Major Challenges to Formal E-waste Management Systems in Developing Countries

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Abstract

Most third-world nations struggle mightily to establish functional e-waste management systems. Electrical and electronic equipment (EEE) surpluses from developed countries are easily exported to developing countries and largely populated countries. After its end of life (EOL), the transported and their own generated EEE becomes e-waste, a growing source of concern for developing countries. Because of the serious consequences to people's health and the environment, informal e-waste management techniques have emerged as a major challenge for authorities and other interested parties in developing countries like India. In developing nations, there are few formal recyclers and legislation to manage e-waste, which gradually reduces the harmful impact on the environment. Nonetheless, there have been various impediments to the endeavour to embrace a formal e-waste management system. The research aims to catalogue and rank the most significant challenges (impediments) faced by the formal e-waste management system in developing countries. A DEMATEL (MCDM) approach is applied to eleven impediments which are identified by extensive literature review and institutional experts' opinions. The study determined that "Lack of awareness of the harmful effects of unregulated e-waste recycling," "Low incentive package for formal e-waste recovery," "Lack of Training empowerment," "Insufficient funds for a formal e-waste recycling management system," "Lack of corporate social responsibility initiatives," and "Lack of awareness of the cost of returning in formal e-waste recycling" were the most significant and influential causes of the problem. Also, the factor found to be most effective for the current formal e-waste management system is the "Large Ideal duration for formal e-waste value recovery." This research has the potential to help policymakers in a developing nation with a large population create an effective e-waste management system.

Keywords
DEMATEL, Impediments, E-waste, developing countries, cause-and-effect

1. Introduction

As a consequence of alterations in cultural norms and technical advancements, our dependence on electronic and electrical gadgets has risen. Numerous electrical and electronic equipment (EEE) obsolescence rate has grown as a result of the rapid and intelligent improvements and changes in technology that have shortened their lifespan (Garg 2021). In recent years, population increase, technological enhancement, and consumers' ravenous want for new products or gadgets directed the rise of e-waste (Qu et al. 2019). It is difficult to collect, transport, sort, treat and dispose of electronic waste because it comprises both hazardous and non-hazardous components (Wang et al. 2017). Numerous industrialized countries have devised and implemented e-waste management processes since it has been recognized that unofficial e-waste management activities are the main reason for the release of hazardous substances (Wang et al. 2017, Schumacher and Agbemabiese 2019). The institutionalization of e-waste management methods is elaborated as the utilization of trained employees, cutting-edge technology, innovative systems, and processes that may recover valuable elements from discarded electronic devices without compromising human health and the environment (Qu et al. 2019).

According to the report "Global E-waste monitor" (Forti et al. 2020), the world will create around 74.7 million metric tonnes of WEEE by 2030, up from 53.6 million metric tonnes in 2020 and future, it will increase exponentially (Kumar et al. 2022). The most discouraging aspect is that just one-fifth of all e-waste is handled and recycled, and the remains are sent to open burning and landfills. The developed country has successfully developed sustainable solutions for the expanding mountain of electronic waste while simultaneously assuring the effective recovery of vital metals and minerals without upsetting the delicate environmental balance (Garg 2021). Developing countries have failed to establish appropriate policies to address the issue of e-waste reduction and management. Electronic waste is one of

the most important challenges that emerging nations must address immediately (Garg 2021). Asia, which includes major emerging nations including China, India, Pakistan, Sri Lanka, and Bangladesh, generates the most e-waste, 18.2 Mt. (Garg 2021). E-waste in an emerging economy like India, Kenya, India, Ghana, and Vietnam, 85% of the world's e-waste is recycled informally (Curry-Lindahl 2019).

To rescue useable components from e-waste, informal recyclers frequently resort to risky and inefficient practices, such as open e-waste burning, plastic and electrical board heating, manual disassembly, and leaking corrosives (Tong et al. 2018). Up to ninety percent of e-waste created in developing nations is collected by the informal sector and scrap dealers. The absence of a comprehensive recycling organization and the use of obsolete technology by these informal recycling and disposing of contributes to harmful waste and pollution, ecological deprivation, the exhaustion of natural resources, and social suffering (Prakash & Barua 2016). For informal channels, recovering from e-waste that has polluted water sources, the ground, and the air and endangered the existence of live species is of the utmost importance (Gollakota et al. 2020).

