*Journal of Scientific Reports 2025, 9(1), 17-26*
ISSN: 2708-7085
*Journal: ijsab.com/jsr*

# Global WEEE Management: Behavior and Future Projections

**Bryan A. Lundberg** [1]

[1] Division of Advanced Postgraduate Studies TecNM, Orizaba, Mexico.
Email: m16010924@orizaba.tecnm.mx

**Abstract**
The exponential growth in Waste Electrical and Electronic Equipment (WEEE) represents one of the most pressing environmental challenges of the modern era. This study analyzes historical trends in WEEE generation and treatment from 2010 to 2022, employing linear regression models to forecast future scenarios up to 2040. Findings reveal a consistent increase in WEEE generation, projected to exceed 100 million tons annually by 2040, with only marginal improvements in recycling rates. The analysis highlights a widening gap between discarded and treated WEEE, underscoring the need for enhanced recycling infrastructure, technological innovation, and policy enforcement. The study validates its models through comparative projections, demonstrating their reliability. The research emphasizes the urgency of aligning WEEE management with sustainability to address environmental risks.

***Keywords***: *WEEE, e-waste, circular economy, recycling, sustainability*

**ARTICLE INFO**

**Short communication**
Received: 18 December 2024
Accepted: 24 January 2025
Published: 28 January 2025
DOI: 10.58970/JSR.1092

**CITATION**
Lundberg, B. A. (2025). Global WEEE Management: Behavior and Future Projections, *Journal of Scientific Reports*, 9(1), 17-26.



## 1. Introduction

Modern society has undergone multiple stages of progress, evolving continuously to address human needs (Veenhoven, 2010). Over the years, advancements in technology have facilitated the development of complex social and economic systems that not only fulfill these needs but also enhance overall quality of life (Javaid et al., 2024). Technological innovation has driven rapid global development, reshaping industries, improving communication networks, and revolutionizing transportation systems (Rashid & Kausik, 2024). These innovations have significantly transformed human lifestyles, fostering unparalleled economic growth and societal progress. However, the unprecedented pace of technological advancement has also led to critical challenges, particularly in the management of waste electrical and electronic equipment (WEEE). Manufacturers, motivated by competitive market dynamics, often implement practices such as planned obsolescence, resulting in shortened lifespans of electronic devices (Lanux, 2023). This trend has significantly increased the generation of WEEE (Bressanelli et al., 2020). Improper management of WEEE not only contributes to resource depletion but also introduces hazardous substances into ecosystems, posing significant risks to both environmental and public health (Pekarkova et al., 2021). Addressing these issues requires aligning WEEE management with broader sustainability goals, particularly within the framework of the circular economy (Lundberg Jiménez et al., 2024). By emphasizing practices such as extending product lifecycles, enhancing recycling efficiency, and promoting resource recovery, the circular economy offers a pathway to mitigate the environmental burden of electronic waste (Georgiadis & Besiou, 2010). Despite ongoing efforts to implement these principles in some regions, gaps persist in global recycling infrastructure, consumer participation (Carvalho et al., 2025). Moreover, inconsistencies in global reporting and data availability present challenges for accurately assessing the effectiveness of WEEE management systems. Addressing these issues requires urgent alignment with global sustainability goals, including those agenda for sustainable development (United Nations, 2018). Integrating WEEE management into a circular economy framework, which emphasizes resource recovery, lifecycle extension, and waste minimization, is a crucial step toward achieving these goals (Parajuly et al., 2020). Despite ongoing efforts, gaps remain in global recycling infrastructure, consumer awareness, and policy enforcement, necessitating a data-driven approach to inform decision-making and enhance sustainability outcomes (Sánchez-García et al., 2024). This study aims to provide new projections on e-waste generation and treatment trends for the coming decade, offering updated values that reflect the latest data and developments in the field. By analyzing these projections within the context of sustainability, this research seeks to serve as a foundational reference for further studies in WEEE management research agenda.

