An Integrated and Sustainable Model for E-Waste Management for Pune City Households

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Abstract. Worldwide use of electronic devices has led to a serious socio-economic-technical challenge for managing them at their end-of-life stage. Managing EOL electronic devices or e-waste using traditional methods has been potentially hazardous to the environment and health. United nation’s sustainable development goals also have linked e-waste to three of its SDGs and support the sustainable consumption and quantification of e-waste. Policy interventions, consumer awareness, and active environmentalist roles have forced developed nations to engage in scientific ways of e-waste treatment. The high cost of treatment and increasing volume has led to a scenario where developing nations, including India, have been more attractive and easy targets for dumping e-waste. Out of 1.7 million tons of e-waste generated in India, 8% of e-waste reaches the landfill as useless material, 1.5% of which are formal recycling, and the informal sector handles more than 90%. Ineffective policy implementation and lack of stakeholder participation pose a challenge in improving the scenario of e-waste management. Although, there is many stakeholders have been brought into the sphere of policy, household have not been considered major generators, with about 16% of the total e-waste. Growing urbanization increased dependency on electronic product usage due to the pandemic; we need to channel the household e-waste to the formal treatment units with a systematic approach. Pune is one of the proposed smart cities and has been in the news due to the solid waste treatment challenges due to the treatment sites and infrastructure. With municipal solid waste, e-waste collection and treatment at the regular treatment facilities, not equipped to handle e-waste leads to untreated e-waste parts in whole or in traces. Lack of awareness and non-segregation at source, inadequate collection channels has impacted the environment, requiring a focused and workable systematic framework for household generated e-waste disposal. Access to disposal at the doorstep develops an integral behavior that can be altered by providing proper doorstep MSW disposal infrastructure as an extension of the existing municipal solid waste segregation model. This paper proposes a theoretical, sustainable, and integrated model built with the current MSW model foundation aimed at household e-waste management, providing collection and inventory services for Pune residents.

Keywords: E-waste, Pune Households, Integrated Model, Sustainability, MSW, stakeholder, management.
1. Introduction
Global concerns about increasing e-waste volume, inadequate treatment infrastructure, illegal e-waste trade, and consumer awareness have been major concerns for developing e-waste management policies. Informal recycling practices have been predominant due to the functional comfort and cost advantage proposed at the price of detrimental effects on the atmosphere and health. Several stakeholders' participation, e-waste constitution, and deficient awareness related to hazardous health and environmental impacts have been linked to inappropriate-waste discarding. Outdated treatment methods wide-ranging from burning, land filling, dumping has been applied for e-waste treatment, resulting in loss of precious resources and environmentally toxic. Optimization processes to reduce toxic elements and maximize valuable materials recovery from e-waste management need to be developed and implemented. Inadequate planning, stakeholder’s contribution at each step, consciousness about the guidelines, and urgency coupled with severity involved need an interconnected approach to accomplish sustainability goals.

E-waste management requires shared responsibility among stakeholders, unlike regular waste management, governing bodies' function. E-products from the design stage till disposal involve producers, consumers at the useful life and back to manufacturers as e-waste. Electronic devices may turn into e-waste at different stages of their life span due to users’ elimination of products due to changing trends, necessity, and end of life. Various stages with multiple processes and multiple participants handling the discarded e-products at different levels have been a real challenge. Discarded products may not always be useless and hence have to be considered for reuse, refurbish or recycling.

2. Literature Review
With different objectives by stakeholders such as manufacturers looking at revenue-boosting; consumers requiring ease, cost-effectiveness, and device feature simplicity for consumer use while the civic establishments struggle to manage the waste at EOL stage, e-waste needs a strategic partnership. E-waste management requires stakeholder's thoughtful and responsible partnerships as e-waste has a resource-rich and complex nature. Stakeholders approach to achieve compliance coupled with lack of e-waste awareness among stakeholders, favorable local infrastructure to handle multilevel processes and hence need active sharing to handle e-waste [8].