Few formal recyclers in developing countries have no access to the latest technology and environmentally friendly handling facilities and systems required for the effective recovery and safe disposal of electronic trash (Garg 2021). An extensive study has been conducted on the interaction and cause-and-effect analysis between the challenges and motivations confronting developing countries in creating and implementing an efficient formal e-waste management system. Few studies found only mentioning challenges faced by formal recyclers in developing countries like India (Bharadwaj 2016, Sengupta et al. 2022). Due to insufficient infrastructure, obsolete technology, and a lack of financial support, emerging countries lack processing and recovery e-waste management systems. In addition, the informal recovery system is extensively used in this nation, and it is sometimes the only choice for destitute children, men, and women seeking employment. In addition, the inappropriate rules and operational structure of the official e-waste management system in developing nations make it difficult for these individuals to integrate and get involved. For the correct operation of e-waste management, these issues and obstacles are becoming a source of worry for emerging nations, notably India. For the effective and efficient operation of the present formal e-waste management system, it is necessary to identify and address these obstacles in order to adopt the resolved solution to the current system (Garg 2021).

1.1 Objectives

The following goals aim to accomplish in the study are to examine the challenges of the existing formal e-waste management systems in developing countries:

1. To identify impediments faced by the formal e-waste management system in developing countries.
2. To prioritize and rank these impediments as per their effectiveness in the formal e-waste management system.
3. To establish cause and effect relationship with the help of the identified impediments.

2. Literature Review

In developing nations, the electronic industry is among the most quickly expanding. Several reasons, including the rise of metropolitan areas, the acceleration of technical advancement, the decline in product prices, and the propensity of consumers to upgrade their electronic gadgets frequently, contribute to the spread of electronic waste (e-waste). The disposal and improper recovery operations of e-waste are one of the most important concerns confronting developing countries like India. India is now attempting to establish an efficient and effective e-waste management framework to protect the environment, manage and regulate the increasing waste, pollution, and disposal system, and guarantee ecological parity among all living species (Prakash & Barua 2015). The informal handling and disposal of e-waste have resulted from a lack of consumer and public awareness or administrative incentive methods (Yadav and Bandyopadhayay 2015). When EEE has outlived its usefulness, it should be returned, and discussion and encouragement of the issues, methods, and importance of e-waste recycling should ensue. Mehta (2019) states that India's e-waste regulations are inadequately administered. India released the "2011- The E-waste Management and Handling Rules" in 2011; they were enforced in 2012 and were reinforced in 2016 due to a lack of compliance between 2011 and 2015. Following this, the government issued new e-waste laws with revised instructions titled "e-waste management amendment rules 2018" and "deposit return scheme" to change community attitudes about the e-waste management system (Gollakota et al. 2020).