## 2. Literature review

The Waste Electrical and Electronic Equipment (WEEE) is one of the most pressing environmental challenges of the modern era. Parajuly & Wenzel (2017) define WEEE as discarded devices no longer intended for reuse, representing a rapidly growing waste stream. Its components often contain substances such as lead, mercury, cadmium, and arsenic, posing severe risks to human health and ecosystems if improperly managed (Zuo et al., 2020). To ensure clarity and consistency, it is important to define the key terms frequently referenced in the context of Waste Electrical and Electronic Equipment (WEEE) management: Recycle WEEE are electronic devices and equipment that have undergone formal processes for the recovery of valuable components and safe disposal of hazardous materials (Ardente et al., 2014). Recycling typically involves collecting, dismantling, sorting, and processing activities carried out in compliance with regulatory standards to minimize environmental and health risks (Chu et al., 2024). Discarded WEEE are electronic devices and equipment no longer in use or intended for reuse that have been disposed of by their owners (Liu et al., 2023). Examples include outdated smartphones, broken appliances, or obsolete computers (Jain et al., 2023). Discarded WEEE becomes part of the waste stream requiring proper management to prevent environmental harm and recover valuable materials (Andersen et al., 2020). Unmanaged WEEE are discarded electronic devices that have not undergone proper recycling processes. This includes devices improperly handled, often resulting in environmental pollution and the loss of recoverable materials (Pekarkova et al., 2021).

Improper management of WEEE exacerbates environmental degradation, releasing pollutants into terrestrial, aquatic, and atmospheric ecosystems and contributing to climate change (Pekarkova et al., 2021). This issue has been identified as a critical challenge for achieving sustainability (Pan et al., 2022). Despite these challenges, WEEE also presents an opportunity as a secondary source of critical materials. WEEE contains precious and strategic metals, such as gold, silver, platinum, and copper, essential for various industries (Marra et al., 2018; Golev & Corder, 2017). The initial records on WEEE generation estimated a global production of 41.8 million tons in 2014, with 84.44% (35.3 million tons) unmanaged (Baldé et al., 2015). These figures underscore the magnitude of the problem and the lack of adequate management mechanisms at the time. Despite limited global awareness of the issue, countries with high WEEE generation rates, such as China and India, began implementing targeted legislation to mitigate its impact and establish stricter control measures, marking a pivotal moment in WEEE management. By 2016, global WEEE generation had risen to 44.7 million tons, with 80.08% (35.8 million tons) unmanaged. While this reflected a marginal improvement of 4% equivalent to an additional 500,000 tons correctly managed progress remained insufficient (Baldé et al., 2017). Subsequent reports documented even more alarming trends. By 2019, WEEE generation had riched to 53.6

million tons annually, an increase of 8.9 million tons over three years (Forti et al., 2020). Despite international efforts, only 17.36% (9.3 million tons) of this waste was recycled, leaving 82.64% (44.3 million tons) unmanaged. The most recent data for 2022 revealed a historic high of 62 million tons of WEEE generated annually (Fig. 2.1). Alarmingly, 76.7% (47.7 million tons) unmanaged, reflecting a setback in treating progress achieved in previous years (Baldé et al., 2024).

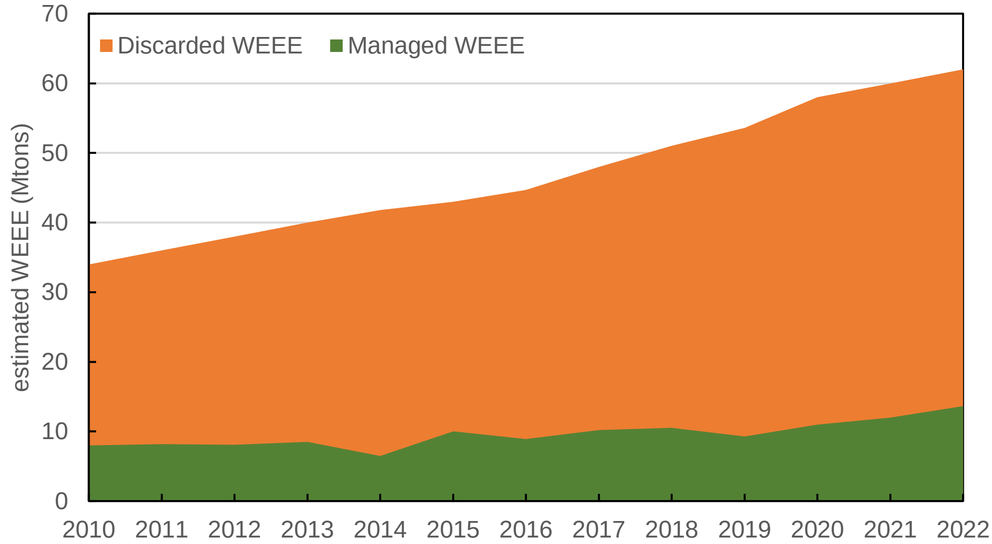


**Figure 2.1** Historical Growth of WEEE (2010–2022)

Own elaboration based on (Baldé et al. 2015; Baldé et al. 2017; Forti et al. 2020; Baldé et al. 2024)

These trends highlight a growing disparity between the increasing demand for electronic devices and the global capacity to manage the resulting waste. This underscores the urgent need for more ambitious and effective measures to address the challenge. Proper WEEE management presents significant economic opportunities by generating value across various sectors (Table 2.1). This dual benefit improves environmental outcomes while fostering economic growth through sustainable recycling practices.

