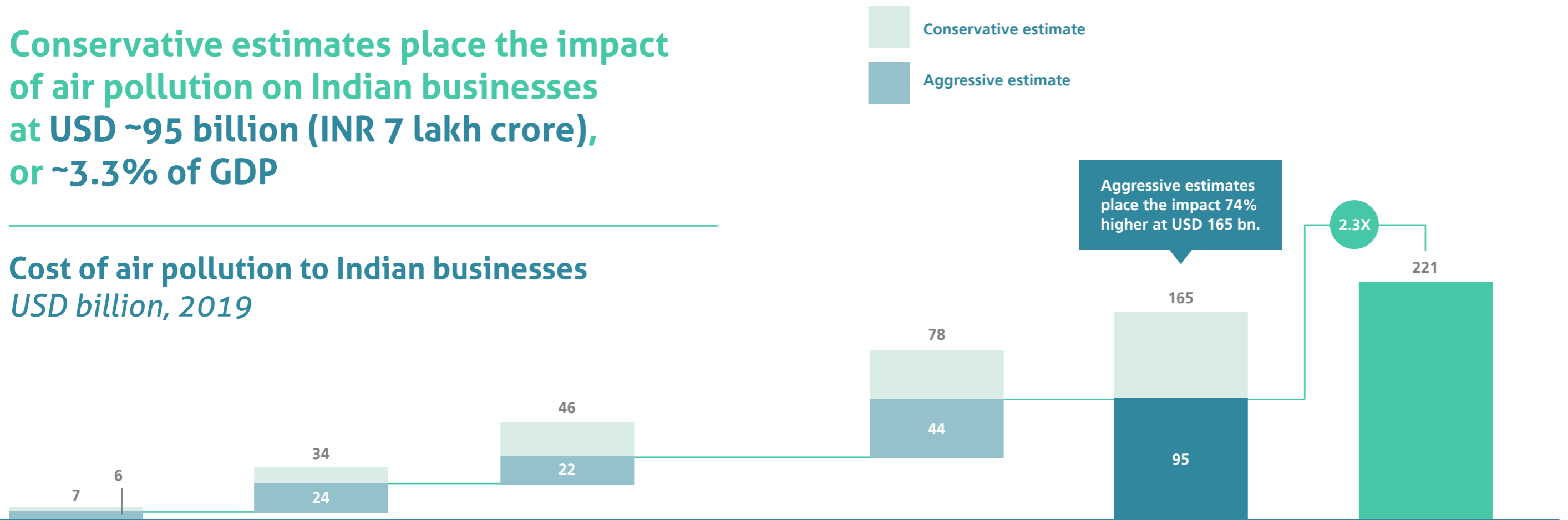
**These impact figures do not account for other important but less direct pathways of impact, including healthcare expenditure and non-market welfare loss.** Global healthcare costs for pollution-induced co-morbidities are projected to increase to USD176 billion in 2060 vs USD21 billion in 2015<sup>13</sup>. The higher rates of air pollution drive up the overall expenditure on healthcare. However, the specific impact on businesses is harder to capture, given the variation in the amount and nature of different employers' healthcare coverage. Non-market welfare costs primarily cover the inability or impaired ability to participate in activities outside of formal employment, for example, when air pollution prevents volunteers and caregivers from travelling, engaging with beneficiaries, or otherwise being productive in the delivery of their service<sup>14</sup>. Given the second and third-order consequences for businesses, this study does not consider these costs.

11 PRS Legislative Research, "Demand for Grants 2020-21 Analysis: Defence", 2021  
12 India GDP (current USD), 2019, World Bank  
13 OECD, "The economic consequences of outdoor air pollution", 2016  
14 DEFRA, "Valuing the impacts of air quality on productivity," 2014

**Air pollution causes a business impact equal to 43% of that of the Covid pandemic**

# Conservative estimates place the impact of air pollution on Indian businesses at USD ~95 billion (INR 7 lakh crore), or ~3.3% of GDP

## Cost of air pollution to Indian businesses USD billion, 2019



### Absenteeism

~1.3 billion working days are lost p.a. due to absenteeism

Absenteeism impact is higher with working age population with dependents, such as children

### Presenteeism

Presenteeism is a hidden cost which may directly impact corporate profits

Skilled services and manufacturing sector are disproportionately affected

### Consumer footfall

Air pollution drives a 1.3% decrease in India's consumer spending

The impact in segments such as international tourism is as high as 7.41%

### Premature Mortality<sub>1</sub>

India had 1.7 million premature deaths from air pollution in 2019, 1~18% of overall mortality in the same year

India contributes ~25% to the global cost of premature mortality

### Total impact

The total economic impact of air pollution is equal to:  
 150% India's healthcare budget  
 150% India's defense spending  
 50% of tax collected annually

### Loss due to COVID<sub>2</sub>

Cost of air pollution to businesses is equal to 43% of the pandemic's impact

Unlike the pandemic, this is an annually recurring cost

Despite this, only INR 4,400 cr. has been invested in air pollution, <10% of total outlay on COVID response

**In other words, every year air pollution costs India's businesses close to 50% of the cost of managing the COVID-19 pandemic**

Sources: (1) A World Bank study estimated that 1.4 billion deaths (including children) account for a loss of USD 55.4 billion in 2013 by applying the economic value of a working year to the average number of working years lost per deceased person. This number has been extrapolated to 2019 by adjusting for the change in GDP and pollution levels; (2) India Ministry of Statistics & Programme Implementation, 2021; Dalberg analysis



