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A Study on Industrial Wastages and Its Impact on HDI

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Abstract

This study has been conducted to elaborate the human health, environmental and economic impacts that result from industrial hazardous waste and e-waste due to miss management of dumping sites. The aim of the study is to assess the impact of industrial waste on the environment which results in series of harmful problems such as decrease of crop production in that area, and on human health such as respiratory disease, cancer etc. The study followed many ways of collecting data and information as personal meetings reports and so on, but the main method was a questionnaire for a sample consisting of 111 persons of the population selected randomly. The results show that more attention should be given to the waste management in order to avoid the future problems and to achieve sustainable development. Lastly, the most important recommendation of the study: is to put more emphasis on proper waste management.

Keywords: Industrial Wastages, Human Development Index, Environmental Pollution, Public Health, Education Impact, Standard of Living, Sustainable Development, Waste Management.

1. Introduction

Industrial waste management is one of the complex problems faced by the developing as well as developed countries. The hale and hearty relationships between man and nature have been largely affected by rapid industrialization. Both small scale and bigger industrial units dump their waste unscientifically, more often hazardous and toxic that causes pollution to air, water and land. The technical and ecological challenge due to unscientific dumping of industrial organic waste is a matter of concern among scientists around the world. India accounts for 17.99 percentage of the total population of the world that represents at least one in every six people on this planet (Chiranjeevi *et al*., 2018). The United Nations Development Program (UNDP) report 2017 revealed that the average national human development index (HDI) for India was 0.640, which directly put India in the medium human development category.

A significant increase of nearly 50 percentage was recorded between 1990 and 2017. The quantity of waste generated is directly related to rapid urbanisation and the rise in population also influences quantity and types of waste. With an annual increment of 5 percentage about 69 million tonnes of solid waste was generated in India per year (Gupta *et al*., 2015). Only 43 million tonnes is being collected and 12 million tonnes is being subjected to further treatment (Chiranjeevi *et al*., 2018). Many industries generate both inorganic as well as organic waste. The non-recyclable organic waste can be used as a reasonably good feed for the earthworms in the vermicomposting process. During the vermiconversion of organic waste products earthworms consume, crush and digest the products with the help of both aerobic and anaerobic microflora, stabilising it into a much homogenised, humified and microbially active product.

The generated vermicast has desirable aesthetics and it may contain reduced levels of environmental contaminants (Ndegwa and Thompson, 2001), besides being a superior plant growth medium (Aranda *et al*., 1999). More than 3,920 earthworm species have been reported worldwide so far. In India, 509 species belonging to 67 genera and ten families were reported (Kale and Krishnamoorthy, 1981). Certain species of earthworms viz. Allolobophora chlorotica, Lumbricus terrestris, Dendrobaena rubida, Eisenia fetida, Aporrectodea tuberculata, and Eiseniella tetraedrahave been found most efficient in removing a wide range of pollutants from soil. The objective of the present study is to mainly focus on the vermicomposting potential of the earthworm species Eisenia fetida on industrial organic waste generated from different agro-based industries.

2. Statement of the Problem

Rapid industrialization has contributed significantly to economic growth, but it has also led to a substantial increase in industrial wastages. Improper disposal and inadequate management of these wastes have resulted in severe environmental degradation. Communities living near industrial areas are increasingly exposed to polluted air, water, and soil. Such exposure adversely affects public health, leading to reduced life expectancy. Industrial pollution also disrupts educational attainment due to illness and unsafe living conditions. Livelihoods and income levels are negatively impacted as productivity declines and healthcare costs rise. These factors directly influence the core dimensions of the Human Development Index (HDI). Despite economic progress, many industrial regions continue to show stagnant or uneven HDI growth. Existing policies often prioritize industrial output over human well-being. Hence, there is a critical need to examine the impact of industrial wastages on HDI to promote sustainable and inclusive development.