**Table 2.1** Potential Economic and Value Contributions in WEEE Management

| Value creation process | Contributions with references |
|---|---|
| Employability | ▪ WEEE management generates jobs, supporting local economies and social inclusion (Pini et al. 2019; McMahon et al. 2021). |
| Recycling | ▪ Valuable materials like metals and plastics, along with recyclable components of electronic devices, drive economic viability (Mahmoudi et al., 2019).<br>▪ Recovering valuable materials gains economic significance with increased WEEE management (Cucchiella et al., 2015). |
| Reuse | ▪ Functional WEEE offers potential for reuse, reducing waste (Parajuly & Wenzel, 2017).<br>▪ Modular designs and optimize recycling, reuse, and lifespan extension of devices (Regenfelder et al., 2016). |
| Repair | ▪ Advances in repair and recycling methods enhance resource recovery (Deng et al., 2021).<br>▪ Standardized databases optimize global repair efficiency (Peiró et al., 2020). |
| Recommissioning | ▪ Recommissioning functional decommissioned items maximizes value across their lifecycle (Tsanakas et al., 2020) |

The efficient management of waste electrical and electronic equipment not only benefits the environment but also presents significant economic opportunities. It fosters job creation and drives advancements in recycling, reuse, and repair processes, all while adhering to the principles of the circular economy (Pan et al., 2022).

## 3. Research Methods

This study adopts a quantitative approach, leveraging historical data on global Waste Electrical and Electronic Equipment (WEEE) generation from 2010 to 2022. The methodology involved three primary stages: data collection, data processing, and model validation. In the data collection phase, information was gathered from global WEEE reports and credible secondary sources to ensure a comprehensive dataset for analysis. During the data processing stage, linear regression models were applied to project WEEE generation trends for the period 2022–2040. Finally, the model validation process involved comparing the projections with estimates from various academic sources to ensure the reliability and accuracy of the results.

### 3.1. Data collection

Table 3.1 provides a summary of the evolution of WEEE management and recycling in the global market. Although not all reports provide annual data, reliable information was compiled from diverse sources.

**Table 3.1** Historical Trends of WEEE (2010–2022, in Million Tons)

| Year | EE Place in Market | Discarded WEEE | Unmanaged WEEE | Recycled WEEE | Recycled WEEE | Unmanaged WEEE |
|---|---|---|---|---|---|---|
| 2010 | 62 | 34 | 26 | 8 | 23.53% | 76.47% |
| 2011 | 63 | 36 | 27.8 | 8.2 | 22.78% | 77.22% |
| 2012 | 64 | 38 | 29.9 | 8.1 | 21.32% | 78.68% |
| 2013 | 66 | 40 | 31.5 | 8.5 | 21.25% | 78.75% |
| 2014 | 68 | 41.8 | 35.3 | 6.5 | 15.55% | 84.45% |
| 2015 | 70 | 43 | 33 | 10 | 23.26% | 76.74% |
| 2016 | 82 | 44.7 | 35.8 | 8.9 | 19.91% | 80.09% |
| 2017 | 85 | 48 | 37.8 | 10.2 | 21.25% | 78.75% |
| 2018 | 89 | 51 | 40.5 | 10.5 | 20.59% | 79.41% |
| 2019 | 82 | 53.6 | 44.3 | 9.3 | 17.35% | 82.65% |
| 2020 | 83 | 58 | 47 | 11 | 18.97% | 81.03% |
| 2021 | 86 | 60 | 48 | 12 | 20.00% | 80.00% |
| 2022 | 96 | 62 | 48.36 | 13.64 | 22.00% | 78.00% |

Own elaboration based on (Baldé et al. 2015; Baldé et al. 2017; Forti et al. 2020; Baldé et al. 2024)

### 3.2. Data processing

The primary goal of the analysis was to examine and predict trends in Waste Electrical and Electronic Equipment (WEEE) management over time. To achieve this, a linear regression model was selected due to its ability to establish clear relationships between dependent variables, such as treated WEEE, and independent variables like electronic device consumption and recycle capacity growth (Montgomery et al., 2012). Linear regression is particularly suitable for this scenario because it provides an optimistic outlook based on existing trends. Allows for projecting these trends in a straightforward manner, assuming consistent progress. This method assumes that the historical patterns observed in the data will continue, making it an ideal choice for forecasting future WEEE management, defined as $Y = a + bX$ … (1).

