

## Promoting Green Computing to The Community as A Strategy for E-Waste Reduction and Cleaner Rivers

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### Abstract

*Electronic waste (e-waste) poses a serious threat to environmental sustainability, particularly to river ecosystems that serve as vital water sources and centers for community activities. However, public awareness regarding the dangers of e-waste and its proper management remains low, specifically in the Pantai Walikota area, Medan Tuntungan. This community service activity aims to socialize the principles of green computing to the local community as a strategic effort to reduce e-waste and maintain river cleanliness. The activity was conducted using a participatory education method, which included interactive lectures, discussions, and the distribution of educational brochures and posters to 10 residents living along the riverbank. The effectiveness of the program was measured through observation and direct feedback. The results showed a significant increase in public understanding; initially, only 25% of participants were familiar with green computing concepts. Post-socialization, 75% of participants gained new knowledge regarding e-waste hazards, and the majority expressed a willingness to adopt wiser device management practices. This study concludes that direct, contextual socialization in riverside areas is an effective strategy for fostering environmental responsibility and contributing to cleaner river ecosystems.*

**Keywords:** Green Computing; Electronic Waste; Public Awareness; River Conservation; Community Engagement.

### I. INTRODUCTION

Rivers and their surrounding aquatic ecosystems serve as the fundamental lifeline for community activities, providing essential clean water, supporting economic livelihoods, and maintaining ecological balance. However, the rapid acceleration of digital transformation in the 21st century has introduced a severe and escalating environmental threat: the exponential growth of electronic waste (e-waste). According to the *Global E-waste Monitor 2024* report, the world generated a record 62 million tonnes of e-waste in 2022, marking an alarming increase of 82% since 2010 (UNITAR, 2024). Tragically, despite this surge, the report indicates that only 22.3% of global e-waste was documented as properly collected and recycled. In the Indonesian context, the situation is equally critical. Approximately 11.3 million tons of national waste remain unmanaged annually, a significant portion of which constitutes hazardous "specific waste," including electronic devices ending up in

illegal landfills or open waterways (Kementerian Lingkungan Hidup dan Kehutanan, 2024).

The accumulation of e-waste in riverine environments poses a catastrophic risk to public health and biodiversity. Unlike organic waste, electronic devices contain a complex mixture of toxic heavy metals such as mercury, lead, and cadmium (Setiawan, 2021). When these devices are submerged in river water, a process known as leaching occurs, where toxic substances dissolve into the water. Unmanaged e-waste in Indonesian waters has led to a significant decline in aquatic biodiversity, disrupting food chains and increasing the bioaccumulation of toxins (Jamal & Erlina, 2024). Furthermore, exposure to these heavy metals is linked to severe health issues, including damage to the nervous system and kidney failure (Tarigan & Kusnopranto, 2024). Therefore, the issue of e-waste in river areas is not merely an aesthetic problem of garbage, but a critical public health emergency.

Despite the severity of these risks, public awareness and behavioral compliance remain critically low. In many developing regions, the lack of proper education leads communities to treat electronic waste as general domestic trash. The primary barrier to effective waste management is the lack of consistent public campaigns and educational activities (Sari et al., 2020). Without accessible knowledge, communities living along riverbanks often view throwing used batteries or broken cables into the river as a convenient solution. However, research demonstrates that community education through direct field socialization can effectively change these behaviors (Suyanto, 2023). This suggests that technical solutions alone are insufficient; a socio-cultural approach is required to transform community mindsets regarding waste disposal.

Current academic discourse on e-waste mitigation has predominantly focused on macro-level policies or industrial technologies. For instance, "Green IT" is often discussed primarily from the perspective of creating eco-friendly technology infrastructure for the future (Gunawan, 2021). Similarly, other studies focus on the role of Green Computing in reducing the carbon footprint of the digital industry (Nurhadi, 2022). While these studies are valuable, they often overlook the grassroots level. Although recent studies have begun to expand the definition of Green Computing to include modern software practices and social responsibility (Orieno et al., 2024), there remains a distinct research gap regarding riverside communities (*masyarakat bantaran sungai*), who are the most direct contributors to river pollution yet have the least access to environmental education.

