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Underlying factors behind the low participation rate in electronic waste recycling

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ABSTRACT

This study aims to understand influential factors for Jakarta's residents to participate in a formal electronic waste recycling programme. It questions the efficacy of providing facilities to collect electronic waste despite the lack of legislated regulations or policies. Using the goal-framing theory as a foundation, a survey conducted on 208 respondents in 2018 revealed that selling obsolete electronic devices to peddlers or retaining them at home were standard practices in society, and only 2% of respondents recycled their electronic waste at formal facilities. The results show that electronic waste recycling intention correlates highest with information and convenience, 0.521 and 0.411, respectively. While knowledge has the least correlative value with attitude and intention, that is 0.204 and 0.240. It clarifies that the normative goal is weaker than hedonic and gain goals. Respondents had enough awareness about the hazards of electronic waste. However, their behaviour did not exhibit it. It is imperative to lessen the gap between normative and hedonic goals by campaigning continuously and place the facilities at easily accessible locations to increase recycling participation. Furthermore, collecting electronic waste requires a collaboration between the government and electronics businesses, and must be supported by a legal framework.

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INTRODUCTION

This study aims to understand how consumer behaviour of discarding end-of-life (EOL) electronic appliances influences the success of electronic waste (e-waste) management in developing countries. Drawing inspiration from Nduneseokwu *et al.,* 2017 in Onitsha, Nigeria, the present study highlights the case of Indonesia by questioning the validity of the provision of such facilities without any supporting regulation. As of 2016, e-waste management policies were absent in 113 countries (Baldé *et al.,* 2017). While drafting and ratifying legislative measures are a time-consuming process, the absence of laws and regulations should not hinder sustainable treatment of e-waste. E-waste is a negative result of rapid technological advancement in modern times that demands global attention (Garlapati, 2016). As EOL electronics contain not only valuable materials but also hazardous substances, sustainable treatment is necessary to recover their precious components while mitigating their negative impact on the environment and human health (Julander *et al*., 2014; Pascale *et al., 2016;* Dai *et al.*, 2017; Du *et al*., 2018; Jensen *et al., 2018;* Zeng *et al., 2018*). Sustainable e-waste management includes public policies, reliable collection systems, safe transportation, and trustworthy processing facilities (UNEP, 2007). This system has been widely adopted in European Union (EU) and developed nations like Japan, South Korea, and the United States (US) (Kiddee *et al.*,2013; Sthiannopkao and Wong, 2013; Borthakur and Govind, 2016). In contrast, Indonesia, and many developing countries, face challenges in managing domestic e-waste while also forbid the illegal import of obsolete electronic devices and scrap (Manomaivibool, 2009; Olowu, 2012; Tansel, 2017). Several factors, such as lack of policies, infrastructure, collection systems, and poor enforcement of extended producer responsibility (EPR), present challenges in addressing e-waste (Osibanjo and Nnorom, 2007). This condition allows informal sectors to find economic opportunities in collecting and processing e-waste. Indonesia's 265 million residents (BPS, 2018a) generated 1.27 million tons of e-waste in 2016, making it the highest e-waste producer in Southeast Asia and ninth in the world (Baldé *et al.,* 2017). This number will grow steadily as Indonesia's high population makes it a prospective market for the electronics industry. Hence, the time is right to adopt a robust and integrated e-waste treatment system despite the legal framework for e-waste management. After ratifying the Basel Convention, the Indonesian government regulated the management of hazardous and toxic waste in 1999 (GoI, 1999), and again in 2014 (GoI, 2014). Following this policy, the government enacted Law No. 18 on waste management in 2008 (GoI, 2008). None of the policies specifically regulate e-waste, but they endorse the EPR practice; an environmental approach by which companies must extend their responsibility until products reach their EOL cycle (OECD, 2001). However, despite these policies, the programme's implementation faces obstacles as clear guidelines and systems remain unavailable (Sulami *et al*., 2018). Aware of the situation, the government and municipalites have initiated a formal e-waste collection service in Jakarta. Since 2017, the Ministry of Environment and Forestry and the local government provide e-waste drop boxes in their offices and several public places. The latter also provides a hotline service where citizens can request official collectors to pick up large e-waste, such as refrigerators and washing machines from their homes. These endeavours aim to encourage Jakarta's residents to recycle their EOL electronic appliances. However, residents' behaviour and attitudes towards e-waste recycling play a significant role in the e-waste collection programme. Without compelling regulations, the programme will compete with gatherers who collect e-waste as a livelihood (Herat and Agamuthu, 2012). When scavengers dismantle e-waste, their main aim is to extract precious materials, largely unaware of the harmful effects this can have on the environment and human health (Chen *et al*., 2018). Previous studies have investigated what impacting citizens' behaviour on e-waste collection in developing countries (Li *et al.*, 2012; Roy, 2016; Borthakur and Govind, 2017; Echegaray and Hansstein, 2017; Nduneseokwu *et al.,* 2017; Awasthi and Li, 2018; Tan, *et al*., 2018). Those studies focused on influencing factors of recycling behaviour. This study discusses the recycling behaviour of Indonesians from the perspective of goal-framing theory. In this theory, there is a conflict between normative, hedonic, and gain goals in pro-environmental behaviour (Lindenberg and Steg, 2007). The normative goal activates a proper and appropriate action to contribute to the clean environment, and behavioural studies focusing on this