The economic value of e-waste increases due to gold and silver, among many other precious metals, whereas toxic metals such as lead and chromium enhance environmental degradation. Dumping and incineration lead to long-lasting and irreversible impacts in rare and scarce metal resource loss. The rising size of worldwide e-waste and the universal alarm raised by environmental activists/agencies has imposed the governing bodies across diverse nations to announce an appropriate instrument for dealing with e-waste. Due to nature and complexity, the e-waste lifecycle requires stakeholders' participation with clearly defined roles in the policies/regulations/legislation introduced in almost all nations, be it developed or developing. Legislations/ regulations have been developed based on approaches, namely Extended Producer Responsibility, Tax credits, and Advanced Recycling Fees, with a focus to ensure that e-waste finds the recognized recyclers for better wealth retrieval and nominal ecological effect. Existing methods place major weight on producers for applying sustainable methods to lessen the later effects of handling and challenges the global supply chain of the e-products as the product manufactured in one nation turns out to be e-waste in some other nation [1]. Producers focus on maximizing profit by trade expansion. It gets an additional responsibility of handling their products after their useful life and has been a real challenge for them due to the scope of the product reach. Many multinational firms have placed a procedure to gather EOI products termed [6]as e-waste from selling outlets as assembly points and channelize them back into their premises targeting 3R - Remanufacturing, Recycling, repair, and reuse[9] Worldwide spread manufacturing, logistics network, and inadequate market placement for the reconstituted e-products in both industrialized and emerging nations consider recycling the preferred choice to follow the respective nations' guidelines.
where the product gets sold. Higher costs associated incurred for recycling e-waste. Advanced countries perceive evolving countries as a prepared secondary selling place, throwing away location for reprocessing has they have financial and ecological benefits of non-treatment at the place of production [16]. The informal and inexpensive option has been a favorite choice [15] for parties in cooperation where rich nations benefit from discarding deadly e-waste and the not-so wealthier nations treated as collection centers [11].

Efficient e-waste management needs to chase inflow-outflow of e-products to develop policies and infrastructure [10] to maximize retrieval's economic value with minimum impact on the environment, hence needing a robust database. Administrative and regulatory requirements, matured consumer’s participation aids the maintenance of a detailed inventory [15] of EOL products in forward-thinking countries. In contrast, unlawful imports, the market for used products, not-branded product [5] constantly flourishing refurbishing plants in emerging nations pose grave challenges to record the EOL statistics and sustain e-waste records [12]. Effective management systems require the right information related to the products starting from manufacturing until the point of disposal. Developing nations lack information gathering and, hence, the gap in EPR implementation. The economic value proposition offered in informal recycling in the developing nations encourages illegal imports adding to the domestic e-waste. More than 150 countries have ratified the Basel Convention by banning them from exporting e-waste to other nations. Still, in reality, a large amount of e-waste export has been actively taking place in the unregulated recycling centers. India, China, and many Asian countries get a large amount of e-waste from developed nations and pose a challenge for managing e-waste.

Amongst emerging nations, India finds eminent spot generating e-waste measuring 1.7 million tons and merely 1.5% out of the total getting treated formally in recycling units, 8% being labeled not usable reaches the dumping sites as per report [3]. Old-style treatment methods process more than 95% of e-waste as the scrap traders control the disorderly marketplace where e-waste dismantling and disposing of as an alternative to recycling. Valuable metals like gold, silver, platinum, and copper are reclaimed with the help of concentrated acids and caustic soda using labor-intensive elementary procedures with bare hands working with toxic chemicals for extended hours. The absence of consciousness of the deadliness to which they are getting uncovered has been ignored due to income recyclers get because of VOW-value out of wealth scenario by nominal investment using unskilled workforce [2]. Indian cities, together with Pune, have been struggling in implementing a systematic approach for management of waste owing to the presence of informal sector, non-segregation of waste at source, inadequate collection/treatment centers, absence of e-waste [6] inventory at the city level or regional level, absence of knowledge related to e-waste and education among stakeholders[13]. Primarily all these reasons pose an interrelated and interconnected scenario requiring[19] an organized style to handle e-waste and needs solutions with adaptable and convenient working systems, supportable concerning the localities they function in [18].