Predicted value of the dependent variable ($Y$). Independent variable ($X$), $a$ is the Y-intercept. And $b$ slope of the regression line. The coefficients $a$ (1) and $b$ (2) were determined using the following formulas: $b = \frac{N\sum XY - \sum X \sum Y}{N\sum X^2 - (\sum X)^2}$ ... (2), $a = \frac{\sum Y - b\sum X}{N}$ ... (3).

The regression model was applied to various parameters of WEEE management, yielding the equations and determination coefficients ($R^2$) summarized in Table 3.2. The $R^2$ value represents the proportion of variance in the dependent variable explained by the model. A value closer to 1 indicates a better fit, suggesting that the model reliably predicts future trends (Gao, 2024).

**Table 3.2** Regression Models and Coefficients of Determination for WEEE

| Parameter | Equation | $R^2$ |
|---|---|---|
| **EE Place in Market** | y = 2.7473x - 5461.8 | 0.8721 |
| **Discarded WEEE** | y = 2.3747x - 4740.5 | 0.9833 |
| **Recycled WEEE** | y = 0.4123x - 821.61 | 0.7106 |

Among the models, the discarded WEEE model shows the highest $R^2$ value (0.9833), indicating the strongest fit and highest reliability in predicting discarded waste trends. The recycled WEEE model, while having a lower $R^2$ value (0.7106), still provides a reasonable estimate of the expected treatment capacity in future years. By using this approach, we can gain insights into the long-term patterns of WEEE generation and treatment. The strong fit of the discarded WEEE model suggests that, assuming consistent improvements in treatment and recycling capabilities, the model can reliably forecast the future trajectory of WEEE management. This provides a framework for understanding the trends and support the development of effective, data-driven management strategies to address this growing challenge.

### 3.3. Model validation

To validate the accuracy and reliability of the linear regression model, projections from this study were compared with predictions from other studies. The results of this comparison are presented in Table 3.3, highlighting the consistency and any discrepancies between the model's projections and those reported by external authors.

**Table 3.3** Comparative Projections of WEEE by Various Authors

| Year | Model prediction | Other authors projections |
|---|---|---|
| 2025 | 68.2 Mt | 65.3 Mt (Shittu et al., 2021) |
| 2027 | 73.02 Mt | 69.2 Mt (Forti et al., 2020) |
| 2030 | 80.14 Mt | 82 Mt (Baldé et al., 2024) |

The observed differences between the projections are primarily the result of variations in data sources, methodologies, and the inclusion of updated information. Variations in underlying data, such as differences in the base years used for analysis or regional adjustments, can lead to minor discrepancies. Some studies may rely on data from regions with higher WEEE generation rates or apply alternative methodologies for estimating waste production. This study incorporates more recent data and trends, including the latest figures on global WEEE generation. Additionally, the choice of modeling techniques can influence projections. While this study employed linear regression to estimate steady, linear growth trends, other studies may have used alternative models, such as exponential growth or scenario-based forecasts, leading to differences in results. Despite these discrepancies, the projections from this study align closely with those reported in external sources. This consistency reinforces the reliability of the model and supports its use as a valuable tool for understanding WEEE trends. Furthermore, the updated data and methodology enhance the precision of the projections, highlighting the growing need for effective and sustainable WEEE management strategies in response to the increasing volumes of electronic waste.

## 4. Results and Discussion

The analysis reveals critical trends in Waste Electrical and Electronic Equipment (WEEE) management, highlighting the application of regression models to evaluate and project future scenarios. For WEEE placed in the market, the regression equation $y = 2.7473x - 5461$, with a coefficient of determination ($R^2$) of 0.8721, explains 87.21% of the variability. This indicates a strong model fit and suggests that WEEE placed in the market increases by an average of 2.7473 million tons annually. Similarly, the model for discarded WEEE is defined by the equation $y = 2.3747x - 4740.5$, with a $R^2$ value of 0.9833, explaining 98.33% of the variability. This model is the most accurate, projecting an annual growth of 2.3747 million tons of discarded WEEE. For recycled WEEE, the equation $y = 0.4123x - 821.61$ has a moderate $R^2$ value of 0.7106, indicating 71.06% of the variability is explained. Recycled WEEE shows a slower annual capability growth of 0.4123 million tons, reflecting significant gaps compared to the amount of discarded WEEE. Projections from 2022 to 2040 provide further insight into these trends, emphasizing the widening disparity between discarded and recycled WEEE. For example, by 2032, projections indicate that approximately 120 million tons of new electrical and electronic equipment will enter the market annually, while 84.8 million tons of WEEE will be discarded. Alarmingly, only 16.8 million tons of the discarded WEEE are projected to receive adequate treatment (Fig.4.1).