goal had positive findings. Several factors like attitude towards behaviour, subjective norms, and perceived behaviour control drive the normative goal related to e-waste recycling (Li *et al.*, 2012; Nduneseokwu *et al.,* 2017), as well as knowledge of e-waste toxicity (Akhtar *et al.*, 2014). Knowledge is a situational factor that controls environmental attitudes and behaviour (Otto *et al*., 2018). People with a hedonic goal in mind will take action that makes them feel better in a certain situation. Previous studies found that convenient access to recycling facilities was a determining factor for hedonic goal in recycling (Wang *et al.,* 2011). The gain goal will make people strongly guard their financial resources. There are contrasting opinions on how the gain goal affected recycling habits. Jafari *et al.* (2015) stated that offering incentives increased resident participation in the programme, while Nduneseokwu *et al.* (2017) argued that recycling behaviour was independent of incentives. In summary, this goal had driven people to consider the cost of recycling before participating (Otto *et al*., 2018). If the practice has significant monetary cost, curbside recycling is often preferred due to its affordability. This article extends the debate on how incentive correlates to residents' willingness to recycle their e-waste. Existing literature has never employed the goal-framing theory to assess recycling intention and engagement in Indonesia. This study aims to fill this gap by probing willingness and response towards formal e-waste collection in the country. Both new and experienced facilities face the challenge of increasing participation rate in e-waste recycling. Previous studies showed that formal facilities for e-waste collection were not always well received and had positive responses for various reasons. Wang *et al.* (2011) investigated that the habit of recycling mainly influenced the willingness of Beijing residents to recycle e-waste. Moreover, the study also revealed that the desire to recycle e-waste was higher in areas with many electronic industries. Another study showed that knowledge of the hazardous nature of e-waste was not enough to motivate people to recycle (Saphores *et al.*, 2012). Instead, it was determined by previous recycling experience and the distance to the drop-off facility. In the case of information and communication devices, Deng *et al.* (2017) stated that residents did not want to recycle their obsolete cellphones through the official government schemes, because they were worried about leakage of personal data. The purpose of this study is to understand three inter-related issues: 1) Residents' disposal methods of EOL electronic products; 2) Factors influencing public responses to formal e-waste collection, and 3) Residents' support of the formal e-waste recycling programme. This study was cunducted in the Tanah Abang district of central Jakarta, Indonesia in 2018.

MATERIALS AND METHODS

Study area

The study site was Jakarta, Indonesia's capital. The city's population was around 10.1 million or 2.6 million households with diverse cultural backgrounds and social strata. Because of its dense population combined with various large-scale economic activities, the city has the potential to become the largest generator of e-waste in the country. The informal sector has dominated the e-waste collection in the city for decades. However, a breakthrough occurred when the municipality set up a formal e-waste collection system. By exploring the underlying factors of e-waste recycling behaviour, this study offers improvements to the current programme and suggestions for other municipalities facing similar problems. The study took place in the Tanah Abang district, in the sub-district of Benhil, an area about 1.58 square kilometres. According to Statistic Indonesia, in 2018 this area's population was 25,619 (BPS, 2018b). Families living in this area are from lower, middle, and upper-class backgrounds. Many informal sectors collect and process e-waste in this area. They pick up e-waste from households in exchange for money. They then dismantle the e-waste manually using a traditional tool kit. The dismantling process often occurs on the curbside, unaware of the danger this poses to passers by.