Pune, a city known as the cultural capital of the state of Maharashtra, has been known for its Zero waste model and depicts a Public-Private model with the association between the governing bodies involving the Municipal Corporations of Pune and Pimpri Chinchwad, non-governmental entities such as SWaCH and Janwani, business houses like Cummins India. The MSW management model exists in many wards of Pune and Pimpri Chinchwad's twin cities with replicable nature [14]. SWaCH-model’s success and realization needs to be credited to dynamic involvement among households in waste separation, corporate establishments in providing monetary funding, and NGO’s for assisting with the labor force, civic authorities-PCMC and PMC) The foremost part demonstrates the finest Public-Private Partnership, evolution of a model with the current PPP model for e-waste management desires partaking from all source of e-waste generation. Several-waste sources in the Pune region summarized as a block diagram are depicted in Figure 1, which would help understand the point of start in developing the integrated model.
Figure 1: Stakeholders in E-Waste Management

All stakeholders’ role in the impending e-waste challenge is critical. The shared responsibility model needs to be developed to manage e-waste from cradle to cradle stage, focusing on Extended Producer responsibility. E-waste rules implemented in 2012, followed by stakeholder feedback amended rules in 2016 by MOEFC, India's government. Tasks have been clearly defined in the guidelines for e-waste generators termed bulk consumers such as business and government bodies, educational establishments, and producers, excluding the households. Covid pandemic has forced everyone to work in a virtual mode where the households have been acting as offices and schools; the use of e-devices has amplified, leading to the subsequent contribution to e-waste is presently just about 16% [17]. Disposal function of the household’s in terms of EOL e-devices can be successfully supported out with a change in behavioral function with the slightest resolution as the user’s awareness has been improving during the pandemic. Post pandemic, the behavioral changes can be easily adapted and sustained by providing collection and disposal channels at their doorsteps and guarantees its path to the formal recycling units. The present-day situation of houses usage of e-devices would add to the volumes of e-waste significantly in few years. There would be a substantial effect on environmental pollution and health hazards due to the negligent disposal behavior. An essential sharing model with a participatory and favorable environment, a structured methodology, and the current collection system development to gain economic benefits must be introduced.

2.1 Pune region- Existing Model of e-waste management
The footprint of the technology progression and inclusion in day-to-day life devices has been witnessed in the preceding few years worldwide, empowering individuals in the form of electronic appliances or devices. Regardless of the need or income levels, appliances, namely refrigerators, washing machines, ovens, televisions, battery-operated toys, mobile phones, are found in households. Personal webcams, laptops, smartphones, air conditioners, computers, security appliances have been normal in upper-income households. All these gadgets have found an irreplaceable place in our lives and have both good and harmful effects. The darker side of the technology innovations in the electronics sector referred to as toxic of the digital age, has been e-waste generated from EOL electronics gadgets used in every household. Pune region adds a considerable quantity of 10,000 Metric Tons of e-waste yearly, and importantly, operational e-waste reaches destination scrap market or landfill. Unaware of the embedded value of resources in e-waste, the generators and the collectors mix it up with municipal solid waste. Various phases in e-waste management commencing with gathering, separation, disassembling, reutilizing, reprocess restoration, dissemination, and exposed burning/landfilling all activities taken care of by sound and connected informal sectors. Deficient
awareness combined with discarding comfortable ways available for household overrides the associated dangers e-waste compromises, which boosts careless disposal behavior. Even though households contribute to the growing volume of the existing e-waste, they must be critically examined in e-waste management. Post-implementation of E-waste Management Rules, 2016, individual consumers have been identified as important stakeholders and have a vital role in the household. In [13] discussed about five major cities of India to assess the individual's knowledge about e-waste and related issues. These cities were Mumbai, Delhi, Bengaluru, Chennai, and Kolkata [12]. In Pune region, an e-waste assessment study was carried out in 2008, and recently, no studies have been carried out in the Pune region for e-waste Assessment.