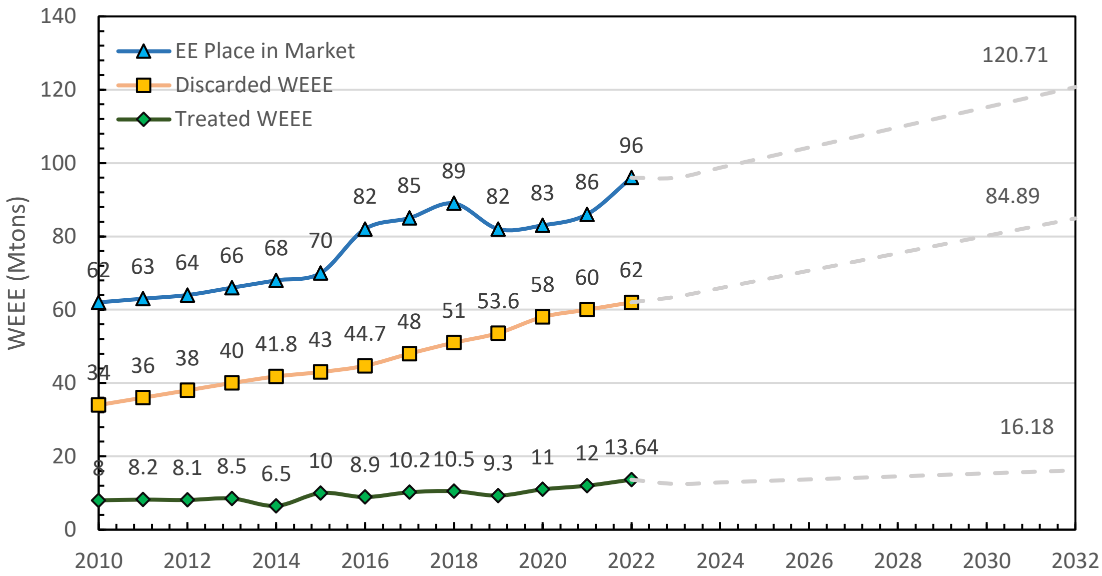


**Figure 4.1** Projected Trends in WEEE Management (2022–2032)

Detailed projections for the years 2022 to 2040, as summarized in Table 4.1, illustrate a consistent increase in EEE placed in the market, discarded WEEE, and treated WEEE. For instance, EE placed in the market is expected to rise from 96 million tons in 2022 to 142.69 million tons in 2040. During the same period, discarded WEEE is projected to grow from 62 million tons to 103.89 million tons, while treated WEEE increases only marginally from 13.64 million tons to 19.48 million tons.

**Table 4.1** Projected Trends in WEEE Management (2022–2040, in Million Tons)

| Year | EE place in market | Discarded WEEE | Recycled WEEE |
|---|---|---|---|
| 2022 | 96.00 | 62.00 | 13.64 |
| 2023 | 95.99 | 63.52 | 12.47 |
| 2024 | 98.74 | 65.89 | 12.89 |
| 2025 | 101.48 | 68.27 | 13.30 |
| 2026 | 104.23 | 70.64 | 13.71 |
| 2027 | 106.98 | 73.02 | 14.12 |
| 2028 | 109.72 | 75.39 | 14.53 |
| 2029 | 112.47 | 77.77 | 14.95 |
| 2030 | 115.22 | 80.14 | 15.36 |
| 2031 | 117.97 | 82.52 | 15.77 |
| 2032 | 120.71 | 84.89 | 16.18 |
| 2033 | 123.46 | 87.27 | 16.60 |
| 2034 | 126.21 | 89.64 | 17.01 |
| 2035 | 128.96 | 92.01 | 17.42 |
| 2036 | 131.70 | 94.39 | 17.83 |
| 2037 | 134.45 | 96.76 | 18.25 |
| 2038 | 137.20 | 99.14 | 18.66 |
| 2039 | 139.94 | 101.51 | 19.07 |
| 2040 | 142.69 | 103.89 | 19.48 |

This growing disparity between discarded and recycled WEEE highlights critical environmental and policy challenges. Despite the optimistic growth trends demonstrated by the linear regression models, the slow improvement in treatment rates raises concerns about the sustainability of current practices. Addressing these issues will require a multifaceted approach, including policy reforms, technological innovation, and expanded recycling capacities. The results emphasize the importance of proactive measures to bridge the gap between discarded and recycled WEEE. Without significant intervention, the environmental risks associated with unmanaged e-waste will continue to escalate.