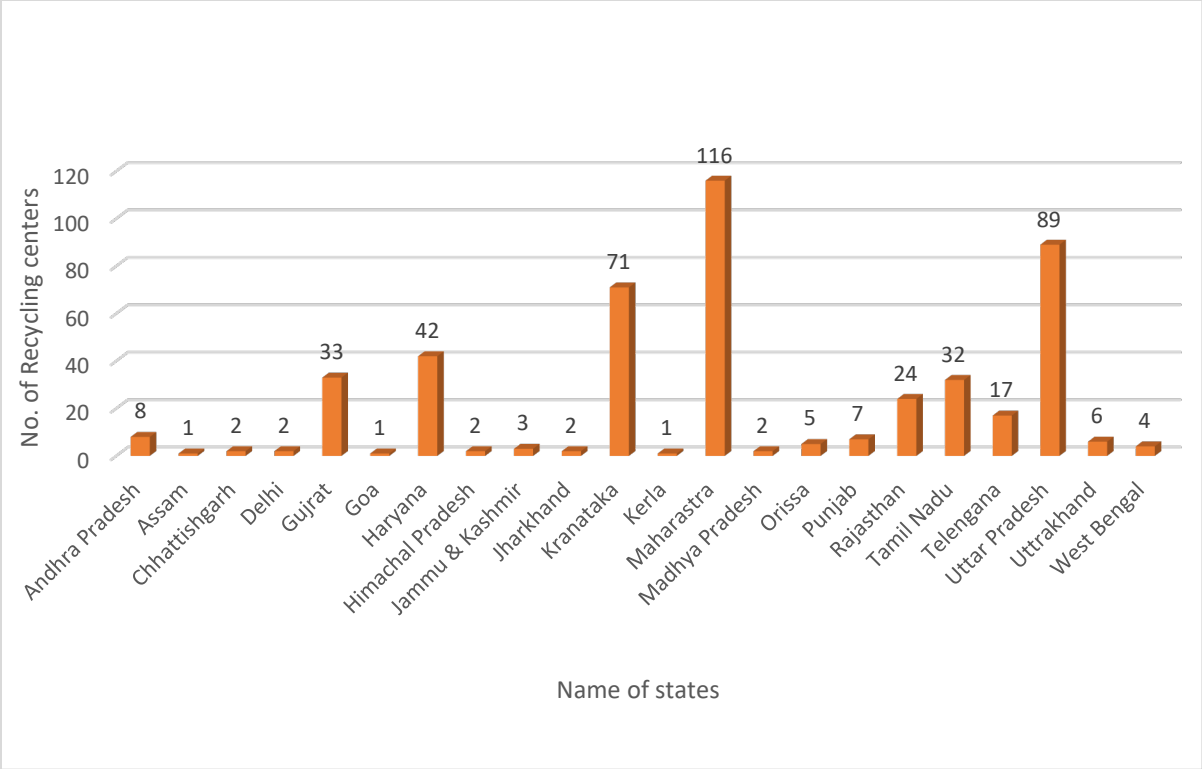

Figure 1. State-wise recycling centres of e-waste in India, April 2022

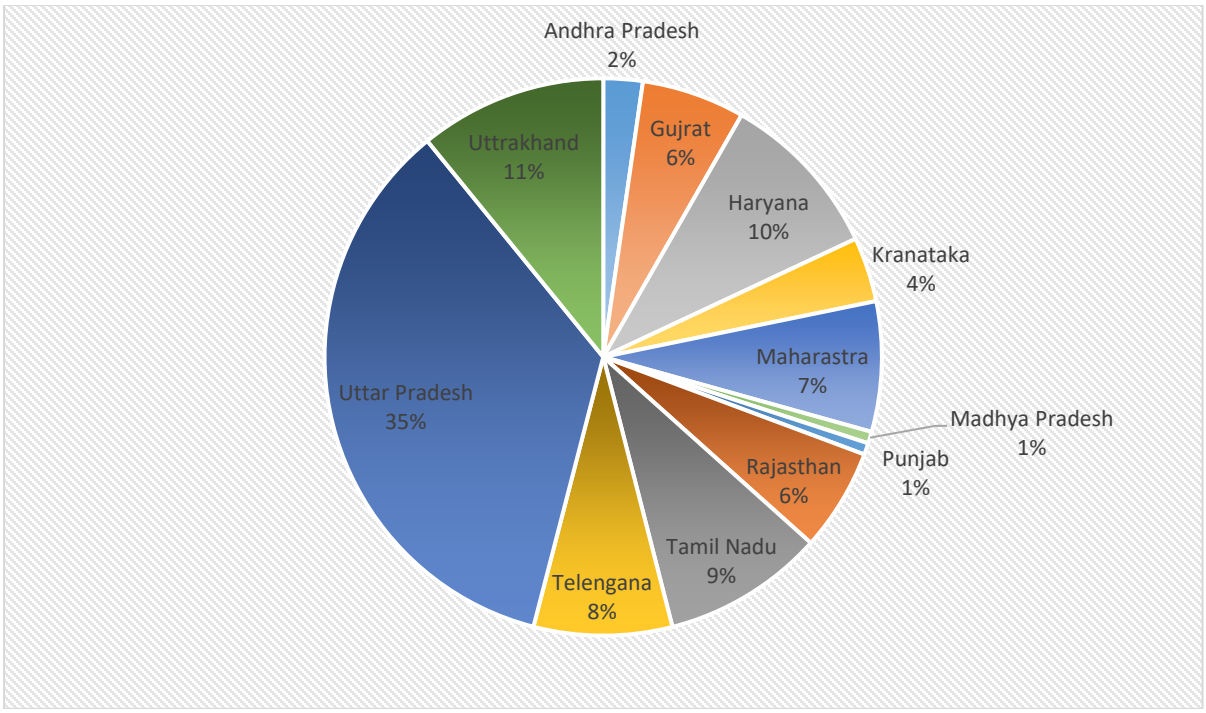

Figure 2. State-wise recycling capacity of E-waste in India, April 2022 (top 12 states)

Currently, in April 2022, India has 472 authorized recyclers (state-wise distributed in Figure 1.) for electronic waste with a total yearly capacity of 1.42 million tonnes, shown in Figure 2 (Central Pollution Control Board, 2022). The

data has increased by four more recyclers and 0.24 thousand metric tonnes of e-waste capacity from December 2021 (Sengupta et al. 2022). In addition, 2,140 manufacturers are awarded ERP Authorization [under the 2016 e-waste (management) Rules]. 77 producer responsibility organizations are enrolled with the central pollution control board (CPCB) in April 2022 (Central Pollution Control Board 2022a).