# India's missing employees

## Lost labour productivity costs Indian businesses USD 30 billion



India's employers lose **~1.3 billion** working days per year to air pollution, amounting to an annual loss of USD ~6 bn. Employers may see a ~10% net decrease in attendance on days when air pollution reaches hazardous levels. This is driven by reasons ranging from short-term health complaints to workers' need to act as caregivers for the elderly and out-of-school children. However, while the reasons for driving absenteeism are broadly uniform across population groups, the distribution of its impact is not. The result of absenteeism is driven by sectors in which employees do more physically intensive work, making them more vulnerable to health effects over time. Construction and food processing, two of the biggest employers in India's manufacturing sector, contribute almost a third of the overall impact. Further, older members of the labour force are disproportionately affected, contributing ~44% to total working days lost, despite only ~10% of the labour force. This puts specific segments of the informal service sector – namely, the primary employer of the 60+ workforce in India's cities – at risk<sup>15</sup>.

<sup>15</sup> Reddy, "Labour force participation of elderly in India", 2012



## SPOTLIGHT 1

### Bangalore's Whitefield corporate zone

Bangaluru's Whitefield corporate zone observed a 12% reduction in worker traffic during highly polluted winter months (November-January) compared to low pollution months (June-August). A 10-unit increase in PM2.5 levels correlated with a 3.9% decrease in worker traffic in this area, despite the city having a relatively low average PM2.5 level of 38.4 µg/m<sup>3</sup> for 2019. This demonstrates workers are sensitive to pollution spikes even if absolute pollution levels are low and suggests that pollution is not a uniquely North Indian problem. Whitefield is also home to Bengaluru's youthful IT sector, meaning air pollution impact stretches across age groups.

**In reality, the cost of missing work is prohibitive for many.** While air pollution causes India's workforce many serious health concerns, introduces heightened caregiving responsibilities, and sometimes even creates challenges for commuters, the opportunity cost of a missed workday is high. The active decision to take time off work to safeguard against air pollution is not one that many Indian workers can rationalise unless air quality is truly hazardous.

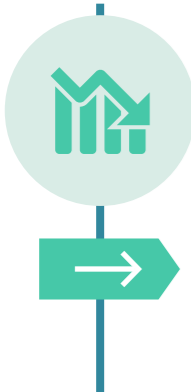
**As a result, employees suffer an 8-10% productivity reduction while at work according to business heads.** Workers often make up for this by working longer hours. Presenteeism, or lost productivity on the job, costs Indian businesses around USD 24 billion, amounting to 25% of the overall economic effects of air pollution and 80% of total losses due to reduced labour productivity. As India's workforce resists the option to take time off work, air pollution takes a progressively higher toll on their cognitive and physical performance. These losses grow even more severe as employees work overtime to compensate for their under-productivity and cover for their absent colleagues.

**These productivity losses are more pronounced in physically intensive and/or cognitively more demanding professions.** Due to the escalating cognitive impacts of air pollution, productivity loss in 'skilled' service sector professions, e.g., more advanced roles in IT and BFSI, is ~7X higher than in unskilled and semi-skilled job roles. The difference is similarly steep between workers in the unskilled service sector and manufacturing jobs. The latter is subject to adverse effects on stamina and lung capacity, mainly when working in outdoor and poorly ventilated indoor spaces.

**The productivity lost due to air pollution has dire long-term consequences.** Over time, absenteeism and presenteeism's cumulative effects lead to overworking to compensate for productivity loss and – ultimately – burnout, attrition, and hiring difficulties. Strict performance timelines imposed in results-oriented sectors such as IT put pressure on employees to compensate for their productivity loss and their absent colleagues. While this may pay off in the short-term, it affects motivation levels in the medium term. A survey of 41 IT businesses revealed that 12% and 17% observe higher irritability and reduced morale, respectively, on days with more severe air pollution. This not only may result in more profound productivity loss for affected workers, but also potentially wider morale and productivity drops across teams and organisations. Lower personal and professional quality-of-life due to air pollution may also introduce challenges for employers seeking to retain and attract talent in polluted urban metros. 12% of surveyed employers reported more significant attrition as a long-term consequence of air pollution, while 28% reported hiring challenges in highly polluted cities.

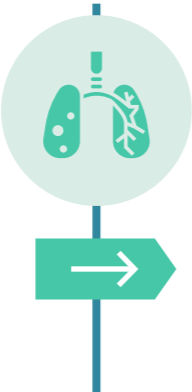


The productivity costs of air pollution go beyond absenteeism : employees overwork to compensate for lost productivity, leading to burnout and attrition



Under-productivity

Employees continue working despite pollution – sometimes persisting through health problems – causing on-the-job productivity loss.  
  
Losses are more severe for employees working overtime to compensate for absent colleagues.



Burnout and overworking

Overworking and declining health are among factors contributing to morale loss (reported by 65% of employers).  
  
These contribute not only to individual productivity loss, but could lead to wider dips in productivity and additional absenteeism in the long term.



Employee Attrition

Declining morale and feelings of overexertion lead to burnout, and potentially higher rates of attrition  
  
Companies incur costs to either incentivize employees to stay or to more frequently identify, recruit, hire, and train talent.



Difficulty in Hiring

Attracting talent, particularly in ‘white-collar’ industries such as IT and BFSI, becomes a challenge in highly polluted cities.  
  
