

Electronic Waste Valuation Analysis Supports A Circular Economy In Dki Jakarta

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Abstract

This study aims to assess the valuation of electronic waste in DKI Jakarta using the Total Economic Value (TEV) approach to support circular economy implementation. The analysis compares direct value, indirect value, and standardized prices, while also evaluating the relevance of the TEV approach for economic decision-making among electronic waste management actors, particularly collectors. The study employed a cross-sectional mixed-methods design with data collected through field observations, transaction price records, document analysis, and questionnaires involving informal e-waste collectors. Descriptive statistical analysis using mean values and standard deviation was combined with TEV calculations to estimate the comprehensive economic value of electronic waste. The results indicate that collectors demonstrate high environmental awareness (mean = 3.92) and strong recognition of the social benefits of e-waste management (mean = 4.24). Knowledge of standardized e-waste prices is also relatively high (mean = 4.06). However, economic motivations remain dominant, as reflected by the moderate agreement that monetary value is more important than environmental impact (mean = 3.64). Perceptions regarding the usefulness of the TEV approach in determining purchase prices are relatively strong (mean = 3.90). Profitability perceptions vary across device categories, with used mobile phones (mean = 3.02) and large household appliances (mean = 3.04) considered more profitable than computers or laptops (mean = 2.18) and electronic cables (mean = 1.60). Overall, the findings demonstrate that the TEV-based valuation exceeds standardized market prices by incorporating environmental and social benefits that are not captured by conventional pricing mechanisms.

Keywords: *Electronic Waste, Valuation Analysis, Total Economic Value, Circular Economy, DKI Jakarta.*

INTRODUCTION

The development of information and communication technology has brought about a major transformation in modern society. One significant impact of this phenomenon is the increasing consumption of electrical and electronic devices, from mobile phones and computers to televisions and household appliances. On the one hand, this development provides benefits in improving productivity, efficiency, and people's quality of life. However, on the other hand, the acceleration of technological innovation also shortens the life cycle of electronic products. Devices that previously lasted for years are now replaced more quickly due to new technological trends, software updates, and changes in consumer lifestyles. This phenomenon has implications for increasing the amount of electronic waste (e-waste) globally and nationally.

According to the Global E-waste Monitor 2024 report, the world generated 62 million tons of e-waste in 2022, and this figure is projected to increase to 82 million tons by 2030 (Amin et al., 2022). Ironically, only 22.3% of this amount is collected and recycled through official channels. The remainder is largely disposed of in landfills, incinerated, or enters informal channels that do not meet environmental standards. In fact, e-waste contains precious metals such as gold, silver, copper, nickel, and palladium, which have high economic value. (Tundjungsari et al., 2025) noted that the value of materials lost due to improperly managed e-waste reaches over US\$62 billion per year. Thus, e-waste is not only an environmental issue but also involves significant lost economic potential.

At the national level, Indonesia is among countries with rapid e-waste growth. The Ministry of Environment and Forestry (KLHK) estimated e-waste generation at around 2 million tons in 2021, projected to rise to 4.4 million tons annually by 2030, equivalent to 12,187 tons per day. This growth poses major management challenges, as e-waste processing in Indonesia

remains largely informal, constrained by limited infrastructure, low public awareness, and weak implementation of extended producer responsibility (EPR) (Ratnasari & Aschemann, 2024).

From an environmental perspective, e-waste contains hazardous substances such as mercury, lead, cadmium, and hexavalent chromium that can contaminate soil, water, and air if improperly managed, causing ecosystem degradation and serious health risks (Otivriyanti et al., 2023). Consequently, poor e-waste management results in both economic value loss and increased environmental and health burdens.

DKI Jakarta was selected as the study location for several strategic reasons. As Indonesia's economic center contributing approximately 16–17% of national GDP, Jakarta exhibits very high electronic consumption. In 2023, 98.6% of households owned mobile phones, and with a population of 10.67 million, the city generates substantial e-waste potential. Jakarta also produces 7,500–8,600 tons of waste daily, or 3.11 million tons annually, where e-waste though smaller in volume has significantly higher economic value per unit mass (Soesanto et al., 2023).