Lack of information about the negative influences of uncontrolled e-waste recycling and the returning price of WEEE to formal collection facilities hinders the family and institutional willingness of customers to dispose of rubbish in the formal sector (Turaga et al., 2019). In India, informal trash collectors are favoured over official e-waste collecting methods for e-waste disposal because they provide a more appropriate door-to-door collection facility and minor monetary incentives to e-waste disposers (Borthakur and Govind 2018). Poor documentation exists on how commercial recyclers deal with the solid and liquid waste generated by their activities. Several scholars working in developing countries (Yong et al. 2019) have identified this as an important problem.

3. Methods

Since there are fewer formal recyclers in impoverished nations like India, several researchers have investigated ways to enhance the possibility of the adoption of successful formal e-waste management by proposing or developing policies, and legislative frameworks for e-waste management (Patil and Ramakrishna 2020). Also, to adopt circularity in the e-waste management system, research on resource or component recovery has been done (Li and Xu 2019). E-waste production forecasts and EEE import/export statistics have been also focused in various studies (Prakash and Barua 2016). The issues confronting the formal e-waste management system of an emerging economy were highlighted via a review of relevant literature and comments from institutional experts. DEMATEL analysis has been used to evaluate the known impediments. The proposed framework explores the impediments to the broad adoption of formal e-waste management and activities in India. The DEMATEL method was introduced at the Battelle Geneva Institute to research qualitative and factor-related social problem categories (Jangre et al. 2022, Kashyap and Shukla, 2022). Researchers can learn more about how to address a specific problem or a group of similar problems using this way. This technique is superior to others because it emphasizes the importance of one element over another, ranks factors according to the nature of their interrelationships, and shows their interrelationships (Maqbool et al. 2020, Kashyap et al. 2022). The procedure to perform the DEMATEL for this study is represented in Figure 3.

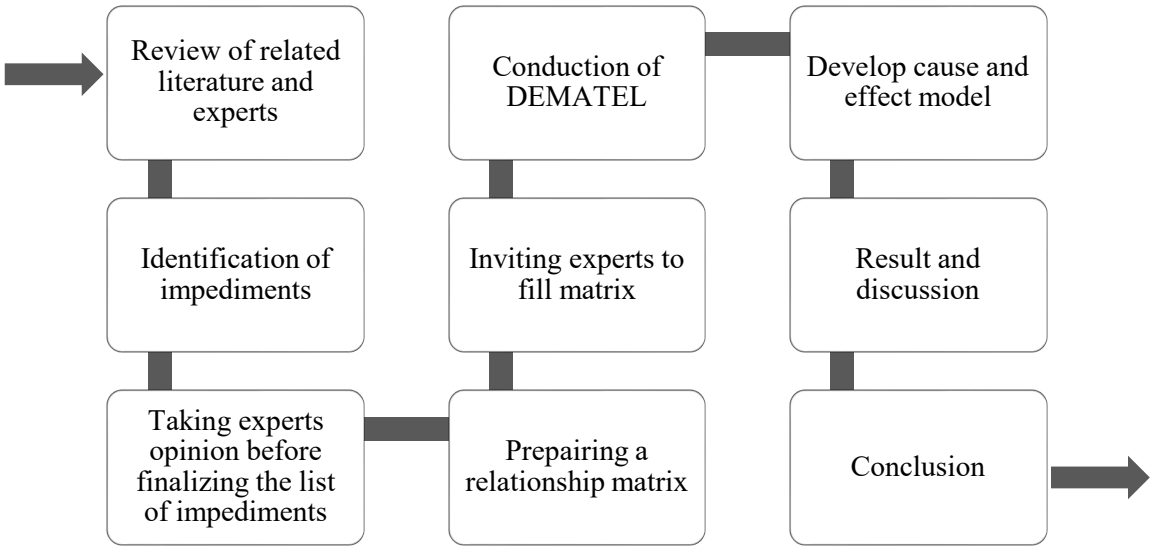

Figure 3. Methodology

4. Data Collection

Extensive literature review and experts from engineering institutes are respondents to identify the impediments in the study, enlisted with description in Table 1.

