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Advancing environmental protection with sustainable financing: a case for waste management through superfund policy in India

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Rapid urbanization has contributed to the growing issue of waste generation. It has been well-documented that the process of disposal of hazardous waste can harm human health and environment if not managed properly. Uncontrolled waste generation impedes the realization of SDGs and affects India's ambition to achieve net zero emissions by 2070, ultimately impacting India's mission to fulfil its obligations made during the Paris Agreement in 2015. Therefore, the Indian Government has adopted a multifaceted approach to regulating waste disposal, which includes using waste technology, capacity building, citizen participation, etc. However, the major challenge faced is the inadequate funds to implement these regulations. The Government of India supports the financing of these efforts through grants, loans, tax exemptions, and other mechanisms, yet there is a need for more effective and sustainable financing.

The paper analyses the trends and mechanisms of financing waste management in India. The paper further delves into the case study of the Love Canal Disaster in the USA. It discusses the need and feasibility of creating a Superfund policy to address the challenges of waste management. Furthermore, the paper evaluates best practices from across the globe and concludes with viable recommendations to improve and enhance financing for waste management and environmental protection.

Keywords: environmental protection; love canal disaster; superfund; sustainable financing; waste management.

INTRODUCTION

The growing world population and the longing urge for development have led to many issues in the present times. One of the major problems is that of waste generation. The present production-consumption model generates a lot of waste, out of which India alone produces 62 million tons of waste annually, with 70% of the waste being collected and only 12 million tons treated, while 31 million tons end up in landfills. With the changing production and consumption pattern like online food delivery, etc. digitization and advancement in technology including public services, there is a likelihood of three times surge in waste generation by 2030.

Recent data from the Central Pollution Control Board (2024) indicate that India's waste generation has increased by 25% since 2021, reaching approximately 77.6 million tons annually. Urban areas contribute disproportionately to this volume, with metropolitan cities generating 55% of the total waste. The implementation of digital India initiatives and the rapid growth of e-commerce have led to a projected 40% increase in e-waste generation by 2025 [1]. This escalating waste crisis presents both environmental challenges and opportunities for sustainable waste management solutions.

The member states of United Nations through its sustainable development goals Agenda 2030 have pledged to reduce waste like the solid waste generated from cities (11.6.1), food waste (12.3.1), chemical waste (12.4.1), hazardous waste (12.4.2) by proper and adequate treatment. Since there is a diverse range of waste generated through human activities, therefore one fit for all formula will not be able to resolve the problem, thus, the member states have tried to cater to the issue of waste generation through various law and policy initiatives.

Effective waste management has been a challenge for developing countries. India exemplifies the issue through its diverse demography and demographical requirements with different production consumption habits and diverse requirements of the waste for its management. Apart from an international effort to minimize and manage the waste, the Indian Government has tried to regulate waste by catering to various techniques of waste segregation, waste disposal, waste treatment, etc. using various law and policy instruments. However, the results of these efforts are still desired. One of the major reasons for the same is the lack of funds to carry out the process of waste management. More than three-fourth of solid waste management budget is allotted to collection and transportation, leaving little for processing or resource recovery

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and disposal [2].

A multifaceted approach is required to address the financing issue which will involve public-private partnerships, government incentives, and innovative funding mechanisms to ensure sustainable management of waste and safeguard the environment for future generations. Therefore, there is a need to devise sustainable financing mechanism which can generate sufficient funds for waste management infrastructure, recycling techniques and facilities, awareness campaigns, research and development and other initiatives to do away with the possibility of waste leakage.

The paper adopts a doctrinal method of research for exploring mechanism for financing waste management. The paper highlights the need for financing mechanism for waste management. The paper also delves into the mechanism and challenges of financing waste management in India. The paper explored various best practices used across the globe for managing waste to find out the possibility of adopting one for India. To determine a framework for financing waste management, the paper probes the effectiveness of a Superfund created in US by studying the love canal disaster. The paper further examines the need and feasibility of creating a Superfund in India for financing waste management and thereby protecting the environment and preventing health hazards.

While extensive research exists on waste management technologies and policies, there remains a significant gap in understanding sustainable financing mechanisms specifically adapted to India's unique socio-economic context. Previous studies have focused primarily on technological solutions [3] or policy frameworks [4], but few have examined the intersection of policy, finance, and implementation in the Indian context. This research aims to:

1. Evaluate existing financing mechanisms for waste management in India;
2. Analyze the applicability of global best practices in the Indian context;
3. Develop a framework for implementing a Superfund-style policy adapted to Indian conditions;
4. Propose sustainable financing solutions that integrate public, private, and community stakeholders.

LITERATURE REVIEW THROUGH BIBLIOMETRIC SURVEY USING SCOPUS DATABASE

The literature review is performed through bibliometric analysis by analyzing the existing published literature on financing waste management in India. The study was conducted using SCOPUS database which is a global abstracting and indexing database which consists of all the high-quality published documents. The literature review highlights the linkage between Waste Management and Financing Strategies. Various were used to identify the relevant published documents to remove the possibility of excluding relevant documents.

Search strategy

The SCOPUS database was searched using various keywords to get the relevant data on clean air and sustainable development. The database was searched using the category of "Abstract, Article Title, and Keywords". This category was used as it is most useful in identifying the relevant documents and avoiding misleading results.

The flowchart below explains the search strategy used to identify the relevant literature.

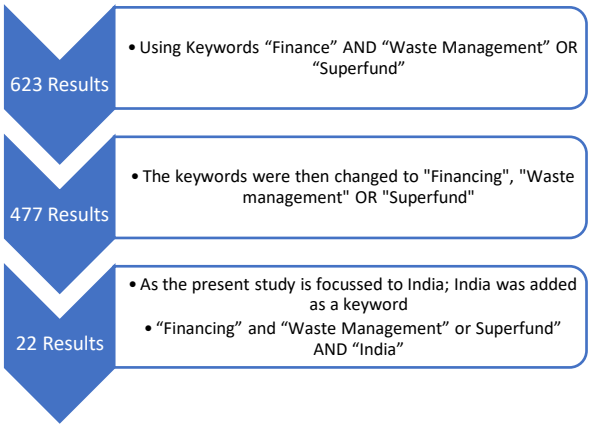

Fig. 1. Search strategy applied on SCOPUS database

All the results were manually scrutinized to check the relevance of the results to the topic. All the documents were found relevant to the subject and thus, all the documents are being considered for the bibliometric analysis and no documents from the search result have been excluded.

