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Exploring the Relationship and Policy Implications of GSDP and E-Waste Management Nexus

Naibin George[1], Dr. Andrejs Cekuls[2], Dr. Neenu Joseph[3], Sweety Joy C.[4]

[1]Faculty of Economics & Business, University of Latvia, Riga, Latvia
Email: *naibingeorge[at]gmail.com*

[2]Professor, Faculty of Economics & Business, University of Latvia, Riga, Latvia
Email: *andrejs.cekuls[at]lu.lv*

[3]Department of Electronics & Communication, Albertian Institute of Science & Technology, Kochi, Kerala, India
Email: *neenujoseph[at]aisat.ac.in*

[4]Department of Software Engineering, St.Alberts College, Kochi, Kerala, India
Email: *84.sweety[at]gmail.com*

Abstract: ***This study explores the relationship between Gross State Domestic Product (GSDP) and electronic waste management. As economies grow and technological advancements continue, the generation of electronic waste (e-waste) has increased significantly, posing environmental and health challenges worldwide. This research aims to examine whether higher GSDP levels correlate with improved e-waste management practices and to identify potential policy implications. This study adopts a mixed-method approach, combining quantitative analysis of GDP data and e-waste generation with qualitative assessments of e-waste management policies in different states in India. Data is collected from international databases, governmental reports, and academic literature. Statistical analyses are performed to assess the association between GDP and e-waste generation, considering factors such as population density, urbanization, and industrialization.***

Keywords: Gross State Domestic Product (GSDP), electronic waste management, e-waste generation, environmental challenges

1. Introduction

As economies continue to grow and technology proliferates, the generation of electronic waste (e-waste) has become an alarming global challenge. The increasing pace of economic development has led to a significant surge in e-waste production, resulting in widespread environmental and health concerns. India, known for its rapid economic growth, is not immune to this issue. As one of the world's fastest-growing economies, the country faces mounting challenges in effectively managing its e-waste.

With the rapid obsolescence of electronic devices, the proper management of e-waste has become crucial for sustainable development [1]. Disposed electronics often contain hazardous materials, posing potential risks to both the environment and human health if not handled responsibly. India is estimated to generate millions of tons of e-waste annually, and this figure is expected to rise further due to escalating urbanization and continuous technological advancements [8]. Proper e-waste management, therefore, assumes critical importance in mitigating these environmental and health impacts and fostering a sustainable future.

As Gross State Domestic Product (GSDP) serves as a vital indicator of economic growth at the state level in India, it becomes imperative to investigate its association with e-waste management. The growth of gross state domestic product is an important parameter to measure the state of economic health of states and as a whole of the country[7]. It helps to describe the status of public welfare of the states and overall picture of the economy. But there is uneven growth of state domestic product (SDP) of Indian states which is a constraint on the overall growth of India's gross domestic product (GDP). The growth of most of the Indian states is found to be featured with instability and volatility.

Understanding the relationship between economic development and e-waste generation can offer valuable insights for crafting effective policies and interventions. By exploring the dynamics of GSDP and e-waste management, we can identify potential strategies to address the mounting e-waste challenge in India while ensuring continued economic progress.

2. Literature Review

The main concerns and challenges of E-waste management are that Consumers and manufacturers are not aware of the correct disposal of e-waste. There is no check on E-waste generation and recycling. E-waste is majorly processed by the informal sector, which uses old techniques resulting in polluting the environment. The workers working in the informal sector are not aware of the generated toxics and health hazards and Lack of the latest technologies in the informal sectors, resulting in the partial extraction of the resources. There are no specific rules defined and imposed to handle E-waste. Partial dismantled products are landfilled [6].

Due to the distinct nature of E-waste (containing both valuable and toxic chemicals), the waste products and the material constituting E-waste flow in a number of directions. In developing countries e-waste is considered a valuable commodity and customers get paid by the collectors [2]. On

the other hand, developed countries implemented strict regulations by which the flow of E-waste through illegal channels is banned and illegal dumping is banned. Identification of the flows of such a waste stream in both visible and illicit media is an important area of investigation for all countries from the point of view of resource conservation, transboundary movement, and human-health protection [4].