This forces employers to either overpay for talent or to sacrifice on the quality of talent hired.

Sources: Primary research with IT businesses; Dalberg analysis



## CASE STUDY

# IT sector loses USD 1.3 billion due to pollution-induced productivity loss per year

**This loss amounts to 1% of its sector value.** If air pollution continues to increase at currently projected rates, this impact figure on the IT sector could nearly double by 2030.

**Presenteeism drives 80% of this impact overall.** As a globally competitive industry mainly due to its human capital's quality and productivity, the IT sector experiences these impacts in a magnified way. Survey

results indicate that aggressive internal and client-imposed turnaround times mean that only 10% of employees can afford to take time off work on the highest pollution days. Some employers suggest that people may work through sickness to ensure output targets are met on time. The effects of overworking could lead to progressively higher presenteeism effects, culminating in challenges in hiring and retention. 12% of HR managers report higher attrition

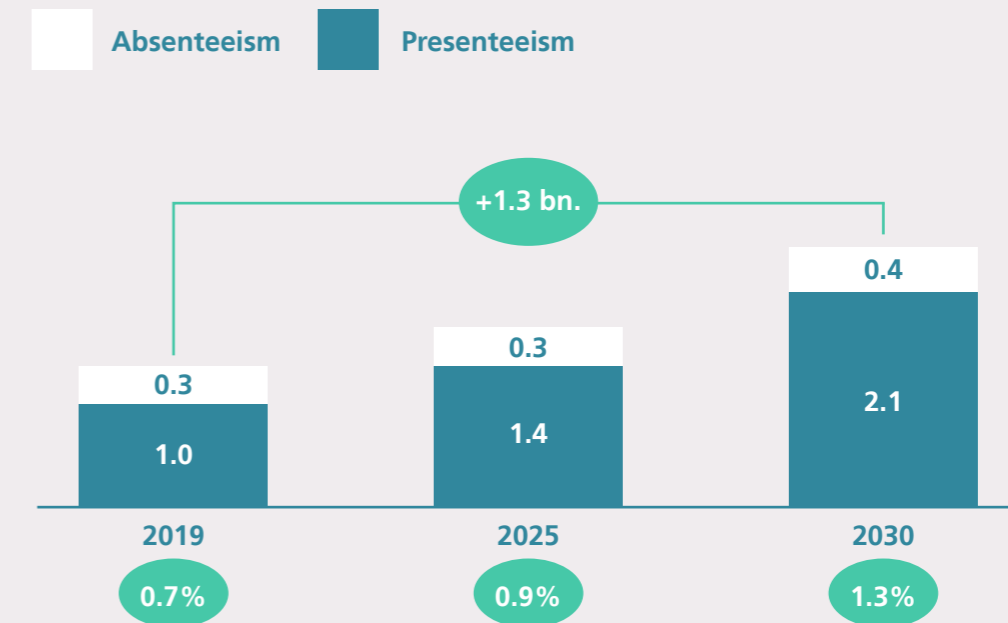


<sup>16</sup> ManpowerGroup, "Talent Shortage 2020", 2019

<sup>17</sup> Payscale.com, Dalberg analysis

## Economic impact of air pollution on the IT sector

USD billion, assuming sector value to be constant at 2019 levels



**IT sector faces a 0.7% impact on its GDP due to air pollution, amounting to USD 1.3 bn.**

rates due to air pollution, which could be a source of concern for IT businesses, many of whom (63%) already report severe talent shortages<sup>16</sup>.

**As the IT sector increasingly reorients towards emerging sector hubs in the North and East, these impacts are likely to grow.** Currently, the industry is insulated because 60% of the value is concentrated in India's less polluted southern part. However, if even 10% of this value were to move North, the sector's overall impact could increase by as much as 80%.

**IT firms are recognising some of these challenges through investments in hiring talent and developing better infrastructure; however, these investments may drive down cost competitiveness.** While these investments may offer short-term gains, they are likely to drive costs further up and profits down. For example, India's 33% cost advantage over the Philippines<sup>17</sup> – another emerging Asian IT hub – could quickly be as expenditure on air purifiers on other tech drive up the cost per worker. This could erode India's competitive advantage in the long-term.



# India's suffocating consumer economy

## Decreased consumer footfall costs the economy USD 22 billion



Air pollution impacted consumer footfall by 1.3%, silently undermining the country's consumer economy and costing Indian businesses as much as USD 22 bn in foregone revenue. As consumers reduce outdoor activities to limit pollution exposure, they spend less, and consumer-facing industries take a hit – similar to the effects of the Covid-19 pandemic. The reduction in consumer footfall is 3x during the more polluted



“People will continue to put in hours. If they are sick, they step out to buy medicine and return to work. Productivity takes a hit”

BPO business head, Mumbai

winter months; in January, November, and December, air pollution levels are 116% higher than during the rest of the year than in the other months. This concentration of impact means consumer-facing companies cannot adapt to the lower consumer footfall by reducing capacity as the demand falls and rises more sharply. Predictably, North India is impacted disproportionately, contributing 74% of India's total impact despite being home to only 47% of the population. South and West India together account for only 10% of the overall effect on North India, having 51% lower pollution levels.