Quantitative analysis of the literature

The study first of all conducts a quantitative analysis of the present literature by analyzing the publication trend during the timeline from 1991 till date and then focusing on the subject area of the research. The survey shows that although there has been a lot of study already done on the topic Waste management, however, the there is a lack of study about the financing strategies for waste management. At global level, several researchers have focused on the financing strategies for managing the waste but India lacks behind in the same. The results show mere 22 publications during the whole timeline.

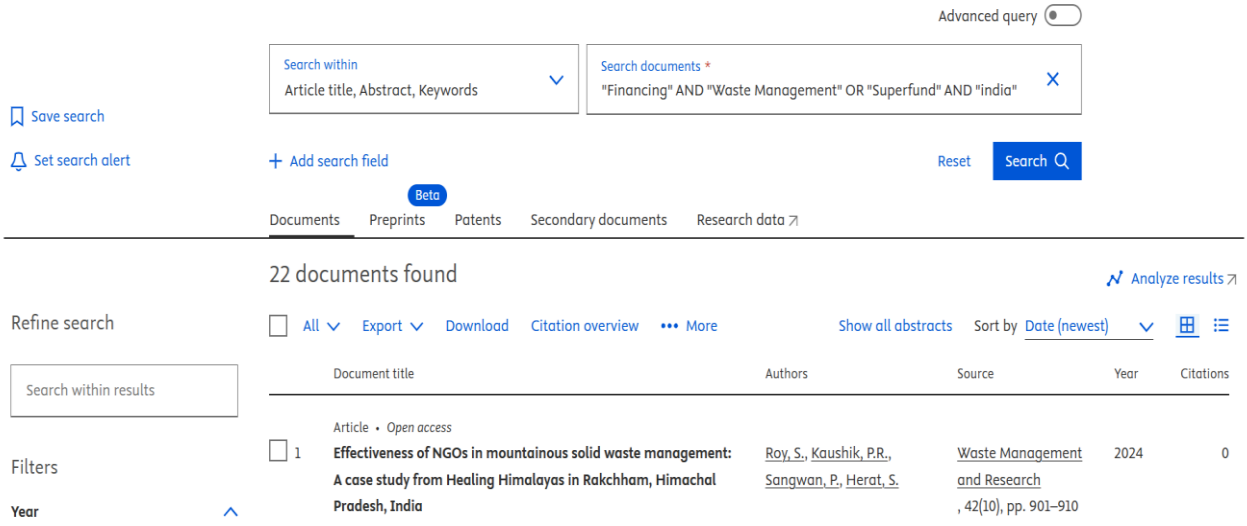

Fig. 2. 22 documents found using the search strategy (SCOPUS database)

The topic did not gain much attention of the researchers in any year except 2011 and 2021 wherein three research publications have taken place in both the years which is quite an insignificant number as compared to the significance the topic holds in the present times (see Fig. 3).

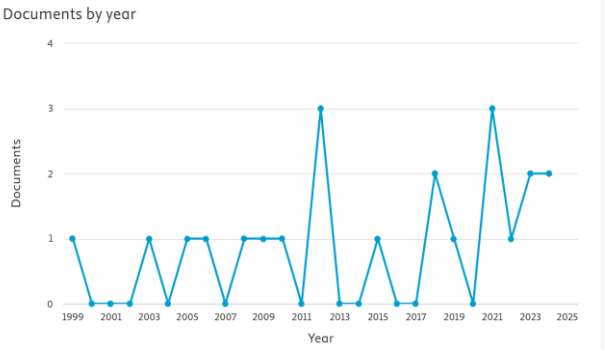

Fig. 3. Publication trend in the field of financing waste management in India (SCOPUS database)

Furthermore, the analysis shows that 35.7% of the total publications focuses on the environmental science domain and only 14.3% of the research is from social science perspective. A manual scrutiny of the present documents showcase that a very little research has taken place from a legal and a policy aspect on financing waste management and protecting the environment and human health.

Qualitative analysis

Research has been conducted on effective methods for waste management in various sectors like banks, corporates, educational institutes, etc. and it has been found that now everyone uses an active management method of waste management [5]. With changes in types of waste generated there have been changes in the methods and means to manage the same.

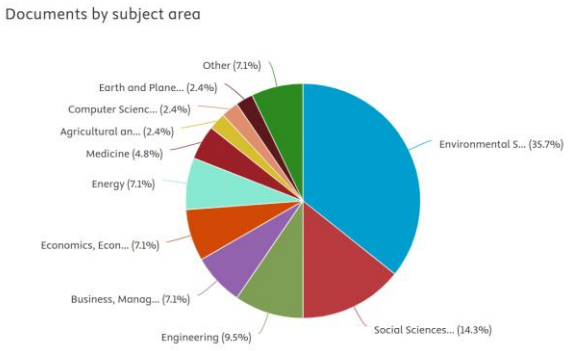

Fig. 4. Subject domain in which research on the topic has been conducted (SCOPUS database)

Technological advancements have made it easier to manage the waste by using technologies like blockchain technology to regulate e-waste as one of the competitive waste management techniques. [6] The concept of waste management is as challenging as it is significant in the present world. There have been many challenges like data availability, education in sustainable consumption and production (SCP) patterns, financing of SDG targets and data use which act as obstacles to monitoring and achieving target 12.3 [7].

One of the significant questions often raised is how to finance these waste management strategies. Various financing mechanisms are listed by conventions like Stockholm conference, Paris Agreement, etc. [8] Most of the developing countries have been devising strategies for revenue generation like levying of tax, charging of fees, etc., on waste generation depending upon the volume of waste generated, however, it has restricted implementation

due to less government support, weak policy structure, unawareness among consumers, and poor extended producer responsibility (EPR) system [9].