## 5. Conclusion

This study underscores the critical importance of addressing the growing challenges associated with Waste Electrical and Electronic Equipment (WEEE) management. By employing linear regression models, we identified key trends in WEEE generation and treatment, offering a quantitative basis for projecting future scenarios. The findings reveal a consistent increase in the placement of new electronic equipment in the market, paralleled by a substantial rise in discarded WEEE. However, the comparatively slower growth in recycled WEEE highlights a significant gap in current management practices. The high determination coefficients of the regression models validate their reliability, particularly for projecting discarded WEEE, which achieved an exceptional 98.33% variability explanation. These projections indicate that by 2040, discarded WEEE will exceed 100 million tons annually, with treatment rates failing to keep pace. This disparity emphasizes the urgent need for targeted interventions, advancements in recycling technologies, and the expansion of treatment capacities. The results presented in this research contribute to the growing body of knowledge on WEEE management and highlight the pressing need for sustainable solutions. By bridging the gap between projections and actionable strategies, stakeholders can foster a more efficient and environmentally responsible approach to e-waste management, ensuring a balanced interplay between economic growth and environmental preservation.

## 5.1 Applications

The projections and models developed in this study serve as an initial step for future research in the field of Waste Electrical and Electronic Equipment (WEEE) management. Given that current projections have reached their limits due to outdated data, this work paves the way for new investigations that will build on these initial findings. By reassessing and updating key parameters, future research can refine these models to incorporate new variables, such as technological advancements in recycling methods and changing consumption patterns. This study sets the stage for continuous exploration and adaptation, ensuring that future research will continue to address the challenges of WEEE management in a rapidly changing world.

## 5.2 Limitations and Future Research Directions

This study has certain limitations. Firstly, the models assume linear growth patterns, which may oversimplify the complexities of WEEE dynamics, especially in the context of emerging recycling technologies and policies. Further research is needed to enhance the accuracy and robustness of the models. This could involve incorporating non-linear models or machine learning algorithms to better capture complex patterns and trends. Additionally, more granular data from diverse geographical regions and a broader range of electronic devices would contribute to refining the projections and improving their global applicability. Future studies should also explore the socio-economic factors that influence WEEE generation and disposal behaviors, as well as the technological advancements in recycling processes that may impact future treatment rates.
Furthermore, while this study focuses on the quantitative aspects of WEEE management, future research could investigate the qualitative factors, such as the effectiveness of public awareness campaigns, the role of policy incentives, and the societal impact of electronic waste. Finally, as the environmental impact of WEEE continues to grow, it is crucial to investigate the potential long-term ecological consequences of current waste management practices and explore innovative solutions for circular economy models in the electronics sector.

## References

Andersen, T., Jæger, B., & Mishra, A. (2020). Circularity in waste electrical and electronic equipment (WEEE) directive. Comparison of a manufacturer’s Danish and Norwegian operations. *Sustainability (Switzerland)*, *12*(13). https://doi.org/10.3390/su12135236

Ardente, F., Mathieux, F., & Recchioni, M. (2014). Recycling of electronic displays: Analysis of pre-processing and potential ecodesign improvements. *Resources, Conservation and Recycling*, *92*, 158–171. https://doi.org/10.1016/j.resconrec.2014.09.005

Baldé, C. P., Forti, V., Gray, V., Kuehr, R., & Stegmann, P. (2017). *The Global E-waste Monitor – 2017*. United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Vienna. https://ewastemonitor.info/wp-content/uploads/2020/11/Global-E-waste-Monitor-2017-electronic-spreads.pdf

Baldé, C. P., Kuehr, R., Yamamoto, T., McDonald, R., Althaf, S., Bel, G., Deubzer, O., Fernandez-Cubillo, E., Forti, V., Gray, V., Herat, S., Honda, S., Iattoni, G., Khetriwal, D. S., & Luda di Cortemiglia, V. (2024). *Global E-waste Monitor 2024.* International Telecom- munication Union (ITU) and United Nations Institute for Training and Research (UNITAR). https://ewastemonitor.info/wp-content/uploads/2024/03/GEM_2024_18-03_web_page_per_page_web.pdf