Predictably, the impact is higher for discretionary consumer spending. These are also the categories that have been most affected during the COVID-19 pandemic, where people have avoided prolonged outdoor exposure or found viable online substitutes. Spending on clothing and footwear, for example, is highly sensitive to these impacts; overall, the category sees as much as a 2.5% decrease in overall consumer spending, 2.5X the average impact seen in other categories. The absolute dollar impact on food consumption is also high, driving ~43% of overall value lost due to reduced consumer footfall. This impact is driven primarily by more discretionary food spend, e.g., on restaurants and other F&B retail.

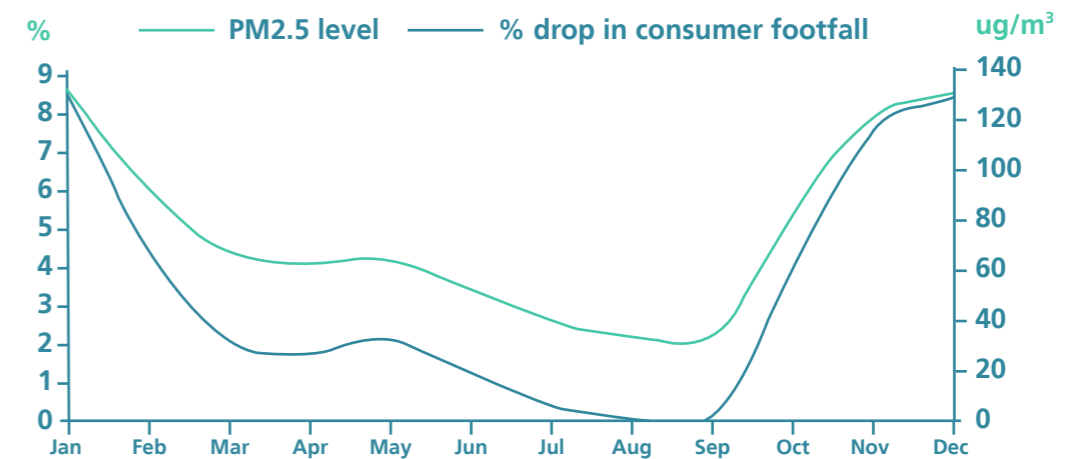


“People from other parts of country who come here suffer more and leave sooner, as they aren't so used to the pollution”

IT HR head, Ghaziabad

## Increased Pollution results in increased % drop in footfall

(%, ug/m<sup>3</sup>, 2019)



Consumers in India are highly sensitive to air pollution levels which leads to a significant dip in consumer footfall in markets during high pollution months..

## SPOTLIGHT 2



# Footfall drops by 5% in Mumbai's Linking Road due to pollution

Mumbai's Linking Road market zone observe a ~5% reduction in consumer traffic during highly polluted winter months (November-January) when pollution levels in the city nearly tripled. A 10-unit increase in PM2.5 levels correlated with a ~1% decrease in consumer

footfall in this area. The drop in footfall was highest in the first month of high air pollution but eventually recovered, albeit not till pollution levels decreased, indicating that while consumers are hesitant to step out at first, they ultimately get desensitised and step out to markets over time.



## CASE STUDY

# Reduced tourist footfall costs the sector USD 1.7 billion every year

**Air pollution costs an annual 0.7% reduction in tourist arrivals and USD 1.7 billion in economic loss.** With air pollution levels projected to rise anywhere from 10-15% over the next decade, this loss could rise to USD 2.4 billion by 2030. A disproportionately high share of this loss is driven by the higher-value foreign tourist segment, contributing ~21% to the overall economic hit compared with ~2% of overall footfall loss.

**Not only does air pollution create short-term shifts in tourist demand, but it also results in long-term reputational risks.** A survey of 39 tourism and hospitality businesses revealed that ~64% of businesses see air pollution contributing to declining domestic tourism. Domestic tourists forgo travel altogether or – where they can afford it – elect to travel abroad instead. These demand shifts extend beyond people travelling for leisure. Businesses are increasingly aware of pollution, with some corporations empanelling only hotels that undertake strong anti-pollution measures, e.g., installing air purifiers in every room. As

of now, only 28% of surveyed businesses identify declining foreign tourism as a concern. However, interviews also suggest that air pollution tarnishes tourists' experience in different ways, leading to word-of-mouth effects that cause damage to India's long-term reputation as a tourist destination.

**The problem is urgent, with over 30% of India's tourism sector concentrated in the five states where pollution is most severe.** Madhya Pradesh, Rajasthan, Telangana, Uttar Pradesh, and West Bengal are among the top ten states in domestic tourists' volume. In 2019, all five had an average PM2.5 concentration above 70  $\mu\text{g}/\text{m}^3$  – well above the WHO benchmark for unhealthy air quality. Driven by lost footfall in these five states, India's domestic tourism industry lost 2.5 million tourist arrivals and over USD 1.3 billion in revenue. The impact of these losses on the sector's bottom line could see over 800,000 jobs lost in core tourism sector businesses and allied sectors (e.g., food and beverage, retail).



## India's burgeoning health crisis

### Premature mortality costs the economy USD 45 billion



**Air pollution is responsible for 18% of all deaths in India in 2019, translating to a loss of 3.8 million workdays.** In 2019, India had 1.7 million deaths linked to air pollution, incurring an economic cost of USD 45 billion. For businesses, this carries solid consequences for labour productivity; people's productive working lives are cut short. Men are disproportionately affected, with a 62% higher chance of dying prematurely from air pollution than women, primarily due to greater participation in jobs that expose them to outdoor environments (e.g., construction workers) and highly polluted indoor environments (e.g., factory workers). Moreover, 34% of the dollar impact of premature mortality is driven by children's deaths below one year of age.