In India, the source of capital has been the major problem since the present "tipping fees" charged for managing waste are very low and inadequate to make the operation profitable and thus attract private investors [10]. Various other techniques have been devised to facilitate key policy objectives for generating economic growth and reducing environmental impacts. However, the implementation phase requires revenue mobilization and collection [11] which cannot be done only by a long-term financing protection through government subsidies to cover higher capital cost [12]. Therefore, there is a need for innovative financing to direct investments into waste management [13], which would require policy-based reforms to strengthen the financing mechanism [14]. Some researchers have suggested alternative modes to address the issue of financing like policy instruments such as a deposit-refund system, [15] viability gap financing through PPP [16] however feasibility of such programs is under discussion.

Recent systematic reviews of waste management financing [17] indicate three emerging trends in sustainable financing: blockchain-based waste tracking systems, green bonds for infrastructure development, and community-based micro-financing initiatives. Analysis of 156 peer-reviewed articles published between 2020-2024 reveals that while technological solutions have received significant attention, financing mechanisms remain understudied, particularly in developing economies. The following thematic areas emerge as critical:

a) Public-private partnership models (35% of studies);

b) Innovation in financial instruments (28%);

c) Policy integration and implementation (22%);

d) Stakeholder engagement and community participation (15%).

Though there has been sufficient literature that highlights the need of financing waste management for sustainable development and environmental protection, however the present literature is insufficient to provide an effective and a feasible measure to ensure sustainable financing for waste management in India.

FINANCING WASTE MANAGEMENT

Increased waste generation has a significant impact on the planning and readiness for waste management and infrastructure development [18] and unplanned and unscientific way of managing the waste can significantly impact the environment and can have multiple health hazards [19]. Usually, the waste generators tend to dump and burn waste proceeds due to the easy and feasible availability of land. This leads to high emission of hazardous chemicals and poorly managed waste poses threats to the environment and has adverse impact on public health, thus necessitates waste management for providing a welfare society.

Waste management is a complex process which includes waste segregation, waste disposal, waste treatment, waste recycling, conversion of waste to energy, etc., however what is essentially required at each stage of waste management is funds. The data about the collection and expenditure of waste-related revenue is inadequately available in public domain however various studies suggest that the expenditure incurred on waste specific services has always been more as compared to the public revenue generated for the same. The developing countries with high level of environmental taxes collect a very low amount (around 0.02%) of global GDP on average as solid waste related charges [20].

Earlier, the sustainability efforts were limited only to cater to the environmental issue, however, now there has been a shift in the approach where scholars are adopting concept of triple bottom line which includes environment, economic and social methods towards sustainability [21]. The economic component which includes the cost incurred on environmental protection and revenue generated through environmental protection policies are significantly market-driven. A study by United Nations Environmental Programme (UNEP) suggests that expenditures incurred on waste management are around 0.5 percent of global GDP [22].

The major roadblock in financing waste management is the lack of cost assessment and implementation of techniques. Key challenges also include limited financial resources, inadequate infrastructure, lack of advanced treatment facilities and need for context-specific solutions like efficient wet waste management [23]. There are various costs involved in the entire process of waste management some are direct cost [24] which includes the cost of cleaning up sites, recycling, segregation, etc., another is indirect cost which is incurred due to the loss of health [25], etc., which is most difficult in measuring and monitoring. The Global Wastes management Outlook (GWMO) emphasizes on considering many factors while estimating the cost as the capital required for various disposal facilities varies with technology.

In most countries, the local government is vested with the responsibility of waste management which

constitutes majority of their expenditure. In India, local governments are responsible for their provision but are hindered by poor finances and implementation capacity. However, it is a general trend that the waste expenditure is often more than the revenue generated by local government and their spending capacity. The most common source is the revenue collected through property tax which on an average is 0.7% of global GDP. Property tax merely contributes to 1.1% of the total GDP in a developed country while the share in a developing country is even less to around 0.4% of the GDP [26]. Another problem in financing waste management is that the general people are under an impression that waste disposal is free and thus they do not bother to pay for the meagre fee charged. The budget analysis observed increasing investments, but inadequate financing is reflected in the poor service levels of infrastructure [27].

Due to the low level of waste related revenues, many countries have tried to expand their revenue source to help finance the increasing waste. The Government has started to generate revenue through grants, taxes, exemptions, loans, voluntary contributions and various other mechanisms. Various countries have also started collaborating with private entities to expand their revenue base. Several countries have a dedicated environmental fund which comes from environmental taxes and charges. Several other countries use external public financing for the same to support low-income countries.

It is suggested to adopt an integrated method of financing which includes external funding through various organizations, Private funding including companies and Government funding [28]. However, Government funding has always been insufficient to cater to the costs involved. Private funding has been much difficult to procure and external funding in the form of loans burdens the government and ultimately an individual. The present system of financing has weak institutional capacity, a lack of transparency in accounting systems, and limited revenue streams. It is even more difficult for developing countries to cater to their increasing need of waste generation especially in a country like India which has a vast and diverse population. This stresses upon a need to investigate the present framework for waste management and the challenges thereof.

FINANCING WASTE MANAGEMENT IN INDIA: TRENDS AND ISSUES

India is the second most populous country in the world with 1.27 billion people out of which 68% live in rural areas and 32% in urban. However, with rapid urbanization, urban population is at an increase. Population explosion and rapid urbanization have led to increased waste generation in India. India generates an approx. solid waste of 133,760 tons per day, of which 68% gets collected and only 19% is treated [29].