Conducted survey

This study used both primary and secondary data. Primary data was collected through a survey conducted from October to November 2018 using a self-administered questionnaire. Enumerators distributed the questionnairs to 225 randomly selected households in the area, with only 208 responses considered valid for further analysis. Secondary data, was obtained through official demographic data published on the internet, while data on e-waste collection through official facilities came from the

local government of Jakarta. To understand the pro-environmental behaviour related to e-waste recycling, this study uses five research variables; knowledge, information, convenient access to facilities, attitude toward recycling and recycling intention. Two steps analysing method were employed. First, responses for every statement were calculated to find the mean score and standard deviation. Their mean scores were classified into three categories: 1-2 as low, 2-3 as moderate, and 3-4 as high. Then, data from the survey was analysed using IBM SPSS statistics to determine the correlation between research variables. The correlation coefficient value shows the direction and strength of the relationship between a pair of variables. Fig. 1 presents the conceptual framework to model the hypotheses of the relationships between all mentioned variables.

RESULTS AND DISCUSSION

Ownership of electronic appliances

Ten electronic appliances were selected commonly owned by Indonesian households, namely, TVs, refrigerators, washing machines, air conditioning units (ACs), DVD players, rice cookers, irons, desktop personal computers (PCs), laptops, and mobile phones. The results showed a high penetration rate of electronic household appliances (Fig. 2). Amongst products evaluated, TVs and mobile phones followed by irons and refrigerators had the highest penetration rate, while PCs were the least commonly-owned devices. Televisions and mobile phones were found in every home, while only 42 participants owned PCs.

The survey revealed that the usage period, even for similar devices, varied among participants. Inferior quality household appliances with affordable prices have widely penetrated the Indonesian market. However, this study did not analyse how brand and quality correspond to product lifespan. As presented in Table 1, compared to other appliances, TVs have the most extended lifespan (average 6.84 years), followed by refrigerators and washing machines (6.08 and 5.39 years respectively), while mobile phones have the shortest, averaging only at 3.58 years.

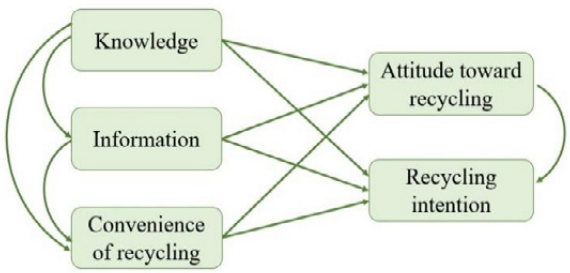

Fig. 1: The study framework

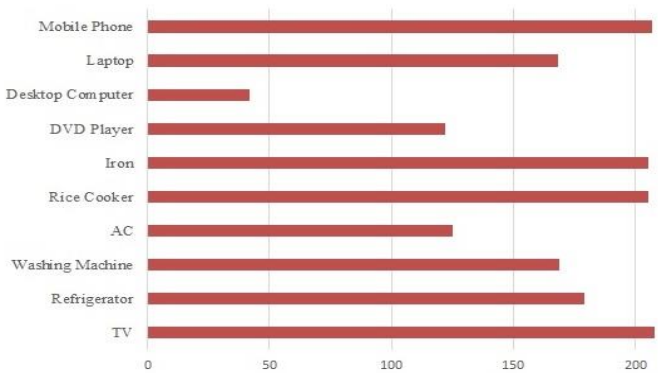

Fig. 2: Penetration of electronic products

Table 1: Products lifespan (year)

Electronic products	Mean	S.D.
TV	6.84	3.52
Refrigerator	6.08	2.96
Washing machine	5.39	2.57
AC	4.14	2.40
Rice cooker	5.81	3.27
Iron	5.47	2.99
DVD Player	5.28	2.85
Desktop PC	5.27	2.39
Laptop	4.60	1.88
Mobile phone	3.58	1.85