3. Review of the Literature:

i). Victora *et al*., (1988) stated that the southern region of Brazil, a study found that factors significantly associated with an increased risk of mortality from diarrhoea included lack of plumbed water, lack of flush toilets, poor housing conditions, and overcrowded households. Households without access to piped water had a 4.8 times higher risk of infant death from diarrhea than households with access to piped water [2].

ii). Cheung *et al*., (1990) stated that the prospective epidemiological study of beach water pollution was conducted in Hong Kong in the summer of 1986–1987. The study found that swimmers on Hong Kong's coastal beaches were more likely than non-swimmers to complain of systemic ailments such as skin and eyes. And swimming in more polluted beach waters has a much higher risk of contracting skin diseases and other diseases. Swimming-related disease symptom rates correlated with beach cleanliness [3].

iii). Marwaha *et al*., (2018) stated that the basic pillars for the development of a sustainable society must explicitly pass through the development of efficient technologies, with moderate cost, ecologically correct and that have parameters that facilitate the increase of scale for industrial production. The role of an ecologically correct waste reuse industry is precisely to guarantee the well-being of the planet and to contribute to the economy and society [4].

iv). Prasad *et al*., (2018) stated that the Agricultural crops are one of the main sources of food production worldwide, which play an important role in the distribution of income, generating a profound impact on the socio-economic dynamics. In a broader aspect, it influences the entire global economy [5].

v). Caldeira *et al*., (2020); cristobal *et al*., (2018); freitas *et al*., (2021) there stated that the main limitations for the food industry are the heterogeneity of matrices, perishability, elevated microbial load, seasonality, and the feasibility of the processes. Therefore, optimization of extraction and recovery of bioactive compounds is still a very active research area towards the extraction of these compounds and the formulation of value- added products [6].

4. Research Gap of the Study

Existing studies on industrial development mainly focus on economic growth, with limited emphasis on the comprehensive impact of industrial wastages on the Human Development Index. There is a lack of integrated research linking industrial waste exposure directly with all three HDI dimensions—health, education, and income. Most studies are macro-level, leaving a gap in micro-level, community-based analysis. The long-term and cumulative effects of industrial wastages on human development remain underexplored. Regional disparities within industrial zones are often overlooked in existing literature. Limited research examines the effectiveness of waste management policies in improving HDI outcomes. There is insufficient use of primary data reflecting community perceptions and lived experiences. Inter-sectoral linkages between environmental degradation and social development are not adequately addressed. Comparative studies between polluted and non-polluted industrial regions are scarce. Hence, there is a clear need for focused research assessing industrial wastages and their multidimensional impact on HDI.

5. Objectives of the Study:

Some of the objectives are:

i). Analysis of the impact of industrial wastages on health outcomes affecting life expectancy.
ii). To find out the effectiveness of existing industrial waste management practices in reducing negative impacts on HDI.
iii). To examine the effectiveness of industrial waste management policies in reducing adverse impacts on human development.
iv). To evaluate the relationship between industrial wastage exposure and the overall Human Development Index (HDI).
v). To understand the role of industrial waste management practices in shaping human development outcomes.
vi). To suggest strategies that improves life expectancy in areas affected by industrial pollution.

6. Methodology:

This research is based on both doctrinal and non-doctrinal research, the sources of data collected from different newspapers, journals, magazines, AIR and e- resources. This research is used to satisfy random sampling; there are 111 sampling sizes from the respondents. In this research, I adopted some of the statistics tools such as percentage and average method. The duration of this research is three months.

7. Signification of the Study

This research is useful to the government as it provides a clear understanding of how industrial wastages affect key components of the Human Development Index such as health, education, and income. It helps policymakers identify industrial regions where human development is adversely impacted despite economic growth. The findings support the formulation and strengthening of effective industrial waste management and environmental protection policies. The study also assists in planning targeted public health and educational interventions in pollution-affected areas. It enables better allocation of resources for healthcare, sanitation, and livelihood improvement. Moreover, the research aids in monitoring the effectiveness of existing environmental regulations. Overall, it helps the government balance industrial development with sustainable and inclusive human development.

This research is useful to me as it helps in gaining a deeper understanding of how industrial wastages affect human development, particularly health, education, and standard of living. It enhances my knowledge of the relationship between industrial growth and HDI. The study strengthens my research and analytical skills by applying theoretical concepts to real-world issues. It improves my ability to critically evaluate environmental and development policies. The research also supports my academic growth by contributing to project work and future studies. Additionally, it increases my awareness of sustainable development and social responsibility. Overall, this study helps me develop a holistic perspective on industrialization and human well- being.

8. Hypothesis of the Study:

This research is based on following hypothesis are,

i). Industrial wastage affect the standard of living of nearby communities.
ii). Poor enforcement of industrial waste laws affects HDI.

