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Industrialization and Its Impact On Human Health – A Critical Appraisal

Hiteyjit Singh Gujral[1] and Gpi Singh[#]

[1] Heritage International Xperiential School, India
[#]Advisor

ABSTRACT

Industrialization is the process of applying mechanical, chemical, and electrical sciences to reorganize production, with inanimate sources of energy, to develop industries[38]. It is understood that as there is an increase in industrialization, it brings about a subsequent increase in living standards, economic prosperity, healthcare services and population as a result[1][2]. However, with this increase, there is a significant impact on the environment, specifically, air and water conditions. Most effluent-intensive industries directly discharge wastes, including pesticides, chemicals, oil and heavy-metals into the nearby water bodies, thereby polluting it[3]: More than 80 toxins have been found in industrial pollutants, which are released into the air[7]. Toxins released from these industries into the air are estimated to lead to 4.2 Million deaths a year[8], and these pollutants also impact the condition of human health, by certain toxins acting as carcinogens, disease carriers, infection catalysts, etc.

Other than these immediate effects, industrialization causes several long term impacts such as the acidity of oceans, due to high CO_2 with predictions of extreme increases over the next century, leading to severe second order effects[9]. Several solutions exist, including audits, legislative action, health education, and waste treatment technologies.

This report discusses the impact of industrialization on human health by taking a balanced view on advantages and disadvantages of industrialization, possible courses of action and a personal perspective. The report evaluates the different factors of the issue, considering highly industrialized countries such as USA, vis-à-vis the national perspective of India to finally conclude with how regulated industrialization is beneficial and advantageous.

Reasons of Progressive Industrialization

Within India, from 1948 to 1963, the rate of industrial growth fluctuated between 2 to 12%. However, after a short stagnancy period until 1968, there has been a steady and strong growth of approximately 8% annually[48]. Although in subsequent years the industrial growth did fluctuate due to certain industries performing better than others, it represented India's efforts to expand its industries and their growth plans[48] . India has been spurred on the path of industrialization since it needs to compete on a global scale and enable its poor to become prosperous. This growth and development of industries has allowed for India to make products of higher quality and quantity[10]. Nominal GDP of India has reached $2,940 Billion, growing at 7.5%, thereby positively impacting the Indian Economy[11]. With effective economic development, any country is able to create new employment opportunities for its citizens, and attract FDI[12][13][17] that enables further growth. The government earns through an increase in tax revenue, which is invested back into the country and benefits its people. India has used this opportunity to increase its provision of essential services, improved healthcare , developing a higher standard of living, better education allowing for a skilled workforce, and decreasing poverty in the country[39]. India aims to build 2,500 new hospitals, and thereby create 2.5 million jobs[14]. As a whole this has a positive

impact on human health with better infrastructure, improved healthcare, education and a higher quality of life that provides a general well-being for India's citizens.

Globally, industrialization has been accelerated by the proliferation of capital investment, labor input, investments and technological progress[15]. Taking a specific example of the prominent driving factors for industrialization in the US, was an increase in capital and an abundance of labor[16]. Rapid industrialization has played a major role in the development of its economy, reflected in the growth of GDP[1]. The growth of the USA-GDP was 2.3% (2019), amounting to $21.44 Trillion, making it the world's largest economy[18]. With economic development, comes proliferation of wealth and financial strength[19]. This creates a cushion for economic regression, allowing for the better development of healthcare infrastructures due to an increased working capital, and greater healthcare budget allocations. Economic development in the US enabled the population to become more self-reliant, allow for lesser inequality and more employment opportunities, hence providing a major incentive towards a continued increase in Industrialization[20].

Both Nationally and Globally, industrialization is fundamental for the economic development of a country as it opens a plethora of opportunities as stated above. Combined with good government policies, it results in improved healthcare and better standards of life for all. This steady growth of industries both nationally and globally, has allowed economies to grow with a significant margin (as compared to pre-industrial times), and has substantially increased per-capita incomes globally.