S.D.: Standard deviation

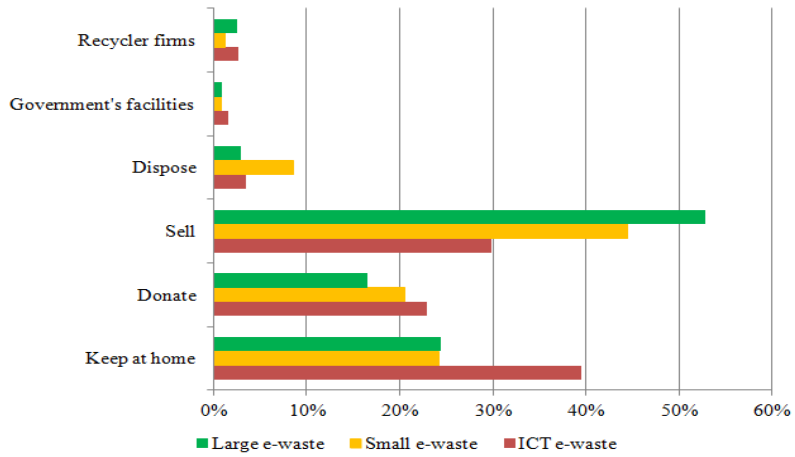

Fig. 3: Methods to discharge e-waste

E-waste disposal

This study identifies different levels of information and techniques used by people disposing of ICT waste and other EOL electronics. Results presented in Fig. 3 indicate that of the six available methods, selling is the most popular, with 53% for large e-waste and 44% for small one. This practice is enabled by scavengers who regularly visit neighbourhoods to collect recyclable materials. The second most common method was the traditional practice of keeping obsolete devices at home with 24%. In contrast to large and small e-waste, ICT waste like PCs, laptops, and mobile phones were commonly retained by their owners, with nearly 39%, while 30% preferred to sell malfunctioned ICT. A disappointing finding was that only 2% of respondents voluntarily participated in formal e-waste recycling, either through government facilities or private companies.

E-waste recycling behaviour

Table 2 presents a summary of the study's variable components. Of 17 statements, 12 had $\mu \geq 3$ and were categorised as high, while five had $2<\mu<3$, classified as moderate. Each account in the knowledge factor had $\mu \geq 3$ and $\sigma \leq 0.05$. In conclusion, respondents understood the need for e-waste recycling as it contained hazardous substances and precious materials. While responses for components of the information variable had $2<\mu<3$, reflecting that some participants were poorly informed about the formal recycling programme or the nearest drop-off location. On the other hand, responses to the convenience of recycling were unique; in terms of cost, participants showed moderate responses ($2<\mu<3$), but they had a higher answer for the financial benefit ($\mu \geq 3$). To sum up, participants regarded e-waste recycling as unattractive if it cost money, time, and energy,

Table 2: Responses summary of the survey

Variables	Statements	Mean	S.D.
Knowledge	I know that e-waste contains hazardous substances.	3.25	0.050
	I know that e-waste contains valuable components.	3.00	0.044
	I know that e-waste should be recycled.	3.20	0.048
Information	I know that the local government has a collection programme for e-waste.	2.64	0.057
	I know the nearest e-waste drop box from my house.	2.83	0.059
Convenience of recycling	I don't mind paying to dispose of my e-waste.	2.49	0.057
	I don't mind travelling long distances to dispose of my e-waste in a safe place.	2.87	0.052
	I don't mind to spare time to dispose of my e-waste in a safe place.	2.91	0.046
	I like to accept money in exchange for my e-waste	3.23	0.046
Attitude toward recycling	E-waste disposing and processing should be regulated	3.27	0.045
	The government should collect e-waste from households	3.03	0.051
	Electronic companies should have take-back system for obsolete products	3.18	0.051
	Electronic resellers should have take back system for obsolete products	3.02	0.057
	Electronic stores should have take-back system for obsolete products	3.13	0.058
Recycling intention	I intend to participate in formal e-waste collection	3.27	0.049
	I am willing to influence people around me to dispose of their e-waste at formal facilities	3.00	0.055
	I intend to recycle e-waste at drop-off points.	2.86	0.055