Furthermore, the Jakarta Provincial Government has introduced e-waste drop boxes and collection services to support formal management systems. Jakarta is also highly relevant to Indonesia's circular economy agenda, which prioritizes waste management under the 2025–2045 Circular Economy Roadmap. Studies highlight that circular e-waste management can enhance resource efficiency, create jobs, and reduce environmental impacts (P. H. Sari & Zahra, 2025).

Despite these efforts, valuation studies on e-waste in Indonesia remain limited, as most research focuses on technical or behavioral aspects (D. P. Sari et al., 2024). Valuation analysis is crucial to assess recoverable material value, cost–benefit structures, and effective policy options (Habiburrahman et al., 2025), while also capturing avoided environmental impacts through material recovery and reduced resource extraction. Based on the description above, several knowledge gaps remain that need to be addressed through this research. First, direct value, which refers to benefits that can be utilized directly and possess explicit market prices, making them relatively easy to quantify in economic terms. Second, indirect value, which represents benefits that are not directly consumed but play a crucial role in maintaining environmental and ecosystem functions. Third, Total Economic Value (TEV), which provides a comprehensive framework for estimating the full economic value of environmental resources by incorporating both market-based benefits and non-market or intangible benefits.

Therefore, this study aims to contribute to addressing the growing problem of electronic waste while supporting the implementation of a circular economy in Jakarta. By examining the economic valuation potential of e-waste, this research seeks to identify more sustainable management approaches that can generate positive environmental, economic, and social impacts for urban communities. The findings of this study are expected to serve as an evidence-based foundation for the development of circular economy–oriented e-waste management policies in Jakarta, which may also be adapted and implemented in other major cities across Indonesia.

RESEARCH METHODS

Research Design

This study employed a mixed-methods approach with an explanatory design. The quantitative phase, consisting of surveys and Total Economic Value (TEV) calculations, was complemented by qualitative methods, including observations and interviews, to explain empirical findings and pricing constraints encountered in the field (Sugiyono, 2022). Data collection was conducted using a cross-sectional design.

Research Location and Period

The research was conducted in DKI Jakarta, focusing on locations directly involved in the collection, trading, and management of electronic waste (e-waste). The selection of DKI Jakarta aligns with the study's objective to analyze e-waste valuation in supporting circular economy implementation using the TEV approach. Research sites included: (1) e-waste collection points such as waste banks, e-waste drop boxes, and government- or privately managed collection facilities; (2) e-waste market actors, particularly collectors and scrap traders; and (3) formal e-waste treatment facilities operating in Jakarta or its surrounding areas connected to Jakarta's e-waste flow. These locations enabled the collection of empirical data on direct value (market transaction prices), indirect value (environmental benefits such as reduced landfill burden and pollution), and the relevance of TEV for economic decision-making. The study was conducted in 2024 using cross-sectional data to reflect current e-waste management conditions.

Population and Data Collection Techniques

The study population included upstream actors (collectors and waste banks), market actors (scrap traders, refurbishers, and formal processing facilities), and electronic devices across 12 predefined categories. Data were collected through structured field observations, questionnaires, and desk research. Observation instruments captured direct value through transaction prices and indirect value through environmental benefits using an avoided-cost approach. Questionnaires assessed stakeholders' perceptions of TEV relevance. Secondary data were obtained from SILIKA DKI, BPS, government guidelines, academic studies, and commodity price references.

RESULTS AND DISCUSSION

Validity & Reliability Test

As a first step, researchers will conduct validity and reliability tests to determine the feasibility of the questionnaire used. The validity test is based on a comparison of the calculated r -value $>$ r -table, where the results of the calculated r -value are obtained from the test results using the SPSS version 31 application and the r -table is known through the r coefficient table by looking at the df value ($n-2 = 50-2 = 48$) and a significance value of 5% (0.05). It was found that the r -table value was 0.279, meaning that the calculated t -value must be more than 0.279 to be declared valid, while the following are the results of the validity test using the SPSS application.