Figure 2 depicts the present-day method of e-waste management implemented by Pune region households.

![Figure 2: E-waste management in Pune city – Present-day scenario](image)

As Pune region successfully segregates the dry and wet waste, it plays an important role in channelling the waste to formal. Suppose the same behavior gets practiced by households for e-waste disposal. In that case, the collection centers and formal recyclers will obtain the required quantity to meet the targets specified in the e-waste law. In the last four years, e-waste laws have been enforced, but their implementation has not been very successful. A large quantity of e-waste reaches the informal collectors and recyclers, resulting in resource loss and environmental degradation. Pune is the second-largest generator of e-waste in Maharashtra. The Pune region households are one of the major stakeholders who can influence the disposal behavior. Well-informed and aware households help in practicing the systemic behavior and can help manage the sustainable systems for e-waste management. Households obtain monetary benefits in return against e-waste from scrap dealers; however, product at the end of life stage gets channelized to the black market for dismantling or refurbishing. On reaching the outright stage of EOL wherein their further usage is not possible, robust set-up of informal collectors confirms their path to the informal recovering plants. Insufficient collection arrangement by governing bodies extensively spread informal sector, and the monetary value of e-scrap encourages the adoption of existing e-waste management model. Among cities' waste management model, the Pune region model has been recognized for effective execution of dry-wet waste management adopted in the form of PPP model exists with a wide gap not covering e-waste in the scope. Joint projects executed in the GIZ partnership- SWaCH, directed at convincing the informal recyclers to carry out the collection to reach formal recycling units, have not been successful as the former model's economic return has been more lucrative than the monetary incentives offered. A suitable, modest collection channel, comfortable and easily available at the doorstep to residents in their localities for household EOL products by offering an efficient collection system, real-time,
updated e-waste facts recorded starting from generation to treatment requirement for the Pune region. A low-cost solution for reclamation of the toxic and precious metals is also a critical issue to be addressed. With the shortcomings identified in the existing scenario, the authors have proposed a simple, low-cost PPP model for managing e-waste of households with sustainability and integration of various processes with the concrete objective for formal e-waste collection for the Pune region.

3. Proposed Methodology

3.1 E-waste collection and inventory model for households

Impact on environment and health due to informal recycling of e-waste is not just a concern for today but a very hazardous future issue due to the toxicity potential of an electronic product at the EOL stage. Landfilled e-waste leaves traces of toxic metals for a long time; its impact is seen in people's form of diseases. E-waste resourcefulness characteristics are an interconnecting function of multiple stakeholders beyond the manufacturing stage involving product design. Culture, generation-based preferences, usability decisions, affordability and convenience, evaluation of positive and negative essential assessment, comparative analysis of material value versus functional value, and supply chain consideration play a vital role in the manufacturer's product design preposition. E-waste regulations have widened their scope beyond manufacturing and sales. Careful consideration needs to be given for the product take-back processes and procedures, treatment ecosystem, and thus fulfillment of EPR. However, without every stakeholder's participation with shared, differentiated responsibility in covering products' resourcefulness, e-waste management achievement seems difficult. The current pandemic scenario has compelled every household to equip as a working and learning space, with many e-gadgets being in use mandatorily. Households can be treated as major stakeholders as they can be empowered in shared value creation with an eco-friendly model for the collection of e-waste. Households as primary stakeholders with a high volume e-waste generation potential would play a key role throughout product lifespan besides having no compliance risk in the present regulations.