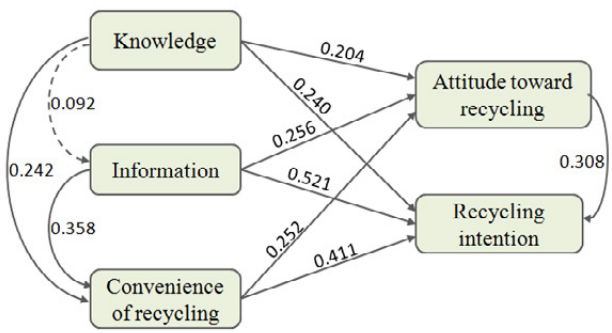

Fig. 4: Relationship among research variables

but attractive if it resulted in economic benefits. Attitude toward recycling, measured using five attributes, each showed a positive response (μ≥3). Participants strongly supported government regulation for e-waste and collaboration between the government and electronic businesses to collect obsolete electronic appliances from society. The recycling intention had varied responses for its three statements. Respondents showed positive reactions on willingness to participate in the formal e-waste collection programme and influence on others to perform similar actions (μ≥3). In contrast, they showed a moderate response (2<μ<3) to carrying e-waste to formal facilities. In short, they would participate in e-waste recycling if they did not have to bring it themselves to the collection sites.

Fig. 4 shows the Spearman correlation identified the direction and the degree of relationship between research variables. A significant correlation at α 0.01 exists between all variables, except between information with knowledge. All coefficients indicate positive correlations; however, their strength categorises as weak (0.200-0.399) and moderate (0.400-0.599). The most substantial relationship is between recycling intention and information (0.521), followed by the convenience of recycling (0.411). Residents can gather information on e-waste characteristics from many sources, but that information does not mention the formal collection programme. Hence, the government must actively

Fig. 5: E-waste drop boxes in Jakarta

inform the public about the e-waste recycling programme and its facilities.

This study indicates that e-waste recycling habits in Jakarta are still minimal. Only 2% of e-waste ended up in the formal recycling programme provided by the local government, while a large portion went to informal sectors. This number is significantly lower than developed countries like the US and Poland, which have about 30% collection rates (Saphores *et al.,* 2012; Nowakowski, 2016). The e-waste processing by informal sectors is less efficient compared to formal processing. Traditional processing by the informal sector is often performed without safety equipment, and poses dangers for workers and those around them. Besides, processing e-waste in open space can pollute the environment. Although the obtained components can be used in a circular economy, this process, however, is not optimal because some parts are still wasted. For example, many informal workers do not have the skill to process printed circuit boards (PCBs) and consequently, many discarded PCBs still contain lots of metal and have flame retardants; further polluting the environment. In contrast, formal e-waste processing has rigorous safety standard. Optimal extraction of materials embedded in e-waste can help mitigate the negative impact of e-waste. However, without stringent regulation, collecting e-waste formally across the country poses a significant challenge as it competes with informal sectors that actively collect e-waste on a door-to-door basis and offer monetary enticement for broken electronic devices. Various factors were responsible for the low participation rate in formal recycling programme of e-waste. First, the results indicated that lack of information was a significant driving factor of low recycling intention. The information had a weak relationship with the convenience of recycling and attitude toward recycling, with a coefficient of 0.358 and 0.256, respectively. However, this variable is moderately related to recycling intention and possessed the highest coefficient amongst others, 0.521. Among the participants, only 60% were aware of the government programme to collect e-waste officially, and 67% of them knew the location of the nearest drop box. Some respondents saw the e-waste drop boxes in public places but did not realise that the government provided them.