The Indian Government has taken various steps to manage waste to preserve the environment and to protect human beings from its adverse effects. Waste is a general term that encompasses various types like solid waste, plastic waste, chemical, and hazardous waste and with the advancement of digital India and the E-governance system, there is E-waste generated. The Constitution of India, through Article 51A, has given to all its citizens the duty to protect the environment and it has become a directive for the state to safeguard the environment. [30] To manage different types of waste there have been various laws and policies enacted by the government. The Environmental Protection Act, 1986 acts as an umbrella legislation that enables and empowers various central institutions for waste management. At the same time, it makes the polluter responsible for any expenses incurred for the damages caused to the environment due to discharging pollutants [31]. Responsibilities of waste generators have been established by the Solid Waste Management Rules, 2016. Other rules provide a framework for waste management for different types of waste like Plastic Waste (The Plastics (Manufacture, Usage and Waste Management) Rules, 2009), Hazardous Chemical Waste (The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008), E-waste, (The E-Waste (Management and Handling Rules) 2010), etc. In 2014, The Government of India has launched Swachh Bharat Abhiyan which aimed at 100% waste collection and processing in all towns and cities across India. During the last decade, the government has launched the Clean India Mission, Smart Cities, Amrut Cities, and Digital India to improve living standards. E- and waste management are core infrastructure elements of these missions [32].

Governance and citizen services, urban mobility, affordable housing, health, education, water, energy,

with sufficient laws and policy in place, the pertinent question to answer is the source of revenue to finance the processes. The inadequacy of funds for waste collection, segregation and treatment and lack of government finance regulatory framework are major barriers to achieving effectiveness in waste management in India [33] After the 73rd and the 74th Constitutional Amendment Act, the Municipal Corporations, i.e. the local bodies have been entrusted with the task of waste management [34]. From planning to execution, this function is performed by the local bodies. This means that the responsibility to raise revenue for waste management is primarily on the municipal corporations. Generating the required revenue is a major challenge faced by the local bodies. Under the 12th Five-Year Plan (2011), the Working group on financing urban infrastructure suggested that urban local bodies can raise their own funds through taxation, collection of fees, intergovernmental transfers, public private partnership model, commercial borrowings, etc., for financing their needs. Figure 5 shows that the majority of funds are generated through taxes and cesses levied by the central, state and local governments. Out of which the share of revenue generated by local government which form their own source of revenue is substantially less. Overall, municipal infrastructure has largely depended on fiscal transfers provided by central and state governments, with modest contributions coming from their own source of revenue or commercial financing.

The major source of local bodies' revenue are property tax and user charges. Most of the Indian States that are performing better as compared to other states, collect very small amounts as compared to global standards. [35] Since the property tax is not a buoyant source of revenue, another mode of generating revenue was User Charges which is a fee imposed on the household/ user who generates waste and is taken to collect the same. The user fee is charged as per the bye laws made by the local government. However, the percentage of collection of user fee in ranged from 0 to 35.89% only [36]. Loans taken from various international agencies like the World Bank, public-private partnerships (PPP), and corporate social responsibility activities are the major funding sources to develop the waste infrastructure in ULBs.

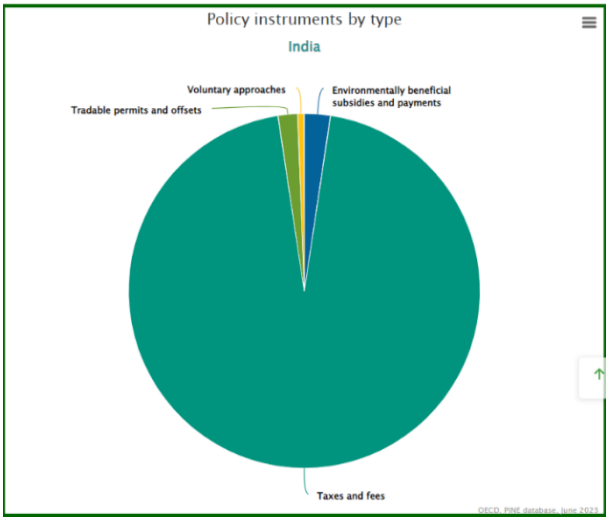

Fig. 5. Type of policy instruments in India to generate revenue for environmental needs (OECD Open Data)

User charges and revenue from waste recovery is are negligible in most of the urban local bodies. The literature shows that the local bodies are in dire need of finance to discharge their duty of waste management and are barely able to do the same with the existing funds available with them. Most of the Local bodies are largely dependent on the Grants from the central and the state government [37].

Therefore, another mode of financing waste management is Government Grants. The Central Government, by way of grants or through centrally sponsored schemes, provides grants to the Municipal Bodies for expenditure on waste management. Under Swachh Bharat Abhiyan, the government has allocated around 11 billion dollars for solid waste management project [38]. Apart from direct funding from central and state governments, special taxes and cess have been implemented to finance these projects. During the FY 2015-16, the government has enabled the implementation 2% tax on services to fund the clean India initiative and a tax of 0.5% on all taxable services was officially notified. [39]. Various grants have also been sanctioned by the Indian Government under the 12th and 13th Finance commission, various projects like JnNURM, UIDSSMT, Swachha Bharat Abhiyan, etc. [40], however, the grants are given in sharing pattern where the center shares 25% and state funding is around 12-12.5% and the local bodies have to bear the remaining financial burden of 65-67% which most of the ULBs are incapable of.