Houses that include housing societies and bungalows are sources of e-waste creation resulting from the unwanted usage of electronic equipment, IT equipment, and small but harmful components such as chargers and batteries. Classified in individual consumer category as per schedule II of amended rules' Waste (Management) Rules 2016, have been assigned well-defined duties. Individual consumers' responsibility starts with appropriate separation[4] and then making sure of their disposal to authorized collection centers fore-waste or approved point of sale of the manufacturer or designated dismantler or even registered recycler either themselves or through the nominated take backchannel. The report published [13] presented facts about consumer consciousness. The nonexistence of discarding services has been two areas of concern for non-fulfillment of duties as per recommendations of e-waste rules. The hydrothermal treatment process, MSW, is the way to produce a solid coal-like product for energetic purposes. The prototype HTC reactor has been fabricated to perform experiments to separate the organic e-waste into fractions of MSW characteristics [20].

Strategy level interference is not sufficient to resolve the e-waste problem across various levels nationwide and hence essential to address the matter at the native level (i.e., city-level). As the perfect model in Municipal Solid Waste treatment, the Pune region has not given due attention to toxic e-waste and has been generally collected along with the regular waste. The mounting volume of household e-waste can utilize the prevailing PPP model applied for MSW treatment with minor alterations, which has been the proposition by authors of this paper, particularly for e-waste collection and data maintenance. Figure 3 illustrates a model for E-waste collection from Households (Banglows and Housing Societies). This model will aid in a well-organized collection as well as e-waste inventory focused on households. On completion of the building, housing societies have to complete the mandatory registration to avail of door-to-door waste collection service and get an additional 5% tax rebate as an incentive yearly (pmc.gov.in). This paper’s suggested model recommends several participants' inclusion and appropriate incentivization in the form of economic value for applying the right methods of e-waste collection and tracking e-waste inflow and outflow for inventory
maintenance. Figure 3 depicts a step-by-step constructed proposed model having roles for all stakeholders, including civic authorities, housing societies/bungalows, official recyclers, and authorized collection agencies.

![Diagram](image-url)

**Figure 3:** Model for e-waste Collection - Inventory model for households

Many e-waste related problems get the solution when we change the awareness of members in the households, which would support transforming behavioral alterations in the long run. Disposal behavioral changes also help track e-waste influx-outflow forms the basis for the evolution of collection machinery, recycling set-up, and constructing a countrywide e-waste database. The stimulus for involvement need not be in the form of economic benefits acquired by households from e-waste trading with scrap dealers. Rewards, enticements, and tariff rebates by civic bodies and other players in the e-waste supply chain do turn out critical aspects of the implementation stage's motivation.

Separation followed by the e-waste collecting process done at the place of generation is the main step performed by the housing society or ward offices level supported by the households by positioning-waste in a distinct bin at their doorsteps. Doorstep collection has to be followed by subsequent bulk collection by aggregation at the designated places in societies or wards. A considerable volume of e-waste can be at a predetermined frequency being transported to the formal recycler. The transportation needs to be taken care of by civic authorities. Frequency of generation of e-waste collection at bigger residential societies or bungalows communities with more than 1000 to 2000 residents becomes the source of disposable e-waste almost every day in mobile or laptop chargers, electronic watches, fitness bands, shavers, batteries, etc. Bins of small and bigger size, the required assets can be procured through the funds allocated for socially responsible activities under the clean city initiative supported by Adar Poonawalla. A dedicated portion of CSR funds can also be a good proposition for infrastructure establishment for the collection and transportation of e-waste.
Educational institutions can be partnered for awareness promotions being the frontrunners in e-waste drives on the ground level and simplifying the participants' collective behavioral change.