Baldé, C.P, Wang, F., Kuehr, R., & Huisman, J. (2015). *The global e-waste monitor – 2014*. United Nations University, IAS – SCYCLE. https://i.unu.edu/media/ias.unu.edu-en/news/7916/Global-E-waste-Monitor-2014-small.pdf

Bressanelli, G., Saccani, N., Pigosso, D. C. A., & Perona, M. (2020). Circular Economy in the WEEE industry: a systematic literature review and a research agenda. In *Sustainable Production and Consumption* (Vol. 23, pp. 174–188). Elsevier B.V. https://doi.org/10.1016/j.spc.2020.05.007

Carvalho, M. C. N. de, Souza, A. P. S. de, Oliveira Neto, J. F. de, Mendonça Silva, M., Florencio, L., & Machado Santos, S. (2025). Management and recovery of critical and strategic raw materials from E-Waste: A case study in Brazil with a focus on printed circuit boards. *Journal of Hazardous Materials Advances*, *17*. https://doi.org/10.1016/j.hazadv.2024.100544

Chu, T., Zhang, J., Zhong, Y., Jia, W., & Zhang, B. (2024). An approach to formalization of WEEE informal collectors: Collection model under a membership-based community. *Heliyon*, e38992. https://doi.org/10.1016/j.heliyon.2024.e38992

Cucchiella, F., D'Adamo, I., Lenny Koh, S. C., & Rosa, P. (2015). Recycling of WEEEs: An economic assessment of present and future e-waste streams. In *Renewable and Sustainable Energy Reviews* (Vol. 51, pp. 263–272). Elsevier Ltd. https://doi.org/10.1016/j.rser.2015.06.010

Deng, R., Chang, N., Lunardi, M. M., Dias, P., Bilbao, J., Ji, J., & Chong, C. M. (2021). Remanufacturing end-of-life silicon photovoltaics: Feasibility and viability analysis. *Progress in Photovoltaics: Research and Applications*, *29*(7), 760–774. https://doi.org/10.1002/pip.3376

Forti, V., Baldé, C. P., Kuehr, R., & Bel, G. (2020). *The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential*. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA). https://ewastemonitor.info/wp-content/uploads/2020/11/GEM_2020_def_july1_low.pdf

Gao, J. (2024). R-Squared (R 2 ) – How much variation is explained? . *Research Methods in Medicine & Health Sciences*, *5*(4), 104–109. https://doi.org/10.1177/26320843231186398

Georgiadis, P., & Besiou, M. (2010). Environmental and economical sustainability of WEEE closed-loop supply chains with recycling: A system dynamics analysis. *International Journal of Advanced Manufacturing Technology*, *47*(5–8), 475–493. https://doi.org/10.1007/s00170-009-2362-7

Golev, A., & Corder, G. D. (2017). Quantifying metal values in e-waste in Australia: The value chain perspective. *Minerals Engineering*, *107*, 81–87. https://doi.org/10.1016/j.mineng.2016.10.021

Jain, M., Kumar, D., Chaudhary, J., Kumar, S., Sharma, S., & Singh Verma, A. (2023). Review on E-waste management and its impact on the environment and society. *Waste Management Bulletin*, *1*(3), 34–44. https://doi.org/10.1016/j.wmb.2023.06.004

Javaid, M., Haleem, A., Singh, R. P., & Sinha, A. K. (2024). Digital economy to improve the culture of industry 4.0: A study on features, implementation and challenges. *Green Technologies and Sustainability*, *2*(2), 100083. https://doi.org/10.1016/j.grets.2024.100083

Lanux, T. (2023). La lucha contra la obsolescencia programada, entre protección y responsabilidad de los consumidores. *Bioderecho.Es*, *16*. https://doi.org/10.6018/bioderecho.545321

Liu, K., Tan, Q., Yu, J., & Wang, M. (2023). A global perspective on e-waste recycling. In *Circular Economy* (Vol. 2, Issue 1). Elsevier B.V. https://doi.org/10.1016/j.cec.2023.100028

Lundberg Jiménez, B. A., Cortés Robles, G., Castillo Intriago, V. R., Roldán Reyes, E., & Sánchez Cervantes, J. L. (2024). Selección de funciones relevantes en la gestión de residuos de aparatos eléctricos y electrónicos (RAEE) basado en el Proceso de Análisis Jerárquico. *LATAM Revista Latinoamericana de Ciencias Sociales y Humanidades*, *5*(6). https://doi.org/10.56712/latam.v5i6.3209