**As India's median age rises from 27 in 2019 to 32 in 2030, susceptibility to air pollution will increase, as will the impact on mortality.** The mortality rate for pollution-linked and -exacerbated diseases, such as COPD and lung cancer, is twice as high for individuals aged 30-34 compared with those aged 25-29. The progressively sharper health impacts of these and similar diseases on the country's ageing population could signal an increase in the economic impact of premature mortality and the intensity of labour productivity and footfall loss.



## India's lost assets

### Air pollution diminishes the lifespan and productivity of various business assets



**The impact of air pollution extends beyond people to physical assets, reducing the lifespan and productivity of a variety of business assets.** For example, air pollution blocks sunlight from reaching solar panels, reducing energy generation efficiency by those panels and ultimately hurting solar energy providers and businesses reliant on that energy to generate output<sup>18</sup>. Alternatively, sulfur dioxide (SO<sub>2</sub>) and other pollutants speed up the degradation of electronic circuitry, reducing the efficiency and shelf life of IT assets, and increasing the frequency at which businesses incur replacement costs. Notably, airborne pollutants – especially ground-level ozone – stunts the flowering and growth of crops, causing an estimated 5-12% loss in agricultural yields and causing associated economic losses across the agricultural and food value chain<sup>19</sup>. Emissions of pollutant compounds like sulfur dioxide and nitrogen oxide cause acid rain, which corrodes infrastructure, machinery and historical monuments<sup>20</sup>. This leads to more frequently incurred repair and renovation costs and damage to the tourism industry. The productivity of transport vehicles is also reduced by smog-induced lower visibility, increasing time delays in transport and logistics dependent industries<sup>21</sup>.

<sup>18</sup> Yeeles, "Solar power reduced by haze", 2018

<sup>19</sup> Hardcastle, "Air Pollution Hurts Computers, Intel Says", 2013; Burney and Ramanathan, "Recent climate and air pollution impacts on Indian agriculture", 2014

<sup>20</sup> Rao, Rajasekhar and Rao, "Detrimental effect of Air pollution, Corrosion on Building Materials and Historical Structures", 2014