Consequences of Industrialization

If not managed well, the growth of industrialization causes considerable waste to be released in Air & Water bodies, as an outcome of the manufacturing process[37]. Dust, smoke, fumes and toxic gas emissions occur through highly polluting operations such as steel and petrochemicals industries[21]. The US EPA concluded that more than 80 toxins have been found in industrial pollutants, which are released into the air[7]. Toxins released from these industries into the air lead to 4.2 Million deaths a year[8], and these pollutants also impact the condition of human health, by certain toxins acting as carcinogens, disease carriers, infection catalysts, etc.

These industries also pollute surrounding water bodies and percolate into groundwater due to the discharge of chemical waste, oil, toxic substances and harmful liquids or effluents all without treatment[22][23]. As a result, humans that consume water from such sources can accumulate heavy metals in their body[24]. 2.2 billion people lack basic water facilities, out of which 144-435 million people collect water from untreated water bodies, which may contain industrial discharge[4]. A study has also stated that 1.2 trillion gallons of untreated industrial waste is being dumped into the water bodies of the US each year[5]. By 2025 half of the world's population will inhabit water-stressed areas due to these activities[4]. It is estimated that 9 Million deaths occur prematurely each year due to water pollution[6].

In an Indian context, many rural areas do not have access to treated water, hence, several times the only available option, is from surface water bodies which may be highly contaminated. Upon consuming water from such sources, , there is a high chance of contracting water-borne diseases such as, typhoid, dysentery and cholera[4]. Each year, over 1.5 million children in India under the age of 5 succumb to these diseases and die[25]. On the other hand, unregulated industrial air pollution significantly deteriorates the AQI, with toxins such as NO, CO and SO_2released into the air[26]. Upon analysing AQI trends of India's large industrialized cities, the worst cities had a range between 200-400+ i.e Poor/Severe levels[27]. These conditions cause reduced lung function, aggravated asthma, lung-cancer, chronic lung-diseases and long-term nerve and kidney damage as well[28][29]. Severe Air pollution causes more than 1.67 million deaths yearly in India, with industrial sources playing a large role in this[28].

Globally, the story is not much different. In one instance, 35,000 Tonnes of sludge containing pollutants such as arsenic & lead, were sent to a landfill, in the city of Ringwood, New Jersey, severely polluting its groundwater[22]. In another example, 1,000+ residents in the state of North Carolina, living near a coal-fired

power plant are restricted from using tap-water, due to elevated levels of Chromium-6, which is known as a major carcinogenic agent[22]. Water pollution has also caused several cases of typhoid, cholera, paratyphoid fever, amoebiasis and salmonella[4]. In the context of air pollution, in the US, approximately 60% of SO_2, 75% of all Acidic-Gases, and 13% of NO emissions were released from its power Industry[30]. Several diseases such as lung cancer, chronic heart disease, emphysema, and brain damage are known to be caused due to these toxins[31]. Globally, each year, air pollution causes 4.2M deaths, whereas water pollution leads to 3.8M deaths[8].

The US and India face similar industrial pollutants, such as SO_2, acidic-gases and NO[7]. People living in such polluted conditions are varingly impacted depending on age and pre-existing medical conditions[41]. The deteriorating effects of water and air pollution are diverse and can severely deteriorate the health conditions. Quite often those with little or no access to proper healthcare services are more affected than others. In developed countries such as the US, while this may have a lesser intensity of impact, due to a well developed healthcare system[32], India's rural population (which is 65.53% of India's population[34]), is impacted more due to low quality of healthcare available to it[33][40] . Bad healthcare services leads to deteriorated health, and further reduce the economic contributions people can make, thereby lessening the government resources available for reducing the impact of pollution[35].

Existing and Suggested Solutions

Within India, although significant regulatory progress has been made (through the NCS and PSE&D, 1992) towards preventing industrial pollution, stricter enforcement is required. This short-term strategy should include regular and stringent audits of an industry's wastes and stricter repercussion implementation. Unregulated waste disposal by industries in India, happens unrestrained, since many audits are not done seriously[36]. To ensure this does not happen, very strict audits with legislative control should be implemented.