Mahmoudi, S., Huda, N., & Behnia, M. (2019). Photovoltaic waste assessment: Forecasting and screening of emerging waste in Australia. *Resources, Conservation and Recycling*, *146*, 192–205. https://doi.org/10.1016/j.resconrec.2019.03.039

Marra, A., Cesaro, A., Rene, E. R., Belgiorno, V., & Lens, P. N. L. (2018). Bioleaching of metals from WEEE shredding dust. *Journal of Environmental Management*, *210*, 180–190. https://doi.org/10.1016/j.jenvman.2017.12.066

McMahon, K., Ryan-Fogarty, Y., & Fitzpatrick, C. (2021). Estimating job creation potential of compliant WEEE pre-treatment in Ireland. *Resources, Conservation and Recycling*, *166*. https://doi.org/10.1016/j.resconrec.2020.105230

Montgomery, D. C., Peck, E. A., & Vining, G. G. (2012). *Introduction to Linear Regression Analysis* (5th ed.). Wiley-Blackwell. https://www.kwcsangli.in/uploads/3--Introduction_to_Linear_Regression_Analysis__5th_ed._Douglas_C._Montgomery__Elizabeth_A._Peck__and_G._.pdf

Parajuly, K., Fitzpatrick, C., Muldoon, O., & Kuehr, R. (2020). Behavioral change for the circular economy: A review with focus on electronic waste management in the EU. In *Resources, Conservation and Recycling: X* (Vol. 6). Elsevier B.V. https://doi.org/10.1016/j.rcrx.2020.100035

Parajuly, K., & Wenzel, H. (2017). Potential for circular economy in household WEEE management. *Journal of Cleaner Production*, *151*, 272–285. https://doi.org/10.1016/j.jclepro.2017.03.045

Pekarkova, Z., Williams, I. D., Emery, L., & Bone, R. (2021). Economic and climate impacts from the incorrect disposal of WEEE. *Resources, Conservation and Recycling*, *168*. https://doi.org/10.1016/j.resconrec.2021.105470

Pini, M., Lolli, F., Balugani, E., Gamberini, R., Neri, P., Rimini, B., & Ferrari, A. M. (2019). Preparation for reuse activity of waste electrical and electronic equipment: Environmental performance, cost externality and job creation. *Journal of Cleaner Production*, *222*, 77–89. https://doi.org/10.1016/j.jclepro.2019.03.004

Rashid, A. Bin, & Kausik, M. A. K. (2024). AI revolutionizing industries worldwide: A comprehensive overview of its diverse applications. *Hybrid Advances*, *7*, 100277. https://doi.org/10.1016/j.hybadv.2024.100277

Regenfelder, M., Slowak, A. P., & Santacreu, A. (2016). Closed-loop innovation for mobile electronics - the business model innovation approach of the sustainablySMART project. *2016 Electronics Goes Green 2016+ (EGG)*, 1–6. https://doi.org/10.1109/EGG.2016.7829847

Sánchez-García, E., Martínez-Falcó, J., Marco-Lajara, B., & Manresa-Marhuenda, E. (2024). Revolutionizing the circular economy through new technologies: A new era of sustainable progress. *Environmental Technology and Innovation*, *33*. https://doi.org/10.1016/j.eti.2023.103509

Tsanakas, J. A., van der Heide, A., Radavičius, T., Denafas, J., Lemaire, E., Wang, K., Poortmans, J., & Voroshazi, E. (2020). Towards a circular supply chain for PV modules: Review of today's challenges in PV recycling, refurbishment and re-certification. In *Progress in Photovoltaics: Research and Applications* (Vol. 28, Issue 6, pp. 454–464). John Wiley and Sons Ltd. https://doi.org/10.1002/pip.3193

United Nations. (2018). *The 2030 Agenda and the Sustainable Development Goals An opportunity for Latin America and the Caribbean Goals, Targets and Global Indicators* (LC/G.2681-P/Rev.3, Ed.).

Veenhoven, R. (2010). Life is getting better: Societal evolution and fit with human nature. *Social Indicators Research*, *97*(1), 105–122. https://doi.org/10.1007/s11205-009-9556-0

Zuo, L., Wang, C., & Sun, Q. (2020). Sustaining WEEE collection business in China: The case of online to offline (O2O) development strategies. *Waste Management*, *101*, 222–230. https://doi.org/10.1016/j.wasman.2019.10.008

**Published by**

IJSAB International