Table 1. Validity Test Results

Statement	r-count	r-table	Information
P1	0.696	0.279	Valid
P2	0.396	0.279	Valid
P3	0.640	0.279	Valid
P4	0.460	0.279	Valid
P5	0.374	0.279	Valid
P6	0.440	0.279	Valid
P7	0.325	0.279	Valid
P8	0.311	0.279	Valid
P9	0.483	0.279	Valid
P10	0.511	0.279	Valid
P11	0.522	0.279	Valid
P12	0.325	0.279	Valid
P13	0.323	0.279	Valid

Source: Researcher Data Processing, 2025

The table above shows that all 13 statements in the questionnaire are valid. This is because the calculated t-value is greater than the t-table. Therefore, these 13 valid statements can be used further in this study.

Table 2. Reliability Test Results

Reliability Statistics	
Cronbach's Alpha	N of Items
.862	13

Source: SPSS 31 Output, 2025

The table shows a Cronbach's Alpha value of 0.862. This indicates that the reliability of the 13 statements is considered good, as it falls within the range of 0.800-0.890. The validity and reliability test results are positive, indicating that the 13 statements can be explained in this study regarding respondents' perceptions, environmental awareness, and economic valuation of e-waste.

Descriptive Analysis of Environmental and Economic Values

This descriptive analysis aims to map the level of ecological awareness and economic orientation of informal sector actors (collectors) in electronic waste management in DKI Jakarta. It examines the interaction between respondents' knowledge of the environmental risks of hazardous electronic waste and the economic motivations underlying their collection activities. Questionnaire data provide insights into how collectors perceive the material value of different electronic device categories and their willingness to support environmentally sound recycling practices. By capturing these perceptions, the analysis goes beyond market transaction values to include qualitative aspects such as social responsibility and sustainability literacy among informal actors. The findings serve as a foundation for explaining variations in economic value across device types and how respondents' attitudes shape the overall economic value structure within Jakarta's e-waste ecosystem.

Table 3. Results of Descriptive Statistical Tests of a Survey of E-waste Collectors in DKI Jakarta in 2024

Statement / Question	Mean	Minimum	Maximum	Std. Dev
I know that electronic waste can harm the environment if it is not properly managed.	3.92	2	5	1.214
I believe that electronic waste management can provide social benefits (e.g., job creation, public health).	4.24	4	5	0.427
In my opinion, the environmental and social value of electronic waste is more important than its monetary value.	3.90	3	5	0.700
I know that there are standard prices for different types of electronic waste.	4.06	1	5	0.732
I feel that the direct monetary value from selling e-waste is more important than its environmental or social impact.	3.64	2	5	0.889
I am willing to accept a lower price if e-waste is managed in an environmentally friendly manner.	3.06	2	5	0.835
I have heard of the "Total Economic Value" (TEV) approach in valuing electronic waste.	3.34	2	4	0.790
In my opinion, the TEV approach can help me determine the purchase price of electronic waste.	3.90	3	5	0.458
How do you assess the profitability of selling used/damaged mobile phones?	3.02	2	4	0.836
How do you assess the profitability of selling used/damaged computers or laptops?	2.18	2	4	0.433
How do you assess the profitability of selling cables and electronic components?	1.60	1	4	0.632

How do you assess the profitability of selling washing machines, refrigerators, and large household electronic appliances?	3.04	2	5	1.038
How do you assess the profitability of selling used batteries and accumulators?	2.66	2	4	0.863

Based on the table, respondents demonstrate a high level of awareness regarding the environmental risks of electronic waste, with a mean score of 3.92. However, the wide range of responses (minimum 2, maximum 5) and the highest standard deviation (1.214) indicate substantial variation in ecological understanding among collectors. This finding highlights uneven ecological literacy within the informal sector. Perceptions of the social benefits of e-waste management are very strong and consistent, reflected in a high mean of 4.24 and a low standard deviation (0.427), indicating broad agreement that e-waste activities contribute to employment and public health.

Respondents also show a relatively balanced orientation between environmental and economic values, with a mean score of 3.90 and a stable distribution, suggesting that sustainability considerations are increasingly acknowledged alongside profit motives. Knowledge of standard market prices for e-waste is relatively high (mean 4.06), indicating adequate price literacy within the informal market, despite some variation among individuals.