<sup>21</sup> Times of India article, 2019

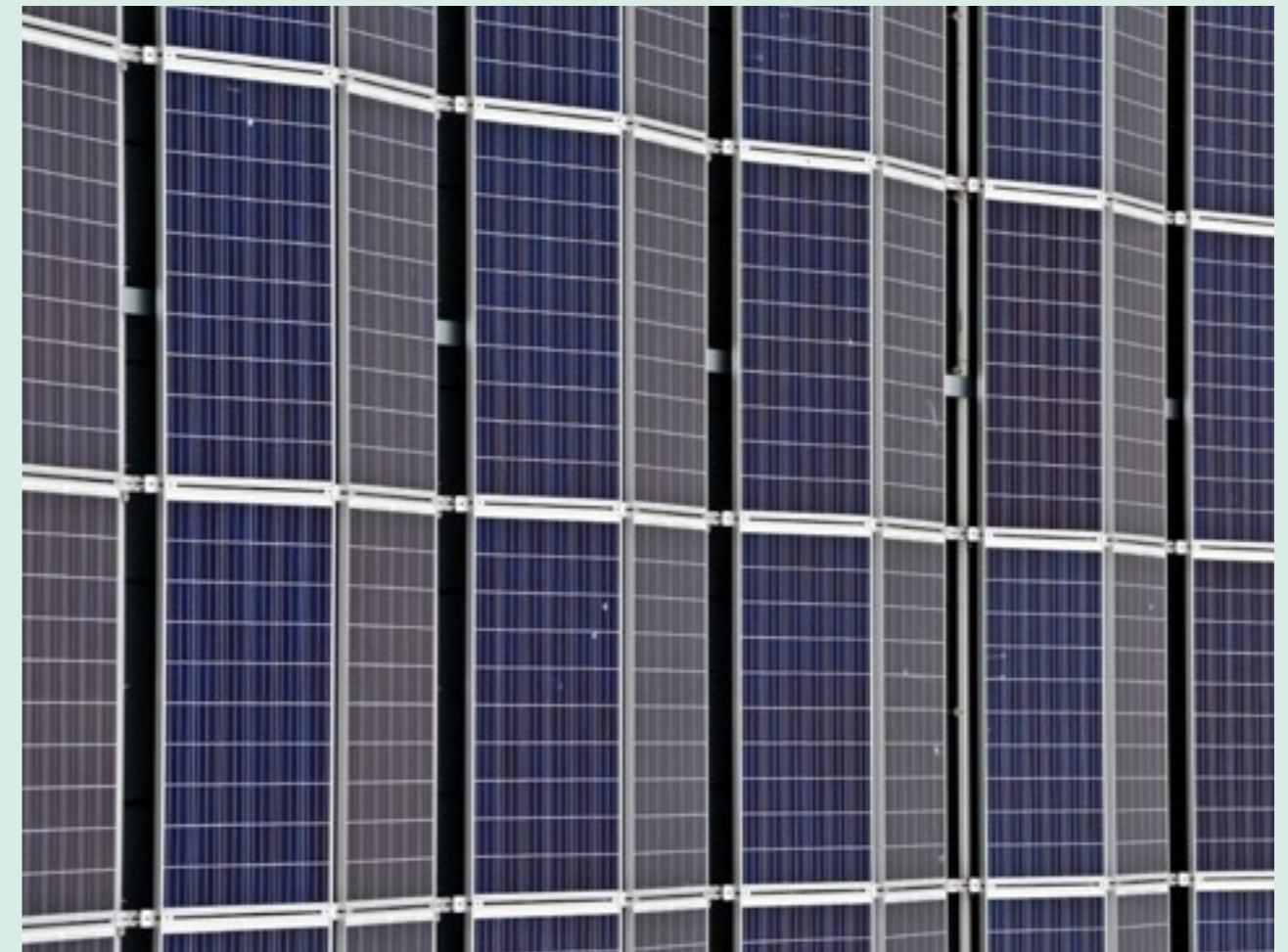


### SPOTLIGHT 3

## The productivity of solar panels drops steeply on high pollution days

**A rooftop solar company saw a 13% decrease in its solar panels' productivity on high pollution days, reducing economic viability for solar in India going forward.** Every 100-unit increase in PM2.5 levels correlated with a 13% decrease in solar panel productivity. This went up to a 23% decrease at hazardous levels of PM2.5, i.e., 250 units. The loss in productivity translates to a 12% increase in the breakeven period for consumers installing

home solar systems, which can disincentivise consumers from choosing solar. On an industrial level, the productivity loss increases the cost to produce solar from INR2.61/kWh to INR2.91/kWh, eroding 67% of the cost advantage that solar holds over coal. If pollution levels rise by 30%, the cost to produce solar power would be the same as coal, setting India back on its ambitious objective to reach a renewable energy capacity of 450GW by 2030<sup>22</sup>.



<sup>22</sup> Speech by Prime Minister Modi, 2020



# Understanding how air pollution undermines the competitiveness of Indian cities

**The business impact of air pollution could spell a loss of competitiveness for India's economic powerhouses.** Delhi and Kolkata contribute significantly to India's economic well-being and its competitiveness in the global economy. Unfortunately, severe air quality in these economic

hubs means that the impact of air pollution deeply affects the value generated in each city. The case studies below capture the absolute dollar impact of air pollution on two of India's key urban centres, as well as how that impact undermines each city's unique competitive advantages.



## CASE STUDY

# New Delhi loses 6% of its GDP to air pollution

**India's capital, New Delhi, is well established as a seat of political and economic influence; however, the city's well-documented air pollution problem cost it USD 5.6 billion (6% of its GDP) in 2019.** This impact figure is disproportionately higher than the ~3% on India's overall GDP in relative terms. In absolute terms, it is higher than the combined economic loss suffered due to air pollution in Mumbai, Bengaluru, and Chennai combined. Nearly half of this impact is attributed to the 11,310 pollution-induced premature deaths and 12.2 million working days lost due to absenteeism. These economic losses are staggering when taken in isolation; placed in context, air pollution threatens to undermine Delhi's critical competitive advantages.

**Delhi serves as a decision-making centre for both the private and public sector: this might change going forward if pollution goes unaddressed.** Delhi is the seat of India's political power. It is also home to >25% of India's registered

companies, making it a focal point for private sector decision-makers. The ~7X higher impact of air pollution on job roles carrying a higher cognitive burden implies significant productivity and efficiency loss for the city's senior corporate offices and the risk of severe illness and premature mortality for more susceptible individuals. With 550 flights delayed in just a single week of November 2019<sup>23</sup>, smog-related travel disruptions in New Delhi can also cost business travellers valuable time through delayed meetings and missed connections. The public sector is not untouched: India's judges may take ~22% longer to reach a verdict on bad-air days<sup>24</sup>. The decline in dispute resolution efficiencies can have knock-on effects on businesses as well.

### **Air pollution could diminish Delhi's attractiveness as a hub for talent.**

A recent survey of 17,000 Delhi residents found that 40% would prefer to move out of the city to avoid air pollution and its health effects<sup>25</sup>. Interestingly, this problem is not exclusive to economically more

<sup>23</sup> Reuters, "India air travel restart hits chaos and cancellations", 2020

<sup>24</sup> Kahn and Li, "Air pollution lowers high skill public sector worker productivity in China," 2020

<sup>25</sup> Local Circles, Delhi NCR Pollution Survey, 2019

privileged sections of the city's population. A separate study found that ~57% of migrant workers in Delhi prefer the living conditions in their hometowns to those in Delhi, including due to air quality.<sup>26</sup>

**Finally, air pollution threatens to undermine Delhi's reputation as a critical cog for India's tourism sector.** Air pollution affects tourists' ability to enjoy Delhi's many sites in the short-term, with low visibility and health risks reducing the appeal of the city's many outdoor attractions. This is evidenced by a 40% drop in online booking enquiries for Delhi in November 2019, when PM2.5 levels spiked to >2X the annual average.

**As a result, Delhi is losing ground to its counterparts – both at home and abroad. In the space of just one year, Delhi fell 30 ranks in the annual Global Talent Competitiveness Index (GTCI)<sup>27</sup>, which measures the attractiveness of cities around the world as places to live and work.** Ironically, Delhi's standing on the Index improved ~10% in absolute terms between 2019 and 2020. However, a dire ranking on environmental quality – the lowest of any of the 155 cities on the Index – meant that in a single year, Delhi was overtaken and far exceeded by both cities in India (including Mumbai and Bengaluru) and abroad (including Sao Paulo and Beijing).