Drop boxes stationed at public places were used only by people who accidentally passed through them. Mostly they threw small-sized e-waste such as torn cables, broken headsets, fractured disks, and split chargers. Besides, the drop box hole size does not allow users to put in more substantial sized e-waste (Fig. 5). It implied that putting an e-waste drop box in a public place was not effective enough to encourage people to recycle. If residents did not have enough information about the programme, or how they could participate, then they could not be

involved in this respected activity. It supports previous findings which stated that a formal collection programme requires continuous publicity to be well known by citizens, and so, influence their willingness to recycle e-waste (Wang *et al.,* 2016; Wang *et al.,* 2018). The Jakarta municipality initiated the formal programme in 2017. It was still in nascent stages and not widely recognised. Therefore, the government must publicise the programme through various channels to improve recycling participation. Even in developed countries where the programme has long been operational, informing residents is considered essential (Nowakowski, 2016). Another significant factor affecting the willingness to engage in recycling is convenient access to the facility. This variable is related to cost-benefit consideration. A study in China revealed that the cost of recycling did not correspond to recycling intention (Wang *et al.,* 2016). In this study, the correlation coefficients of 0.252 and 0.411 explained the presence of weak correlations between this variable and attitude toward recycling and recycling intention. The citizens will not burden themselves with high costs of e-waste disposal. Respondents' answers varied with regards to willingness to bear the cost of recycling. If the cost was monetary, only 50% of them did not object. However, if it cost only their energy and time, more participants were willing to participate, with 70% and 85% respectively. One interesting finding is that as many as 90% of them were happy to receive incentives in exchange for their discarded e-waste. It explains why more respondents sold their e-waste to peddlers, rather than voluntarily gave it over to official facilities. To sum up, when many still consider e-waste recycling an expensive endeavour, it discourages them from participating in the programme (Otto *et al.,* 2018). Therefore, it is necessary to design a strategic plan to enhance the collection rate. In Jakarta, e-waste drop boxes are mostly in public places like bus stops, train stations, and a few selected buildings of local government offices; places people often find too hard and costly to reach. Therefore, the government should reassess whether to continue using these locations since they attract so few citizens. Studies suggest that drop-off facilities placed in the community are more favourable. A study in Nigeria suggested that properly managed facilities and adequate infrastructure located close to the community significantly influence recycling intention (Nduneseokwo *et al.,* 2017). While in the US, the number of recyclers declined along with the increased distance to drop-off centres (Saphores *et al.,* 2012). Results also indicated that economic incentives offered by peddlers could be triggering factors for preference in selling EOL electronics. This similar habit was also seen in countries like Iran and China (Wang *et al.,* 2011; Jafari *et al*., 2015). Furthermore, residents' knowledge of e-waste characteristics is also relevant. In this study, the knowledge variable reflects the proper understanding of hazardous and valuable substances embedded in e-waste and the importance of e-waste recycling. Respondents' answers in the knowledge section of the questionnaire showed that they had sufficient understanding of e-waste, and were aware of the minerals and toxicant present. However, storing EOL equipment at home was still preferred as they saw this type of waste as valuable goods and were consequently reluctant to release their devices. It explained why the correlation between knowledge and other variables fell in the very weak and weak category. It reflected on the small coefficient values of 0.242, 0.204 and 0.240; each for convenience of recycling, attitude toward recycling and recycling intention variables. Besides, with a coefficient of 0.092, this variable did not correlate to the information variable. To conclude, knowledge of e-waste characteristics is inadequate in stimulating residents to actively engage in recycling programme. Although, knowledge about the hazardous effects of e-waste exists, it did not manifest in their daily behaviour. Saphores *et al.,* (2012) raised a similar argument in the case of e-waste recycling by Americans. In their study, other internal variables that were strongly affecting willingness to recycle were moral norms, environmental beliefs, and social pressure. Other studies have contrasting findings. When investigating community participation in waste separation in the country, Ruliana *et al*. (2019) found a relation to the level of environmental knowledge, while Otto *et al.* (2018) stated that knowledge is an important driving factor behind ecological behaviour. Hence, before asking people to recycle their e-waste, it would be prudent to internalise them with the dangers of home e-waste storage. About 24% of respondents who retained EOL electronic devices at home exhibited their unawareness of the issue and even though they knew the dangers of e-waste, they underestimated it. Agreeing with Steg *et al.,* (2014),