In contrast, attitudes prioritizing monetary value over environmental impact reveal moderate agreement (mean 3.64) and noticeable variability, reflecting ongoing tension between economic necessity and environmental awareness. Willingness to accept lower prices for environmentally friendly management is neutral to moderate (mean 3.06), suggesting that financial incentives remain important to encourage sustainable practices.

Finally, familiarity with the Total Economic Value (TEV) concept is moderate (mean 3.34) with no respondents indicating high expertise, underscoring limited dissemination of environmental valuation concepts among informal e-waste actors and the need for further capacity building and outreach.

The findings indicate that respondents strongly perceive the Total Economic Value (TEV) approach as helpful in determining purchase prices, reflected by a relatively high mean score of 3.90 and low variability. This consensus suggests broad confidence in TEV as a fair pricing framework that incorporates extrinsic values of e-waste, providing a solid foundation for future value-based policy implementation.

Profit perceptions vary across e-waste categories. Used mobile phones generate moderate profits (mean 3.02), explaining their high circulation in Jakarta's second-hand market. In contrast, used computers and laptops show lower perceived profitability (mean 2.18), likely due to higher acquisition and repair costs, posing challenges for office equipment recycling. Electronic cables and small components yield the lowest perceived profit (mean 1.60), resulting in weak incentives for proper management and highlighting the need for value-added policies.

Large household appliances such as washing machines and refrigerators show relatively high profit potential (mean 3.04) but with substantial variability, making them key drivers of revenue for large collectors. Batteries and used accumulators present below-average profitability (mean 2.66), despite being highly hazardous waste, underscoring the urgency for subsidies or specialized collection systems (Awasthi et al., 2016).

Overall, the analysis reveals a strong tension between ecological awareness and economic realities among informal e-waste collectors. While social and environmental awareness is emerging, direct economic value remains the primary motivation. The study emphasizes TEV as a critical approach to bridging financial needs and environmental responsibility in Jakarta's e-waste management system (Awasthi et al., 2016).

Discussion**Differences Between Indirect Value and Standardized Pricing in E-Waste Management**

Indirect value emphasizes environmental, ecosystem, and social benefits generated by e-waste management, such as reduced landfill pressure, job creation, and public health improvements (Kothari et al., 2010). However, standardized prices set by markets or government regulations in Jakarta remain rigid and focus solely on residual material value, failing to internalize long-term ecological and social benefits. As a result, the real environmental investments made by informal collectors are not reflected in transaction prices.

Although environmental awareness among collectors is relatively high, this does not translate into higher standardized prices, as pricing mechanisms are still driven by fluctuating global metal markets rather than avoided environmental recovery costs (Jambeck et al., 2015). Consequently, indirect values are treated as externalities rather than core price components. This gap confirms that conventional market mechanisms inadequately internalize environmental externalities, reinforcing the marginalization of sustainability considerations in daily transactions (Irma Dwi Puspita Dewi et al., 2023). The findings highlight the need to financially recognize environmental services provided by informal collectors through value-based policy integration.

Differences Between Direct Value and Standardized Pricing in E-Waste Management

Direct value refers to the actual cash income obtained by collectors through the full utilization of electronic devices, including reusable components and recoverable valuable materials. In contrast, standardized pricing often underestimates e-waste value by focusing narrowly on single-material content and rigid recovery assumptions, leading to systematic undervaluation. Informal collectors therefore offer more competitive prices by accounting for total utility and flexible recovery potential (Rimantho et al., 2022).

The study shows that direct value is closely tied to collectors' economic survival and is shaped by negotiation skills, material literacy, and reuse potential, making it more subjective and situational than standardized prices. Items with high direct value, such as household appliances, are prioritized despite similar or lower official prices per kilogram. Statistical results confirm that economic decisions in the informal sector are driven more by perceived immediate benefits than by standardized market references (Cucchiella et al., 2015).

Overall, the dominance of direct value over standardized pricing explains why informal actors continue to outperform formal systems. However, this orientation may discourage environmentally responsible practices when they reduce profit margins. Therefore, aligning direct value with standardized pricing through subsidies or incentives is essential to create a more sustainable and balanced e-waste market in Jakarta.