4. Results and Discussion
Possessing records of e-waste collection histories at the micro-level generation sites supported by a structured and reliable information system integrated into the model helps in e-scrap asset valuation and projecting future statistics related to e-waste. Influx and outflow e-waste data categorized item-wise help the civic authorities in planning for the infrastructure for collection. Information system supported record-keeping without human intervention guarantees proper management of reliable data and can be retrieved anywhere, anytime, facilitating the governing bodies for awareness and promotion campaign scheduling, capacity building for collection, recycling, and recovery. City-level databases connected to the state pollution control board databases update the central level database to be managed by the Central pollution board of control through cloud-centered platforms. Harmless transfer, transportation of segregated e-waste from the point of generation and can be owned by recyclers supported by the civic bodies to the respective recycling site. Inadequate quantity of e-waste has been one reason for the non-operational mode of the recycling unit as a function. It is a money-making business that gets addressed in the proposed model. An additional step of segregation of e-waste at the premises of formal recyclers would benefit them in product classification labeled as resell, retrieval of materials, or refurbish for ease of operation and effective functioning. As per the regulations, recyclers need to submit the e-scrap records annually to the state pollution boards as a mandatory requirement that can be easily maintained and accounted for as e-waste inflow and outflow. Forecasted bulk size of e-waste generation by household and the subsequent data management of e-waste figures at municipal level serve as input for a system approach development. Especially for the Pune region, the factual figures maintained at the ward levels would be significant for capacity building in light of the planned ISWM plan under the smart city development project. Ensuring that e-waste reaches the treatment facilities is of prime importance, but not all e-waste collected gets treated, so a solution based on socio-economic and environmental perspectives aiming to recover metals has been given significance in the model.

The model addresses the e-waste risk mitigation efforts and addresses the cost-to-compliance with sustainability investments. Taking due cognizance of the strong and well-connected informal dismantler ecosystem with existing collection systems strengthens the ecosystem. It will be a win-win for consumers, producers, recyclers, the environment, society, and the nation. The model and the collection system transformation can happen if the municipal authorities assist the informal ecosystem with a major focus on handling waste at the source. The model strengthens the reverse supply chain, provides linkages between consumers and recyclers, and facilitates the quantum of e-waste as urban mines. The model based on the shared responsibility proposition redefines the EPR with a scope beyond compliance and instills safe and healthy practices with up-grading social behavior from informal to a responsible and formal system-based. Environmental benefits are experienced by retaining and reusing functional parts, which attributes to a much higher value than product constituent materials lost if dumped instead of recycled. Gain at the national level in retaining the rare materials and reducing the toxicity of hazardous materials with an appropriate extraction infrastructure leading to e-waste imports can be felt for economic gains. A simple and realistic model proposition can help handle the collection burden, which is the first step in achieving the e-waste management objective.

5. Conclusion
Behavioral changes brought the model with motivation and credit sharing as encouragements by implementing bonus schemes or prizes or tax rebates. The presence and participation of stakeholders with assigned roles in the model proposed supports all stakeholders’ cost-effective waste management. The model developed for households in Pune established on the prevailing infrastructure with less investment, inexpensive for the civic authorities. Fresh roles have been well-defined for exiting participants such as business organizations by their inclusion indirectly in the form of financial support.
through CSR funds. The model also paves the path for utilization of CSR funds to benefit the community where the business operates and hence builds more interconnections in simple and practical nature. Separation, collection, transference, recording systems, databases have been integrated to carry out a cooperative function to reduce environmental degradation and health hazards. The model has an integrated and sustainable functionality and serves as a hands-on solution with two important systems - time and energy consumed in many processes being an integral part of the arrangement. The model has easy to replicable capability with value and economic propositions as the core functions considered while designing with all stakeholders.

References

[1]. Abid, M., Zulfiqar, F. and Raza, M., 2019. Managing Electronic Waste Pollution: Policy Options and Challenges. In Electronic Waste Pollution (pp. 329-345). Springer, Cham.

[2]. Arora, R., 2008. Best Practices for e-waste management in developing nations. Europe Aid Co-Operation Office, pp.1-24.

[3]. ASSOCHAM and cKinetics (2015): “VOW: Value out of Waste: The Next $1.5 Billion Opportunity for Indian Industry,” New Delhi: ASSOCHAM. Available at HTTP://www.ckinetics.com/publications/Value Out of Waste_2015.pdf. Retrieved on 15 February 2020.