<sup>26</sup> News18, "How Delhi's Air Pollution is Giving Birth to Reverse Migration and Joblessness," 2019

<sup>27</sup> Global Talent Competitiveness Index, 2019, 2020





## CASE STUDY

# Kolkata loses 4% of its GDP to air pollution

**Kolkata, the gateway to East and Northeast India, suffered an economic loss of USD 2.1 billion (~2.5% of the city's GDP) due to air pollution, higher than Mumbai and Bangalore.** Kolkata lost 6,000 people through air pollution linked diseases in 2019 at a mortality rate of 33%, higher than even Delhi. Kolkata's air quality is 6X poorer than the WHO guidelines<sup>28</sup>.

**Kolkata's competitive edge as a city rests on three factors, all of which are hit by pollution.** Kolkata is a national hub for MSMEs, an epicentre of steel manufacturing, and a commercial transport hotspot. Air pollution causes a 3.4% decline in consumer footfall in Kolkata, leading to losses for the high number of consumer-facing MSMEs located in Kolkata, particularly apparel manufacturers, who comprise the most significant chunk. Air pollution reduces steel manufacturing workers' productivity by 2.4%, threatening the steel industry's profitability and West Bengal's status as India's 5th largest steel producer.<sup>29</sup> The effects of large pollution shocks are 35% higher on older manufacturing workers<sup>30</sup>, creating a potential workforce crisis for Kolkata's ageing population going forward. Air pollution also poses a significant challenge to Kolkata's dominance in all trade and logistics to and from East and Northeast India, with up to 13% of all

flights delayed on low visibility days during winter months<sup>31</sup>. The significant delays in shipping and cargo-handling at Kolkata's primary commercial port due to fog and air pollution<sup>32</sup> can lead to more significant logistical expenditure and reduced consumer satisfaction, risking sales loss.

**With Kolkata already lagging other Indian metros in economic growth and FDI inflows, high air pollution levels can potentially set back the entire state of West Bengal from achieving its economic ambitions.** Kolkata ranks far below counterparts like Mumbai, Bengaluru, and Hyderabad in terms of environmental quality and its ability to grow, attract and retain talent. This indicates that quality talent is likely to choose other destinations to work in as air pollution decreases the quality of life in Kolkata.

<sup>28</sup> IQ Air: World's Most Polluted Cities 2018

<sup>29</sup> Worldsteel Association, "State Wise Steel Demand in India", 2018

<sup>30</sup> Adhvaryu et al, "Management and Shocks to Worker Productivity", 2019

<sup>31</sup> Times of India article, 2020

<sup>32</sup> Haldia Dock Complex Trade Circular, 2020

## Call to action

Traditionally, air pollution has been regarded as an inevitable cost of a developing economy and as a public health burden that must, to a large extent, be borne by society as a whole. However, this report shows how air pollution is very much a profitability issue; clean air is a precondition for businesses to thrive – and for India to realize its vision of becoming a USD 5 trillion economy by 2025. The survey insights, interview and data analysis that went into this report highlight that individual businesses – and their employees – have a direct stake in improving air quality. Thus, going forward,

industry leaders should take more ownership and become advocates in the movement for cleaner air. While there is much thinking to be done here, business solutions to this business crisis include "greening" business operations and supply chains, adopting renewable energy technology, mitigating emissions through CSR activities, and campaigning for more ambitious pollution policies. Through active and sustained collaboration between the public and private sectors, bluer skies and a healthier economy can soon become India's reality.

# Annexe Summary of methodology

## APPROACH 1

### Extrapolation from existing literature

*Synthesised existing research on the impact of air pollution on economies and businesses globally and extrapolated it to the Indian business context.*

Analysed 50+ reports on the economic impact of air pollution globally, from both peer-reviewed journals and grey literature, prioritising for analysis, the top reports based on (i) credibility of the author, (ii) relevance to current report's objectives, (iii) extent of coverage of cost elements and (iv) robustness of the analysis.

**Absenteeism:** Identified from a study in India, the # of working days missed in India in 2018 due to air pollution. Extrapolated to 2019 by adjusting for the change in pollution levels, GDP and the difference assumed "safe pollution level" between the original study and this report.

**Presenteeism:** Identified from studies in China and the USA, the % drop in productivity among

manufacturing and service workers for a unit rise in PM2.5 concentration. Calculated impact on India by multiplying the % drop with India's pollution levels and manufacturing and service sector GDP.

**Consumer footfall:** Identified from studies in Spain and China, the drop in consumer spending per unit rise in PM2.5 as well as the drop in international tourism per unit rise in PM2.5 and calculated the impact on India by adjusting for India's pollution levels and the value of domestic consumer spending and the size of international tourism.

**Premature mortality:** Identified from a study in India, air pollution's economic impact linked premature deaths in India in 2013. Extrapolated to 2019 by adjusting for the change in pollution levels, GDP and the difference assumed "safe pollution level" between the original study and this report.

## APPROACH 2

### Big data macro analysis

*Leveraged big data analytics to identify a correlation between air pollution and consumer footfall/worker health; used economic indicators to evaluate economic impact on India*

**Absenteeism:** Gathered data on years lived with disability (YLDs) caused by air pollution from the Global Burden of Diseases Study 2019, representing the years of productive life individuals lost while living, hence a proxy for years of work missed. To estimate the economic impact on the Indian economy, YLDs from air pollution were multiplied with the economic value of a working year, accounting only for the existing labour force

vs everyone in the working-age and labour's share of GDP vs entire GDP.