Table 1. Identified Impediments

Code	Impediments	Description	References
I1	Less formal e-waste collectors/Pickers	There is a dearth of e-waste collectors among staff and members	Expert
I2	Insufficient supply of e-waste at formal recycling centres	Insufficient personnel are employed formally to collect and sort e-waste, disrupting the usual operation of recycling facilities	(Bharadwaj 2016)
I3	Large Ideal duration for formal e-waste value recovery	Lack of e-waste causes the cessation of recycling and value recovery activities for e-waste	(Bhardwaj 2016)
I4	High setup and operational cost	A significant preliminary investment would be required to create e-waste management strategies, including the construction of recycling facilities, collecting centres, training and awareness program	(Raghupathy et al. 2018, Jangre et al. 2022)
I5	Low incentive package for formal e-waste recovery	Low financial incentives for formal e-waste recycling contribute to a lack of organization-wide enthusiasm	Expert
I6	Lack of awareness of the detrimental effects of unregulated e-waste recycling	A lack of understanding about the harmful effects of unmanaged e-waste recycling leads to disorganization in the treatment and disposal of e-waste	(Sengupta et al. 2022)
I7	Lack of awareness regarding the cost of returning in formal e-waste recycling	Low awareness practices on the benefits of proper e-waste recycling.	(Sengupta et al. 2022)
I8	Lack of corporate social responsibility (CSR) initiatives	Under a CSR program, organizations might invest minimum revenue to recycle garbage in an environmentally responsible way	(Jangre et al. 2022)
I9	Lack of Training empowerment	Training for official e-waste management members encourages and trains them to work to their full ability	(Jangre et al. 2022)
I10	Insufficient funds for a formal e-waste recycling management system	Government management of a competent e-waste recycling system requires a massive investment	(Kumar and Dixit 2018)
I11	Limited human resources for formal recycling centres	Fewer workers and personnel at government recycling and deconstruction facilities	Expert

After the impediment's identification, the relation matrix with the DEMATEL scale was used to full fill by the different respondents. The scale is ranged from 0-4, in which "0 indicates no influence of a factor on other, 1 for low influence, 2 indicates medium influence, 3 for high influence and 4 for very high influence". One of the respondents filled out matric (E1) mentioned in Table 2, similarly, two more matrices are filled by different respondents. The average Direct-Relation Matrix (A) (Table 3), was developed after averaging all three respondents' matrices.

Table 2. Exert matrix-1 (one of the experts filled matrix)

E1	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11
I1	0	4	4	1	0	2	2	1	1	0	3
I2	1	0	4	1	1	2	2	2	1	3	3
I3	2	2	0	2	3	0	0	0	2	1	3
I4	1	1	1	0	2	1	1	0	1	3	1
I5	4	3	2	1	0	2	3	1	2	3	3
I6	3	3	2	1	1	0	4	3	1	3	3
I7	2	3	3	2	4	3	0	2	2	3	2
I8	1	4	3	1	1	3	2	0	1	2	1
I9	3	2	2	2	2	2	3	1	0	1	2
I10	3	3	3	4	3	2	2	2	1	0	3
I11	2	2	4	2	1	1	2	1	2	1	0

Table 3. Average Matrix of the impediments

A	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11
I1	0	3.3333	3.6666	1	0.3333	2	2.3333	0.6666	1	0.3333	2.6666
I2	1	0	3.6666	1	1	2	2	2	0.6666	3	3
I3	2	2	0	2	3	0	0	0	2	1.3333	3
I4	1	1	1.3333	0	2	1	1	0	1	3	1
I5	4	3	2	1	0	2.3333	3	1	2.3333	3	3
I6	3	3.3333	2.3333	1	1.3333	0	4	3.3333	1	3	3
I7	2	3	3	2	4	3	0	2	2	3	2
I8	1	4	2.6666	1	1	3	2	0	1	2	1
I9	3	2	2	2.333333	2	2	3.3333	1	0	1	2.3333
I10	3	3	3	4	2.6666	2.3333	2.6666	2.3333	1.3333	0	3
I11	2.3333	1.6666	4	2.333333	1	1	2	1	2	1	0

5. Results and Discussion

In India, government agencies have made tremendous progress in e-waste management and regulation, but the informal sector continues to dominate, while the official system is not widely recognised and faces several difficulties. The rising amount of domestic and international e-waste in India has prompted calls for improved e-waste management methods that preserve the environment, human health, and social well-being, as well as a more organised and efficient approach to recycling. This article identifies several e-waste impediments by examining relevant literature and conducting expert opinions. It then assesses and analyses these impediments to identify their relevance and the nature of the cause-and-effect relationship they pose for formal e-waste management systems in developing countries.

5.1 Numerical Results

The maximum sum of all rows is used to divide each cell of the average matrix to obtain a normalised matrix (Y), shown in Table 4.