[4]. Charmane, P., 2012. Integrating waste pickers into municipal solid waste management in Pune, India. WIEGO Policy Brief (Urban Policies), 8, p.23

[5]. Guarnieri, P., e Silva, L.C., Xavier, L.H. and Chaves, G.L.D., 2020. Recycling Challenges for Electronic Consumer Products to E-Waste: A Developing Countries’ Perspective. In E-waste Recycling and Management (pp. 81-110). Springer, Cham.

[6]. Guerrero, L.A., Maas, G. and Hogland, W., 2013. Solid waste management challenges for cities in developing countries. Waste Management, 33(1), pp.220-232.

[7]. Hickey, S., Fitzpatrick, C., Maher, P., Ospina, J., Schischke, K., Beigl, P., Vidorreta, I., Yang, M. and Williams, I.D., 2014. A case study of the D4R laptop. Proceedings of the ICE-Waste and Resource Management, 167(WR3), pp.101-108.

[8]. Hong, I.H. and Ke, J.S., 2011. Determining advanced recycling fees and subsidies in “E-scrap” reverse supply chains. Journal of Environmental Management, 92(6), pp.1495-1502.

[9]. Jeon, C., Zhang, E.D., Wang, X.T. and Chen, H., 2014. An investigation into evaluating laptop computers using The Triple Bottom Line (Environmental). Available at https://open.library.ubc.ca/cIRcle/collections /undergraduate research/18861/items/1.0108772., Accessed on 20 April 2018

[10]. Leclerc, S.H. and Badami, M.G., 2020. Extended producer responsibility for E-waste management: Policy drivers and challenges. Journal of Cleaner Production, 251, p.119657.

[11]. Lepawsky, J., Araujo, E., Davis, J.M. and Kahhat, R., 2017. Best of two worlds? Towards ethical electronics repair, reuse, repurposing, and recycling. GeoForum, 81, pp.87-99.

[12]. Links T, 2015. Time to Reboot II. Available at http://toxicslink.org/docs/Time-to-Reboot-2-Full-report.pdf. Retrieved on 12 March 2018.

[13]. Links, T., 2016. What India Knows about e-waste: Report on Awareness Levels of E-waste amongst common citizens in India Available at http://toxicslink.org/docs/What-India-knows-about-e-waste.pdf. Retrieved on 10 March 2018.

[14]. Mundhe, N., Jaybhaye, R. and Dorik, B., 2014. Assessment of municipal solid waste management of Pune city using geospatial tools. International Journal of Computer Applications, 100(10).

[15]. Pagell, M. and Wu, Z., 2009. Building a complete theory of sustainable supply chain management using case studies of 10 exemplars. Journal of Supply Chain Management, 45(2), pp.37-56.

[16]. Raghupathy, L., Krüger, C., Chaturvedi, A., Arora, R. and Henzler, M.P., 2010. E-waste recycling in India: Bridging the gap between the informal and formal sector. Recycling
[17]. Secretariat, RS, 2011. E-waste in India. India Research Unit (Larrdis), Rajya Sabha Secretariat, New Delhi. Available at http://cure.org.in/wp-content/uploads/2014/11/E-Waste_in_india.pdf Retrieved on 10 January 2016.

[18]. Van Rossem C, Tojo N, Lindhqvist T. Extended producer responsibility: an examination of its impact on innovation and greening products. The IIIEE Report commissioned by Greenpeace International, Friends of the Earth Europe, and European Environmental Bureau; September 2006. Available at http://www.greenpeace.org/eu-unit/Global/eu-unit/reports-briefings/2009/3/extendend-producer-responsibil.pdf Accessed on 9 September 2015

[19]. Wath, S.B., Vaidya, A.N., Dutt, P.S. and Chakrabarti, T., 2010. A roadmap for the development of sustainable E-waste management systems in India. Science of the Total Environment, 409(1), pp.19-32.

[20]. Kumar, S., & Kandasamy, M. A. (2017). Fabrication of HTC Plant for Carbonisation Of Municipal Solid Waste. International Journal of MC Square Scientific Research, 9, 26-33.