A long-term solution is that of building adequate incentives that can leave a long-lasting impact towards reduction of waste, as industries will benefit from subsidies in acquiring modern machinery or tax exemptions, etc for practices such as proper waste disposal. These solutions will allow for the negative impact of industrialization to be reduced and to prevent pollutants or emissions from growing uncontrollably.

In 1976, the US Government appointed the EPA to regulate all waste material under the Resource Conservation and Recovery Act which includes guidelines for industrial waste sludge disposal , along with the Clean-Air-Act, which sets limitations on emissions of specific air pollutants, and maximum limits that can be present in air.

In a global context, Free-Trade-Agreements (FTAs) should be adequately calibrated with Environmental-Impact measurements, so that industrial processes that generate waste over certain limits are reduced and eliminated. Specific FTAs can allow for certain industries to sell within and outside their borders only if they adhere to cap-n-trade programs that limit greenhouse and poisonous emissions thereby creating major industrial incentives towards good practices.

A major advancement that has been made in the 21st century is that of the development of technology. These advancements can accordingly be applied in industries as well, especially those with high waste generation. To allow industries to realize the need for these technologies, the audits outlined above can include the need for industry-specific machinery for the reduction of toxic waste, which can target specific industries and their specific harmful waste. For example, in the Tannery Industry, paired with the surveillance the audits provide, those part of the industry should be directed to implement machinery such as high-temperature pyrolysis and biochar dechroming methods to reduce the harmful amount of Chromium in the affluents released[42] . Overarching technology for air and water pollution that can be implemented across all industries includes:

1. Electrostatic Precipitator: A machine to capture toxic gaseous particles and convert them to inert, non-toxic gases (figure 1) [43]. Multiple other alternatives also exist for the ESP, including Ceramic Filter

Systems (catalytic or non-catalytic), which can be applied wherever there is a lower amount of Particulate Matter[44].

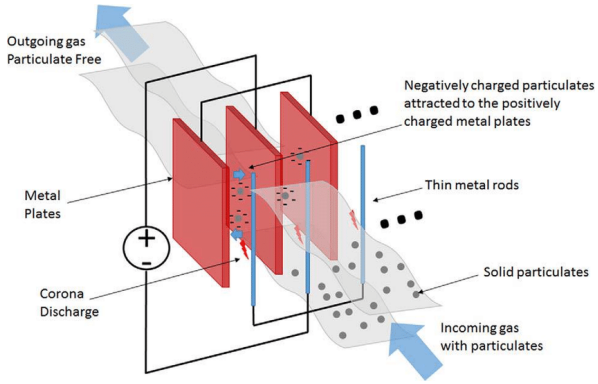

Figure 1. The functioning of an electrostatic precipitator in capturing toxic gaseous particles. Source: Data from Kurt Becker[45]. ©2010 Nova Science Publishers.]

2. Common Affluent Treatment Plant: A plant responsible for treating the specific harmful effluents before releasing into water supply, to ensure decontamination (figure 2). Plant treatment methods should work to remove both chemical and solid effluents from the water supply. There are multiple water treatment technologies including[46] :
    a. Reactive Media Filtration
    b. Reverse Osmosis
    c. Phosphorus Recovery
    d. Compressible Media Filtration
    e. Nanofiltration
    f. Microwave Ultraviolet Disinfection

    And many more[46] .