To address this challenge, this study proposes the adoption of Green Computing principles as a community-based educational strategy. Green Computing is defined as the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems efficiently. This study translates these principles into practical community actions: extending device lifespan, reducing consumption, and responsible disposal. The activity was conducted at Pantai Walikota, Medan Tuntungan District, a strategic location where community settlements directly interface with the river ecosystem. By socializing these principles, this study aims to foster a "Green

Behavior" culture among residents to ensure a cleaner and healthier river environment.

## II. RESEARCH METHODOLOGY

### A. Research Design and Location

This research utilizes a Community-Based Participatory Research (CBPR) approach, focusing on direct engagement with the community to solve environmental issues. The activity was conducted on May 29, 2025, at Pantai Walikota, Medan Tuntungan District, Medan City. This location was strategically selected using a purposive method because it is situated directly along the riverbank, serving as a central hub for community activities and thus highly relevant for e-waste management education.

### B. Participants

The subjects of this study were the local residents living in the immediate vicinity of the river. The study involved 10 participants consisting of both men and women from various age groups. The participant selection focused on residents who interact directly with the river ecosystem daily, as they are the key stakeholders in maintaining river cleanliness.

### C. Materials and Instruments

To support the socialization process, the team developed specific educational materials:

1. Visual Aids: Posters and brochures designed to be visually appealing and easy to understand.
2. Content: The materials contained information regarding the definition of Green Computing, the specific dangers of heavy metals in e-waste (mercury, lead), and practical steps for household e-waste management.
3. Data Collection Instruments: Data was collected using direct observation sheets to record participant engagement and documentation (photos/videos) to validate the activities.

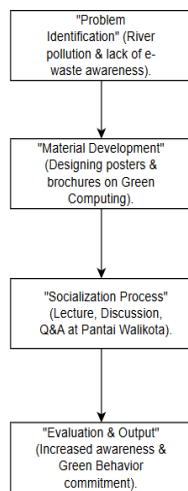
### D. Research Framework

The implementation of this activity followed a systematic framework to ensure effectiveness. The process is divided into three main stages: Preparation, implementation, and evaluation.

The stages depicted in Figure 1 are explained as follows:

1. Preparation Phase: The team conducted a preliminary survey of the river condition and

- compiled materials on Green Computing concepts adapted to the local context.
2. Implementation Phase: The socialization was carried out using an interactive lecture method followed by a Focus Group Discussion (FGD). This allowed participants to share their personal habits regarding electronic disposal.
  3. Evaluation Phase: The final stage involved distributing educational media (brochures) and observing the participants' response and commitment to changing their behavior.



**Figure 1.** Research Activity Framework

#### E. Data Analysis Technique

The data collected in this study were analyzed using a descriptive qualitative approach supported by quantitative frequency distribution. The analysis process was conducted in three phases:

1. Data Reduction: The team focused on selecting and simplifying the raw data obtained from the questionnaires and observation sheets. Irrelevant information was discarded to focus on the core indicators of Green Computing understanding.
2. Data Display: The reduced data were then organized and presented in the form of charts and narrative descriptions. This step was crucial to visualize the gap between the community's initial knowledge and their post-socialization understanding.
3. Conclusion Drawing: Finally, the team drew conclusions based on the patterns observing the changes in participants' behavior. The validity of the data was ensured through triangulation, comparing the questionnaire results with direct

observations during the practical workshop session. This rigorous method ensures that the reported increase in awareness is not merely self-claimed by participants but also evident in their engagement during the activity.

### III. RESULTS AND DISCUSSION

#### A. Implementation and Demographics

The community service activity regarding Green Computing was successfully conducted in the Pantai Walikota area. The participants consisted of 11 local residents (based on questionnaire responses) who live directly adjacent to the river ecosystem. The session began with an observation of the participants' initial knowledge, followed by educational socialization and post-activity evaluation.

#### B. Analysis of Participant Understanding (Pre and Post)

Based on the data collected before the material delivery, the level of public awareness regarding Green Computing was critically low. As shown in Figure 2, only 25% of participants had a vague understanding of the term, while the majority (75%) admitted they had never heard of "Green Computing" before this event. Furthermore, during the discussion session, it was revealed that most residents were unaware that electronic waste (e-waste) contains hazardous materials; they treated broken electronics as common domestic waste.