Table 4. Normalized direct relationship Matrix (Y) of the impediments

Y	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11
I1	0	0.1220	0.1341	0.0366	0.0122	0.0732	0.0854	0.0244	0.0366	0.0122	0.0976
I2	0.0366	0	0.1341	0.0366	0.0366	0.0732	0.0732	0.0732	0.0244	0.1098	0.1098
I3	0.0732	0.0732	0	0.0732	0.1098	0.0000	0.0000	0.0000	0.0732	0.0488	0.1098
I4	0.0366	0.0366	0.0488	0	0.0732	0.0366	0.0366	0.0000	0.0366	0.1098	0.0366
I5	0.1463	0.1098	0.0732	0.0366	0	0.0854	0.1098	0.0366	0.0854	0.1098	0.1098
I6	0.1098	0.1220	0.0854	0.0366	0.0488	0	0.1463	0.1220	0.0366	0.1098	0.1098
I7	0.0732	0.1098	0.1098	0.0732	0.1463	0.1098	0	0.0732	0.0732	0.1098	0.0732
I8	0.0366	0.1463	0.0976	0.0366	0.0366	0.1098	0.0732	0	0.0366	0.0732	0.0366
I9	0.1098	0.0732	0.0732	0.0854	0.0732	0.0732	0.1220	0.0366	0	0.0366	0.0854
I10	0.1098	0.1098	0.1098	0.1463	0.0976	0.0854	0.0976	0.0854	0.0488	0	0.1098
I11	0.0854	0.0610	0.1463	0.0854	0.0366	0.0366	0.0732	0.0366	0.0732	0.0366	0

Table 5. Total relation matrix (T) of the impediments

T	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11
I1	0.1778	0.3170	0.3548	0.1829	0.1699	0.2105	0.2483	0.1341	0.1591	0.1819	0.2937
I2	0.2444	0.2407	0.3867	0.2112	0.2167	0.2349	0.2652	0.1960	0.1675	0.2925	0.3327
I3	0.2326	0.2475	0.2040	0.2012	0.2337	0.1297	0.1579	0.0929	0.1795	0.1917	0.2806
I4	0.1821	0.1984	0.2244	0.1210	0.1918	0.1509	0.1740	0.0890	0.1325	0.2332	0.1957
I5	0.4001	0.4087	0.4101	0.2554	0.2251	0.2975	0.3603	0.2005	0.2591	0.3432	0.3989
I6	0.3683	0.4298	0.4292	0.2595	0.2793	0.2268	0.3938	0.2819	0.2193	0.3529	0.4016
I7	0.3529	0.4252	0.4523	0.2971	0.3709	0.3297	0.2737	0.2412	0.2587	0.3634	0.3825
I8	0.2384	0.3705	0.3501	0.2023	0.2112	0.2682	0.2663	0.1314	0.1719	0.2635	0.2668
I9	0.3242	0.3259	0.3519	0.2604	0.2600	0.2511	0.3271	0.1708	0.1525	0.2441	0.3270
I10	0.3785	0.4224	0.4546	0.3611	0.3283	0.3064	0.3575	0.2472	0.2367	0.2634	0.4101
I11	0.2653	0.2705	0.3682	0.2339	0.1992	0.1834	0.2429	0.1428	0.1971	0.2071	0.2091

The normalized matrix is multiplied by the inverse of the subtraction of the normalized matrix by the identity matrix to obtain the total relation matrix (T) (refer Table 5), shown in equation (1).

$$T = Y\,(I - Y)^{-1} \qquad (1)$$

This total relation matrix (T) is further used to find the threshold value (μ). This threshold value provides an Inner dependence matrix (B) (refer Table 6) to identify the dependency of impediments on others. The average of the total relation matrix gives the threshold Value, $\mu = 0.266391$

Table 6. Inner dependence matrix (B)

B	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11
I1		**0.3170**	**0.3547**								**0.2937**
I2			**0.3867**							**0.2925**	**0.3327**
I3											**0.2805**
I4											
I5	**0.4000**	**0.4087**	**0.4101**			**0.2975**	**0.3603**			**0.3431**	**0.3988**
I6	**0.3683**	**0.4298**	**0.4291**		**0.2792**		**0.3937**	**0.2819**		**0.3529**	**0.4015**
I7	**0.3529**	**0.4251**	**0.4522**	**0.2971**	**0.3709**	**0.3296**	**0.2737**			**0.3634**	**0.3825**
I8		**0.3705**	**0.3500**								**0.2668**
I9	**0.3242**	**0.3259**	**0.3519**				**0.3271**				**0.3270**
I10	**0.3784**	**0.4224**	**0.4545**	**0.3611**	**0.3282**	**0.306**	**0.3575**				**0.4101**
I11		**0.2705**	**0.3682**								

The sum of each row and column is Ri and Cj which were further utilised to calculate Ri+Cj and Ri-Cj. The ranking of the impediments is considered by the Ri+Cj value. Classification of impediments in the cause-and-effect group was identified by Ri-Cj, the -ve value indicating cause and +ve, effect (refer Table 7).