9. Limitations of the Study

The study is limited to a specific geographical area, which may restrict the generalization of findings to other regions. The accuracy of the results depends on the reliability of secondary data and respondents' perceptions. Time constraints limit the depth of longitudinal analysis. Financial limitations restrict the use of advanced measurement and monitoring techniques. The study may not fully capture the long-term cumulative effects of industrial wastages. Variations in industrial types and waste composition are difficult to standardize. Some environmental and health impacts may be underreported. Policy implementation differences across regions are not fully addressed. The study focuses on selected HDI indicators, which may not reflect all dimensions of human development. External factors influencing HDI, such as migration and climate change, are beyond the scope of this research.

10. Result and Discussion:

Part-A: Doctrinal Research

Industrial wastes are generated in the course of any manufacturing, processing, or production operation, and all other activities connected with mining, construction, manufacturing, or chemical processing. Industrial waste comes in many forms, including solids, liquids, and gases. Many times, these wastes have to be appropriately disposed of so they do not pose an environmental hazard.

Major Types of Industrial Waste:

i). **Hazardous Waste:** The toxic, flammable, corrosive, or reactive materials presenting a serious threat to human health and the environment. Their commonest representatives include chemical solvents, heavy metals (including mercury and lead), radioactive substances, and some components of e-waste.
Examples: include-used oil, industrial chemicals, pesticides, and lead-based paints.
ii). **Non-Hazardous Waste:** According to this classification, these wastes, while being non-threatening to life and the environment, may have adverse long-term effects. Examples include packaging materials, glass, scrap metals, and untreated industrial wastewater.
iii). **Solid Waste:** Solid industrial waste covers items such as scrap metals, plastics, packaging materials, paper, sludge, and construction debris. For example, when a metal fabrication facility operates, it produces metal shavings and leftover pieces as solid waste.
iv). **Liquid Waste:** Liquid industrial waste includes wastewater, oils, solvents, acids, and other chemicals that come from production or cleaning. Energy plants and chemical manufacturers often create large amounts of liquid waste.
v). **Chemical Waste:** Chemical waste comes from industries that use or produce chemicals. This includes used solvents, acids, alkalis, and reactive compounds. Industries such as pharmaceuticals, paints, and plastics contribute a lot to chemical waste.
vi). **Electronic Waste (E-waste):** Electronic waste includes old equipment, circuit boards, and batteries from electronics manufacturing. These wastes often have dangerous parts but can also contain useful metals for recycling [7].

Environmental Impact:

To get huge amounts of water for manufacturing operations or equipment cooling, many factories and most power plants are built near bodies of water. Electric generating stations are the top water users in the United States. Pulp and paper mills, chemical facilities, iron and steel mills, petroleum refineries, food processing plants and aluminum smelters are some businesses that need a lot of water.

Many developing countries that are becoming industrialized do not yet have the resources or capacity to dispose of their trash in an environmentally responsible manner. Untreated and partially treated effluent is frequently discharged into a nearby body of water. Metals, chemicals and sewage dumped into bodies of water have a direct impact on marine ecosystems and the health of individuals who rely on the waters for food or drinking water. Depending on the contamination, wastewater toxins can kill marine life or induce varied degrees of disease in individuals who ingest these marine species. Metals and chemicals dumped into bodies of water have an impact on marine ecosystems.

Nutrient containing wastewater (nitrates and phosphates) frequently causes eutrophication, which can kill off existing life in bodies of water. According to the Thailand study on the causes of water pollution the highest amounts of water contamination in the U-tapao River exhibited a direct association to industrial wastewater discharges.

Thermal pollution (the release of hot water after it has been used for cooling) can also result in polluted water. Elevated water temperatures limit oxygen levels, which can kill fish and change the makeup of food chains, reduce species biodiversity and encourage the invasion of new thermophiles species.

Hazardous Waste in India:

It is estimated that about 74.6 lakh tons of hazardous waste are generated annually in India. Among this, waste that can be disposed of in landfills constitutes nearly 34.1 lakh tones or 46 percent of the total. Recyclable hazardous waste consists of 33.5 lakh tones or 45 percent of the total trash in landfills. Hazardous waste is considered more dangerous due to its impact on our health and the environment. The combustible gas methane is a common by-product of hazardous waste accumulation. It is causing ailments such as lung infection, heart disease, and radiation leading to cancer. Methane affects water bodies, leaving them useless due to the accumulation of the gas on the surface.