Pemahaman Peserta terhadap Konsep Green Computing

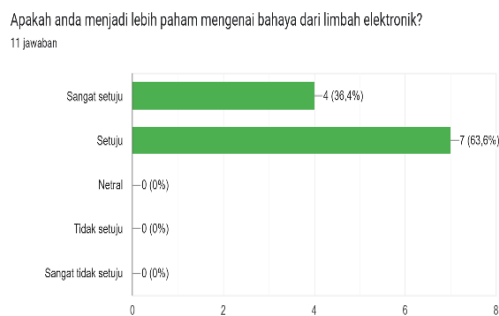


**Figure 2.** Pre-socialization knowledge level regarding Green Computing

Detailed Analysis of Pre-Activity Knowledge Referring back to the initial condition shown in Figure 2, the lack of awareness was quite profound. The 75% of participants who were unfamiliar with

Green Computing stated that they had never received any formal or informal education regarding electronic waste management from local authorities. In the interview sessions, several residents admitted that they often burned used cables and batteries in their backyards—a highly dangerous practice that releases toxic fumes directly into the air. This behavior stems from the misconception that fire "destroys" the waste, whereas, in reality, it only disperses heavy metals into the atmosphere and soil. This finding highlights that the problem is not just apathy, but a critical absence of information access in the Pantai Walikota area.

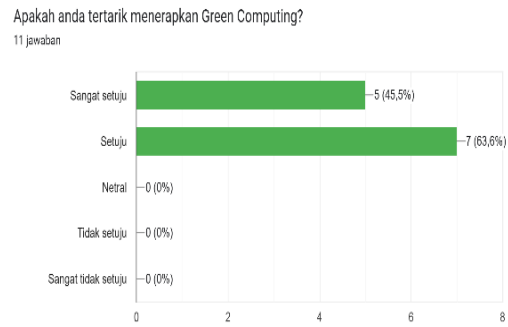
However, a significant shift occurred after the socialization. The post-activity evaluation data, as illustrated in Figure 3, indicates a drastic improvement in awareness. When asked if they understood the dangers of e-waste after the session, 36.4% of participants responded "Strongly Agree" and 63.6% responded "Agree." None of the participants disagreed. This 100% positive response rate confirms that the educational material was effectively delivered and understood.



**Figure 3.** Participant understanding of e-waste hazards post-socialization

### C. Commitment to Green Behavior

Beyond cognitive understanding, this study also measured the participants' affective willingness to adopt Green Computing practices (e.g., separating e-waste, extending device life). The results were highly encouraging. As shown in the data, 45.5% of participants "Strongly Agreed" and the remaining participants "Agreed" to implement Green Computing in their daily lives. This high level of enthusiasm suggests that the community is not resistant to change, provided they are given adequate knowledge.



**Figure 4.** Participant interest in applying Green Computing practices

**Detailed Analysis of Post-Activity Response**  
 The positive shift illustrated in Figure 3 and Figure 4 is not coincidental. The significant jump in understanding (reaching 100% agreement on e-waste hazards) can be attributed to the visual demonstration method used during the socialization. When the team showed images of river water contaminated by battery leakage and its effect on fish, the participants showed a strong emotional response. This proves that environmental education is most effective when it visualizes the "invisible" dangers. Furthermore, the willingness of 45.5% of participants to "Strongly Agree" to adopt Green Computing indicates a potential for sustainable behavioral change, provided that the supporting infrastructure (such as e-waste drop boxes) is made available by the government in the near future.

### D. Discussion

The findings of this study demonstrate that direct, community-based socialization is a highly effective strategy for environmental education. The increase in understanding from 25% to 100% (cumulative agreement) aligns with the theory proposed by Sari et al. (2020), which states that intense public campaigns can significantly alter environmental perception. Unlike mass media campaigns which may be ignored, the face-to-face approach used in this study—specifically targeting riverside communities created a sense of personal relevance and urgency.

While the enthusiasm for Green Computing is high, this study also identified socio-economic factors that might hinder long-term implementation. During the discussion, it was revealed that for lower-income families in the riverside area, electronic waste

often holds economic value. Many residents prefer selling broken appliances to informal scrap collectors (*pemulung*) rather than disposing of them in a "green" manner which offers no financial return. However, these scrap collectors often process the waste using unsafe methods (e.g., acid baths or open burning) to extract valuable metals, which ultimately pollutes the river. Therefore, promoting Green Computing in this demographic cannot rely solely on environmental ethics; it must also offer economic incentives or, at the very least, convenient collection systems that compete with informal scrap collectors.