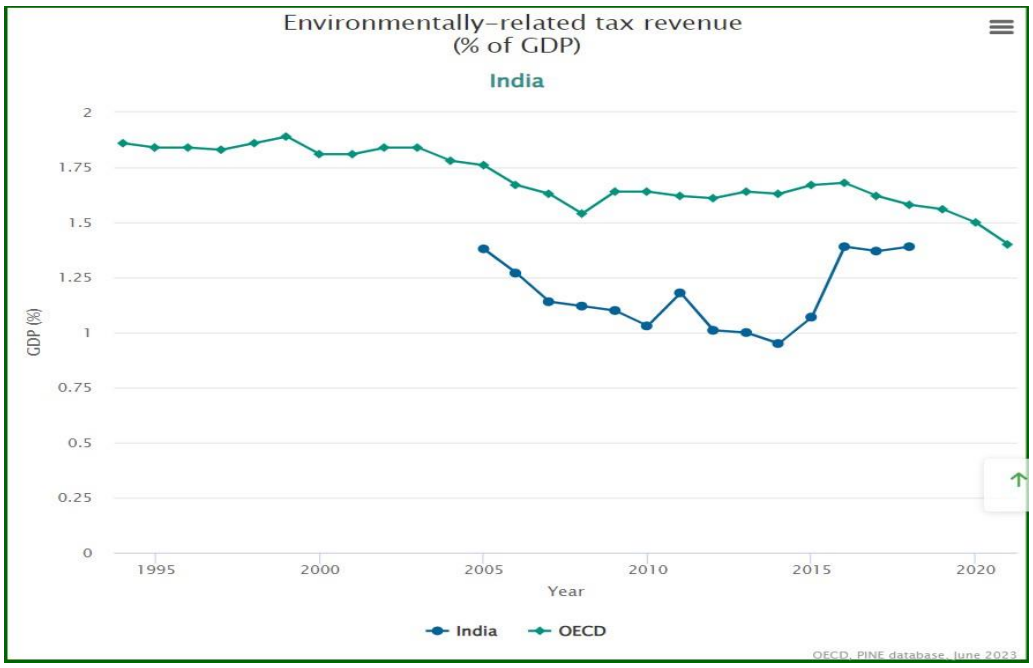

Fig. 6. Trend of Environment-related tax revenue collection in India (World Data: Open Access Source)

Under the 12th Finance Commission, government has released funds to local bodies for development of infrastructure for collection and transportation of waste. Design-Build-Operate-transfer (DBOT) and Design-Build-Finance-Operate-transfer (DBFOT) modes were implemented to develop projects for waste treatment and waste disposal. The PPP models are successful in a lot of local bodies but the rationale behind Public private partnerships is to gain efficiency, expertise, and technology, not finance. [41]. Under the Companies Act 201 r 3, Companies are mandated to spend 2% on Public Welfare under their corporate social responsibility [42]. However, these CSR funds are not restricted to merely Waste Management but the companies may contribute to the same. Therefore, private investments, in the present framework, are a source of funding for waste management however are not a sustainable source of finance due to the risk of market failure.

Recent policy developments have significantly impacted waste management financing in India. The National Clean Air Programme (NCAP) 2024 update has allocated ₹12,000 crores specifically for waste management infrastructure. Additionally, the Green Finance Initiative 2024 has introduced new mechanisms for municipal green bonds and waste-linked securities. Key policy innovations include:

- *Municipal Green Bonds*: Successfully implemented in cities like Pune and Indore, raising ₹1,200 crores for waste processing facilities;
- *Waste-to-Value Credits*: A new market mechanism allowing trading of waste processing certificates;
- *Digital Waste Exchange Platform*: Facilitating direct trading between waste generators and processors.

Filling this funding gap has been identified as a key objective of sustainable finance and therefore, there is a need for a mechanism for sustainable financing in India.

SUSTAINABLE FINANCING MECHANISM FOR WASTE MANAGEMENT THROUGH POLICY EFFORTS: PRACTICES ACROSS THE GLOBE

Many technological innovations have taken place for waste management which includes methods of waste segregation, waste collection, waste disposal, waste recycling etc. An important element of these innovation has been spending upon the infrastructure and technology. The traditional model of funding across the globe cast a burden on government to finance the waste management models through public spending. It has been already seen that how government funds are insufficient to manage the huge waste generated. Therefore, a new model of financing has involved privatization and public private partnership to cater to the financial needs of the current waste management program. This new model of financing and involving the private sector for furthering the public agenda has paved way for sustainable financing method. Sustainable financing means integration of the environmental, social and governmental aspects while investments or making lending decisions [43].

There have been various changes in the public policy globally however, policy agendas specific to sustainable financing are contingent on a country's social, political, economic and cultural conditions. Therefore, under this part, best practices across the world shall be studied to reach at a feasible solution which can be adopted in Indian scenario.

Various transnational efforts have been made by the United Nations as a measure for financing member states to achieve their agenda of attaining net zero waste [44]. An Environment fund is managed by United Nations Environment Program to provide funds to their partners globally to support areas like green technology transfer, capacity building, research, planning and management etc. In 2019, they have provided a support fund of $70 million for the same [45].

There have been various measures across the world to enhance efficient and outcome-based funding mechanisms for waste management. Some of the best practices are discussed as under.

One of the oldest ways of financing waste management was through taxes. Landfill taxes are the taxes charged on the companies who would want to dispose the waste in the landfills (instead of recycling and reusing it or disposing it as per policy). European Union member states along with Switzerland and Norway have imposed taxes for the amount of waste sent to landfills. The tax is imposed over and above the cost that has been charged for sending the waste to landfills and it is collected by tax and custom authorities, environmental agencies or municipalities [46]. The poor collection of property tax has already been discussed above. Italy has spiked its waste related revenue by replacing the property tax to waste management tax.

Jamaica is another example of increasing the finances for waste management by introducing Jamaica's Environmental Protection Levy (EPL). This imposed an *ad valorem* charge of 0.5% to offset the cost of waste material, especially plastic waste [47].

Various countries have also turned their face to private sectors for financing their waste management like Japan has increased involvement of private sector for collection and segregation of waste. Israel has involved private sector finance for waste to energy plants. Estonia also has started involving private sector in investment decisions for new waste treatment facilities. One successful, large-scale PPP waste management project in the private sector was developed in Serbia in 2019.

External funding is another major source of funding used by the countries. Like Estonia has used the grants from the EU Funds which have been used for remediation of old landfills for mining and industrial waste and abandoned industrial areas.

Another best practice is introduction of the Credit guarantee schemes for providing fixed capital for waste management projects. A credit guarantee scheme involves three parts, i.e. the borrower, the lender and the guarantor. The borrower which usually is the company or any individual who is seeking finance for establishment of a waste management model/ infrastructure seeks finance from the lender who usually are banks or ending agencies.

Ideally, the banks do not provide loans till they see any profit coming from the business model, however, under this scheme the government becomes the guarantor through various institutions like credit guarantee corporations, etc., and therefore, the loan sanction becomes more likely.