this study reveals that in terms of pro-environmental behaviour, the normative goal is weaker than hedonic and gain goals. Another significant finding is the respondents' positive attitude toward formal e-waste recycling. This variable reflects how participants' responses to the idea of regulating e-waste and giving responsibility for government and electronic business to collect e-waste. This variable has a correlation value of 0.308 to the intention of e-waste recycling. As many as 92% of participants consented e-waste should be regulated. They realised that the country must adopt policies to address the e-waste problem. With a legal framework, the government will have guidance to overcome obstacles related to current practices. Furthermore, participants supported the government's shared responsibility with electronics companies, resellers, and shops to collect e-waste. Among the respondents, 81% of them approved the e-waste collection by the government, and 84% agreed the electronic companies should conduct a similar programme. However, fewer respondents support e-waste collection by resellers and electronic stores, with only 70% and 61% respectively, displaying their serious concern. Respondents understood that many parties should support the government approach to e-waste management. As implementation of EPR is not effective (Sulami *et al*., 2018), an obligation to engage in the programme will automatically impose this system. Successful implementation of the programme requires a well-organized system. The current state of e-waste management, performed only by the municipality, is insufficient in reaching all of Jakarta's residents. By involving additional parties with an increased number of facilities, the programme may serve a bigger community and ultimately increase the quantity of e-waste formally collected. Finally, the results showed that as many as 88% of respondents gave positive responses for participation in formal e-waste collection. Besides, 72% of them intend to recycle their e-waste at the drop-off point. This implies that many residents are in favour of this scheme. However, the lack of information and convenient access to facilities caused reluctance. It answers why only 2% of participants discarded their e-waste through formal facilities. As stated by Steg *et al*., (2014), that providing additional facilities will increase the potential to reduce conflicts between normative goals and hedonic goals so that people will more easily decide to engage in pro-environmental behaviour. This study took placed in locations where there were many informal sectors found collecting e-waste from households and that many respondents sold their e-waste to them, indicating residents had a keen perception of the informal sector. However, this variable was not embraced in this study. Besides, the habit of storing e-waste at home was also widespread. However, this study did not investigate whether the house size or the number of family member could relate to this habit. It is because saving e-waste at home, especially large appliances, requires ample space. Future studies need to look at how these variables will relate to e-waste recycling intention.

CONCLUSION

About 81% of the participants favoured the e-waste recycling programme by the government. However, most of them preferred selling their e-waste or storing it at home, while only 2% were engaged in formal e-waste collection. Many factors influenced this habit. The information about the programme and the convenience of access to facilities had the highest correlation coefficient value with the dependent variables, each with 0.521 and 0.411 respectively. Meanwhile, respondents' knowledge about the characteristics of e-waste had a correlation value of 0.204 and 0.240. Although many understand that e-waste may pose dangers to the environment and human health, participation in the recycling programme is low because they did not have enough information about the existing programme and facilities. Additionally, even though they strongly support the programme, respondents felt burdened to participate in e-waste recycling due to its perceived high cost. As a result, it hindered their willingness to participate in the programme, resulting in a low collection rates. Numerous methods can be implemented to improve e-waste collection rates, for example, through an intensive campaign to disseminate information about the programme in the community. Adequate facilities spread evenly near residences would also support the programme. In addition, drop-off locations should be easily accessible as participants were reluctant to commute to long distances or sacrifice time and money to dispose of obsolete products. To achieve this goal, the government should consider collaborating with companies, resellers, and stores of electronic goods

to collect e-waste. Moreover, the government can begin to formulate policies and implement EPR to facilitate sustainable e-waste management in the country.

AUTHOR CONTRIBUTIONS

Throughout the current study performance; R. Siringo performed design of the study, coordinating the field survey, analyzing the data and wrote the manuscript draft. H. Herdiansyah coordinated the field survey, reviewed the manuscript draft and contacted all relevant third parties. R.D. Kusumastuti reviewed and edited the manuscript draft.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

ABBREVIATIONS

%	Percentage
AC	Air conditioner
BPS	Badan Pusat Statistik (Statistics Indonesia)
DVD	Digital video disc
EOL	End-of-life
EPR	Extended producer responsibility
EU	European Union
Fig.	Figure
GoI	Government of Indonesia
ICT	Information and communication technology
IDR	Indonesian Rupiah (currency in Indonesia)
OECD	Organization for Economic Co-operation and Development
PC	Personal computer
PCB	Printed Circuit Board
S.D.	Standard deviation
SPSS	Statistical package for social sciences
TV	Television
UNEP	United Nations Environment Programme
US	The United States

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