The Benefits of the Total Economic Value (TEV) Approach in Supporting Economic Decision-Making

The Total Economic Value (TEV) approach is highly relevant as a decision-support framework that enables informal e-waste collectors to understand the full economic value of electronic waste beyond short-term material profits. By integrating direct and indirect values, TEV guides strategic collection decisions, including the prioritization of items with high environmental significance but low market prices, such as batteries and accumulators. This approach encourages a shift from selective profit-driven practices toward more professional and sustainable e-waste management, while also providing a rational basis for advocating government incentives or subsidies by demonstrating measurable public cost savings and environmental benefits.

The integration of direct and indirect values within the TEV framework allows simultaneous assessment of market potential and ecological contributions (Baldé et al., 2020). For informal actors, TEV helps balance profitability with environmental responsibility, reducing reliance on volatile international metal prices and reframing e-waste as a form of environmental investment that supports both ecosystem resilience and economic welfare (Kabul et al., 2024).

As a result, collectors begin to transition from informal traders to key actors within a professional circular economy system.

From a policy perspective, TEV offers a comprehensive framework for recognizing e-waste as a complex economic asset rather than mere waste. By converting abstract environmental impacts into quantifiable economic values, TEV enables fairer pricing mechanisms and more informed policy deliberations. The findings show strong respondent agreement that TEV facilitates fairer purchase price determination and supports sustainable decision-making by internalizing environmental externalities (Kirchherr et al., 2017).

Furthermore, the adoption of TEV legitimizes the role of the informal sector as a significant provider of urban environmental services, including energy savings and emission reductions generated through urban mining activities (Widyarsana et al., 2026). TEV-based decision-making also helps identify priority waste streams requiring immediate policy intervention, particularly components with low market value but high environmental risk. Overall, the study confirms that TEV is not merely an academic construct but a practical and essential tool for transforming e-waste management in Jakarta into a more equitable, professional, and sustainable system.

CONCLUSION

The research, titled "E-Waste Valuation Analysis Supports a Circular Economy in DKI Jakarta," has presented its findings in the previous chapter. The following conclusions can be drawn from this discussion.

1. Disparity Between Indirect Value and Government Standardized Prices

The findings reveal a substantial gap between indirect values encompassing environmental and social benefits and the standardized prices set by the government. The calculated indirect value demonstrates that avoided landfill costs and employment absorption generated by informal e-waste collectors far exceed official sanitation fees or landfill operational costs. Current government pricing mechanisms primarily reflect logistical waste management expenses and fail to internalize the true economic value of environmental preservation and positive social impacts created by informal collectors in Jakarta.

Based on this comparison, the study recommends that collectors shift toward independent processing practices rather than relying solely on low government reference prices. Independent processing enables e-waste to be transformed into circular commodities with measurable social benefits, including fairer wages for local labor. This approach allows collectors to capture environmental benefits that remain unrecognized within formal pricing schemes, thereby improving their overall economic welfare.

2. Disparity Between Direct Value and Government Standardized Prices

The study also identifies a sharp disparity between the direct value obtained from real market transactions and government standardized prices. The direct value earned by collectors reflects the full unit price of e-waste, incorporating valuable materials such as copper and precious metals as well as reusable components. In contrast, government pricing is often based on a narrow assessment of a single material (e.g., iron) with limited recovery efficiency. This undervaluation results in significantly higher economic returns within informal transactions, as collectors utilize the full utility value of electronic waste, while standardized pricing remains constrained to minimal raw material valuation.

3. Relevance of the Total Economic Value (TEV) Approach

The Total Economic Value (TEV) approach proves highly relevant as a primary navigational tool for supporting economic decision-making among e-waste collectors. TEV integrates direct material value with indirect environmental and social benefits, enabling collectors to

prioritize waste types based on total economic contribution rather than short-term metal price fluctuations. This framework supports more sustainable business decisions and highlights the role of collectors in generating public budget savings through environmental services.

To optimize waste processing outcomes, the study recommends adopting TEV as the foundation for developing independent processing units. TEV-based decision-making strengthens collectors' bargaining positions with stakeholders and allows positive externalities such as pollution reduction to be converted into tangible economic value. Ultimately, this approach enhances productivity and improves the welfare of collector communities across Jakarta.

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