Initially CGS was implemented in Japan, South Korea and Hong Kong. Later, European Union has agreed to become a guarantor for 90% of loans for member states which later increased to 100% [48]

Another best practice in financing waste management was by involving community for funding. There have been various ways wherein the community has been involved in funding projects for waste management. Many countries involve the community in the form of either by taxing them or by levying user fees. While Japan has created an investment by way of Hometown funding known as Hometown investment trust (HIT). HIT funds were introduced with the objective of connecting the local investor with projects in their locality keeping their personal knowledge and interest in mind. Individual investors choose their preferred projects and make investments *via* the Internet. Investments are encouraged *via* advertisements from various sectors like corporate sector, municipal governments, international government, etc. Although it was a voluntary mechanism of financing, however, this was well accepted in countries like Cambodia, Vietnam, Peru, and Mongolia [49].

Another way of involving community was by charging Advanced Disposal Fees. In furtherance to the polluters' pay principle, ADF's charge product-based fee at the end of the life of the product by adding the same to the cost of the product thereby internalizing costs that are often externalized to the environment. Unlike deposits, they are non-refundable to the consumer. Unlike the HITs, it is more compulsory in nature and therefore leaves no leeway for lesser collection of funds.

There is a view that instead of burdening the common producer, there is a need to identify the polluter and then they should be mandated to pay for

the cost of waste management. This idea was implemented through Extended Producer Responsibility. Through EPR, the producers who generate waste due to the production of goods cover the costs of collecting and processing the waste generated during production and packaging of their goods when they reach the end of their lifecycle their products and packaging once they reach the end of their lifecycle.

Ireland has imposed a tax called 'Latte Levy' on single-use plastic (coffee cups) and the income raised from the scheme was used to develop a system of recycling and reusing the same (Single-Use Foodware and Litter Reduction Ordinance). Similarly, Wales and Scotland have imposed a mandatory charge on carrier bag irrespective of their material [50]. In Japan, the owner or polluter not only has to pay for the remediation of the contaminated sites but here are also potential liabilities on the company due to contamination in their annual balance sheet. Similarly, Columbia has put an onus of remediation of site on the companies.

The measures taken worldwide have been great and significantly helped in increasing revenue for waste management. However, all these measures are burdening a single stakeholder, be it the government, the people, or the companies. Thus, OECD suggests use of blended finance for waste management which will include all the possible stakeholders to contribute to financing of waste management. Blended Finance is "the strategic use of development finance to mobilize additional finance towards sustainable development in developing countries" [51]. Blended finance can be useful in increasing finance for those countries which are in dire need of investments. It acts as a bridge for grants and donors to invest for waste management and can add value by shifting funds towards more sustainable self-financing approaches. Various agencies like IMF and GEF have used Blended finance in the climate change mitigation space to finance new technologies in renewable energy, energy efficiency, urban transport, and other related fields [52].

Another model of blended financing can be in the form of Environmental Impact Bonds. EIBs are models wherein the public agencies work with the private entities. EIBs are structured in a similar ways as traditional bonds where the private entities purchase Environment impact bond raising the revenue and it can be returned back with interest based on the environmental benefits incurred due to their project. EIB's work with the pay-for performance repayment mechanisms [53].

Korea is one example for the use of blended finance where they have used financial aid from sources like government subsidies, tax credits and long-term low-interest loans for constructing a waste-to-energy plant. Another example is Poland, funds from various agencies like private sector, EU funds, national funds have been taken to construct an incinerator [54]

Sustainable financing can also be achieved by setting up of Environmental Fund like the United Nations. Various countries have set up their environmental funds like Estonia's environmental investment Centre; The Czech Republic's State Environmental Fund and Poland's national and regional environmental fund. These funds receive the proceeds of environmental charges and use the revenue [55].

Various best practices are seen across the world to finance waste management. Some best practices are based on a policy however, most of them are voluntary in nature or without any legal backing to enforce the same. It is clear that levying of compensatory payments is not a substitute for a policy framework and thus, we need to look for a policy-oriented framework for financing waste management.

SUPERFUND: A CASE STUDY OF LOVE CANAL DISASTER

Love canal case study

An aborted canal project, named Love Canal because of its shape, is situated near Niagara Falls in New York. Since it is an aborted project, it remained unused for a long period of time and therefore was used as a dumping ground for urban waste. Apart from urban waste, waste generated due to World War II was also dumped there.

Around 1940s, a company named Hooker Chemical Company used this place to dump chemical waste of around 21000 tons. Later in the year 1953, the land was sold to the Education Board for a token amount of $1 with the caution of a huge waste dumped underneath. The Board has then established a school on it and the nearby land sold off to build the residential societies. While the construction was going on clay cap of the canal was breached which damaged the metal barrels.

After the construction, the chemicals were inactive for many years, however in late 1970s the waste began to seep to the surface. The residents started complaining about noxious fumes and oozing toxic sludge. The toxins also started to pollute the groundwater leading to various issues of miscarriage, birth defects and other health hazards. The superfund aims at two core aspects of waste management, i.e., remedial and removal. A core aspect of the Superfund is the principle of "polluter

pays," which holds current and past owners/operators of contaminated sites financially liable for clean-up costs. As per this policy, it is first identified that who is the polluter which is known as the potentially responsible party (PRPs). PRPs fall into four categories: the current owner or operator of the site, anyone who owned or operated the site before, anyone who arranged for hazardous wastes to be dumped on or treated at the site, and anyone who transported hazardous wastes to the site. Seldom there is an involvement of one single party. Usually the identified PRP helps in identifying other responsible parties so as to distribute the liability. If a PRP can't be found, it's considered an orphan site and Superfund pays for the entire cleanup.

After conducting the initial tests, the state of New York declared the state of emergency in 1978 and evacuated around 200 families from neighborhood. This led to a huge national outcry and highlighted the lack of federal regulation and funding to address such environmental catastrophes.