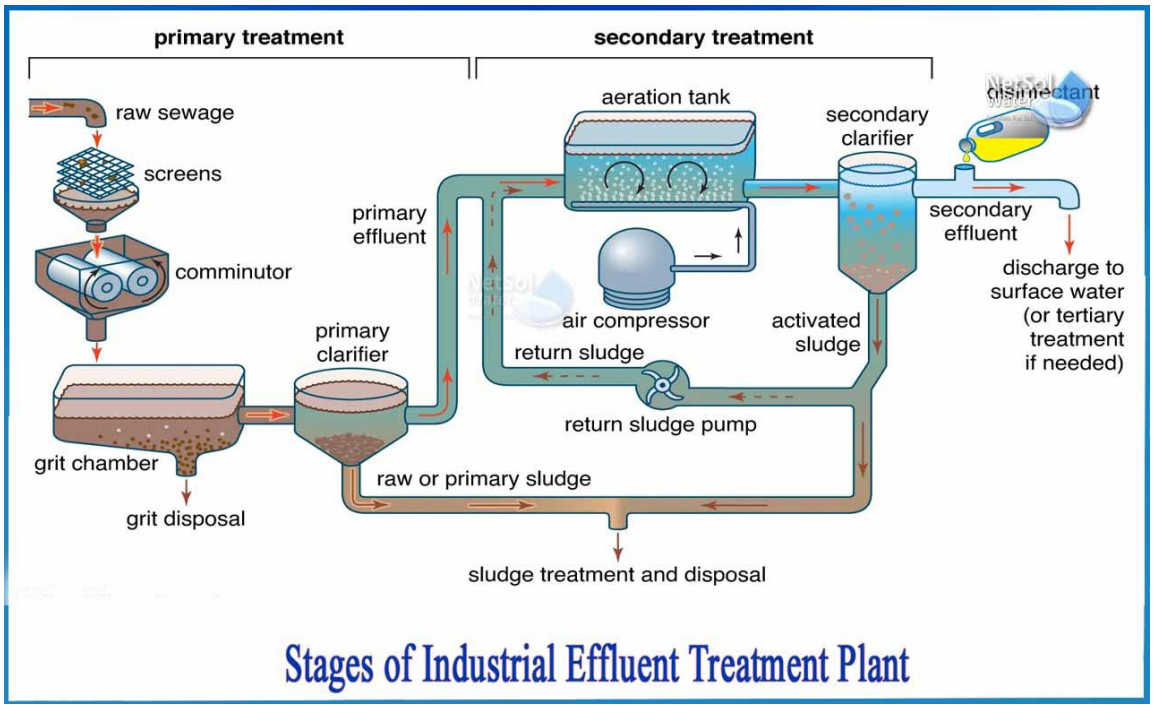

Figure 2. Stages of an Industrial Effluent Treatment Plant [47]. Source: netsolwater.com. © NetSol Water Solutions Pvt. Ltd.]

Another, more population-based solution is by making use of health education. Although industries may use their own purification methods to treat affluents, another step of purification should be taken for water meant for direct human consumption at a household level. Health education amongst the general population regarding the hazards of using untreated water should take place to deter the general population from using possibly contaminated water sources as much as possible. Moreover, simple house purification methods (such as by installing water filters) should be given importance, to ensure maximum decontamination from dangerous water sources.

Personal Perspective and Conclusion

Prior to my research, I was aware of Economic Development being a catalyst for an improved quality-of-life. Upon beginning my research, I came across several sources which underscored the importance of Industrialization for Economic Development. With deeper investigation, I later became aware of the effects of industrialization and aimed to present these in my report. In particular, the impact on human health stood out, aptly captured in an Investopedia article titled, "The drawbacks of Industrialization", specifying the threats posed by *unregulated* industrialization. Through this and similar reports, I was able to thoroughly understand the negative long run impact on human health. My view of industrialization was enhanced by the fact that unregulated industries may lead to significant health and environmental damage while regulated management is beneficial.

Even though Governments have made laws to control the impact of industrialization, these need to be strictly enforced. This action is essential, as they impact the overall health and wellbeing . Preserving this, while modernizing industry will aid sustainable economic development. Moreover, an increased level of awareness amongst general population and industry leaders would also fully work towards minimizing hazards. In conclusion, as it stands currently, advantages, however fruitful, do not evenly outweigh the disadvantages since the impact on human health is quite negative and much more broad based. Nevertheless, there is hope that with increased awareness, effective legislation and adequate implementation, governments and people will undertake

steps to curtail the fallout of industrialization and work towards improving the health standards that we all enjoy. Industrialization has advanced society to a much greater extent in modern times, and will continue to do so. By ensuring it's shortcomings are regulated, we can ensure that industrialization acts as and remains as a boon rather than a bane.

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