2.1 Informal System

This sector is managing the major e-waste in India. The collection has been done by the local scrap vendors. After collection, the recycling process involves segregation and dismantling the products. Primitive techniques are used in this process. Which may include (i) disassembling of electronic equipment; (ii) heating or manual dismantling of printed circuit boards; (iii) recovering metals by opening or cutting cables; (iv) breaking or melting plastics; (v) toner sweeping; (vi) metals recovery by open acid leaching of e-waste. Most of the scrap vendors are not much educated; moreover, the people working under them are also not skillful and educated[6]. They also do the repair and refurbishment of old products, which will be sold in the second-hand market. They just use their older and traditional illegal methods of burning the products to extract the metals – in many cases, they are not aware of the risk/health risks involved. The extraction process emits various toxic elements polluting the air and the disposal/ smudges of e-waste contaminate the water. The remaining waste is then landfilled somewhere illegally. Additionally, workers work in an environment with no ventilation, or personal protection equipment, leading them to direct exposure to these hazardous elements causing many chronic diseases. As our society is not doing anything, this sector is growing day by day.

2.2 Formal System

As most of the e-waste in India is handled in a non-regulatory method, some policies need to be implemented to make it regulated. A formal system is a sector where e-waste is managed in an environment-friendly manner. The latest available technologies are used to manage and recover the resources. But a lot more cost investment is required to maintain the measures, making the road tough for the formal recyclers, as they have to face competition from the informal sector. Electronic equipment is collected and segregated on the basis of its use. Categorized equipment is sent for refurbishment or dismantling process, as required. After processing, the reusable components from refurbishment are sent to the market and the rest may be sent for dismantling [6]. During dismantling, the proper procedure is taken to ensure environment-friendly disposal of residues. Various items are separated and categorized to recover important materials for the market. The number of cycles the process takes may vary.

2.3 Gross Domestic Profit

Financial Architecture plays a crucial role in promoting the sustainability of an economy by fostering a consistent and desirable growth rate. GDP serves as a key indicator of an economy's growth, with a higher GDP reflecting robust economic expansion, and vice versa. Consequently, every country endeavours to maximize its GDP growth rate. However, the growth rate of GDP is influenced by various macroeconomic factors operating within the economic environment. These factors can either accelerate or impede the GDP growth rate, making them essential considerations for policymakers and stakeholders seeking to foster economic prosperity. [9]

Table1: GSDP of Indian States

States in India	GSDP (rupees)
Andhra Pradesh	9712242.2
Assam	3352381.1
Chhattisgarh	3449553.5
Delhi	8308724.9
Gujarat	16302401.2
Goa	748283.7
Haryana	7806123.5
Himachal Pradesh	1628159.3
Jammu & Kashmir	1703821.1
Jharkhand	3211573.1
Karnataka	16289279.3
Kerala	8546889.9
Maharashtra	28185545.7
Madhya Pradesh	9374051.8
Orissa	5479590.8
Punjab	5396865.5
Rajasthan	9989991.1
Tamil Nadu	17972287.2
Telangana	9572071
Uttar Pradesh	16878179.9
Uttarakhand	2536662.5
West Bengal	12078226.1

Source: Reserve Bank of India

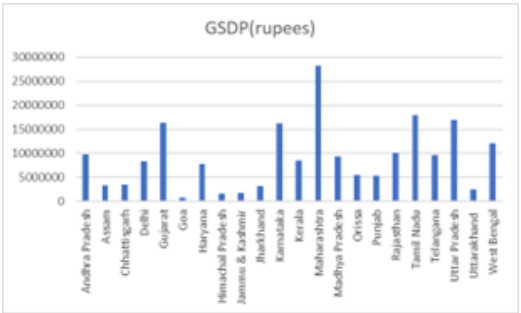

Figure 1: Source economic survey 2022-23, Statistical Appendix

2.4Formal e-waste plant capacity of different Indian states

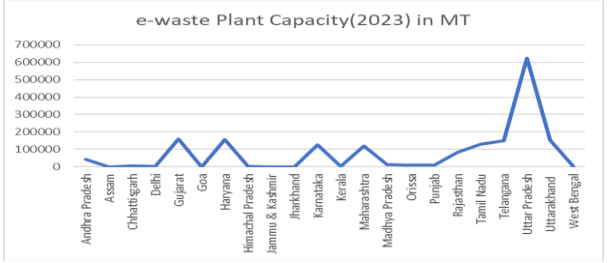

Figure 2: Authorized e-waste plant capacity. (source:CPCB)

Table 2: Formal e-waste plant capacity of different Indian states

States in India	e-waste Plant Capacity (2023) in MT
Andhra Pradesh	44002.5
Assam	120
Chhattisgarh	6750
Delhi	1989
Gujarat	158604
Goa	153
Haryana	157187.67
Himachal Pradesh	1500
Jammu & Kashmir	705
Jharkhand	660
Karnataka	126015.48
Kerala	1200
Maharashtra	118031.5
Madhya Pradesh	13600
Orissa	9050
Punjab	10092
Rajasthan	82007.67
Tamil Nadu	130636
Telangana	148115
Uttar Pradesh	624219.47
Uttarakhand	153068.06
West Bengal	2640

Source: central pollution control board,India

3. Methodology

The study is based on both primary and secondary data.