As a result, to this state of emergency, the Comprehensive Environmental Response Compensation and Liability Act was passed. This is known as Superfund policy. The Superfund policy provides resources to clean up contaminated areas considered to pose substantial risk to human health or the environment. The superfund was initially funded by the taxes imposed upon the chemical and petroleum industries wherein they identify the responsible parties and make them pay for the remediation of the sites [56].

The Superfund program has successfully identified over 47000 potentially hazardous waste sites across the country, out of which 1900 were on the National Priority list. Till 2023, The EPA has completed the construction at 1375 of these NPL sites. Forty-five years after Superfund's inception, the EPA had cleaned up almost 1200 NPL sites. It has become a cornerstone of environmental protection policy, giving the federal government the authority and resources to hold polluters accountable and remediate contaminated areas. The Superfund program has had a measurable impact on hazardous waste management in the United States, though the full extent of its effectiveness can be difficult to quantify**.**

Superfund

The superfund is unique in its own kind as unlike all other funds created, this policy addresses environmental problem that traverse through several medium like water, air, soil, etc. This policy has created a superfund to finance cleaning up the waste disposal sites which causes environmental and health problems.

The EPA has been able to recover over $48 billion in clean-up costs from these responsible parties over the life of the program. This cost recovery helps offset the funding burden on taxpayers and the Superfund budget.

Financing Superfund

When it was passed, CERCLA—Diverse Enforcement Authorities was funded by a $1.6 billion five-year fund that taxed petroleum products and 42 chemicals on a limited basis, targeting industries with a history of producing the majority of hazardous waste. By 1986, however, due Congress's desire to substantially expand the fund and due to the concern for international competitiveness in the chemical industry, many believed that the tax should be redistributed more broadly. A political compromise was reached after a struggle between stakeholders and the revenue sources employed over the next five years came to $8.5 billion total: $2.75 billion from an altered levy on petroleum products, $2.5 billion from a 0.12 percent tax on corporate income over $2 million, $1.4 billion raised by adjusting taxes associated with chemical feedstocks (as raw materials or ingredients from which other compounds are made), $1.25 billion contributed through general revenues of the Treasury Department's "pocket", $0.6 billion obtained through cost recoveries from liable parties associated with CERCLA violations plus interest accrued or accruing thereon upon any unexpended portions [57].

For 26 years, federal policy has allowed entire industries to shift the financial responsibility of cleaning up Superfund sites away from themselves and onto individual American citizens who bear no direct responsibility for their creation and operation. Originally finance by the "polluter pays" laws that taxed petroleum and chemical industries, trust fund monies augmented by these levies were supposed to support Superfund clean-up efforts across the country [58].

In 1995, however, congressional "polluter pays" taxes levied on petroleum or hazardous chemicals expired, after which the program began relying substantially upon annual congressional discretionary spending decisions. Consequently, funding levels for Superfund declined over time while cleanup costs increasingly became an obligation shouldered by taxpayers in general as opposed to those entities actually responsible for creating toxic waste sites. Between 1993 and 2021, it would cost roughly $1.3 billion a year (not adjusted) just to deal with these contaminated sites alone let alone any others. Within this same period

specter was hovering closely around zero due largely to unreplenished revenue pouring another log on the fire after expiration took hold thus stopping progress towards full realization but reaching out towards achieving greater success because past gains had been substantial despite setbacks endured along way according success also revolved funding readjustment once more. Past revenue from these taxes kept the Trust Fund's unobligated balance above zero until 2003, but shortly after the policy expired, cleanup progress at Superfund sites dropped [59].

The Bipartisan Infrastructure Law of 2021 and the Inflation Reduction Act of 2022 restored the Superfund "polluter pays" taxes—thereby putting the program on firm financial ground for the future. In addition to reinstating these taxes, the Congress provided $3.5 billion annually through the Bipartisan Infrastructure Law from user fees.

FINANCING WASTE MANAGEMENT THROUGH SUPERFUND POLICY: A CASE FOR INDIA

As already discussed, the inadequacy of finance is a major constraint in Waste Management in India. Apart from the fact that funds received from the government and funds collected through taxation and Fees are insufficient, the authorities also lack flexibility to spend funds as there are spending restrictions put by the State Government. The lack of financial resources led to inadequate infrastructure to deliver their responsibilities.

Need for a Policy Framework

Financing waste management puts a massive toll on the government. The urgency and intricacies involved in waste management necessitates a strong, coherent and coordinated fiscal response by the government. The need is to create a policy framework to mobilize finance from various stakeholders for waste management solutions in India. A fund which focuses on investing on waste management plays a significant role in dealing with the twin issues of environmental degradation and deteriorating human health. A superfund can raise capital from multiple stakeholders and will play a pivotal role in harnessing economic and environmental potentials.

Framework

India has existing environmental laws and regulations, such as the Environment Protection Act, 1986, and the Municipal Solid Waste Management Rules, 2016, which could provide a legal foundation for establishing a Superfund policy. However, a dedicated legislation or amendment to existing laws may be necessary to create a comprehensive legal framework for the Superfund policy, defining its scope, funding mechanisms, governance structure, and enforcement mechanisms.

Implementing a Superfund policy would require a robust administrative and institutional framework, including a dedicated agency or authority responsible for managing the fund, prioritizing projects, and overseeing implementation. Existing institutions, such as the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs), could potentially be empowered or restructured to take on this role, or a new dedicated agency may need to be established. Capacity building, training, and skilled human resources would be essential for effective implementation and management of the Superfund.

Successful implementation of a Superfund policy would require extensive stakeholder engagement, including industries, civil society organizations, environmental experts, and local communities. Addressing concerns, ensuring transparency, and gaining public support would be crucial for the policy's acceptance and effective implementation. Awareness campaigns and educational initiatives could help build public understanding and support for the Superfund policy.

Financial Viability

Establishing a Superfund would require significant financial resources, which could be challenging given India's fiscal constraints and competing priorities. However, Potential funding sources could include levies or taxes on polluting industries, fines for non-compliance, dedicated budgetary allocations, and contributions from public-private partnerships.