Table 7. Ranking and Cause-Effect Table

C-E	Ri	Cj	Ri + Cj	Ri – Cj	Ranking	Cause/ Effect	Challenge
I 1	2.4300	3.1646	5.5946	-0.7345	8	Cause	Less formal e-waste collectors/Pickers
I 2	2.7885	3.6568	6.4453	-0.868	3	Cause	Insufficient supply of e-waste at formal recycling centres
I 3	2.1513	3.9862	6.1375	-1.8348	6	Cause	Large Ideal duration for formal e-waste value recovery
I 4	1.8929	2.5862	4.4791	-0.6932	11	Cause	High setup and operational cost
I 5	3.5589	2.6862	6.2451	0.8727	4	Effect	Low incentive package for formal e-waste recovery
I 6	3.6422	2.5890	6.2312	1.0532	5	Effect	Lack of awareness of the detrimental effects of unregulated e-waste recycling
I 7	3.7477	3.0670	6.8147	0.6807	1	Effect	Lack of awareness regarding the cost of returning in formal e-waste recycling
I 8	2.7405	1.9278	4.6683	0.8127	10	Effect	Lack of corporate social responsibility initiatives
I 9	2.9951	2.1339	5.1290	0.8612	9	Effect	Lack of Training empowerment
I10	3.7662	2.9371	6.7033	0.8291	2	Effect	Insufficient funds for a formal e-waste recycling management system
I11	2.5195	3.4987	6.0182	-0.9791	7	Cause	Limited human resources for formal recycling centres

These causal impediments may be referred to as decisive strategies owing to their potential weight in the framework for decision-making. Six impediments qualified as the cause of impediments. Using (R-D) data values, the relative significance and influence of these causal impediments on other impediments were further evaluated by ranking them (refer Table 8). I6 is identified as the most significant driving impediment across the entire causal group, followed by I5, I9, I10, I8 and I7. Another side, I3 was found the most effective impediment among the entire effect group (refer Table 9).

Table 8. Ranking of impediments (Cause group)

Impediments	Ranking
I6	1 - Lack of awareness of the detrimental effects of unregulated e-waste recycling
I5	2 – Low incentive package for formal e-waste recovery
I9	3 – Lack of Training empowerment
I10	4 – Insufficient funds for a formal e-waste recycling management system
I8	5 - Lack of corporate social responsibility initiatives
I7	6 – Lack of awareness regarding the cost of returning in formal e-waste recycling

Table 9. Ranking of impediments (Effect group)

Impediments	Ranking
I3	1 - Large Ideal duration for formal e-waste value recovery
I11	2 – Limited human resources for formal recycling centres
I2	3 – Insufficient supply of e-waste at formal recycling centres
I1	4 – Less formal e-waste collectors/Pickers
I4	5 – High setup and operational cost