**Consumer footfall:** Gathered data on traffic levels across market hubs in 6 cities over six months in 2019. Correlated traffic levels with PM2.5 concentration and controlled variables like holidays, rare events, rainfall, and temperature to isolate the impact a unit change in PM2.5 concentration has on traffic levels, taken as a proxy for consumer footfall. Calculated the impact on the economy by multiplying the % drop in footfall per unit rise in PM2.5 with the pollution exceeding "safe pollution levels" the number of consumers and the offline discretionary spending per consumer.

**Premature mortality:** Gathered data on the number of deaths due to air pollution by age group from the Global Burden of Diseases Study 2019. To estimate the impact on the Indian economy, the number of deaths for each age group were

multiplied with the number of working years lost (assuming a retirement age of 79 years), labour force participation rate and the economic value of a working year.

## APPROACH 1

### Sector-level bottom-up analysis

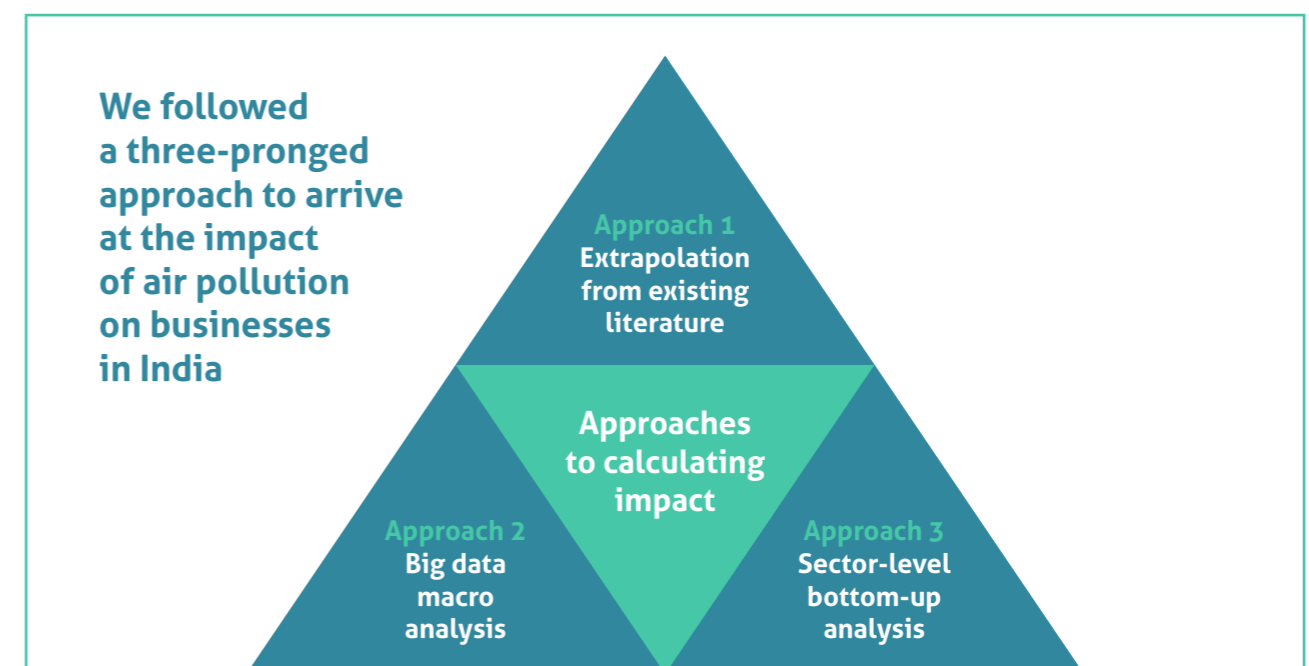
*Performed a deep dive for IT and Tourism using ground-up data through survey and interviews; extrapolated to other 16 major sectors in India*

**Absenteeism:** Gathered data on drop-in worker attendance on high pollution days through a survey of 25 IT service providers and BPOs. Estimated the IT sector's impact by multiplying the drop in attendance with the % high pollution days and the IT sector GDP. Extrapolated impact to other sectors by adjusting for (i) sensitivity of each sector to air pollution vs the IT sector, (ii) % high pollution days faced by each sector vs the IT sector and (iii) GDP of each sector vs the IT sector and aggregated the impact from each sector to estimate the impact on India's economy.

**Presenteeism:** Gathered data on drop in worker productivity on high pollution days through a survey of 27 IT service providers and 33 BPOs. Estimated the IT sector's impact by multiplying the

decline in productivity with the % high pollution days and the IT sector GDP. Extrapolated impact to other sectors by adjusting for (i) sensitivity of each sector to air pollution vs the IT sector, (ii) % high pollution days faced by each sector vs the IT sector and (iii) GDP of each sector vs the IT sector and aggregated the impact from each sector to estimate the impact on India's economy.

**Consumer footfall:** Gathered data on % drop in tourist arrivals on high pollution days through a survey of 25 tour operators, 17 hotels and ten travel agents. Estimated the tourism sector's impact by multiplying the % drop in tourist arrivals with the % high pollution days, the total number of tourist arrivals, and the economic value per tourist. Extrapolated impact on other consumption categories by adjusting for (i) sensitivity of each category to air pollution vs tourism sector, and (ii) GDP from each category vs tourism. Aggregated the impact from each category to estimate the impact on India's economy.





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