Secondary data sources include published data from Environmental Science and Pollution Research, Science of the Total Environment, ScienceDirect, Recovery of Materials and Energy for Resource Efficiency, and The Journal for Decision Makers by IIM-A.

However, primary data was collected using semi-structured interviews with experts and professionals in the field of environmental engineering, NASSCOM, Central Pollution Control Board, and Public works Department in India.

4. Objectives and Hypothesis of the Study

4.1 Objectives: The main objective of the study is:

To identify the relationship between the GSDP of different states in India and the formal e-waste capacity of Indian states.

4.2 The Hypothesis of the Study:

H0: Null Hypothesis-There is a significant relationship between GSDP and formal e-waste plant capacity of Indian states
Ha: Alternate Hypothesis-There is no significant relationship between GSDP and formal e-waste plant capacity of Indian states

4.3 T-Test: Two-Sample Assuming Unequal Variances

t-Testing is a common component of inferential statistics when comparing two means [9]. Testing involves comparing means and since the t-test is a parametric test, it assumes that the data is approximately normally distributed [10]. The author conducted a T-test to study the relationship between the literacy and formal recycling centers in their states of India. For the study, the author has considered Gross state domestic profit of different states in india and capacity of authorized recyclers of the states in India. T-Test: Two-Sample Assuming Unequal Variances are used assuming null hypothesis (Ho) as there exist a significant relationship between GSDP and formal e-waste plant capacity of Indian states and an alternate hypothesis (Ha) as there is no significant relationship between GSDP and formal e-waste plant capacity of Indian states. The result of the T-Test, P(T<=t) value of the two-tail is 4 and is greater than the critical value. So, the author has to accept the null hypothesis Ho, and reject the alternate hypothesis, Ha. So there is a significant relationship between GSDP and the formal e-waste plant capacity of Indian states

t-Test Paired Two assuming unequal Variance

States in India	Gsdp(rupees)	e-waste Plant Capacity(2023)
Andhra Pradesh	9712242.2	44002.5
Assam	3352381.1	120
Chhattisgarh	3449553.5	6750
Delhi	8308724.9	1989
Gujarat	16302401.2	158604
Goa	748283.7	153
Haryana	7806123.5	157187.67
Himachal Pradesh	1628159.3	1500
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Telangana	9572071	148115
Uttar Pradesh	16878179.9	624219.47
Uttarakhand	2536662.5	153068.06
West Bengal	12078226.1	2640

t-Test: Two-Sample Assuming Unequal Variances		
	Gsdp(rupees)	*e-waste Plant Capacity(2023)*
Mean	9023768.382	81379.37955
Variance	4.61746E+13	18816770785
Observations	22	22
Hypothesized Mean Difference	0	
df	21	
t Stat	6.171275636	
P(T<=t) two-tail	4.01741E-06	
t Critical two-tail	2.079613845	

Source:Author

5. Conclusion and Suggestion

Based on the results of the t-test, the author has identified a significant correlation between the Gross State Domestic Product (GSDP) and the formal e-waste plant capacity in Indian states. Despite the dominance of the informal sector in e-waste management, the findings suggest that the GSDP of states is positively associated with the capacity of formal e-waste plants. However, it is crucial to address the unscientific practices and environmental health externalities associated with the informal sector's processing of e-waste to achieve sustainable and environmentally responsible waste management practices in the country.

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Author Profile

Naibin George He received his Bachelor of Engineering in Electronics and Communication (ECE) from Anna University in 2005, and an MBA in Marketing from MG University in 2007. Later, in 2011, he acquired his Master of Engineering in VLSI Design from Anna University. For the duration of 2011-2021, he served as an Assistant Professor and subsequently as an Associate Professor in the Department of Electronics and Communication Engineering at AISAT. Currently, he is at research at the Faculty of Economics and Business, University of Latvia, where he is engaged in groundbreaking research focusing on the management of electronic waste (e-waste) systems in developing countries.