Blended approach can be taken to finance superfund in India. The superfund could be setup using seed funding from the Government (A fixed percentage of the revenue raised through taxes) and finances from the corporations who are highly likely to be the PRPs. Another important channel through which the private sector can improve air quality is via investments made through the Corporate Social Responsibility (CSR) route. Similar to CSR, corporations can be entrusted with Environmental Responsibility wherein they can be mandated to share a percentage of their income based on the waste generated by them (applying the principle of Extended Producer Liability) to the Superfund.

Superfund policy in India: A Probable Framework

- *Objectives*

The policy aims at establishing a National Waste Management superfund for sustainable financing of waste management activities in India thereby promoting environmental protection and human health.

The policy aims at bringing together probable polluters and holding them liable for remediation and cleaning up of contaminated site. The fund further aims at development of waste management infrastructure using the contribution from various stakeholders in Waste management.

1) *Establishment of a Superfund*:

a) The fund shall be named National Waste Management Superfund (NWMSF); b) It must be non- lapsable and non-transferable, managed by an appropriate authority or Board known as a Superfund Management Authority.

2) *Constitution of Superfund Management Authority:*

a) Superfund Management Authority should consist of a chairperson with not less than 20 Years of experience in handling environmental issues and 8 other members committed to the cause of environmental protection; b) Superfund Management Authority shall have members from Central and State Ministries of Environment, Urban Development and Finance. Members must also be from NGOs, Corporations and External Agencies.

3) *Regional and Local Offices*:

a) Regional Offices shall be established as per the rules framed by the Superfund Management Authority to facilitate effective implementation and monitoring of waste management initiatives at the state and local levels; b) These offices shall work in coordination with the respective state governments, urban local bodies, and other relevant stakeholders.

4) *Roles and Responsibilities of Superfund Management Authority*:

a) Formulating policies and guidelines for effective implementation and management of Superfund; b) Determining the criteria and procedure to allocate funds from the superfund of any waste management initiative; c) Determining key performance indicators and targets for waste management initiatives funded by the Superfund; d) Monitoring and evaluating the progress and performance of the funded project; e) Monitoring and Evaluation of the performance of Superfund; f) Formulating ways to increase the finances in the superfund; g) Conducting periodic reviews; h) Promoting research and development for research and development on waste management process and techniques fostering innovation; i) Facilitating capacity building amongst professionals, industries and community by organizing training and awareness program to promote sustainable waste management practices; j) Coordinating and collaborating with Central, state and local government for waste management; k) Preparation and submission of annual reports to the central government to maintain transparency and accountability in management and disbursement of Superfund; l) To ensure periodic financial, social and environmental audit.

5) *Source of revenue for Superfund*: a) The Superfund shall consist of revenue generated through levying of environmental taxes and cesses on:

- Industrial and commercial waste generators;
- Municipal waste generators (households and businesses);
- Landfill operators;
- Importers of certain waste-generating products (e.g., packaging materials, electronics);

b) Revenue generated through User Charges imposed for availing waste management services or Fines and Penalties imposed for not complying with the rules for waste management; c) Revenue generated through Environmental Responsibility of Corporates; d) Revenue generated through Environment Impact Bonds; e) Revenue generated through voluntary contributions; f) Revenue generated through external funding received for waste management.

6) *Allocation and Utilization of Funds*: a) Fund from Superfund can be used for the purpose of waste management in

- Development and Upgradation of Waste Management Infrastructure;
- Cleaning of landfills, dumping sites or any other contaminated sites;
- Research and Development Projects;
- Public Awareness Campaigns, Capacity Building Programme.

7) *Implementation framework*: a) Financial structure which includes Core funding in the form of 0.5% cess on corporate profits; Matching grants from central and state governments; Green bonds and environmental securities and International climate finance integration; b) Governance Mechanism: The Independent regulatory board should have representation from Ministry of Environment, Forest and Climate Change, Ministry of Finance, State Pollution Control Boards, Industry representatives and Environmental experts.

CONCLUSION

The Sustainable development goals have been embraced by all the government; however, its success depends upon the cooperation and collaboration amongst all stakeholders like Government, corporations, individuals, civil society, etc. We cannot allow commercial interests to overpower natural wealth and it must be ensured that the use of natural resources remains as per the standards of sustainability [60]. Addressing the issue of sustainable finance for waste management in India requires a multi-pronged approach that combines sustainable financing mechanisms, policy reforms, public awareness campaigns, and technological innovations.

Although the government is majorly responsible for providing clean environment, however, the entire financial burden cannot be borne by the government alone. There is a need for equitable distribution of the financial burden amongst all stakeholders. Additionally, Policy intervention is necessary for moving towards a system of sustainable financing wherein the policy imposes some responsibility on the stakeholders for contributing for waste management in different capacities.

In conclusion, implementing a superfund policy in India modeled after Superfund Policy in USA appears to be a viable solution to the financial challenges to waste management in India. A Superfund Policy is a wholistic solution which promotes collaboration, holds the polluters responsible and not only generates revenue for cleaning up but also incentivize industries for adopting cleaner mechanisms for development. This also helps in reducing the burden on the Government and the taxpayers.

The present research proposes a skeleton draft for the Superfund policy leaving scope for further research for determining ways for resolving the administrative and regulatory, hurdles in enforcement and coordination between the stakeholders. The potential benefits in terms of environmental protection, public health, and long-term economic savings make it a compelling option worth exploring. By learning from the successes and challenges of similar programs in other countries, India could tailor a Superfund policy to its unique context, paving the way for a more sustainable and resilient waste management system.

The implementation of a Superfund policy in India represents a transformative approach to waste management financing. While challenges exist in terms of institutional capacity and stakeholder coordination, the proposed framework provides a viable pathway for sustainable financing. Success will depend on:

1. Strong political will and legislative support;
2. Effective stakeholder engagement and participation;
3. Robust monitoring and enforcement mechanisms;
4. Integration with existing environmental programs;
5. Continuous innovation in financing instruments.

Future research should focus on developing detailed implementation guidelines for specific urban contexts and exploring innovative financing mechanisms that can complement the Superfund approach.

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