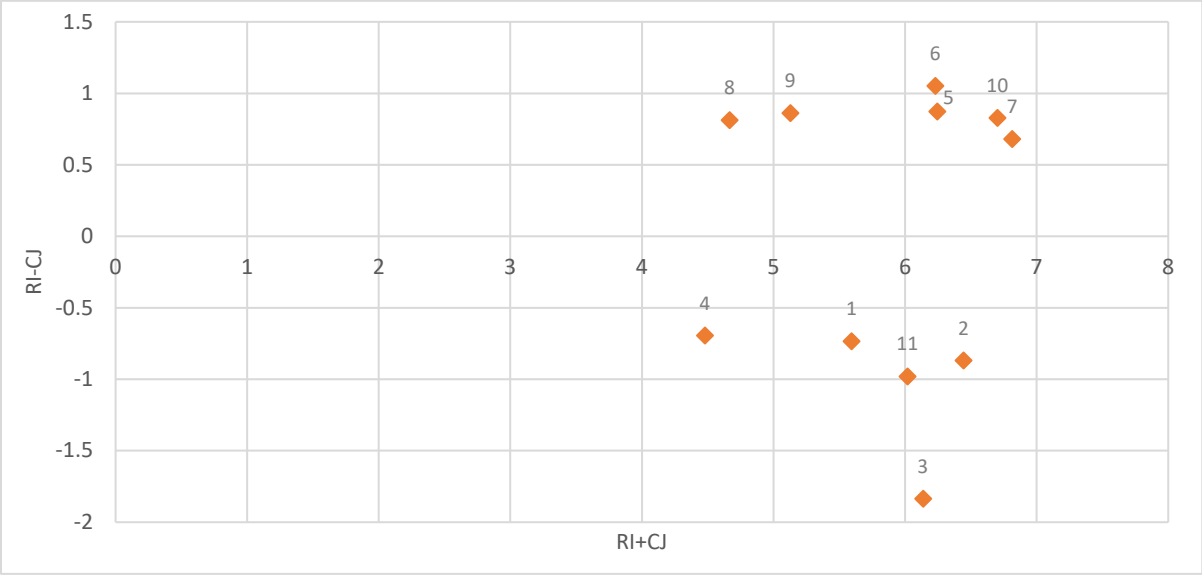

Figure 4. Cause and Effect relationship diagram

5.2 Graphical Results

The cause-and-effect relationship diagram is shown in Figure 4, where Y-axis and X-axis represent Ri-Cj and Ri+Cj. The interconnectedness of the different challenges has been evaluated with the help of expert opinion. Three respondents, including academics and domain experts, have been consulted for their knowledge.

5.3 Proposed Improvements

The management and practice implications of these findings are enormous. The study begins by laying the framework for the understanding of the key factors that influence the effective and efficient formal e-waste management sector. The conclusions of this study regarding possible impediments to e-waste management may serve as a thorough checklist for tackling all the most significant issues in this field. Second, our study illuminates the several dimensions of e-waste management that policymakers must consider. This will assist policymakers in examining all important aspects and their impacts, so enabling the establishment of enhanced and long-term strategies for formal e-waste management. The structural decision model proposed, which is based on DEMATEL, enables the discovery of these tangential relationships between distinct impediments.

The ramifications of these findings for management and practice in formal sectors are significant. The study begins by identification of the impediments to the understanding of essential characteristics that have an impact on formal e-waste management systems. The conclusions of this research regarding possible impediments to formal e-waste management may serve as a full checklist. Second, our study illuminates the multiple aspects of e-waste management that policymakers must consider. In order to fulfil the requirements of formal e-waste management systems in developing countries, this will also assist policymakers in examining all relevant aspects and their impacts so they may make educated, strategic decisions. The proposed structural choice model, which relies on DEMATEL, facilitates the identification of causal links between diverse impediments. The research also provides a framework for policymakers to consider the many obstacles to formal e-waste management.

The primary objective of the e-waste management system is to minimize costs, ensure that waste is properly used to develop resources, reduce environmental contamination, and increase e-waste recovery operations and revenue. The following suggestions are made for the improvement of formal e-waste challenges in developing nations, based on the aforementioned findings:

- The government must organize, at regular intervals, campaigns to raise awareness of e-negative waste's environmental impact.
- Collectors of formal e-waste should recruit local garbage pickers/collectors to improve the supply of formal e-waste to formal recycling services. The integration of existing informal e-waste management collectors and recycling facilities may lessen the environmental impact.
- The government should give appropriate incentives for e-waste management methods and collectors so that a motivating atmosphere may be maintained via them.

6. Conclusion

This research aims to identify and analyse the impediments to successful formal e-waste management in developing countries. Key impediments to the proper management of electronic waste have been identified by analysing the existing literature and inputs from domain experts. Their interaction strengths were analysed using the DEMATEL framework, and the resultant e-waste impediments were categorized according to their natures (cause and effect). The study determined that "Lack of awareness of the harmful effects of unregulated e-waste recycling," "Low incentive package for formal e-waste recovery," "Lack of Training empowerment," "Insufficient funds for a formal e-waste recycling management system," "Lack of corporate social responsibility initiatives," and "Lack of awareness of the cost of returning in formal e-waste recycling" were the significant and influential causes of the problem facing by the formal e-waste management system. For successful formal e-waste management, governments must pay greater attention to the obstacles. Due to the influence, it might have on the overall structure, the establishment of a barrier between cause groups is essential. Moreover, this study's results have consequences for the infrastructure of e-waste management. From effect segment, “Large Ideal duration for formal e-waste value recovery,” “Limited human resources for formal recycling centres,” “Insufficient supply of e-waste at formal recycling centres,” “Less formal e-waste collectors/Pickers,” “High setup and operational cost” are found effective for the management of formal e-waste sectors.

The framework was formulated by considering India a country with similar circumstances to all developing countries. Also, the impediments were identified by overviewing the overall system and supply chain of the formal e-waste system, particular network research can enhance the system from the root level, consider as the limitations of this study. The fuzzy or grey-based MCDM technique as the opinion and decision are uncertain in such a complicated management system. There will be various challenges and arguments throughout the implementation of each of these requirements. In future studies, researchers may investigate these difficulties.

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