Hazardous waste can leak into drainage systems and contaminate drinking water, making it unsafe. Industrialized nations such as Malaysia and Saudi Arabia also exported hazardous waste to India. India reprocesses and recycles it until the revamped rules of 2016 stopped it. Currently, India's hazardous waste is in landfills used for ordinary waste dumping. Those dump sites are not scientifically designed landfills with exclusive designs to dispose of hazardous waste.

Worldwide Generation of Industrial Waste:

The waste management situation of a country evolves when it moves from low-income level to middle-income level. As compared to the residents of developed countries, people residing in developing nations, more specifically the urban poor, are more harshly impacted by unscientifically and unsustainably managed industrial organic waste. In developing countries, over 90% of the waste is either burned openly or disposed of in unregulated dumps. Countries belonging to Central Asia, East Asia and Pacific and the Europe regions contribute 43% of the world's waste by magnitude. Least amount of waste (15%) has been recorded from the Middle East, North Africa and Sub-Saharan Africa regions (Figure 3). In absolute terms, Pacific and East Asia together generated an estimated 468 million tons in 2016 whereas 129 million tons of waste were recorded from North America and Middle East regions. If we consider in an international scale, the largest category of waste generation comes under food and green waste, which makes up about 44% of the total waste (Kaza *et al*., 2018) [8].

Physico-chemical Characteristics of Industrial Organic Waste:

The types of industrial organic waste and their quantities vary from plant to plant depending on the raw material consumed, in-plant control measures, external control measures, house-keeping, waste utilization, collection and recycling practices. Cultural traditions, economic status, climatic and geographic conditions along with dietary habits of a region determine what type of industry will be required, which ultimately determines the type and nature of waste material produced (Jin *et al*., 2006). The composition and amounts of solid waste are also greatly affected by multiple factors including socioeconomic development of the region. The differences in the composition of waste in low, middle and high-income countries are presented in Table 1 [9].

Table 1: The composition of waste in low, middle and high-income countries.

Parameters (%) Organic (putrescible)	Low-income country 40–85	Medium 20–65	High-income 20–30
Paper	1–10	15–30	15–40
Plastics	1–5	2–6	2–10
Metal	1–5	1–5	3–13
Glass	1–10	1–10	4–10
Rubber, leather, etc.	1–5	1–5	2–10
Other	15–60	15–50	2–10
Moisture content (%)	40–80	0–60	5–20
Density (kg m–3)	250–500	170–330	100–170
Calorific value (kcal kg–1)	800–1,100	1,000–1,300	1,500–2,700

Source: *Cointreau (2006)*

Human Development Index (HDI):

Its statistical measure used to quantify a country's achievement in 3 basic dimensions of human development - Long and healthy life, Knowledge, and a decent standard of living. Developed by Pakistani economist Mahbub ul-Haq. Haq worked with Indian Nobel laureate Amartya Sen to develop the HDR. • How HDI value is calculated? The Human Development Index (HDI) value is calculated by taking the geometric mean of three key dimensions: life expectancy, education level (measured by mean years of schooling and expected years of schooling), and per capita income, resulting in a single number between 0 and 1, where 1 represents the highest level of human development; essentially, it is a composite measure of a country's health, education, and standard of living.

India's HDI Performance in Human Development Report (HDR) 2023-2024:

United Nations Development Programme (UNDP) released the Human Development Report (HDR) 2023-2024 titled "Breaking the Gridlock: Reimagining cooperation in a polarised world". HDR Released by United Nations Development Programme (UNDP) annually since 1990. Objective of the report examines major global challenges that affect human development and suggest recommendations are presented in table 2.

Table 2: Major global challenges that affect human development.

Rank	Country	1990	2000	2010	2020	2022	Category of HDI
1	Switzerland	0.850	0.885	0.940	0.885	0.967	Very High Human Development
2	Norway	0.845	0.914	0.938	0.963	0.966	Very High Human Development
3	Iceland	0.834	0.895	0.927	0.927	0.959	Very High Human Development
75	China	0.482	0.586	0.698	0.781	0.788	High Human Development
78	Srilanka	0.641	0.689	0.735	0.777	0.780	High Human Development
89	Brazil	0.620	0.668	0.722	0.758	0.760	High Human Development
129	Bangladesh	0.399	0.491	0.558	0.657	0.670	Medium Human Development
134	India	0.434	0.490	0.572	0.638	0.644	Medium Human Development
164	Pakistan	0.394	0.434	0.496	0.536	0.540	Low Human Development
186	Yemen	0.357	0.434	0.496	0.430	0.424	Low Human Development

Source: *Human Development Index Report (2023-24)*

Smarter Ways to Handle Industrial Waste:

The good news is that there are practical solutions available today. With the right systems in place, industries can turn waste into a resource instead of a problem.