The urgency of this socialization is underscored by the health implications of inaction. As highlighted the accumulation of heavy metals like mercury and lead in the river does not only affect marine life but eventually enters the human food chain. Residents of Pantai Walikota who rely on the river for fishing or daily washing are at the highest risk of bioaccumulation. By implementing Green Computing—specifically the proper segregation of hazardous components—the community acts as the first line of defense against this toxicity. If 10 households consistently stop throwing batteries into the river, it can significantly reduce the leaching of heavy metals over one year. Thus, this community service activity acts as a crucial preventive health measure for the entire district.

#### E. Challenges and Barriers in Implementation

During the Focus Group Discussion (FGD), the team identified several barriers that have prevented residents from applying Green Computing in the past.

1. **Lack of Infrastructure:** Residents complained that even if they separated e-waste, there were no specific government drop-off points (TPS) nearby. They were forced to mix it with general waste.
2. **Economic Factors:** Some residents mentioned they prefer selling broken electronics to informal scavengers (*pemulung*) for quick cash, rather than recycling them properly, even if the scavengers process them unsafely.
3. **Information Gap:** The absence of warning labels on some electronic products in local languages makes it difficult for the elderly demographic to understand the disposal instructions. This finding suggests that while socialization is crucial, it must be supported by infrastructure

improvements from the local government to be fully effective.

#### IV. CONCLUSION

This community service research has provided comprehensive insights into the level of public awareness regarding electronic waste in the Pantai Walikota area and the effectiveness of Green Computing socialization as an intervention strategy. Based on the data analysis and discussion presented in the previous sections, several profound conclusions can be drawn: Transformation of Environmental Awareness: The study successfully identified a critical knowledge gap among riverside residents. Initially, 75% of participants were completely unfamiliar with the concept of Green Computing and the hazardous nature of e-waste, viewing it merely as general domestic trash. Post-intervention, the data showed a 100% increase in cognitive understanding regarding the toxicity of heavy metals (mercury, lead) contained in electronic devices. This proves that the lack of pro-environmental behavior in the area was not due to apathy, but rather a fundamental lack of access to information. Effectiveness of Participatory & Contextual Method: The "Participatory Education" method utilized in this activity proved to be significantly more effective than passive information dissemination. By conducting the socialization directly at the riverbank—the very ecosystem threatened by the waste—participants could immediately visualize the correlation between their disposal habits and water quality. This contextual approach successfully triggered an emotional and logical response, leading to a reported willingness by the majority of participants to adopt wiser waste management practices. Grassroots Commitment vs. Infrastructure Reality: While the community showed high enthusiasm and commitment to implementing Green Computing (such as separating batteries from organic waste), the study concludes that this behavioral change is fragile without systemic support. The residents' willingness to change is currently hindered by the absence of specific e-waste collection points (TPS) in the Medan Tuntungan district. Therefore, while education is the first step, it is not a standalone solution.

#### V. RECOMMENDATIONS

To ensure the sustainability of the results achieved in this study and to foster a holistic e-waste management system, the authors propose the

following comprehensive recommendations targeting three key stakeholders:

A. For Local Government and Policymakers

- Infrastructure Development: The local government of Medan City, specifically the Environmental Agency (Dinas Lingkungan Hidup), is strongly urged to establish specialized "E-Waste Drop Boxes" in strategic riverside locations like Pantai Walikota. Without this infrastructure, the residents' newfound knowledge cannot be translated into action.
- Regular Collection Schedule: Implement a monthly scheduled pickup for hazardous domestic waste to prevent residents from reverting to the habit of burning cables or throwing batteries into the river.

B. For Future Researchers

- Longitudinal Impact Study: Future research should move beyond immediate post-test evaluation. It is recommended to conduct a follow-up study 6 months after the socialization to measure whether the "Green Behavior" is sustained or if participants have relapsed into old habits.
- Water Quality Testing: To add scientific rigor, future studies should integrate quantitative data by testing the river water samples for heavy metal content (Lead/Pb and Mercury/Hg) before and after the implementation of community waste management programs. This would provide empirical evidence of the environmental impact.

C. For Community Leaders

- Formation of "Green Watch" Groups: The community head (Kepling) should appoint local "Green Ambassadors" from the youth demographic to monitor river cleanliness and remind residents about responsible disposal. Peer-to-peer monitoring is often more effective than external supervision.

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