- Waste Segregation Machines Rotary screens or trammel screen machines can separate different fractions of waste quickly and efficiently.
- Waste Composting Machines Industries can process

organic waste on-site, reducing disposal costs and creating compost for landscaping or farming.
- RDF Plants in India Refuse-Derived Fuel (RDF) plants convert non-recyclable waste into fuel for industrial use, lowering dependence on fossil fuels.
- Municipal Solid Waste Processing Plants These plants handle mixed waste at scale, recovering materials and reducing landfill pressure.
- Bio mining and Legacy Waste Management Bio mining plants recover useful materials from old dumpsites, supporting safe legacy waste management.

These technologies are already in use across sectors such as food processing, textiles, packaging, cement, and other manufacturing industries. For instance, a brick manufacturer in Pune set up an RDF huplant to process the waste generated and now uses RDF-generated power to run its operations. Similarly, packaging industries are using trammel screens to recover recyclables that were earlier being sent to landfills.

Need for a New Policy:
The Industrial Policy serves as a critical instrument that will help achieve Tamil Nadu's Vision 2023. Tamil Nadu's Vision 2023 is a roadmap for state's development, encompassing themes like economic prosperity, inclusive growth, world-class infrastructure, a healthy investment climate, and improving the quality of governance to improve and sustain the growth of both manufacturing and associated services. It aims for an 11 percent annual growth rate in the State's economy, a 14 percent growth rate in manufacturing, and targets investments worth INR 15,00,000 cr. (US$ 214.286 billion) in numerous projects over ten years. Growth shall be balanced across regions with a stronger focus on reducing poverty and inequality.
As a leading industrialized State, Tamil Nadu periodically revises its Industrial Policy to respond to the changing economic scenario and technology; and to offer direction and support for future growth. This Policy aims to build on the momentum generated by the State through the Industrial Policy of 2014 in upholding its position as a preferred destination for investment in India. Intending to be contemporary and progressive, this Policy incorporates recent changes in the regional and national economy, new initiatives and policy changes like Make in India, Ease of Doing Business, and Goods and Services Tax, and provides direction for future development. With this Industrial Policy, Tamil Nadu reaffirms its commitment to creating new jobs, improving labor quality, fostering innovation, and ensuring inclusive and balanced growth [10].

Progress & New Goals:
Given the progress that the state has made with respect to the objectives set out in the previous Industrial Policy, we retain, raise and refocus our goals as follows:

Progress:
i). Tamil Nadu has achieved a compounded annual growth rate of 13% in manufacturing between 2014-15 and 2019-20 and is well-positioned to attain a target growth of 14%, in line with Vision 2023. Goal: Achieve annual growth rate of 15% in the manufacturing sector during the policy term.
ii). The State has surpassed its target, attracting incremental investments of over 10% every year in manufacturing, by achieving an annual growth rate of 14% in incremental investments in manufacturing and 25.74% across all sectors since 2013. Goal: Attract investments worth INR 10 lakh cr. (US$ 135 billion) between 2020 and 2025.
iii). The Government of Tamil Nadu has strived to create gainful employment opportunities for 20 lakh persons and has over 45,000 registered factories employing 21.65 lakh persons as of Feb 2020. The State has renewed this effort with a push towards skill development. Goal: Create employment opportunities for 20 lakh (2 million) people by 2025.
iv). Manufacturing sector's contribution to the State has been consistently increasing for the past decade. In 2019-20, the manufacturing sector contributed to 25% of GSVA. Goal: Increase the contribution of the Manufacturing Sector to 30% of GSVA by 2030 [11]

Relevant Case Law:
i). Vellore Citizens Welfare Forum v. Union of India: It was a landmark case concerning pollution from tanneries and industries in Tamil Nadu. The petition highlighted the contamination of the Polar River and its impact on the region's water supply. The Supreme Court in Vellore Citizens Welfare Forum v Union of India directed the central government to establish an authority under the Environment Protection Act, applying the precautionary and polluter pays principles. It imposed fines on tanneries, mandated common treatment facilities and ordered the closure of non-compliant units [12].
ii). Indian Council of Enviro-Legal Action vs. Union of India 1996: In the Bichhri case, also known as the Indian Council of Enviro-Legal Action vs. Union of India 1996, Justice Dalveer Bhandari declared that reversing the imbalance caused to the ecology is part of the industrial process. Thus, the financial responsibility of prevention and controlling the pollution caused should rest upon the industry which caused pollution. The Bichhri court judgment became the pioneering case where the 'polluter pays principle' – which notes that the polluter is liable for environmental pollution and needs to pay for damages – was applied and defined for the first time. In line with the 'polluter pays principle' and the doctrine of Absolute liability, the court directed offending industries to pay Rs. 373.85 million for the remediation of impacted water wells [13].
iii). Sterlite Industries (India) ltd. v. Union of India (2013): The case of Sterlite Industries (India) ltd. v. Union of India (2013) also referred as the Sterlite Tuticorin case, centers around environmental violations by Sterlite Industries situated in Tuticorin, Tamil Nadu. This 2013 Supreme Court judgement addressed some of the critical issues related to Environmental pollution, corporate responsibility and role of government in enforcing government regulations. This landmark case also highlights the conflict between economic interests and environmental sustainability, by raising questions about industrial regulations in India, particularly concerning hazardous emissions, compliance with environmental standards and community health impacts [14].

Part-B: Non Doctrinal Research

Table 3: That industrial wastage has a predominantly negative impact on the standard of living.

Particular	Rural	Semi urban	Urban	Total
Increases employment and income despite pollution	9(8.10)	10(9.00)	4(3.60)	23(20.72)
Causes health expenses and reduces household savings	14(12.61)	11(9.90)	13(11.71)	38(34.23)
Has no significant effect on daily life	10(9.00)	7(6.30)	9(8.10)	26(23.42)
Improves infrastructure and public facilities	7(6.30)	10(9.00)	7(6.30)	24(21.62)
Total	40(36.03)	38(34.23)	33(29.72)	111(100.00)

Sources: *Primary data*

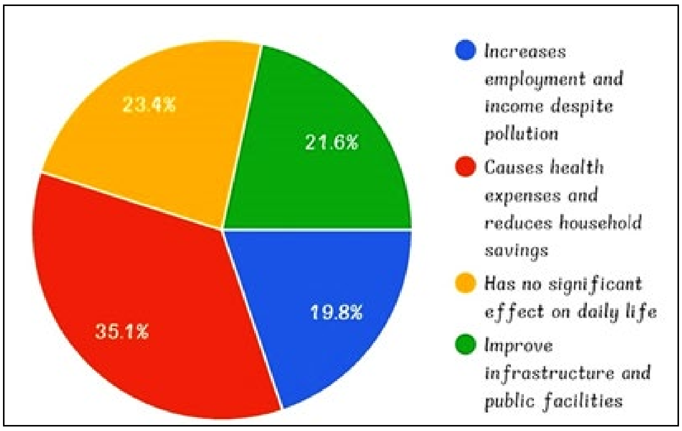

Fig 1: Negative impact on the standard of living

The findings clearly show that industrial wastage has a predominantly negative impact on the standard of living of nearby communities. A significant 35.1 percentage of the respondent of respondents reported that industrial wastage leads to increased health expenses and reduced household savings, indicating a direct burden on economic well-being and quality of life. While 19.8 percentage of the respondent acknowledged employment and income opportunities despite pollution and 21.6 percentage of the respondent felt that industrial activities improve infrastructure and public facilities, these perceived benefits are outweighed by social and health costs. The demographic distribution shows respondents from rural (36 percentage), semi-urban (34.2 percentage), and urban (29.7 percentage) areas, reflecting that the impact of industrial wastage cuts across regions, with health and living conditions emerging as major concerns over economic gains.

Table 4: Perceptions of how poor enforcement of industrial waste management affects the Human Development Index (HDI).

Particular	Male	Female	Transgender	Total
Increasing health risks	5(4.50)	11(9.90)	0(0.00)	16(14.41)
Reducing quality of education	12(10.80)	12(10.80)	0(0.00)	24(21.62)
Lowering living standards	8(7.20)	13(11.71)	0(0.00)	21(18.91)
All of the above	24(21.61)	26(23.42)	0(0.00)	50(45.04)
Total	49(44.14)	62(55.85)	0(0.00)	111(100.00)

Sources: *Primary data*

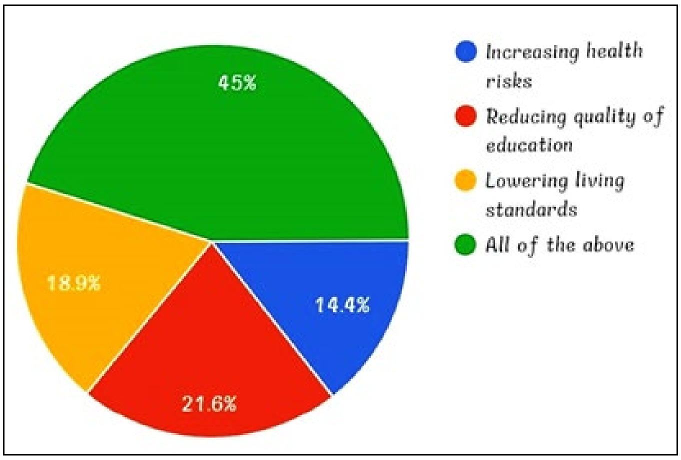

Fig 2: Poor enforcement of industrial waste Management affects the HDI.

The figure shows respondents' perceptions of how poor enforcement of industrial waste management affects the Human Development Index (HDI). Out of 111 responses, a clear majority (45percentage) believe that weak enforcement negatively impacts HDI through all of the listed dimensions—increasing health risks, reducing the quality of education, and lowering living standards—highlighting the interconnected nature of development indicators. Individually, 21.6 percentage feel it mainly reduces the quality of education, 18.9 percentage associate it with declining living standards, and 14.4 percentage point specifically to increased health risks.

Hypothesis Testing

i). **Industrial wastage affects the standard of living of nearby communities:** According to the survey findings table 4, 18.91 percentage of the respondents reported that industrial wastages negatively influence their standard of living, mainly through air and water pollution, improper waste disposal, and contamination of local resources. These conditions lead to increased health problems, higher medical expenses, loss of clean drinking water, and reduced agricultural productivity, thereby lowering overall living standards. This indicates that industrial growth without effective waste management can hinder sustainable human development in nearby communities.

ii). **Poor enforcement of industrial waste laws affects HDI:** As reflected in the above survey results table 3, respondents from rural 36 percentage, semi-urban 34.2 percentage, and urban 29.7 percentage regions reported concerns over declining living conditions due to unmanaged industrial wastage. Environmental degradation also affects livelihoods, agricultural productivity, and access to clean resources, thereby lowering income levels and educational outcomes. Overall, poor implementation of industrial waste laws slows HDI improvement by compromising health, income stability, and quality of life across gender and residential groups.

11. Conclusion

The study concludes that industrial wastages have a significant and adverse impact on the Human Development Index (HDI) of affected regions. While industrialization contributes to economic growth and employment, the improper management and disposal of industrial waste undermine key HDI dimensions—health, education, and standard of living. Exposure to polluted air, water, and soil increases health risks, reduces life expectancy, and raises healthcare costs, particularly for vulnerable and rural communities. Environmental degradation also disrupts livelihoods and limits access to clean resources, thereby constraining income and educational opportunities. The findings highlight that weak enforcement of environmental regulations and inadequate waste management systems exacerbate these developmental setbacks. Therefore, sustainable industrial practices, strict legal enforcement, and community-centric environmental policies are essential to ensure that industrial growth translates into genuine human development rather than long-term social and environmental costs.

12. Suggestion

Here, the research also gives some suggestions are laid down;

i). Strengthen the enforcement of industrial waste management laws through regular inspections, strict penalties, and transparent monitoring mechanisms.

ii). Promote the adoption of cleaner production technologies and waste-minimization practices across industries to reduce environmental and health risks.

iii). Establish proper industrial waste treatment, recycling, and disposal facilities, especially in industrial clusters near residential and rural areas.

iv). Increase community awareness and participation in environmental decision-making to ensure accountability and protection of local livelihoods.

v). Integrate environmental quality indicators into HDI-based development planning to reflect the true impact of industrialization on human well-being.

vi). Encourage collaboration between government, industries, and research institutions to develop sustainable policies and evidence-based solutions

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